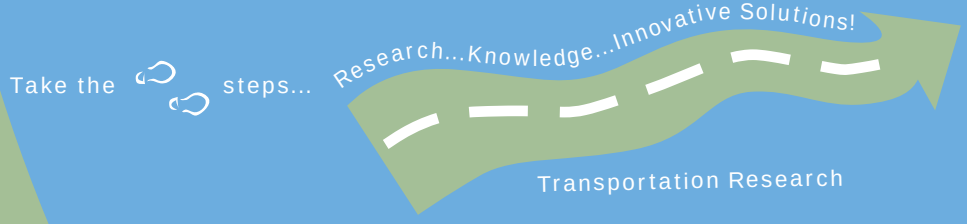
RESEARCH

2007-04

The Safety of Pedestrian and Bicycle Travel in Minnesota: Inventory, Analysis and Prospectus



Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.
MN/RC-2007-04		

4. Title and Subtitle	5. Report Date
The Safety of Pedestrian and Bicycle Travel in Minnesota: Inventory, Analysis, and Prospectus	January 2007
	6.

7. Author(s)	8. Performing Organization Report No.
Kevin Krizek, Gavin Poindexter, Ahmed El-Geneidy, and Edward Sanderson	

9. Performing Organization Name and Address	10. Project/Task/Work Unit No.
Active Communities/Transportation (ACT) Research Group Humphrey Institute of Public Affairs 301 19th Ave. S. Minneapolis, MN 55455	11. Contract (C) or Grant (G) No. (c) 81655 (wo) 134

12. Sponsoring Organization Name and Address	13. Type of Report and Period Covered
Minnesota Department of Transportation Research Services Section 395 John Ireland Boulevard Mail Stop 330 St. Paul, Minnesota 55155	Final report, 2004-2006 14. Sponsoring Agency Code

15. Supplementary Notes
http://www.lrrb.org/PDF/200704.pdf

16. Abstract (Limit: 200 words)

As attention in transportation circles, increasingly focuses on encouraging pedestrian and bicycle travel, it is important that planning initiatives be informed about the safety aspects of these modes. However, recent research suggests a limited understanding of the features that affect the pedestrian and bicycle travel, particularly when it comes to safety. The report examines the information that is collected regarding pedestrian and bicycle crashes in Minnesota in comparison to other states and looks a new ways in which this data can be used increase knowledge of pedestrian and bicycle crashes. To do this exercise exploits a database of crash report information for all pedestrian and bicycle crashes in the State of Minnesota from 1998-2002. Our analysis examines general trends of pedestrian and bicycle crashes. In addition, we demonstrate that pedestrian crashes tend to occur in different locations than bicycle crashes. The final part of the paper focuses on developing a method to identify where pedestrian and bicycle crashes are more likely to occur, Poisson regression to identify the relationships between crashes and neighborhood attributes.

17. Document Analysis/Descriptors	18. Availability Statement
Pedestrian, Bicycle, Crashes, Neighborhood Attributes	No restrictions. Document available from: National Technical Information Services, Springfield, Virginia 22161

19. Security Class (this report)	20. Security Class (this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	114	

The Safety of Pedestrian and Bicycle Travel in Minnesota: Inventory, Analysis, and Prospectus

Prepared by:
Kevin Krizek, Associate Professor
Gavin Poindexter, Research Fellow
Ahmed El- Geneidy, Post-doctoral Research Fellow
Edward Sanderson, Research Assistant

Active Communities/Transportation (ACT) Research Group
at the Humphrey Institute of Public Affairs

January 2007

Published by:

The Minnesota Department of Transportation
Research Services Section
395 John Ireland Blvd, MS 330
St. Paul, Minnesota 55155-1899

Acknowledgements

The research team would like the members of the Technical Advisory Panel for feedback, guidance and expertise at multiple stages of the research process. Special thank the members of the Technical Advisory Panel: Darryl Anderson, Loren Hill, Don Pflaum, Jim Rosenow, Kristie Billiar, Mary Nelsesteun, Barbara Loida, Lisa Austin, Jeff Peltola, and Shirlee Sherkow.

Table of Contents

INTRODUCTION 1
PERTINENT LITERATURE ON PEDESTRIAN AND BICYCLE CRASHES 2
CURRENT SOURCES AND USES OF PEDESTRIAN AND BICYCLE CRASH DATA 5
Data sources 5
How the data is used 8
State level 8
Local level 9
Data collection in other states 13
Changes in crash data collection and storage 16
Shortcomings of currently collected data 16
ROLE OF EXPOSURE 18
Direct measures of exposure 18
Indirect measures of exposure 19
ANALYSIS OF CRASHES 21
General characteristics of pedestrian and bicycle crashes 22
Intersections where the most crashes occur 26
Locations of pedestrian versus bicycle crashes 27
Grid cell analysis results 28
Neighborhood attribute regression analysis 32
Discussion and conclusion 37
IMPROVING CRASH DATA COLLECTION PRACTICES 38
Increase reporting of pedestrian and bicycle crashes 38
Use all available information 39
Improve crash report form 40
Modify the definition of a crash 41
SUMMARY 42
REFERENCES 43
APPENDIX A. STATE OF MINNESOTA ACCIDENT REPORT FORM (LAW ENFORCEMENT FORM)
APPENDIX B. MINNESOTA MOTOR VEHICLE ACCIDENT REPORT FORM (CITIZEN REPORT FORM)
APPENDIX C. EXPLANATORY FACTORS USED IN THE REGRESSION ANALYSIS
APPENDIX D. TRANSCRIPT FROM SYMPOSIUM *NEW DIMENSIONS IN PEDESTRIAN AND BICYCLE CRASHES IN MINNESOTA*

List of Figures

Figure 1 Number of Pedestrian and Bicycle Crashes Recorded by DPS and DOH 21
Figure 2 Locations of Pedestrian and Bicycle Crashes in Hennepin County, MN from 1998-2002 22
Figure 3 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998-2002, by time of day 24
Figure 4 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998-2002, by month 24
Figure 5 Intersections with the Most Pedestrian or Bicycle Crashes in Hennepin and Ramsey Counties from 1998-2002 26
Figure 6 Geographic Areas in Hennepin County 27
Figure 7 Explanatory Factors Used to Estimate Regression Model at Different Scales (separate models were used for pedestrian and bicycle crashes) 33

List of Tables

Table 1 Crash Data Sources Summary Comparison 7
Table 2 Comparison of Data Collected Regarding Pedestrian and Bicycle Crashes in Selected States 14
Table 3 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 to 2002, by day of the week 22
Table 4 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 – 2002, by speed limit of road 23
Table 5 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 – 2002, by lighting conditions 23
Table 6 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 – 2002, by traffic control device at the scene of the crash 25
Table 7 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 – 2002, by common action leading to crash 26
Table 8 Results of the Paired Sample T-Test Examining the Difference in the Location of Pedestrian and Bicycle Crashes 28
Table 9 Matrix of Grid Cells included in the Microanalysis 29
Table 10 Results of Poisson regressions 35

Executive Summary

The Minnesota Department of Transportation (Mn/DOT) and Minnesota Department of Public Safety's (DPS) initiative "Towards Zero Deaths" aims to reduce the number of traffic fatalities in Minnesota. A key part of this initiative is to improve the understanding of pedestrian and bicycle related crashes for these agencies. Towards this aim, the University of Minnesota pursued three research goals: (1) to learn the types of information and knowledge necessary for a complete understanding of pedestrian and bicycle safety, (2) to inventory existing data regarding pedestrian and bicycle crashes, and (3) to use existing data in Minnesota to explore the relationship between neighborhood attributes and pedestrian and bicycle crashes. This report provides an inventory of current sources of data related to pedestrian and bicycle crashes in Minnesota and how the data is used to increase the safety of pedestrian and bicycle travel. This inventory demonstrates Minnesota is a leading state in collecting detailed information about the actions that lead to pedestrian and bicycle crashes.

This report also summarizes the findings of various studies conducted regarding pedestrian and bicycle crashes in Minnesota from 1998 to 2002. It identifies of the intersections in Hennepin and Ramsey Counties where the most pedestrian and bicycle crashes occur and provides a glimpse into crash trends and the conditions that lead to pedestrian and bicycle crashes. This analysis shows that pedestrian and bicycle crashes occur at different locations. Further analysis of select concentrations of pedestrian and bicycle crashes revealed that similar actions by motor vehicle drivers (e.g. making a left turn) preceded a disproportionate number of pedestrian crashes at selected intersections. In addition, the areas around high schools and colleges are the location of multiple concentrations of bicycle crashes, so more than elementary and middle schools. Highway intersections that have a mix of dense residential and retail in close proximity were the location of pedestrian crash concentrations. Examinations conducted by the research team quantified the relationship between neighborhood attributes and the number of pedestrian and bicycle crashes in Minneapolis and Hennepin County. The analysis revealed that pedestrian crashes are more likely to occur in Hennepin County neighborhoods with more intersections.

The report concludes with recommendations to enhance knowledge of pedestrian and bicycle crashes and their reporting. Recommendations include: 1) increase the rate of pedestrian and bicycle crashes reporting by increasing public awareness of the importance of reporting crashes and making it easier for the public to report crashes, 2) using all available information when analyzing crashes and do not limit analyses to the information collected on the crash report because neighborhood attributes often play an important role in a crash, 3) modify the crash report form to clarify what each question is asking and reduce the overlap between questions and add additional questions to the form that pertain to pedestrian and bicycle crashes, and 4) consider modifying the definition of a crash to be more inclusive of incidents involving pedestrians and bicyclists.

Introduction

The Minnesota Department of Transportation (MN/DOT) and the Minnesota Department of Public Safety (DPS) are currently leading an initiative known as "Towards Zero Deaths." The aim of this initiative is to reduce the number of traffic fatalities in the state. A key part of this effort is to better understand the nature of pedestrian and bicycle related crashes. These efforts build on the national Safe Routes to Schools initiative, which was included in the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU). It aims to spur children to walk and bicycle to school by, in part, making such travel safer through various improvements to the neighborhood. Local programs like Maryland's Pedestrian and Bicycle Safety Program focus efforts on K-5 students *(1)* and Alaska's *Bicycle and Pedestrian Plan* calls for both education programs and engineering solutions to make walking and bicycling travel safer *(2)*.

The overarching aims of the University of Minnesota research project titled "Safety of Pedestrian and Bicycle Travel in Minnesota: Inventory, Analysis, and Prospectus," draw attention to the importance of this topic and suggest alternative methods and approaches to better understand bicycle and pedestrian activity and crashes. Towards these goals, this study has five parts: 1) to describe the growing literature about pedestrian and bicycle activity and safety, 2) to identify and inventory existing crash data within Minnesota, 3) to further knowledge of the types of information necessary for a complete understanding of pedestrian and bicycle safety, 4) to draw correlations with pedestrian and bicycle crashes and neighborhood attributes, and 5) to prescribe alternative data collection methods and how such information can be translated to knowledge necessary for a complete understanding of pedestrian and bicycle crashes and safety.

Pertinent literature on pedestrian and bicycle crashes

When it comes to discussing the safety of walking and bicycling, the literature generally breaks down in two respects: (1) research discussing education and safety programs and (2) research examining safety that can be ascribed to various environments *(3-8)*. Our focus in this application rests in the latter. When it comes to studying different environments (e.g., in a community or even along a facility), the research generally measures safety in one of three ways: (1) number of fatalities, (2) number of crashes, and (3) perceived levels of comfort of the user. Explanatory variables influencing each of these outcomes are myriad and complex to identify. For example, the overwhelming majority of pedestrian and bicycle accidents resulting in fatalities are caused by collisions with motor vehicles *(9, 10)*. Less severe accidents tend to occur at intersections or at locations where motor vehicles and pedestrians or bicycles come in contact with each other *(9, 11)*. Research also suggests that accidents are caused by different expectations of behavior between motor vehicle drivers and bicyclists *(12)*. Some bicycle accidents fail to even involve another party—a phenomenon especially true for children *(13, 14)*.

In 2004, the Surface Transportation Policy Project (STPP) completed *Mean Streets*, an evaluation of pedestrian safety from 1994 through 2003. During this ten-year period, the research reports the rate of pedestrian fatalities dropped from 2.14 deaths per 100,000 persons to 1.68 deaths per 100,000 persons, a decline of 21 percent *(15)*. Likewise, The National Highway Traffic Safety Administration reported that 725 bicyclists were killed in 2004 compared to 802 bicyclists killed in 1994 *(16)*, indicating a slight downward trend in bicyclist fatalities. The decline in both suggests good news for advocates and planners alike.

However, these rates of decline need to be weighed against the overall number of people pursuing the activity—a concept commonly referred to as exposure. A decline in the absolute numbers of pedestrian and bicycle crashes means little if fewer people are walking or cycling. For example, the last two U. S. Census Bureau reports indicate that fewer Americans are traveling to work by foot. In fact, the share of pedestrian work trips has declined by almost 25 percent in the last decade *(17)*. Bicycle use, on the other hand, appears to be on the rise. The Nationwide Personal Transportation Survey indicates bicycle trips increased by 55 percent between 1990 and 1995 *(18)*. Furthermore, research suggests a substantial underreporting of bicycle crashes to authorities, further reducing a complete understanding of bicycle activity and safety *(18, 19)*.

To better understand the complexity of bicycle and pedestrian activity and safety, and to gain insight into pedestrian and bicyclist tendencies and preferences, the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) and the Bureau of Transportation Statistics (BTS) sponsored the National Survey of Pedestrian & Bicyclist Attitudes and Behaviors during the summer months of 2002 *(20)*. The results indicate that 27.3 percent of the driving age public (assumed to be 16 and older) rode a bicycle during summer 2002 *(20)*. In comparison, 78.7 percent of the driving age public reported they walked, ran, or jogged outdoors for at least five minutes or more during summer 2002. While males (34 percent) are more likely than females (21.3 percent) to ride a bicycle, males and

females (approximately 79 percent) are both just as likely to walk. The survey reported that bicycling activity declines with age. Approximately 39 percent of the population aged 16 to 24 reported riding a bicycle while only 8.6 percent aged 65 and older reporting riding a bicycle *(20)*. While walking activity also declines with age, it does not decrease at nearly the same rate. Approximately 81.7 percent of the population aged 16 to 24 reported walking and 65.6 percent aged 65 and older reported walking *(20)*. Lastly, the survey indicates that bicycling and walking activity are fairly consistent across race and ethnicity *(20)*.

Although demographic attributes such as race and ethnicity do not appear to be significant indicators of walking and bicycling activity, research into fatality rates indicates that certain ethnic and racial minorities tend to be disproportionately represented *(15)*. While African-Americans comprise less than 13 percent of the total U.S. population, they account for 19 percent of pedestrian deaths *(15)*. Similarly, Latino pedestrians account for 13.5 percent of the total U.S. population but comprise 16 percent of pedestrian deaths *(15)*.

Children also comprise a large percentage of pedestrian fatalities. While pedestrian fatalities of children have declined in the last ten years, much of the literature indicates this is linked back to lack of exposure *(15)*. In recent years, there has been a plethora of research in the field of public health linking obesity in children with lack of exercise *(21)*. The concern over children's health is one of primary factors behind initiatives such as Safe Routes to School.

Additional research has been on the perceived levels of safety for pedestrian and bicycle travel. Schimek found that inexperienced bicyclists perceive motor vehicle traffic approaching from behind as a primary safety concern thus preferring to ride on separated paths and trails *(22)*. A study of the neighborhoods surrounding the University of North Carolina at Chapel Hill, revealed a spatial mismatch between perceived risk of a pedestrian crash and the locations where pedestrian crashes are actually occurring, according to police report crash data *(23)*. The spatial mismatch maybe a result of pedestrians avoiding the area because of perceived risk of being involved in a crash.

A key aspect in determining the relative safety for pedestrians and bicyclists is to marry data about safety (e.g., measured in crashes) with different characteristics of walking and bicycling facilities. For example, some work examines crashes using a myriad of attributes at the county or metropolitan region level *(24)*. Other work focuses on attributes of crashes examining the crashes at the block or sub-block level *(9, 23, 25-32)*. These studies reveal that most pedestrian crashes occur in one- or two-lane roadways with speed limits less than 35 miles per hour, while relatively few occur when a sidewalk is provided on at least one side of the road *(9, 23, 29)*. As vehicle speed increases the severity of injury resulting from a crash tends to increase *(23, 28, 31, 32)*. Site-specific related research has concentrated on crossing delays and crashes at mid-block versus intersections *(26, 27, 30)*. A 1996 study conducted by the Federal Highway Administration found that intersections, driveways and other junctions are the locations of 75 percent of bicycle and motor vehicle crashes *(25)*.

The literature suggests a variety of scales are appropriate for any analysis focusing on the transportation network. Looks primarily at the attributes of the transportation network, speed limit, intersection or sidewalk where the crash occurred *(9, 23, 25-32)*. However, these

applications fail to consider attributes of the larger neighborhood context. Alternatively, studies that analyze pedestrian and bicycle crashes on a regional scale use attributes such as scale block size and population density, failing to hone in on specific neighborhood attributes *(24)*. Our approach presented herein aims to take advantage of the benefits of both scales of analyses using detailed information about crashes and neighborhood attributes.

Current sources and uses of pedestrian and bicycle crash data

Existing literature within the realm of bicycle and pedestrian research suggests that a variety of factors influence bicycle and pedestrian crash rates. In a perfect world, data collection methods would capture all of the desired spatial and non-spatial characteristics to accurately depict bicycle and pedestrian safety. However, current data collection approaches fail to provide a complete picture of all fatalities, near misses, and other types of pedestrian and bicycle interactions.

This section describes the current sources of pedestrian and bicycle safety data in Minnesota, the types of information normally available to those analyzing crashes, and differences among data sources. Our aim is to identify agencies currently collecting data regarding pedestrian and bicycle safety and crashes, determine how it is being recorded, and identify ways in which this data is being used to influence pedestrian and bicycle facility design and policy decisions. To ascertain this information, we focused our review on a select group of entities including state governmental agencies, large and small cities, rural communities, and non-governmental advocacy and interest groups.

For the purposes of this report Minnesota Department of Public Safety (DPS) and Minnesota Department of Transportation (Mn\DOT) definition of a crash has been adopted. A crash is defined as an incident in the public right-of-way resulting in bodily injury or death of any person or property damage exceeding $1,000 *(33)*.

Data sources

Data was gathered from discussions with state agencies, city and town bicycle and pedestrian coordinators, local law enforcement officers, county health officials, and other interest groups. Based on these discussions, the major sources of bicycle and pedestrian safety data include police reports, citizen reports, and hospital records. Each data source is discussed in detail below. These sources are summarized in Table 1. Additionally, miscellaneous sources with varying amounts of supplemental information are also mentioned.

Police reports

Police reports are generated for all crashes within the State of Minnesota involving a motor vehicle on a public right-of-way that results in injury, death, or at least $1,000 in property damage *(33)*. Police respond to a crash event and record information including:

- Name, age, and sex of involved parties;
- Crash time and date;
- State, county, city, and street location;
- Lighting and weather conditions;
- A written description and sketch of the crash event;
- Pre-accident actions and maneuvers by all involved parties, including pedestrians and bicyclists;

- Who is at fault—if known;
- Whether or not an injury was sustained and its severity; and
- Whether any of the involved parties where transported to a hospital.

A blank police report is shown in Appendix A.

The crash reports provide detailed information regarding the location of the crash. For example, the research team reviewed a mid-block crash report in which a bicyclist and automobile collided at a parking lot exit point. The police report provided an estimate of linear feet to the nearest intersection, included a narrative describing the exact actions of the various parties prior to the crash, and provided a sketch depicting the direction of each involved party. Location information can aid in evaluating bicycle and pedestrian safety by allowing the analysis to infer exposure. In addition to spatial information, police reports provide information on non-spatial, human contributing factors such as pre-accident actions and maneuvers. These actions are quite varied and range from failure to yield to chemical impairment. Additionally, demographic characteristics such as age and sex provide insight into what segments of the population may be more involved in crashes than others. While police reports provide an initial step and the richest data source for understanding pedestrian and bicycle safety, they do not provide a full picture. Police reports only capture data related to crashes that occur in public right-of-ways. Little or no information is collect regarding crashes that occur on off-street facilities or private property (i.e. parking lots).

Citizen reports

Individuals involved in a crash also submit crash reports. Chapter 169.09, Subdivision 7 of the Minnesota Statutes requires the driver of a vehicle involved in an accident resulting in bodily injury to or death of any person or property damage exceeding $1,000 to forward a written report of the accident to the commissioner of DPS within ten days of the crash event *(33)*. These reports include the same criteria as police reports, but present the information from the view point of those involved in the crash.

A blank citizen report is shown in Appendix B.

Hospital records

The research team contacted the Minnesota Department of Health (DOH) and the Hennepin County Medical Center (HCMC) to glean additional information about potential data sources. For confidentiality reasons, we were unable to obtain hospital records from either agency. However, based on discussions with Mark Kinde of the DOH and Julie Philbrook at HCMC we know that, in contrast to police reports, hospital records provide extensive injury data. Injury information can assist in the design of safety equipment such as bicycle helmets and public education about the importance of such equipment. The extensive injury data can provide a global benchmark to measure the absolute or relative change in the number and severity of crashes within a particular region. However, hospital records are not linked to the location of a crash. At best, hospital records will identify the county or city in which the crash occurred. Additionally, comparing police reports with hospital records, reveals a difference in the number of incidents involving pedestrians and bicyclists.

Miscellaneous crash data sources

The research team contacted the Twin Cities Bicycle Club (TCBC), the largest citizen based bicycle group in Minnesota, to determine the extent to which these groups record bicycle crashes. TCBC noted that bicycle trip leaders record crash reports for all major occurrences. These reports are submitted to TCBC's insurance company and are also recorded as a method to promote risk awareness. This information may prove helpful in determining which segments of the society are having more crashes, commuters or recreational riders.

The research team also contacted the Minnesota Department of Natural Resources (DNR) to see if the DNR collects any bicycle crash data related to off-road, trail activity. However, the DNR does not collect this type of information.

Table 1 Crash Data Sources Summary Comparison

Data Source	Advantages	Disadvantages
Police Reports	• Provide comprehensive information about: - crash locations - involved parties and who is at fault - time of day, lighting and weather conditions - initial injury severity	• Limited to public right-of-way, thus may only capture small percentage of crashes • Not linked to hospital records or health department records
Citizen Reports	• Provide comprehensive information about: - crash locations - involved parties and who is at fault - time of day, lighting and weather conditions - initial injury severity	• Limited to public right-of-way, thus may only captures small percentage of crashes • Not linked to hospital records or health department records
Hospital Records	• Provide extensive injury data	• Location data is only disaggregated down to the city or county level • Difficult to link to specific urban form improvement locations • Not linked to police reports
Bicycle Groups	• Provide supplemental information for recreational bicycling crashes • Provide information that police reports may fail to capture	• Most likely only capture a small percentage of bicycle crashes occurring

How the data is used

State level

At the state level, DPS and DOH are collecting important data to better understand pedestrian and bicycle safety. This section provides an overview of how their data is used, as well as a description of the Crash Outcome Data Evaluation System (CODES) program, a relatively new joint effort by the DPS and DOH to link their data.

Department of Public Safety (DPS)

Each year, DPS, through the Office of Traffic Safety (OTS), produces *Minnesota Motor Vehicle Crash Facts (34)*. This detailed report summarizes information about crashes, including who was involved, what the conditions were, the location, and time. All types of transportation modes, including pedestrians and bicycles, are addressed in the report. OTS compiles crash data based on data gathered in police department reports and citizen reports from law enforcement agencies around the state.

More detailed in formation about crash reports can be found at the OTS website: www.dps.state.mn.us/OTS/crashdata/crash_facts.asp

Department of Health (DOH)

The Minnesota DOH compiles pedestrian and bicycle related injury data from hospital and medical center records throughout the state into its Minnesota Injury Data Access System (MIDAS). Through MIDAS, injury and violence data for the State of Minnesota, Greater Minnesota, the seven county metro area, a specific county, or major cities (Minneapolis, St. Paul, or Duluth) can be queried by cause of injury, location, type of injury, type of care, outcome, sex, and age. This data set represents approximately 95 percent of all patient discharge data for injuries in Minnesota *(35)*. The data set contains no personal identifiers.

More information on the MIDAS program can be found on the DOH website: http://www.health.state.mn.us/injury/midas/ub92/index.cfm

Crash Outcome Data Evaluation System (CODES) Program

In 1999, the DPS received a CODES grant from the National Highway Traffic Safety Administration (NHTSA). The purpose of the grant was to employ probabilistic linkage theory to link statewide traffic crash records with hospital discharge billing data. In cooperation with Mn/DOT, the Minnesota Hospital Association (MHA), and DOH, the DPS CODES project began in September 2001. The mission of CODES is to provide crash and hospital data in aggregate form to be used in determining the cost effectiveness of safety measures and initiatives in Minnesota *(36)*.

The CODES project strives to maintain total confidentiality in the linkage process. To ensure privacy, no personal identifiers are used. Example linking elements include:

- Date and time of crash with hospital admissions
- Date of birth and sex of individuals involved
- County of crash location and county of treating hospital

The NHTSA CODES model also suggests additional state data such as driver licensing, vehicle registration, citation/conviction records, insurance claims, HMO/managed care data as useful linkage elements *(37)*. However, data elements chosen for linkage must include sufficient identifiers to discriminate among the events and the persons involved.

There are several drawbacks of the CODES program. One being that it does not include any clinic data. For example, an injured person involved in a crash decides not to go to an emergency room but instead visits his or her primary doctor. CODES only links crashes that had an officer report filed by a law enforcement agency and a person involved went to the emergency room. Lastly, the probability of linkage varies considerably between high and low sample probability individuals. For example, it is difficult to match male teenager bicyclists in the Twin Cities Metropolitan Area because there are many possible matches. In contrast, there are few possible matches for older pedestrians in rural Itasca County. Problems with linking data are a result in different standards of reporting and release of public information for crash reports and hospital records. The various standards required by law are in direct conflict.

More information on the CODES program can be found on the OTS website: www.dps.state.mn.us/OTS/crashdata/codes_project.asp

Department of Transportation (Mn/DOT)

Mn/DOT conducts evaluations of pedestrian and bicycle crashes to determine if infrastructure changes could be made to prevent similar crashes from happening in the future. Mn/DOT uses the data collect by DPS. Mn/DOT uses two sources of data to evaluate crashes. The first is the police crash reports filed with DPS. The second is a coded data file composed of information pulled from the crash reports. Examining both the original crash reports and the coded data file, it became apparent to the research group that not all of the information that is being provided by the crash reports appears in the coded data file. Two parts of the report that provide valuable information about the crash do not appear in the coded data file: the diagram and the narrative describing the crash. These sections are not included in the data file because of the difficulty of depicting them in a numerical manner.

Local level

A select group of communities was chosen to better understand bicycle and pedestrian data collection techniques, to learn about the state of crash reporting, and to learn how the data is currently used to influence bicycle and pedestrian design and policy decisions. The communities are diverse in size, location, population, and demographics and are representative of the variety of communities found throughout the state. They include:

- Minneapolis
- St. Paul
- Duluth
- Rochester
- Maplewood
- Park Rapids

- St. Joseph
- Red Lake Reservation

To gather information about each community, the research team contacted pedestrian and bicycle coordinators, traffic engineers, law enforcement agents, and city and town planners. By and large, most communities are using police reports and hospital records to tease out information related to pedestrian and bicycle crashes. In instances where there is no police response to a crash scene, citizen reports are sometimes referenced. Below is a brief description of current activities in each representative community.

Minneapolis

The state's largest city has an extensive network of on- and off-road bicycle paths as well as a comprehensive system of sidewalks, crosswalks, lake paths, and river paths. For the last 10 years, the Minneapolis bicycle coordinator has compiled all police reports from the Minneapolis Police Department, Minneapolis Parks Police Department, and the University of Minnesota Police Department involving bicycle related crashes. In 2003, the locations of bicycle crashes were compiled into a database, geocoded, and mapped using Geographic Information Systems (GIS). Initial interpretations of the data indicate that crashes are a function of density of land use, amount of bicycle use, and average automobile daily volume, therefore increasing closer to the central business district. Preliminary efforts to compare crash location and specific urban form features have recently started, but are still in their infancy. The issue of near misses remains difficult to assess.

Similarly, the Minneapolis pedestrian coordinator obtains copies of all police reports that involve pedestrians. Unlike bicycle crashes, the data is not mapped, reviewed for trends, or used proactively to build additional crosswalks, increase lighting, etc. Proactive planning of pedestrian routes is not a top priority of the city. Instead, pedestrian concerns are raised by residents who contact the city's traffic department directly or through their city councilmember. After receiving a pedestrian concern, the traffic department evaluates the incident or location and may also review police records to determine the correct course of action. Additionally, Minneapolis conducts a cordon count every two years to determine the number of pedestrians within the city limits. To accomplish this task, the number of occupants within cars, trucks, and buses entering the central business district from all surface streets is recorded for a 12-hour period.

St. Paul

Like Minneapolis, St. Paul residents are privileged to an extensive bicycle and pedestrian network with access to its central business district, area parks and lakes, and the Mississippi River. Although St. Paul is not yet mapping bicycle crash locations, the city's bicycle engineer and police department meet from time to time to discuss bicycle crash locations and identify any emerging trends. At their most recent meeting, bicyclist behavior was indicated as the root cause of most crashes. General causes included failure to yield at stop signs, making left turns from right turn lanes, or bicycling into the street from a perpendicular sidewalk. The two most probable bicycle groups involved in these crashes included adults in their mid-thirties and children. Based on this "snapshot" view of crash data, St. Paul has identified education as one approach to decreasing bicycle crashes.

Education is also a strong theme in St. Paul's approach to reduce pedestrian crashes. In July 2003, St. Paul Mayor Randy Kelly and the St. Paul police department began a citywide pedestrian safety awareness campaign, called "Wave, Wait, and Walk" in response to three pedestrian deaths in the prior 18 months *(38)*. The aim of the program is to raise awareness among city employees, businesses, and the general public. A coalition including the St. Paul pedestrian coordinator, the Minnesota Safety Council, the Safe Routes community group, and the police department are working together to improve communication between pedestrians and drivers.

Duluth

Duluth is one of Minnesota's mid-size cities, with a population of approximately 90,000 people. Home to the University of Minnesota-Duluth and active tourism along the shore of Lake Superior, the city also has a pedestrian and bicycle friendly downtown and waterfront district. Duluth's traffic engineer uses bicycle and pedestrian crash data in a proactive way to influence bicycle and pedestrian infrastructure improvements to keep Duluth bicycle and pedestrian friendly. While in constant communication with the police department regarding pedestrian and bicycle crashes, the traffic engineer also fields direct calls from residents regarding near misses and other dangerous bicycle and pedestrian situations. Duluth has used these sources of feedback to shape urban form by implementing such measures as limiting parking located close to intersections or mid-block crosswalks, adding flashing pedestrian cross walk signs, and reducing driving lane widths and increasing parking lane widths. The police reports are referenced when the city updates its bicycle and pedestrian master plan. An issue the city continually addresses is the ever increasing speed of automobiles.

Rochester

Rochester, another mid-size city with a population of close to 90,000, is located in Olmstead County in southeastern Minnesota. The city boasts nearly 60 miles of bituminous or concrete trails that draw bicyclists, pedestrians, and in-line skaters. Trails within the system include the Cascade Creek Trail, Quarry Hill Trail, Downtown Trail, Zumbro South Trail, and the Bear Creek Trail *(39)*. The city's interim traffic engineer could not point to any problematic pedestrian or bicycle crash locations along this extensive trail network. Nevertheless, the city remains proactive in addressing pedestrian and bicycle issues. In addition to the reporting required by DPS as part of the annual *Minnesota Motor Vehicle Crash Facts*, the city's interim traffic engineer works in coordination with the surrounding townships to compile data on bicycle and pedestrian crashes into a report every five to six years. Funded by the Rochester-Olmstead Planning Department, this report serves as a reference for making bicycle and pedestrian planning decisions on future city and county projects.

Maplewood

Maplewood is a first ring suburban community of approximately 35,000 residents located to the east and north of St. Paul. The community examines selected crossing and intersections that have been identified by either the police department or neighborhood residents as possible problem areas. The city engineer then examines crash reports from crashes that occurred at the intersection to determine if there are similarities between crashes and if it would be a

candidate for an engineered solution. The city has considered building grade-separated crossings and increased signage at selected intersections in order to make the intersections safer for pedestrians and bicyclists.

Park Rapids

Park Rapids is a small, rural community of approximately 3,000 people located in northern Minnesota's lake country. The Park Rapids police department indicates that there have only been four or five bicycle or pedestrian crashes in the last 2 years. The most notable crash occurred on the Heartland Trail in September 2004 when a bicyclist ran a stop sign and collided with an automobile, resulting in the bicyclist's death. With a limited bicycle and pedestrian crash history, the city does not have any current planning or policy mechanisms in place to link crashes to infrastructure improvements.

St. Joseph

St. Joseph is a rural college town in central Minnesota. It is home to the College of St. Benedict and the Lake Wobegon Trail. In the past, the City of St. Joseph has not had many pedestrian or bicycle crashes; as a result they have not had a need to retrofit or examine particular intersections. The city does, however, require that all new developments incorporate both sidewalks and bicycle facilities and that these facilities connect to the existing network whenever possible.

Cannon Falls

Cannon Falls is a rural community in southeast Minnesota. There have been four or five pedestrian crashes at a single intersection in as many years. In response to the crashes, the city has recently implemented a program where pedestrians pick up a brightly colored reflective flag from a basket before they cross the street and place it in a basket on the opposite side of the street after crossing. The program is designed to make the pedestrian more visible to the driver and to actively place safety and watching out for motor vehicles on the minds of pedestrians.

Red Lake Reservation

The Red Lake Reservation is home to approximately 5,000 American Indians and is located in northern Minnesota, about 75 miles from the Canadian border. As a sovereign nation, the Red Lake Band is not required to submit pedestrian and bicycle crash data to the DPS. Discussions with a northern Minnesota division Mn/DOT official indicate that pedestrian and bicycle crashes are occurring on the reservation. When crashes result in serious injury or death, the U.S. Federal Bureau of Investigation becomes involved in crash scene investigation.

This section provided an anecdotal look at the current status of data collection methods and uses in various Minnesota communities. Some Minnesota communities are using the data in creative ways to address pedestrian and bicycle safety issues. Larger cities in Minnesota have more resources to focus on pedestrian and bicycle safety issues and can target programs in their communities. Smaller towns, on the other hand, tend not to have as many pedestrian and bicycle crashes, and as a result do not focus more of their pedestrian and bicycle safety efforts on education.

Data collection in other states

In conversations with state offices of traffic safety (or their local equivalent) from six other states throughout the U. S., the research team discovered what data is being collected, how it is being collected, and what the data is being used for. From this, the research team was able to determine that Minnesota is a leader in data collection related to pedestrian and bicycle crashes. None of the seven states that were examined (including Minnesota) has a specialized form for collecting information about pedestrian or bicycle crashes. As a result, data regarding pedestrian and bicycle crashes is gathered using forms designed primarily to collect information about motor vehicle crashes. All of the states' forms provide approximately the same information about the individuals involved, vehicle action, and road and weather conditions in the crash. Based on Table 2, however, it is clear that the different states' crash report forms provide them with different types of information regarding pedestrian and bicycle crashes.

By examining the crash report forms from these seven states it was determined that Minnesota and North Carolina's forms do the best at providing important information in regards to pedestrian and bicycle crashes. Minnesota and North Carolina collect similar information; however, the North Carolina form collects more detailed information about crash location than the Minnesota form. It does so by collecting information about facilities involved in the crash but not located in the roadway (sidewalks and shared-use path/trail). The Minnesota form, on the other hand, collects more detailed information about the action of the pedestrian or bicyclist prior to the crash. The Minnesota and Oregon forms were the only forms that reported how bicycles were traveling in relation to traffic.

Table 2 Comparison of Data Collected Regarding Pedestrian and Bicycle Crashes in Selected States

	Information Collected	Iowa	Minnesota	Missouri	North Carolina	North Dakota	Oregon	Wisconsin
Mode	Pedestrian	x	x	x	x	x	x	x
	Pedecycle or Bicycle	x	x	x	x	x	x	x
	Skater	x	x		x			
Location	At intersection	x	x		x	x	x	
	In roadway				x			x
	Not in roadway		x	x	x	x	x	x
	Sidewalk				x			x
	Shared-use path or trail				x			
Action	Crossing with signal		x	x				
	Crossing against signal		x	x				x
	Darting into traffic	x	x		x			x
	Other improper crossing	x	x					
	Non intersection crosswalk	x			x			
	Driveway access crosswalk	x			x			
	Crossing in marked crosswalk	x	x	x	x		x	x
	Crossing diagonally			x				
	Crossing not at intersection					x	x	
	Crossing (No signal or crosswalk)	x	x	x	x		x	
	Hitchhiking						x	
	Failure to yield right of way to traffic	x	x		x			x
	Failure to yield right of way to pedestrian	x						
	Failure to obey traffic signs, signals, or officer	x			x			
	Inattention/distraction	x	x		x	x		
	Walking/running in road with traffic		x	x	x	x	x	x
	Walking/running in road against traffic		x	x	x	x	x	x
	Standing/lying in road	x	x	x	x	Pedestrian in roadway	x	
	Emerging from behind parked vehicle		x	x	x			
	Child getting on/off school bus		x					
	Person getting in/out of vehicle	x	x	x	x			
	Pushing/working on vehicle	x	x	x	x		x	
	Working in roadway	x	x	x	x		x	
	Playing in roadway	x	x	x	x		x	

	Pedestrian not in roadway		x	x		x	x	
	Wrong side of road	x			x	x		
	Riding with traffic		x				x	
	Riding against traffic		x				x	
	Pedestrian action	x						
	Riding across road		x					
Safety devices	Helmet used	x	x	x	x	x		
	Helmet not used		x	x				
	Reflective clothing	x						
	Lighting	x						
	Dark clothing	x			x			x

The above table includes attributes that are options to be selected on the crash report form that are specific to pedestrian and bicycle crashes. All forms include both an area for a diagram and a written description, in which additional information about the crash could be provided. In addition the table does not include general information (e.g. right turn, left turn, personal information) present on all forms unless it specifically referred to pedestrians or bicycles. Information in this table is derived from:

Iowa "Iowa State Patrol – Investigating Officers Report of Motor Vehicle Accident"
Minnesota "State of Minnesota - Department of Public Safety – Accident Report"
Missouri "Missouri Uniform Accident Report"
North Carolina "Crash Report Form DMV 349"
North Dakota "Motor Vehicle Crash Report"
Oregon "Oregon Traffic Accident and Insurance Report"
Wisconsin "Wisconsin Motor Vehicle Accident Report"

Changes in crash data collection and storage

Mn/DOT and DPS are continually looking for ways to improve the data collection process. The manner in which crash reports are retained has changed twice in the past 10 years. Prior to 1998, the records were stored on microfilm. From 1998 until August of 2002, the reports were stored as electronic photographs. In August of 2002, they began storing the reports online. The quick change in technologies makes a longitudinal study more cumbersome. However, this is not to say that the changing storage methods by Mn/DOT and DPS have not made the data more reliable, easier to use, and more accessible. Having a web version of the report makes it much easier to access the original police report, allowing for more efficiency in analyzing crashes. The web version of the reports also creates a report that is better preserved. Often, the electronic photographs of the crash reports and/or the diagram are illegible due to the quality of the photograph or the handwriting.

The information collected in the reports has also changed. In 2003, DPS began using a new crash report form. In addition, reports are increasingly being submitted on-line. As the transition to electronic reporting continues, handwriting and other problems replicating the forms will become less of an issue. Although the actual crashes examined as part of this study all occurred between 1998 and 2002, both the current paper crash report and the on-line crash reports were evaluated as part of the reporting mechanism.

Shortcomings of currently collected data

Location

The location of the crash is an important detail about the crash. The location of the crash is recorded to the thousandths of a mile (5.28 feet). However, this provides a false sense that the crash occurred in that specific location. Often times the location of the crash was recorded as "x" number of feet from an intersection of two streets by the police officer. However, in rural areas, where the distance from the intersection could be a half mile, the officer most likely did not measure the distance from the intersection.

Multiple questions

The crash report has multiple questions asking about similar attributes of the crash. While this could be beneficial because it allows aspects of the crash to be gathered in more than one way, it can also lead to confusion. It is important that both the officer completing the report and the person evaluating the crash can discern what aspect of the crash the question is referring to. For example, the questions labeled "diagram" and "action by vehicle" overlap somewhat.

During the five-year time period of the study there were 199 crashes that involved a pedestrian or bicycle that were not coded as either pedestrian or bicycle crashes. This was a result of multiple questions referring the same aspects of the crash. While there is a need to track aspects of the crash at both the vehicle level and the crash level the overlap can cause some confusion.

Time of day

Examining how the time of day is recorded presented several inconsistencies with the recording methods. Some of the officers use military time. Some use 12-hour time and indicate such by using am/pm. The times recorded for other crashes make it hard to discern if a crash occurred in the am or pm. This leaves the critical decision of determining if a crash occurred at 8:00 am or 8:00 pm to the person who is entering the data. A standardized time format should be implemented by DPS.

Role of exposure

A key component to improving our understanding of pedestrian and bicycle safety is to better understand exposure, or the amount of pedestrian or bicycle activity in a geographic location or by a person/group of people. Knowledge of the level of exposure is critical because a variety of situations can lead to unsafe environments for bicycle and pedestrian travel. In some cases, crashes may be occurring at locations with extremely high levels of pedestrian or bicycle activity (high exposure); other areas may have a lower exposure but the percentage of pedestrians and bicyclists in the area who are involved in a crash is much higher. It is important that exposure is measured adequately so that it can be controlled. Crude measures for pedestrian and bicycle exposure, population, or employment often do not accurately capture the safety risks of these modes. Diagnosing and comparing safety in terms of such measures is thus often misleading. Of equal importance is identifying neighborhood attributes and the role of such aspects in understanding the relative safety of pedestrian and bicycle travel.

Direct measures of exposure

There are several ways to measure pedestrian and bicycle exposure: 1) number of pedestrians and bicyclists in a given area, 2) number of pedestrian and bicycle trips made in a given time span, 3) distance traveled by pedestrians and bicyclists, and 4) amount of time spent walking and bicycling. Each of these measures quantifies different aspects of exposure.

In order to compare the relative safety of one area to another on a micro geographic level, the best measure is the number of pedestrians and bicyclists in a given area or along a certain facility (or part of a facility), allowing for caparisons of the relative safety of two or more facilities. The major problem with this measure is that it is extremely difficult to collect over a large geographic area (e.g. city, county, metro area, state, or country). It would require visual counts of the number of pedestrians and bicyclists on every road segment and bicycle facility.

The other three measures are most helpful when looking at the relative safety of an area at a macro geographic level. The number of trips made provides information about whether walking or bicycling is considered an option when people are deciding what mode to use to travel. The distance of pedestrian and bicycle trips can be extremely important when considering the location of where to place amenities to improve pedestrian and bicycle safety around destinations and origins (e.g. schools and parks). Amount of time spent walking or bicycling is important because the entire time that someone is participating in one of the activities the individual is at risk of being in a crash. Some drawbacks to these measures are that they do not connect the trip to a specific facility or part of a facility. In addition, these measures are often collected from self reporting; this has inherent problems because walking trips, and to a lesser degree bicycle trips, may not be reported because they are not thought of as trips (e.g. walking from one's work to car or children riding a bicycle for fun). While these may not be thought of as trips or a separate trip by the person making the trip, this person could be involved in a crash while walking to their car from work.

It is also possible to combine more than one of these measures of exposure to learn more about the type of travel in the area. Combining the distance traveled with the amount of time spent doing the activity could provide important information because there is the possibility that individuals who are traveling faster travel in a different manner than those who travel slower and are therefore at a greater or lesser risk of being involved in a crash. Knowing would enable education campaigns and infrastructure modifications to target the type of pedestrian and bicycle travel occurring in the area.

United States census and travel behavior data

U.S. Census data and other travel related data sources, such as the Twin Cities Travel Behavior Inventory and National Household Travel Survey, provide the richest source of data to address exposure. U. S. Census data provides information on the mode and route used for the journey to work. The Twin Cities Travel Behavior Inventory includes a travel diary of origins and destinations accessed by various transportation modes – auto, walking, bicycling, and transit.

Indirect measures of exposure

As a result of the inherent problems with collecting accurate direct measures for exposure, the research team chose to rely on indirect measures of exposure. Indirect measures for exposure are measures of other items that the literature suspect might correlate with exposure, such as population or employment density of an area. In areas where there are more people it is likely that there are more trips being made. Another indirect measure of exposure is density of retail stores. Since pedestrian and bicycle trips are relatively short, averaging 1.2 and 3.9 miles respectively *(20)*, intermixing of retail stores, high population, and employment density create more possible destinations within walking or bicycling distance. As a result, areas that have higher population and employment density and more retail stores are more likely to have more pedestrian and bicycle activity.

Physical characteristics of the environment also indicate indirect measures of exposure. However, it is often difficult to control for exposure or identify a single physical factor that is leading to unsafe pedestrian or bicycle environments. In order to better understand the root causes of bicycle and pedestrian safety and the impact of exposure on crash rates, additional data is necessary. This report examines the need for more information on the physical characteristics that influence bicycle and pedestrian crash rates. Together with existing information sources such as police reports, citizen reports, and hospital records, physical characteristics provide additional information and knowledge necessary for a richer understanding of bicycle and pedestrian safety.

Physical characteristics vary in scope and importance. Possible physical characteristics that may affect the safety of pedestrians and bicyclists travel include: Average Annual Daily Traffic (AADT), road classifications, speed limits, traffic signals, turning lanes, lighting, crosswalks, sidewalks, and on and off-road bicycle facilities.

Some data on physical characteristics are readily available, while other data are difficult to obtain. While the research team has access to some of these data for various portions of Minnesota, others are not readily available or are difficult to measure. Lastly, some of the data

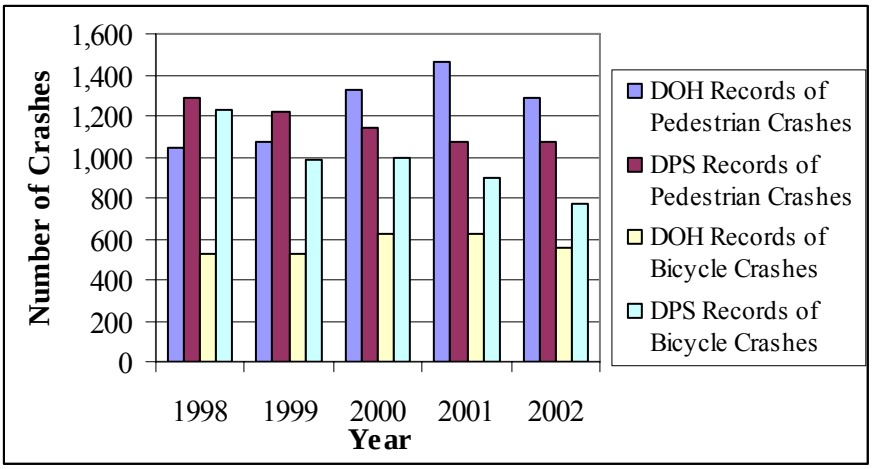
sources help paint a clearer picture of the physical environment, while others provide a clearer understanding of exposure.

Analysis of crashes

This study examines the variety of data available to analyze pedestrian and bicycle crashes and explores the types of analysis that are possible. The research team conducted five different levels of analysis: (1) identifying general patterns and traits of pedestrian and bicycle crashes, (2) identifying intersections where the most crashes occur, (3) determining if pedestrian crashes occur in the same geographic location as bicycle crashes, (4) microanalysis of twelve crash concentrations to determine their patterns and similarities between crashes at the same geographic location, and (5) determining correlations between pedestrian or bicycle crashes and neighborhood attributes. Each of these analyses were shaped by two elements: the availability or lack of data and the frequency of pedestrian and bicycle crashes.

The primary source of information used for these analyses is DPS's *Accident Reports* of pedestrian and bicycle crashes. These forms are also the primary source used by Mn/DOT and DPS in their crash analyses. The research team selected *Accident Reports* because of the valuable information it contains concerning contributing factors of the crash. However, it should be kept in mind that *Accident Reports* only includes crashes which were reported by the police. Police only file a crash report if the crash occurs on a public road and $1,000 of property damage or bodily damage occurs as a result of the crash. DOH, on the other hand, tracks the number of patients who seek medical attention due to pedestrian or bicycle crashes. Figure 1 compares the number of crashes reported by DPS and DOH, demonstrating how the data presents an inaccurate picture of how many crashes actually occur.

Figure 1 Number of Pedestrian and Bicycle Crashes Recorded by DPS and DOH

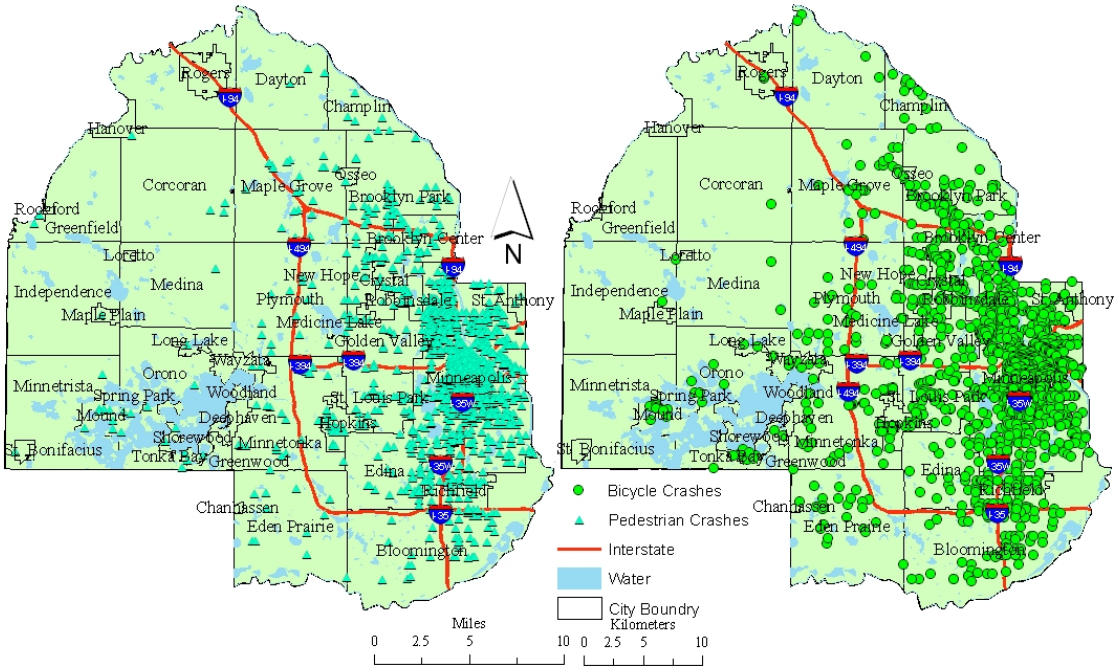


MDH (Minnesota Department Health) records reflect only crashes involving a motor vehicle.
DPS (Minnesota Department of Public Safety) records only reflect crashes involving an injury.

There were 10,940 pedestrian and bicycle crashes in Minnesota from 1998-2002, or 24 pedestrian crashes and 21 bicycle crashes for every 100,000 residents *(17)*. By focusing this study on areas with a concentration of crashes will produce immediate benefits and applications to other areas. Reducing this study to Hennepin County is appropriate because of a disproportionate crash rate. During the same 5-year period, Hennepin County had an average of 43 pedestrian crashes and 37 bicycle crashes per 100,000 residents, about twice the rate of

Minnesota as a whole *(17)*. Figure 2 shows the distribution of these crashes and it is immediately apparent that the number of crashes increases as the proximity to Minneapolis increases. This map illustrates the important role exposure plays in this analysis—since it is commonly known that more urban and higher density environments yield higher levels of walking and cycling.

Figure 2 Locations of Pedestrian and Bicycle Crashes in Hennepin County, MN from 1998-2002



General characteristics of pedestrian and bicycle crashes

An initial investigation of crash data examined various aspects to determine the strength of any patterns or similarities between each. Several similarities and differences exist between bicycle and pedestrian crashes. A few patterns exist independent of whether the crash involves a pedestrian or bicyclist. Crashes are more likely to occur on weekdays (See Table 3) and the majority occur on roads with a 30 mph speed limit (See Table 4). However, these findings lack key information on bicycle exposure rate and fail to quantify the number of road miles in Hennepin County with a speed limit of 30 mph. One point of significance, in Minnesota the speed on a road without a posted limit is 30 mph and on most residential streets in Minnesota the speed limit is 30 mph.

Table 3 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 to 2002, by day of the week

Average number of crashes per day	All Crashes	Pedestrian Crashes	Bicycle Crashes
Weekdays	2.74	1.43	1.31
Weekend	1.72	1.00	0.72

Table 4 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 – 2002, by speed limit of road

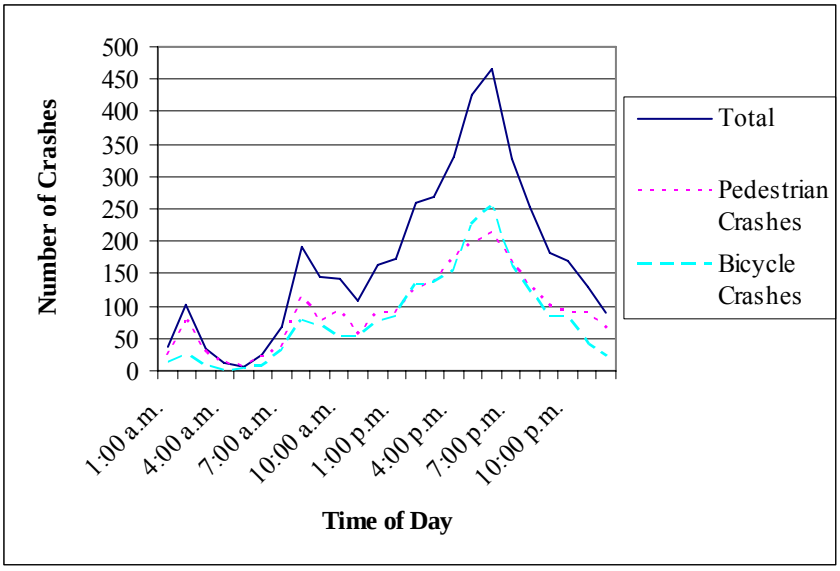
	All Crashes		Pedestrian Crashes		Bicycle Crashes	
Speed Limit	Frequency	Percent	Frequency	Percent	Frequency	Percent
5	8	0.18%	2	0.08%	6	0.29%
10	118	2.65%	61	2.56%	57	2.75%
15	32	0.72%	13	0.55%	19	0.92%
20	23	0.52%	15	0.63%	8	0.39%
25	85	1.91%	37	1.55%	48	2.31%
30	3269	73.35%	1852	77.75%	1417	68.29%
35	422	9.47%	191	8.02%	231	11.13%
40	112	2.51%	36	1.51%	76	3.66%
45	58	1.30%	21	0.88%	37	1.78%
50	25	0.56%	13	0.55%	12	0.58%
55	51	1.14%	32	1.34%	19	0.92%
60	8	0.18%	6	0.25%	2	0.10%
65	4	0.09%	4	0.17%	0	0.00%
70	2	0.04%	0	0.00%	2	0.10%
Unknown	240	5.38%	99	4.16%	141	6.80%
Total	4457	100.00%	2382	100.00%	2075	100.00%

Two other conditions, lighting and time of day exhibit similar patterns. Nearly 90% of pedestrian and bicycle crashes occur in daylight or in the dark with streetlights on (See Table 5). However, a greater percentage of the daylight crashes involve bicycles compared to pedestrians. The time of day during which crashes occur follows a similar pattern as the number of crashes peak during the afternoon rush hour (4:00 and 5:00 pm) (See Figure 3) and bottom out during the late night and early morning hours (2:00 am to 6:00 am). In terms of crashes per hour, bicycles have higher highs and lower lows.

Table 5 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 – 2002, by lighting conditions

	All Crashes		Pedestrian Crashes		Bicycle Crashes	
Lighting	Frequency	Percent	Frequency	Percent	Frequency	Percent
Daylight	3037	68.14%	1440	60.45%	1597	76.96%
Sunrise	96	2.15%	64	2.69%	32	1.54%
Sunset	221	4.96%	117	4.91%	104	5.01%
Dark – street lights on	944	21.18%	661	27.75%	283	13.64%
Dark – street lights off	26	0.58%	15	0.63%	11	0.53%
Dark – no street lights	49	1.10%	37	1.55%	12	0.58%
Other	2	0.04%	0	0.00%	2	0.10%
Unknown	82	1.84%	48	2.02%	34	1.64%
Total	4457	100.00%	2382	100.00%	2075	100.00%

Figure 3 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998-2002, by time of day



Bicycle and pedestrian crashes exhibit differences depending on season and the presence of stop signs. Bicycle crashes are more seasonal than pedestrian crashes and tend to peak during the summer months, while the number of pedestrian crashes remains relatively steady throughout the year (See Figure 4). It is quite possible these patterns have more to do with greater exposure than with a particular trait in causing a crash. A stop sign seems to be more prevalent in bicycle crashes than pedestrian crashes (See Table 6). These charts and tables can be misleading, as they suggest particularly high crash rates during a July weekday, at 5:00 pm on a road segment with a speed limit of 30 mph. The key point is they do not present a picture of crash causes, merely specific attributes that correlate to crashes.

Figure 4 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998-2002, by month

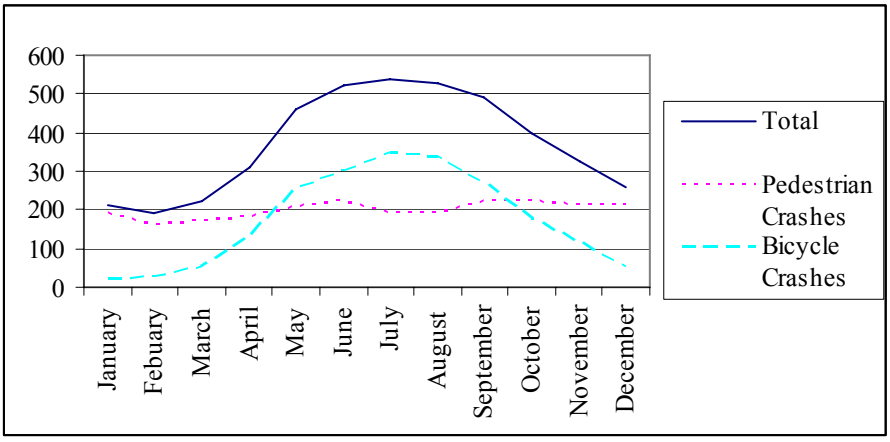


Table 6 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 – 2002, by traffic control device at the scene of the crash

	All Crashes		Pedestrian Crashes		Bicycle Crashes	
Traffic Control Device	Frequency	Percent	Frequency	Percent	Frequency	Percent
Traffic signals	1681	37.72%	949	39.84%	732	35.28%
Overhead flashers	10	0.22%	9	0.38%	1	0.05%
Stop sign – all approaches	107	2.40%	39	1.64%	68	3.28%
Stop sign – other	574	12.88%	168	7.05%	406	19.57%
Yield sign	5	0.11%	0	0.00%	5	0.24%
Officer, flagman, or school patrol	14	0.31%	12	0.50%	2	0.10%
School bus stop arm	1	0.02%	1	0.04%	0	0.00%
School zone sign	2	0.04%	2	0.08%	0	0.00%
No passing zone	4	0.09%	2	0.08%	2	0.10%
Railroad crossing – gates	1	0.02%	1	0.04%	0	0.00%
Other	47	1.05%	20	0.84%	27	1.30%
Not applicable	1896	42.54%	1125	47.23%	771	37.16%
Unknown	115	2.58%	54	2.27%	61	2.94%
Total	4457	100.00%	2382	100.00%	2075	100.00%

Accident Reports also collect information concerning the actions of those involved leading up to the crash. The actions of pedestrians and bicyclists prior to a crash have a wider variance than those of the automobiles involved. However the top three bike and pedestrian actions all involve a similar movement, crossing the street (riding across road, crossing with no signal or crosswalk, and crossing with signal). Together they total 37.4% of the actions prior to the crash. In comparison, the dominant automobile action is much more profound. In 45.83% of the crashes, the vehicle movement is straight ahead following the roadway.

Six combinations of actions prior to the crash resulted in more than 100 crashes throughout Hennepin County from 1998 to 2002 (See Table 7). The results indicate 250 crashes occur when either the pedestrian or bicyclist and the vehicle were most likely obeying traffic signals. The number of crashes in which both the pedestrian or bicyclist and the vehicle were obeying traffic signals is likely higher because this does not include vehicles making a right turn or any bicycles that would have been traveling with or against traffic that received a green light.

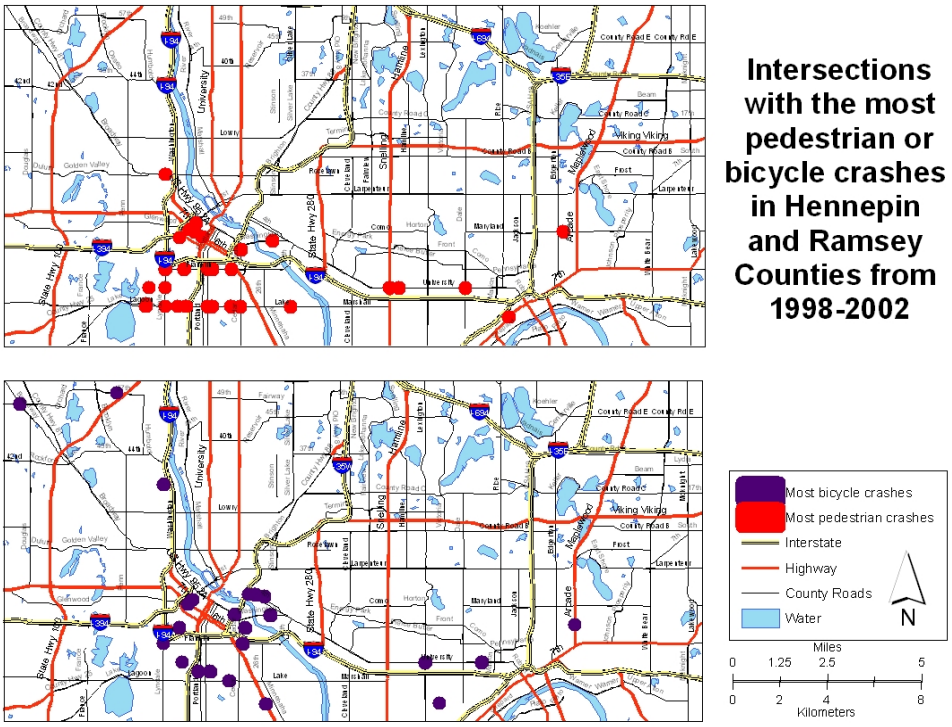
Table 7 Number of Pedestrian and Bicycle Crashes in Hennepin County from 1998 – 2002, by common action leading to crash

	Action of Pedestrian/Bicyclist						
Actions of Vehicle	Crossing with signal	Crossing against signal	Crossing (no signal or crosswalk	Emerging from behind park vehicle	Riding across road	Other	Total
Going straight ahead following road	49	130	398	124	335	1,013	2,049
Making left turn	250	33	57	1	148	154	643
Other	140	35	115	16	209	1,250	1,765
Total	439	198	570	141	692	2,417	4,457

Intersections where the most crashes occur

The next phase of analysis identified the intersections that were high in pedestrian and bicycle crashes in Hennepin and Ramsey Counties. The 20 intersections in Hennepin and Ramsey Counties with the most pedestrian and bicycle crashes were identified by assigning a crash to an intersection if it occurred within 100 feet of the point were street centerlines intersect. The maps below show the locations of the intersections with the most crashes (see Figure 5).

Figure 5 Intersections with the Most Pedestrian or Bicycle Crashes in Hennepin and Ramsey Counties from 1998-2002



Note: there was a tie for the 20th intersection for both pedestrian, bicycle crashes for this reason 30 intersections appear on the pedestrian map, and 24 intersections appear on the bicycle map.

Locations of pedestrian versus bicycle crashes

After examining the intersections where the most pedestrian and bicycle crashes occurred, the data revived that pedestrian and bicycle crashes were occurring at different locations. The next level of analysis aims to look at differences in the geographic locations of pedestrian versus bicycle crashes. To do so we divided Hennepin County into grid cells. The size of the grid cell was an important consideration. They must be large enough that crash concentrations—areas with large numbers of pedestrian or bicycle crashes—are not divided, but small enough that areas that have different neighborhood attributes are not lumped together. Hennepin County was divided into three different sizes of grid cells: 100 x 100 meters, 300 x 300 meters, and 500 x 500 meters.

The geographic location of grid cells containing relatively large numbers of pedestrian and/or bicycle crashes tend to move geographically when comparing the 100 x 100 and 300 x 300 meter grid cells. Most of the geographic movement is gone when comparing the 300 x 300 and 500x500 meter grid cells. As a result, the study uses the 300 x 300 meter grid cells as the unit of analysis. The analysis does not include grid cells that do not contain a road since the traffic accident reports would fail to recognize them (this reduces the number of cells in Hennepin County from 17,445 to 11,625). The number of crashes in a single 300 x 300 meter grid cell ranges from zero to 36 for pedestrian crashes and zero to 14 for bicycle crashes.

After separately tallying the number of pedestrian versus bicycle crashes in each grid cell, we relied on paired sample t-tests to examine a difference in means. This test allows us to compare the normalized number of pedestrian and bicycle crashes in each grid cell. A paired sample t-test is performed at four geographic levels to determine if there is a difference in the locations of pedestrian and bicycle crashes in the central city and suburbs. The four areas are Minneapolis, Inner Ring Suburbs, Outer Ring Suburbs, and Hennepin County in its entirety (See Figure 6).

Figure 6 Geographic Areas in Hennepin County

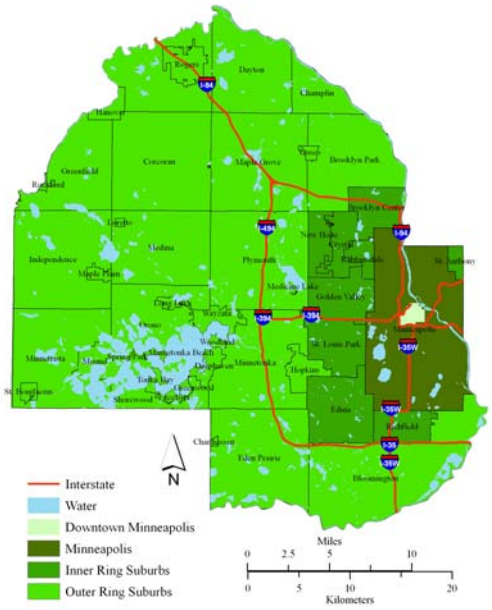


Table 8 shows that for each geographic level of analysis, the tests demonstrate that there are statistically significant differences in the locations of pedestrian crashes versus bicycle crashes. This finding underscores the importance that any analysis examining these aspects needs to separate the locations of pedestrian crashes from cycling crashes. Below are test equations used to determine if pedestrian and bicycle crashes occurred in the same grid cell.

$H\mu$: Pedestrian Crashes in Grid Cell $\neq$ Bicycle Crashes in Grid Cell
Ho: Pedestrian Crashes in Grid Cell = Bicycle Crashes in Grid Cell

Table 8 Results of the Paired Sample T-Test Examining the Difference in the Location of Pedestrian and Bicycle Crashes

	N	Mean	Std. Deviation	Df	t	Correlation	Sig. (2 tailed)
Minneapolis	1,650	-0.0285	0.0965	1,649	-12.00	0.651	.00*
Inner Ring Suburb	1,919	-0.0081	0.0361	1,918	-9.85	0.321	.00*
Outer ring Suburb	8,056	-0.0022	0.0176	8,055	-11.40	0.197	.00*
Hennepin County	11,625	-0.0069	0.0428	11,624	-17.47	0.649	.00*

** Significant at a 95% confidence interval*

Grid cell analysis results

By determining that pedestrian and bicycle crashes occurred at different locations and that there were general patterns related to pedestrian and bicycle crashes, the next step was to examine individual grid cells that had relatively high numbers of pedestrian and bicycle crashes to determine if there were patterns or trends linking the crashes in the same area. Observing the distribution of crash locations, it became apparent that levels of crashes in Minneapolis are much higher than the level of crashes in the suburban parts of Hennepin County. As a result, this report examines crashes in Minneapolis separately from those in the suburbs to broaden the project scope.

The analysis examines 12 grid cells, six urban and six suburban, selecting two grid cells that are high in pedestrian crashes, two grid cells that are high in bicycle crashes, and two that are high in both pedestrian and bicycle crashes (See Table 9). Grid cells in the "Bicycle Crashes" column contain a high number of bicycle crashes compared to pedestrian crashes. The opposite is true for the "Pedestrian Crashes" column. The "Combine Crashes" column represents grid cells high in both pedestrian and bicycle crashes. Each grid cell could only fall into one section of the selection matrix. If a grid cell borders a previously selected grid cell (common in downtown Minneapolis), that cell is not selected and the next grid cell on the list is selected instead. This is done to provide a wider sample of urban form characteristics and high crash locations. However, the examination of the area where crashes occurred will not be limited to the 300 x 300 meter grid cell but more generally covers the broader area were there is a concentration of crashes.

The next step is to determine which grid cells have a greater concentration of pedestrian crashes than bicycle crashes. In order to control for the difference in the concentration in pedestrian and bicycle crashes, the number of crashes in each grid cell is scaled. The process of scaling sets the grid cell with the highest number of pedestrian crashes equal to the grid cell

with the highest number of bicycle crashes. Similarly, the grid cell with the lowest number of pedestrian crashes is set equal to the grid cell with the lowest number of bicycle crashes. The remaining grid cells stretch between these points based on the number of crashes that occurred within the cell. Once the scale has been created, the scale value for bicycle crashes should be subtracted from the scale value for pedestrian crashes. This results in each grid cell having a positive or negative scale value. The greater the absolute value of this number, the larger the difference between the number of pedestrian and bicycle crashes. Positive numbers indicate a greater number of pedestrian crashes and negative numbers indicate more bicycle crashes. Than selected the grid cells with the two highest and the two lowest values for both Minneapolis and suburban Hennepin County. Finally, in the case of a tie score between two or more grid cells select the grid cell with the highest overall number of crashes.

The selection of combination grid cells involves examining the remaining cells. The combination column chooses among the highest total number of pedestrian and bicycle crashes. Table 9 lists the final grid cell selections.

Table 9 Matrix of Grid Cells included in the Microanalysis

	Combine Crashes	Pedestrian Crashes	Bicycle Crashes
Urban	Hennepin Ave S. and 7th St	Hennepin Ave. S. and W. Lake St.	University Ave. S.E. and 12th Ave. S.E.
	Nicollet Ave. S. and Franklin Ave.	Chicago Ave. S. and E. Lake St.	Portland Ave. S. and 28th St. E.
Suburban	Highway 100 and 42 Ave. N.	Portland Ave. S. and I-494	Nicollet Ave. S. and Old Shakopee Rd.
	Penn Ave. S. and I-494	Zane Ave. N. and 78th Ave. W.	W Broadway Ave. and Bass Lake Rd.

The research team examined each of the selected grid cells to determine the role that attributes of the neighborhood may have played in the crashes, the behavior of all parties prior to the crash, and the precise geographic location (i.e. southwest corner of an intersection) looking for patterns within the individual grid cells and that appeared in multiple grid cells.

Hennepin Ave. S. and 7th St.

The common theme among crashes in this grid cell is left turning vehicles, present in half the total crashes (51% pedestrian and bicycle crashes, 64% bicycle crashes, 47% pedestrian crashes). There are major employment centers in the next couple of blocks to the south of Hennepin Ave. and a large parking ramp one block north, as well as the end of the Cedar Lake Trail. The locations of these facilities in relation to employment centers make this an intersection with high exposure for pedestrians and bicyclists. Pedestrians get the walk signal at the same time as vehicles get the green light. When a vehicle is making a left turn, both the pedestrian and the vehicle have received a signal to proceed. Possible solutions include additional signage and modifying the signals by adding an all red phase allowing pedestrians to cross when no vehicles are crossing the intersection.

Hennepin Ave. S. and W. Lake St.

This intersection is the heart of Uptown and features a pedestrian friendly environment. It features several bars, restaurants, and retail shops. Similar to Hennepin Ave. and 7th St. half of

the pedestrian crashes occur when a driver is making a left turn. Examining the 11 pedestrian crashes in which the vehicle was traveling straight ahead following the roadway, six pedestrians were crossing without a crosswalk or against the signal. The addition of an all red phase to the signals should be considered in order to improve the safety of the pedestrian and bicyclist at the intersection.

Nicollet Ave. S. and Franklin Ave.

The majority of crashes in this cell occur at the intersection of Franklin Ave. and Nicollet Ave. S. or just south of the intersection along Nicollet Ave. One possible explanation is pedestrian movement between the local businesses. On the southeast corner of the intersection is a gas station, and the second property south of Franklin Ave. on the west side of Nicollet Ave. S. is a liquor store. All of the pedestrian crashes occurred during the business hours of the liquor store. This pattern suggests trip chaining may be a contributing factor in pedestrian crashes at this intersection. Trip chaining is the combination of two or more trips and in this case, people cross the street and buy liquor while filling up their tank.

The bicycle crashes could be a result of bicycle traffic filtering towards Nicollet Ave. S., which lacks a bicycle facility. The bicycle traffic arrives from two bicycle facilities in downtown Minneapolis on Marquette Ave. S. and 2nd Ave. S. The bicycle facilities end a few blocks north of I-94, directing most bicyclists who wish to continue north-south to travel along Nicollet Ave. S. as they approach or exit downtown Minneapolis. The street design creates a bottleneck of too many users using a myriad of modes trying to use the traffic lanes resulting in crashes.

Chicago Ave. S. and E. Lake St.

This grid cell contains three intersections along E. Lake St., (Chicago Ave. S., Elliot Ave. S., and 10th Ave S.). At these three intersections, 12 crashes involved turning vehicles. Eight of these 12 crashes included pedestrians crossing with the signal or in a marked crosswalk. In addition, 10 crashes involved a vehicle traveling straight following the roadway. This grid cell, like two previous grid cells, has many small businesses, primarily located along E. Lake St. It is likely that there are people walking to and from those businesses. Currently, E. Lake St. is being rebuilt and one of the primary objectives is to make the corridor safer for pedestrian travel. One of the methods that is being used to accomplish this is installing curb bump outs. Curb bump outs are when the street narrows at the intersection decreasing the amount of time that pedestrians spend crossing the roadway.

University Ave. S.E. and 12th Ave. S.E.

This grid cell is located in the heart of Dinkytown, a neighborhood on the edge of the University of Minnesota's Minneapolis campus. This neighborhood is home to many students and full of bars, restaurants, and other business catering to the University students and employees. The most common behavior leading to a crash in this cell is bicycling across the road. Half the crashes in the grid cell involved a bicycle crossing the road. In addition, nine of 22 people involved in bicycle crashes in this grid cell were 18-24 years old and most likely students.

Nicollet Ave. S. and Old Shakopee Rd.
All crashes in this cell involved vehicles making a right turn, sometimes on red. In all of the bicycle crashes in this grid cell the bicyclist was under the age of 18. The grid cell contains part of the Bloomington Kennedy High School campus. The high school was likely either the origin or the destination for many of the bicycle trips.

Portland Ave. S. and 28th St. E.
The nature of this location may have led to a higher exposure rate for bicyclists. Two major bicycle corridors meet at this intersection. Portland Ave. has an on-street bicycle facility for southbound travelers extending from downtown to south Minneapolis. In the year 2000, phase one of the Midtown Greenway, a grade separated off-street bicycle facility built in the 29th St. trench, opened from the western edge of Minneapolis and ended at 5th Ave. At this point, those using the Greenway must begin using surface streets if they are proceeding to either downtown or Abbot-Northwestern, a large hospital along 28th St. Most of the crashes occurred along 28th St. and specifically half at the corner of 28th St. and 5th Ave.

Bass Lake Rd. and W. Broadway Ave.
At the northwest corner of this intersection is a T-bone median, a design that allows for free right turns. Several crashes at this intersection have been the result of vehicles making a right turn. Vehicles as they approach the free right turn are expecting to stop just prior to where the median ends. The crosswalk, however, lines up with the sidewalk out to the median; as a result, many vehicles are stopping to look for oncoming traffic after passing the crosswalk.

Zane Ave. and 78th Ave.
All of the crashes in this grid cell occurred when a pedestrian crossed the street without a signal or crosswalk. The dominant land uses in the area are multi-family housing and commercial buildings. The city should consider installing a crosswalk across Zane Ave. to allow for safer crossing.

Other intersections with high numbers of crashes
The grid cells containing the intersections of Penn Ave. S. and I-494, Portland Ave. S. and I-494, and Highway 100 and 42nd Ave. all contain a high number of pedestrian crashes for suburban areas. Each of these grid cells contains a freeway intersection. Each of these three grid cells has some similar land use characteristics, multi-family residential dominates one side of the freeway and a concentration of retail stores the other. The close proximity of homes to retail stores encourages walking. However, an apparent conflict occurs when drivers coming off the freeway begin driving on the surface streets where there are pedestrians and bicyclists.

The Penn Ave. S. and I-494 intersection and Highway 100 and 42nd Ave. intersections have been rebuilt in years since this data was collected. Future studies should reexamine these intersections and evaluate whether the reconstruction improved pedestrian and bicycle safety.

Crash trends
The behaviors of vehicles prior to crashes tend to differ between selected grid cells in Minneapolis and Hennepin County. In the select Minneapolis grid cells, 29% of the crashes

entailed vehicles making a left turn compared with only 18% of the crashes in the selected grid cells in suburban Hennepin County. Of the crashes that occurred in the grid cells containing Hennepin Ave. S. and W. Lake St., and Hennepin Ave. and 7th St., more than half the vehicles were making a left turn. In many cases when the vehicle is making a left turn the vehicle has a green light or arrow, the pedestrian has a walk signal, and/or the bicyclist has a green light. In many of these crashes, multiple parties are receiving signals indicating that it should be safe to cross the intersection.

Proximity to schools is a common theme for two of the four bicycle crash hot spots.
The edge of the Bloomington Kennedy High School campus is located in the grid cell containing Nicollet Ave. S. and Old Shakopee Rd. The grid cell at the intersections of University Ave. SE and 12th St. SE borders grid cells containing part of the University of Minnesota campus. Located in this grid cell is part of Dinkytown, which is home to many students. It is possible areas where there are concentrations of people in their late teens-early twenties are more likely to be the location of a bicycle crash. Although most attention about safe routes to schools tends to focus on elementary and middle schools, this shows evidence that it is also important to include high schools and colleges in these programs.

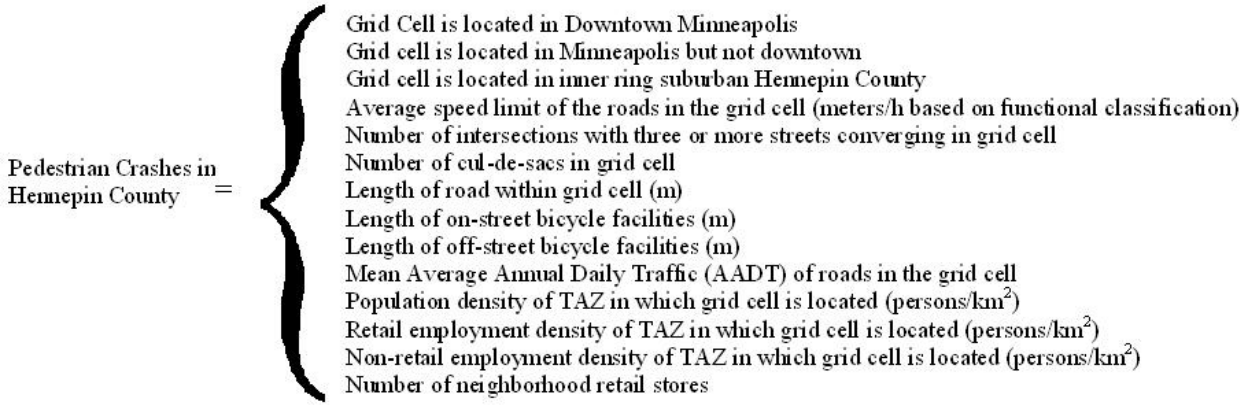
Neighborhood attribute regression analysis

Discerning that pedestrian and bicycle crashes occur at different locations begs the next question: what is the relationship of each to neighborhood attributes? To answer this question we turn to multiple regression analysis. After looking at all the grid cells, we learned that very few have both types of crashes; a mere 485 of the 11,625 (4 percent) grid cells had at least one pedestrian and one bicycle crash. The number of cells containing only pedestrian crashes is 483, while 585 cells contained only bicycle crashes. Since our aim is to compare neighborhood attributes, including grid cells without crashes is important. This decision leads to a skewed distribution of grid cells, since a high number will have a zero value for either pedestrian or bicycle crashes, or both. As a result, a Poisson regression model is used because it is most appropriate when analyzing data with a high percentage of zero values.

We collected a variety of measures using GIS to capture different elements of neighborhood attributes (our explanatory factors). Our approach uses three dummy variables to describe the geographic location of the grid cell. Several of the neighborhood attributes represent the transportation network in the grid cell: average speed limit, number of intersections and cul-de-sacs, length of roadways, length of on-street bicycle facilities, length of off-street bicycle facilities, and mean average annual daily traffic volumes for roads in the grid cell. The remaining four variables—population density, retail employment density, non-retail employment density, and number of neighborhood retail stores in the grid cell—measure various land use features. Each grid cell is assigned a value for each neighborhood attributes; we then estimated Poisson regressions[1] using the same independent variables for both pedestrian and bicycle crashes (See Figure 7) at two different scales (Hennepin County and Minneapolis proper).

[1] Poisson regressions are the most appropriate regression model to use because of the shape of the curve, the large number of grid cells without any crashes.

Figure 7 Explanatory Factors Used to Estimate Regression Model at Different Scales (separate models were used for pedestrian and bicycle crashes)



The models are presented in Table 4. As expected, grid cells located in Minneapolis are more likely to have crashes than grid cells elsewhere in Hennepin County. While many of the variables are significant in all of the models (some of the measures serving as good proxies for increased exposure), there are notable differences between the models.

Looking at the pedestrian models, there is a positive and statistically significant relationship between the number of pedestrian crashes and population density, non-retail employment density, number of retail stores, average speed limit, number of intersections, and length of the on-street bicycle facility. The first three of these measures relate to the density of the area. Densely populated areas, areas with concentrations of non-retail employment, and areas with high number of retail stores are areas that provide more origins and destinations for walking trips. These density variables are likely acting as proxy measures of exposure. The transportation network affects the likelihood that a pedestrian crash will occur. In areas where vehicles are traveling faster and there are more intersections, there tend to be increased pedestrian crashes. The positive correlation between on-street bicycle facilities and pedestrian crashes is most likely a result of locating on-street bicycle facilities in areas that are high in pedestrian and bicycle activity. There is a negative correlation between pedestrian crashes and the mean average annual daily traffic and retail employment density. The concentration of traffic on a relatively small number of roads (freeways) that do not allow pedestrians is most likely a primary reason there is a negative correlation between pedestrian crashes and traffic volume. It is likely that areas with high concentrations of retail employment (i.e., malls and supermarkets) were initially designed to provide access by motor vehicle. As result, many people do not feel comfortable walking to the store.

Focusing on the bicycle models, the relationships between bicycle crashes and population density, number of retail stores, average speed limit, and length of on-street bicycle facilities are statistically significant and positively correlated. Similar to pedestrian crashes, areas with mixed land uses create possible origins and destinations for bicyclists resulting in more trips and crashes. Average speed limit is positively correlated with bicycle crashes. As the speed of vehicles increases the response time of drivers and bicyclists decreases, an increase in the number of crashes could result. Also, as with the pedestrian crashes, the relationship between the amount of on-street bicycle facilities and bicycle crashes likely has to do with the fact that

on-street bicycle facilities were built in areas already experiencing high levels of bicycle activity, or possibly that bicycle activity is being concentrated on these facilities. There is a negative and statistically significant relationship between the number of bicycle crashes and mean average annual daily traffic and retail employment density. The relationship between traffic volume, retail employment, and bicycle crashes is most likely a result of the same factors as the relationship between traffic volume and retail employment and pedestrian crashes.

The length of off-street bicycle facilities is significant in Minneapolis but not in Hennepin County as a whole. The difference in the relationship is most likely a result of the different types of off-street bicycle facilities and the frequency that streets intersect with these facilities. In several of the second and third ring suburban subdivisions off-street bicycle facilities are common. These facilities function almost as sidewalks; they have at-grade crossing for all or most streets they cross. While the presence of off-street facilities was not significant in the Hennepin County model, it is interesting to note that there is a slight positive correlation. In Minneapolis, where there is a significant negative correlation between off-street bicycle facilities and bicycle crashes, most of the off-street bicycle facilities are either grade separated (e.g., Midtown Greenway and Cedar Lake Trail) or follow bodies of water (e.g., Minnehaha Creek Trail, Chain of Lakes Trails, and West River Road Trail). As a result, bicyclists can travel extended distances, at times more than two miles, without crossing a single street. This suggests that off-street bicycle facilities that allow a bicyclist to travel extended distances without crossing a street reduce the possibility of being involved in a crash. A safety benefit does not appear to be present in areas where the off-street bicycle facilities regularly intersect with streets.

Other notable differences are that a grid cell in downtown Minneapolis is more likely to have a pedestrian crash than elsewhere in Minneapolis; this is not the case for bicycle crashes. The following attributes do not reach levels of significance for some of the bicycle models: number of cul-de-sacs, length of roads, non-retail employment density, and length of off street bicycle facilities. Cul-de-sacs and roadway length universally do not matter in each of the pedestrian models.

Table 10 Results of Poisson regressions

	Pedestrian Crashes in Hennepin County			Bicycle Crashes in Hennepin County			Pedestrian Crashes in Minneapolis			Bicycle Crashes in Minneapolis		
Variables	Coef.	z score	P>z		z score	P>z	Coef.	z score	P>z	Coef.	z score	P>z
Located in downtown Minneapolis	2.18493	15.34	0.00*	1.36236	8.18	0.00*	0.31459	2.74	0.01*	-0.08495	-0.56	0.57
Located in Minneapolis	1.83415	19.39	0.00*	1.34165	14.17	0.00*	n/a	n/a	n/a	n/a	n/a	n/a
Located in an inner ring suburb	0.70033	7.18	0.00*	0.67423	8.06	0.00*	n/a	n/a	n/a	n/a	n/a	n/a
Average speed limit on roads	0.05633	9.68	0.00*	0.06986	12.35	0.00*	0.06146	7.9	0.00*	0.06192	7.27	0.00*
Number of Intersections with 3 or more streets converging	0.08739	3.2	0.00*	0.04686	1.57	0.12	0.08176	2.72	0.01*	-0.0347	-0.99	0.32
Number of cul-de-sacs	-0.05731	-0.9	0.37	-0.04082	-0.65	0.51	-0.03549	-0.45	0.65	0.04302	0.5	0.62
Length of road	0.00003	0.31	0.76	0.00006	0.59	0.56	0.00013	-1.21	0.19	-0.00005	-0.43	0.67
Length of on-street bicycle facilities	0.00049	23.36	0.00*	0.00121	20.02	0.00*	0.00057	22.36	0.00*	0.00144	17.89	0.00*
Length of off-street bicycle facilities	-0.00036	-4.13	0.02*	0.00014	-2.73	0.33	-0.00059	-5.38	0.00*	-0.00046	-3.25	0.03*
Mean average annual daily traffic counts for roads segments	-0.00562	4.2	0.00*	-0.00519	0.01	0.00*	-0.00682	0.56	0.00*	-0.00364	0.14	0.00*
Population density of the TAZ	0.00041	11.35	0.00*	0.0004	11.45	0.00*	0.00043	10.19	0.00*	0.00039	9.76	0.00*
Retail employment density of the TAZ	-0.00029	2.93	0.00*	-0.00023	7.06	0.01*	-0.0004	3.23	0.00*	-0.00031	7.77	0.00*
Non-retail employment density of the TAZ	0.00003	-2.28	0.00*	0	0.98	0.99	0.00004	-311	0.00*	0	-2.2	0.89
Number of neighborhood retail stores	0.10925	-6.42	0.00*	0.12463	-53	0.00*	0.10683	-6.47	0.00*	0.12746	-3.21	0.00*
Constant	-6.54913	-24.87	0.00*	-6.92996	-26.92	0.00*	-4.58133	-12.26	0.00*	-4.57545	-11.34	0.00*

** Significant at a 95% confidence interval*

Number of Observations =	11,625	11,625	1,650	1,650

LR $Chi^2(14)$ =	8,061.77	5,134.32	2,382.49	1,375.01
Prob >chi^2 =	0	0	0	0
Pseudo R^2 =	0.4941	0.3798	0.0329	0.2585
Log Likelihood =	-4,126.72	-4,192.15	-2,425.74	-1,972.42

Discussion and conclusion

When designing areas to be pedestrian and bicycle friendly, both modes are often aggregated, suggesting that building an area to be conducive to walking means that it will also be conducive for bicycling and vice versa. Our findings question such an assumption, suggesting that pedestrian and bicycle crashes occur in different geographic locations. One possible reason pedestrian and bicycle crashes are occurring at different locations is that walking trips are not typically as long as bicycle trips. According to the 2002 National Survey of Pedestrian and Bicycle Attitudes and Behaviors, the average walking trip is 1.2 miles and the average bicycling trip is 3.9 miles *(20)*. It is likely that the neighborhood attributes of the origin and/or destination has as much to do with the decision about what mode to use as the attributes along the trip. Walking trips tend to be short and it is more likely that the location of the crash is in the same grid cell as either the origin or destination. Bicycle trips on the other hand are more likely to cross through multiple grid cells. As a result, the neighborhood attributes of the origin and/or destination may have more to with the mode choice than the neighborhood attributes of the area near the crash. Crashes may occur on the periphery of the areas that are conducive to bicycling or in areas in between neighborhoods that are conducive to bicycling.

Another reason walking and bicycling crashes are not occurring in the same location is related to the difference in facilities used for each mode. Sidewalks are the most commonly used facility by pedestrians (45 percent) *(20)*. In many areas it is illegal for bicycles to ride on sidewalks; as a result, the most common facility for bicyclists to ride on are paved roads without shoulders (48 percent of bicycle trips are on paved roads without shoulders) *(20)*. When building or rebuilding neighborhoods it is important to remember the differences in how pedestrians and bicyclists travel. Building a well connected network of sidewalks will decrease the number of pedestrian crashes, but it might not have the same effect on bicycle crashes *(9, 23, 29)*. In addition to building sidewalks for pedestrians, this study shows that it is important to think of ways that bicycle travel can be made safer, possibly through building on-street bicycle facilities and high quality off-street bicycle facilities.

Improving crash data collection practices

A key element to preventing future pedestrian and bicycle crashes is to fully understand the contributing factors to the crashes. Suggestions for improving necessary data collection fall into one of four categories: (1) increase reporting, (2) use all available information, (3) improve the crash report form, and (4) modify the definition of a crash. An important element to understand crashes is to increase the accuracy of reporting. It is also important that those analyzing pedestrian and bicycle crashes use information from additional sources other than crash reports. Make modifications to the crash report forms to obtain better data collection in regards to pedestrian and bicycle crashes. Finally, change the definition of a crash to better reflect pedestrian and bicycle crashes.

Increase reporting of pedestrian and bicycle crashes

Comparing the records of the Minnesota Department of Public Health (DPH) and the Minnesota Department of Public Safety (DPS) revealed an inconsistency in the number of pedestrian and bicycle crashes *(35, 40)*. Other research suggests that under-reporting of pedestrian and bicycle crashes is not unique to Minnesota *(18, 19)*. Several steps can be taken to increase reporting of pedestrian and bicycle crashes, including increasing public awareness of the importance of reporting pedestrian and bicycle crashes, making reporting crashes easier for the public, and developing a form that can be used for crashes that do not occur on a public roadway.

Increasing public awareness of the importance of reporting pedestrian and bicycle crashes should be a part of a pedestrian and bicycle safety outreach programs. Public outreach campaigns focusing on increasing helmet use have been extremely successful in increasing awareness of bicycle safety. Similar methods should be used to increase the public's awareness of the importance of reporting crashes and near misses. The following groups could be used to explain the importance of reporting pedestrian and bicycle crashes.

- Bicycle Groups
- Pedestrian/Bicycle Advocacy Groups
- Schools
- Insurance Companies

Also, the easier it is for people to report a crash or a near miss the more likely they are to report the incident. One way that reporting crashes can be made easier is to create an online form that the public can use to report crashes. The online form could be similar to the one that police officers use to file accident reports. The online form should ask basic questions and be easy to fill out. Another method would be to make paper copies of the form more accessible. In order to do this the *Minnesota Vehicle Accident Report* form should be provided to the above groups as they do education and outreach to the public about the importance of reporting crashes. The *Minnesota Vehicle Accident Report* form should also be made available in hospital emergency rooms and by other health care providers.

Currently police reports are not filed if a crash occurs on an off-street bicycle facility, sidewalk, or elsewhere not on the public right of way. As a result there are a large number of

crashes for which no report is filed. As more off-street bicycle and shared-use facilities are built throughout the state, more and more crashes will occur on these facilities. The form should be user friendly and web accessible. The City of Seattle has a simple online form that allows residents the opportunity to report the location of potholes, http://www.seattle.gov/transportation /potholereport.htm. A form similar to this could be developed to assist in identifying where pedestrian and bicycle crashes are occurring.

Use all available information

Over the past few decades, the ability to collect, store, and match data from different sources has become much easier. It is important that crash evaluation methods take advantage of technological advances. Advancements in GIS have made it much easier to link the locations of crashes to attributes of the neighborhoods where the crash occurs. As part of this study, the research team used data from many different sources and linked it to the crashes. The information gleaned, which is not available on the crash report, enabled the research team to determine the role that neighborhood attributes play in pedestrian and bicycle crashes. The research team used information about the transportation network that it received from or calculated based on the following information from Mn/DOT:

- Speed limit
- Average daily traffic count (for vehicles)
- Presence of on-street bicycle facilities
- Presence of off-street facilities
- Type of road network
  - Grid pattern or cul-de-sacs
  - Intersection density

In addition to the transportation network and information collected by the crash report, characteristics of the neighborhood around the crash can contribute to the likelihood that a crash will occur. Who lives, works, and how many people there are in an area could have an effect on the number and type of pedestrian and bicycle crashes. These can be measured using information from the U.S. Census Bureau, such as:

- Population density
- Employment density
- Demographics of both
  - Residents
  - Employees

Data is available about travel patterns of pedestrians, bicyclists, and motor vehicles in an area. The number of people traveling in a corridor, time of day, and by what mode are examples of data that is available in varying degrees in many areas throughout the state. Each of these factors could play an important role in where crashes occur. The purpose of the trip may play some role in the crash. This information could be collected through interviews or surveys. Through the use of GIS it is now possible to connect information from all of these different sources in order to better understand the underlining conditions that lead to pedestrian and bicycle crashes.

Although there is no current measure for the amount of pedestrian or bicycle activity, efforts should be considered to try and develop feasible means to collect exposure rates, such as:

- Pedestrian miles traveled or bicycle miles traveled (for a city, county, state, or country),
- Average daily pedestrian traffic or average daily bicycle traffic (used for a road, trail, facility, or a segment of them),
- Number of pedestrian or bicycle trips taken in a given time span,
- Time spent walking or bicycling.

Other aspects that are not included in the analysis detailed in this report but could be useful for future examinations of pedestrian and bicycle safety include:

- surrounding land uses,
- if line of sights were obstructed (for driver, pedestrian, or cyclist),
- presence of transit in the area.

Improve crash report form

Minnesota, like most other states, uses a uniform crash reporting form for all crashes that take place on roadways. There are benefits to having only one form but it is important that the form provide police the opportunity to record all pertinent information about the crash in order to make the form better suited for collecting information regarding pedestrian and bicycle crashes.

The first item that should be changed on the crash report form is the name of it. Currently the official name of the crash report form is *Minnesota Motor Vehicle Accident Report*. Two parts of the title are inappropriate: 1) "Motor Vehicle" implies that the form should only be used if the incident involves a motor vehicle, however, since in the state of Minnesota the form is also intended to be used for pedestrian and bicycle crashes it should be expanded to include these other modes. 2) "Accident" implies that chance had something do with the incident. The word "crash" is a more appropriate term and is becoming more widely accepted among transportation and safety professionals because it makes no attempt to explain the circumstances leading up to the incident. A more appropriate name for the form would be *Minnesota Crash Report*.

A second concern with the current crash report form is that multiple questions can seem to be collecting the same information in different manners. This can lead to a miscommunication between the person filling out the crash report and the person evaluating the report. A main reason for the overlap is the crash form collects information at both the individual level (each person or vehicle involved in the crash) and crash level (overall crash). The overlap should be reduced or each question clarified in an effort to increase the accuracy of the data collection and analysis.

In addition to changing the name of the form and rewording existing questions, additional questions should be added to more accurately explain what happened at the time of the crash. Information regarding the signal phase should be added to the crash form. Adding the information about traffic signal phase would require the adding of a single question and seven possible answers:

- Green
- Yellow
- Red
- Right green arrow
- Right yellow arrow
- Left green arrow
- Left yellow arrow

This would aid our understanding of the large number of crashes that occur while the pedestrian is crossing with the signal. Knowing what type of vehicle movement was permitted at the time of the crash could assist traffic engineers and crash analysts in reducing future crashes.

Finally, additional information about the availability and use of facilities would provide valuable information about how effective various infrastructure improvements are at increasing safety. The current form collects this information about sidewalks and crosswalks. This is beneficial if conducting an analysis regarding pedestrian crashes. Similar information should be collected regarding bicycle facilities. Information that would be beneficial to collect includes:

- Riding in bicycle lane on right side of roadway
- Riding in bicycle lane on left side of roadway
- Riding on right side of roadway, no bicycle lane available
- Riding on left side of roadway, no bicycle lane available
- Riding outside of bicycle lane on roadway with bicycle lane

This information could help researchers begin to determine the best place for bicycle lanes on the roadway. Information about how and where people ride bicycles will help experts improve roadway design to better accommodate bicycles turning left from a right-side bicycle lane, or vice versa.

Modify the definition of a crash

Currently a crash should be reported if it results in "…bodily injury to or death of any individual or total property damage to an apparent extent of $1,000 or more…" *(33)*. In motor vehicle crashes it does not take much damage for the dollar amount of property damage to reach $1,000. However, there are likely many pedestrian and bicycle crashes that do not result in death, bodily injury, or $1,000 worth of property damage. Possibly having a lower dollar figure such as $500 for a pedestrian or bicycle crash would provide information about more crashes. These lower dollar amount crashes could rely on online reporting using the form discussed above. In addition to considering lowering the dollar threshold of what qualifies as a crash, methods should be developed to track crashes that do not occur in the public right-of-way.

Summary

After examining crash data collected in Minnesota and other states, the research team has come to a few conclusions. Minnesota is one of the nation's leaders in its ability to collect vital information regarding pedestrian and bicycle crashes. The information collected by both DPS and DOH provide extremely useful information in order to monitor crashes, both the contributing factors and the results of the crash. Notwithstanding that Minnesota is a leader in collecting information about pedestrian and bicycle crashes, several improvements are warranted. As part of the initiative "Toward Zero Deaths," the state of Minnesota is trying to reduce the number of fatalities on roadways. Gaining a better understanding of pedestrian and bicycle crashes is a key component of this initiative. This report not only examined data collection but also the methods by which the data can be used to expand the knowledge of pedestrian and bicycle crashes.

The analysis section of the report detailed four separate types of evaluations and the types of results that each provides. General crash patterns and trends are important for gaining a basic understanding of pedestrian and bicycle crashes. Realizing that pedestrians are different from bicyclists both in the travel patterns and contributing factors to their crashes is important for developing appropriate measures to increase safety of each mode. Through microanalysis, distinct patterns were identified in the areas with the highest concentrations of pedestrians and bicycle crashes. The final type of analysis in the report identified the relationships between neighborhood attributes and pedestrian and bicycle crashes. Knowledge of these relationships should enable identifying potentially dangerous areas for pedestrians and bicyclists before they become dangerous.

After conducting these evaluations using the existing data, the research team was able to identify additional information that would be beneficial when analyzing pedestrian and bicycle crashes. The research team was able to identify four areas where work and resources should be focused in an effort to increase knowledge of pedestrian and bicycle crashes and safety: (1) increase the rate of reporting, (2) use all available information, (3) improve crash report forms, and (4) modify the definition of the crash.

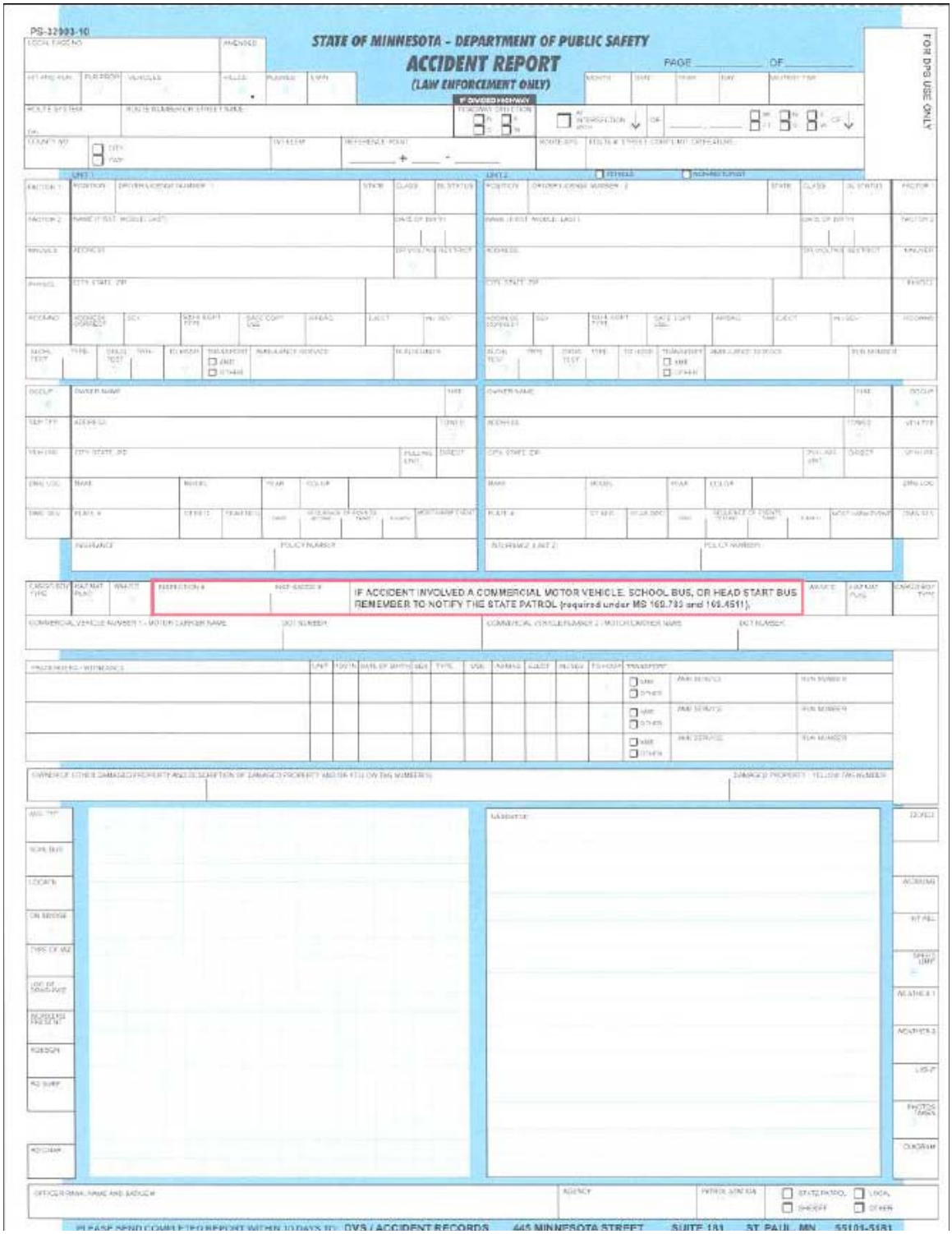
References

1. National Center for Safe Routes to School. International Walk to School: The USA website for International Walk to School events. University of North Carolina Highway Safety Research Center. http://www.walktoschool.org/resources/safety-education.cfm. Accessed: July 28, 2006
2. M. A. Barton. Alaska Bicycle and Pedestrian Plan. Bureau of Transportation Statistics. 1994, http://ntl.bts.gov/DOCS/IGLOO.html. Accessed: July 28, 2006
3. W. D. Cottrell, and D. Pal. *Evaluation of Pedestrian Data Needs and Collection Efforts*. Presented at *82nd Annual Meeting of the Transportation Research Board*. Washington, D.C., 2003.
4. F. Lastennet, J. Sizun, M. Dobrzynski, and L. de Parscau. "Bicycle helmet effectiveness in children: systematic qualitative review." *Archives De Pediatrie*. 8(11). 2001: p. 1246-1250.
5. K. D. Liller, A. Smorynski, R. J. McDermott, N. B. Crane, and R. E. Weibley. "The More Health Bicycle Safety Project." *Journal of School Health*. 65(3). 1995: p. 87-90.
6. A. K. Macpherson, T. M. To, C. Macarthur, M. L. Chipman, J. G. Wright, and P. C. Parkin. "Impact of mandatory helmet legislation on bicycle-related head injuries in children: A population-based study." *Pediatrics*. 110(5). 2002.
7. L. Quine, D. R. Rutter, and L. Arnold. "Persuading school-age cyclists to use safety helmets: Effectiveness of an intervention based on the Theory of Planned Behavior." *British Journal of Health Psychology*. 62001: p. 327-345.
8. L. Svanstrom, G. Welander, R. Ekman, and L. Schelp. "Development of a Swedish bicycle helmet promotion programme - one decade of experiences." *Health Promotion International*. 17(2). 2002: p. 161-169.
9. W. W. Hunter, J. C. Stutts, W. E. Pein, and C. Cox. *Pedestrian and Bicycle Crash Types of the Early 1990's*. U.S. Department of Transportation: Federal Highway Administration. FHWA-RD-95-163. 1996.
10. J. S. Osberg, S. C. Stiles, and O. K. Asare. "Bicycle safety behavior in Paris and Boston." *Accident Analysis and Prevention*. 30(5). 1998: p. 679-687.
11. W. W. Hunter, W. E. Pein, and J. C. Stutts. "Bicycle/Motor Vehicle Crash Types: The Early 1990's." *Transportation Research Record*. 15021995: p. 56-74.
12. M. Rasanen, and H. Summala. "Attention and Expectation Problems in Bicycle-Car Collisions: An In-Depth Study." *Accident Analysis and Prevention*. 30(5). 1998: p. 657-666.
13. E. EilertPetersson, and L. Schelp. "An epidemiological study of bicycle-related injuries." *Accident Analysis and Prevention*. 29(3). 1997: p. 363-372.
14. E. C. Powell, and R. R. Tanz. "Cycling injuries treated in emergency departments - Need for bicycle helmets among preschoolers." *Archives of Pediatrics Adolescent Medicine*. 154(11). 2000: p. 1096-1100.
15. M. Ernst, and B. McCann. Mean Streets 2002. Surface Transportation Policy Project. 2002, http://www.transact.org/PDFs/ms2002/MeanStreets2002.pdf. Accessed: June, 2002

16. National Center for Statistics and Analysis. *Traffic Safety Facts: 2004 Data, Pedalcyclists.* National Highway Traffic Safety Administration. 2005. http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/ncsa/TSF2004/809912.pdf. Accessed: July 18, 2006.
17. U.S. Census Bureau. American FactFinder. U.S. Census Bureau. Website, Http://factfinder.census.gov. Accessed: July 11, 2006
18. J. Pucher, C. Komanoff, and P. Schimek. "Bicycling renaissance in North America? Recent trends and alternative policies to promote bicycling." *Transportation Research Part A-Policy and Practice*. 33(7-8). 1999: p. 625-654.
19. J. C. Stutts, and W. H. Hunter. *Police reporting of pedestrian and bicyclist treated in hospital emergency rooms*. University of North Carolina, Highway Safety Research Center, Chapel Hill, NC. 1996.
20. National Highway Traffic Safety Administration and Bureau of Transportation Statistics U.S. Department of Transportation. National Survey of Pedestrian and Bicycle Attitudes and Behaviors-Highlights Report. 2002, http://www.bicyclinginfo.org/pdf/bikesurvey.pdf. Accessed: February 1, 2005
21. R. J. Jackson, and C. Kochititzky. Creating a Healthy Environment: The Impact of the Built environment on Public Health. 2002, Web site, Http://www.sprawlwatch.org/health.pdf. Accessed: February, 2005
22. P. Schimek. *The Dilemmas of bicycle planning*. Presented at *Joint International Congress of the Association of Collegiate Schools of Planning (ACSP) and the Association of European Schools of Planning (AESOP)*. Toronto, CA, 1996. http://danenet.wicip.org/bcp/dilemma.html. Accessed: February 1, 2005.
23. R. J. Schnieder, and A. J. Khattak. *Identifying Factors Associated with Pedestrians Crash Risk through Spatial Analysis and Perception -based Modeling*. Presented at *Submitted to the Transportation Research Board June 29, 2001*, 2001.
24. R. Ewing, R. A. Schieber, and C. V. Zegeer. "Urban Sprawl as a Risk Factor in Motor Vehicle occupant and Pedestrian Fatalities." *American Journal of Public Health*. 93(9). 2003: p. 1541-1545.
25. Federal Highway Administration U.S. Department of Transportation. Pedestrian and Bicycle Crash Types: Lesson 4. Http://safety.fhwa.dot.gov/ped_bike/unicourse/pdf/swless04.pdf. Accessed: February 1, 2005
26. M. R. Baltes, X. Chu, and M. Guttenplan. *The Role of the Street Environment in How People Cross Roads in Urban Settings*. Presented at *2003 Mid-Continent Transportation Research Symposium*. Ames, IA, 2003.
27. L. B. Crider, J. Burden, and F. Han. *Multimodal LOS-Point Level of Service Project: Final Report*. Department of Urban and Regional Planning, University of Florida, Gainesville, FL. 2001.
28. Gary A. Davis. *A Simple Threshold Model Relating Pedestrian Injury to Impact Speed in Vehicle/Pedestrian Crashes*. Presented at *Transportation Research Board 80th Annual Meeting*. Washington, D.C., 2001.
29. P. A. Koushki, O. I. Al-Saleh, S. Yaseen, A. A. Mohammed, and B. P. Chandrasekhar. *On fatal and Injurious Pedestrian Accidents*. Presented at *80th Transportation Research Board Annual Meeting*. Washington, D.C., 2001.

30. S. Palamrthy, H. S. Mahmassani, and R. B. Machemehl. *Models of Pedestrian Crossing Behavior at Signalized intersections*. Center for Transportation Research, University of Texas at Austin, Austin, TX. 1994.
31. National Highway Traffic Safety Administration U.S. Department of Transportation. *Traffic Safety Facts 1997*. National Highway Traffic Safety Administration U.S. Department of Transportation. 1997.
32. S. S. Zajac, and J. Ivan. *Factors Influencing Injury Severity Of motor Vehicle-Crossing Pedestrian Crashes in Rural Connecticut*. Presented at *80th Transportation Research Board Annual Meeting*. Washington, D.C., 2001.
33. 169.09 Accidents. State of Minnesota, Office of the Revisor of Statutes. 2006, http://www.revisor.leg.state.mn.us/bin/getpub.php?pubtype=STAT_CHAP_SEC&year=current&section=169.09. Accessed: January 3, 2007
34. Office of Traffic Safety Minnesota Department of Public Safety. Minnesota Motor Vehichal Crash Facts. 2003, http://www.dps.state.mn.us/OTS/crashdata/2003Cfacts/CF03-DEF.pdf, April 7, 2005
35. Minnesota Department of Health. Minnesota Injury Data Access System (MIDAS), Hospital Data. http://www.health.state.mn.us/injury/midas/ub92/index.cfm. Accessed: April 7, 2005
36. Office of Traffic Safety Minnesota Department of Public Safety. CODES Project. http://www.dps.state.mn.us/OTS/Crashdata/codes_project.asp. Accessed: April 7, 2005
37. National Highway Traffic Safety Administration U.S. Department of Transportation. The CODES Model. http://www.nhtsa.dot.gov/people/perform/trafrecords/pages/codes/codes.htm. Accessed: April 7, 2005
38. MN City of St. Paul. City Wide Pedestrian Safety Awareness Campaign. http://www.ci.stpaul.mn.us/mayor/newsroom/july10103.html. Accessed: April 7, 2005
39. MN City of Rochester. Recreational Trails. http://www.cohestermn.gov/park/Park_Trails/Trails_page.htm. Accessed: April 7, 2005
40. Minnesota Department of Public Safety. Ped. and Bike Crashes on All Roads, 1998-2002. Electronic Database.

Appendix A. State of Minnesota Accident Report form (Law Enforcement Form)



PS-32993-10

STATE OF MINNESOTA – DEPARTMENT OF PUBLIC SAFETY

ACCIDENT REPORT

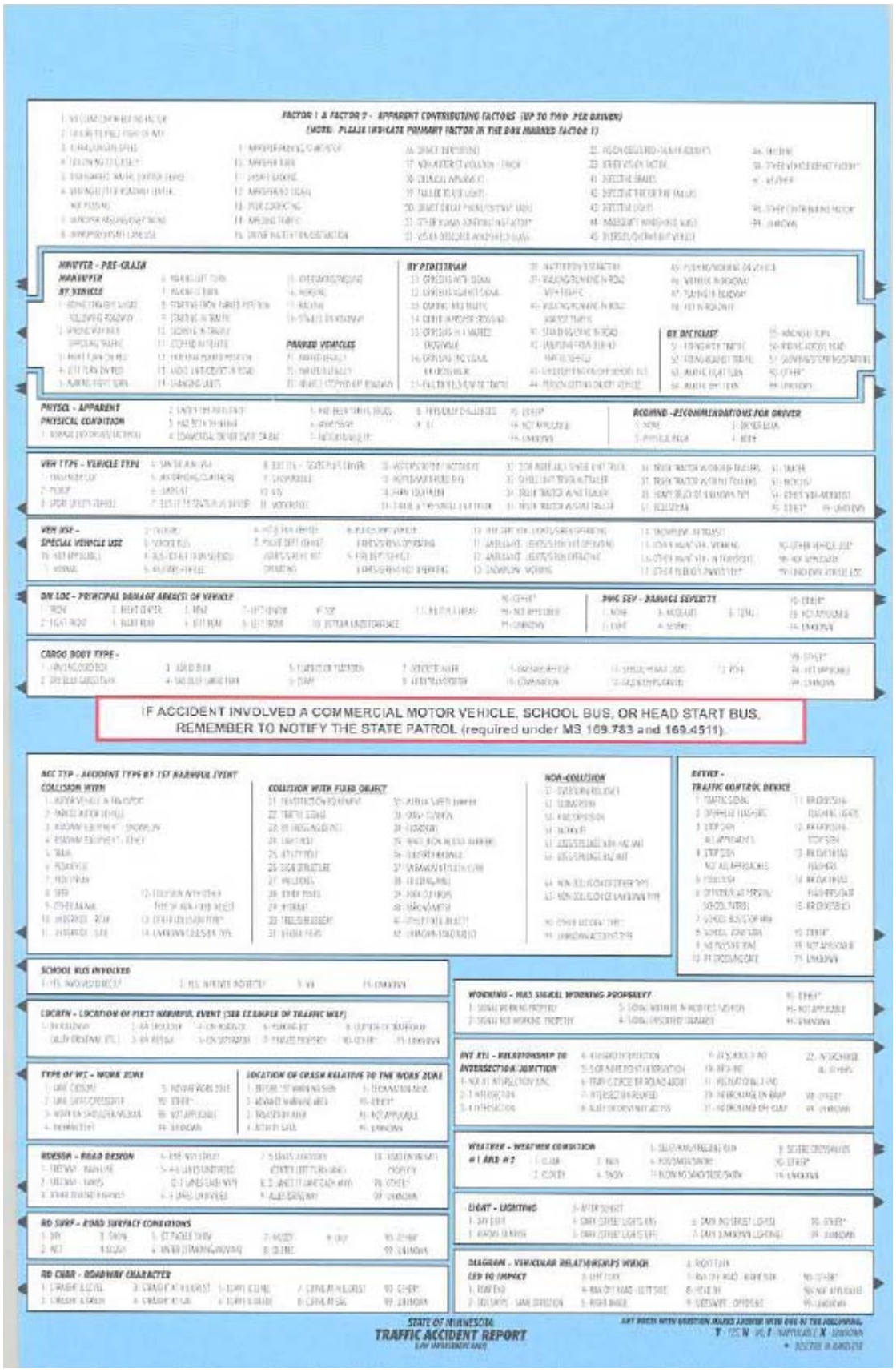
(LAW ENFORCEMENT ONLY)

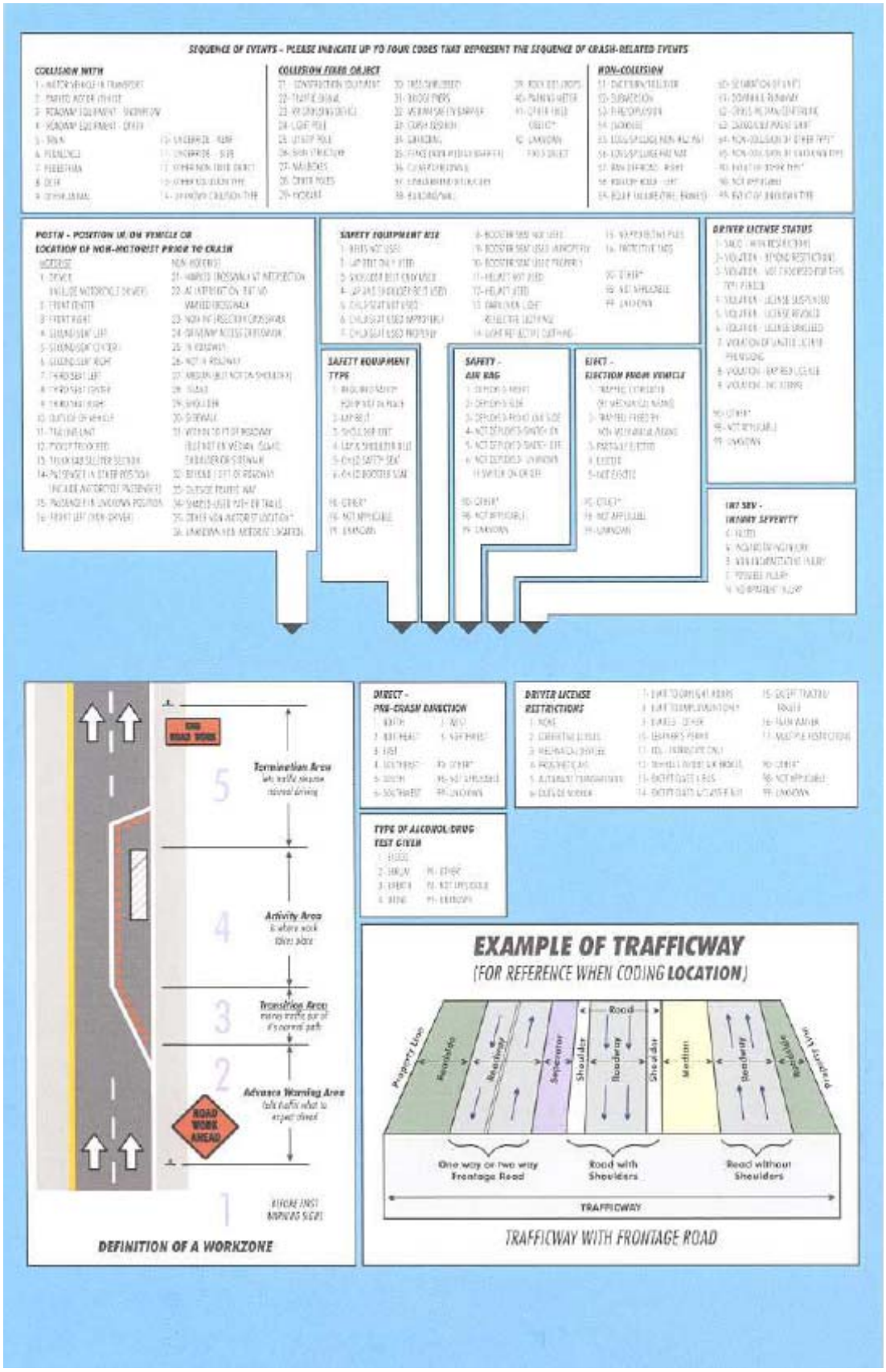
PAGE _____ OF _____

FOR DPS USE ONLY

IF ACCIDENT INVOLVED A COMMERCIAL MOTOR VEHICLE, SCHOOL BUS, OR HEAD START BUS REMEMBER TO NOTIFY THE STATE PATROL (required under MS 169.793 and 169.4511).

PLEASE SEND COMPLETED REPORT WITHIN 10 DAYS TO: DVS / ACCIDENT RECORDS 445 MINNESOTA STREET SUITE 191 ST. PAUL, MN 55101-5191


FACTOR 1 & FACTOR 2 - APPARENT CONTRIBUTING FACTORS (UP TO TWO PER DRIVER)
(NOTE: PLEASE INDICATE PRIMARY FACTOR IN THE BOX MARKED FACTOR 1)
MANEUVER - PRE-CRASH
MANEUVER BY VEHICLE
PARKED VEHICLES
BY PEDESTRIAN
BY BICYCLIST
PHYSCL - APPARENT PHYSICAL CONDITION
RECMND - RECOMMENDATIONS FOR DRIVER
VEH TYPE - VEHICLE TYPE
VEH USE - SPECIAL VEHICLE USE
DIR LOC - PRINCIPAL DAMAGE AREA(S) OF VEHICLE
DMG SEV - DAMAGE SEVERITY
CARGO BODY TYPE -
IF ACCIDENT INVOLVED A COMMERCIAL MOTOR VEHICLE, SCHOOL BUS, OR HEAD START BUS, REMEMBER TO NOTIFY THE STATE PATROL (required under MS 169.783 and 169.4511).
ACC TYP - ACCIDENT TYPE BY 1ST HARMFUL EVENT
COLLISION WITH
COLLISION WITH FIXED OBJECT
NON-COLLISION
DEVICE - TRAFFIC CONTROL DEVICE
SCHOOL BUS INVOLVED
LOCATN - LOCATION OF FIRST HARMFUL EVENT (SEE EXAMPLES OF TRAFFIC WAY)
WORKING - WAS DRIVER WORKING PROPERLY
INT REL - RELATIONSHIP TO INTERSECTION/JUNCTION
TYPE OF WZ - WORK ZONE
LOCATION OF CRASH RELATIVE TO THE WORK ZONE
WEATHER - WEATHER CONDITION #1 AND #2
RDDESGN - ROAD DESIGN
LIGHT - LIGHTING
RD SURF - ROAD SURFACE CONDITIONS
DIAGRAM - VEHICULAR RELATIONSHIPS WHEN LED TO IMPACT
RD CHAR - ROADWAY CHARACTER
STATE OF MINNESOTA
TRAFFIC ACCIDENT REPORT


SEQUENCE OF EVENTS - PLEASE INDICATE UP TO FOUR CODES THAT REPRESENT THE SEQUENCE OF CRASH-RELATED EVENTS
COLLISION WITH
COLLISION WITH FIXED OBJECT
NON-COLLISION
POSITN - POSITION OF/ ON VEHICLE OR LOCATION OF NON-MOTORIST PRIOR TO CRASH
SAFETY EQUIPMENT USE
SAFETY EQUIPMENT TYPE
SAFETY - AIR BAG
EJECT - EJECTION FROM VEHICLE
DRIVER LICENSE STATUS
INJ SEV - INJURY SEVERITY
DIREC - PRE-CRASH DIRECTION
DRIVER LICENSE RESTRICTIONS
TYPE OF ALCOHOL/DRUG TEST GIVEN
END ROAD WORK
Termination Area
Activity Area
Transition Area
Advance Warning Area
ROAD WORK AHEAD
BEFORE FIRST WARNING SIGN
DEFINITION OF A WORKZONE
EXAMPLE OF TRAFFICWAY
(FOR REFERENCE WHEN CODING LOCATION)
Property Line
Roadside
Roadway
Separator
Shoulder
Road
Roadway
Shoulder
Median
Roadway
Roadside
Property Line
One way or two way Frontage Road
Road with Shoulders
Road without Shoulders
TRAFFICWAY
TRAFFICWAY WITH FRONTAGE ROAD

Appendix B. Minnesota Motor Vehicle Accident Report form (Citizen Report Form)

MINNESOTA MOTOR VEHICLE ACCIDENT REPORT

PS32001 - 08

The information on this report is used to help build safer roads.

Every driver in a crash involving $1,000 or more in property damage, or injury or death, MUST COMPLETE this form and send it to Driver and Vehicle Services within 10 days. Failure to provide this information is a misdemeanor under Minnesota Statute 169.09, subdivision 7. See reverse side for address and for data privacy information.

DRIVER'S TRAFFIC ACCIDENT REPORT — E-form available at www.mndriver.fo.org — DO NOT DETACH

A — TIME - PLACE

DATE OF ACCIDENT: MONTH | DAY | YEAR | DAY OF WEEK | TIME ☐AM ☐PM | TOTAL # OF VEHICLES INVOLVED | COUNTY | NAME OF CITY OR TOWNSHIP ☐CITY ☐TWP

ACCIDENT OCCURRED (Choose only one box below and proceed to the right)
- ☐ AT INTERSECTION →
- ☐ NOT AT INTERSECTION →
- ☐ IN PARKING LOT →

LOCATION OF ACCIDENT: ON _____ (Street Name or Route Number) AT _____ (Street Name or Route Number)

LOCATION OF ACCIDENT: ON _____ (Street Name or Route Number) DISTANCE _____ (Number) ☐MILES ☐FEET DIRECTION ☐N ☐E ☐S ☐W FROM _____ (Street Name or Route Number)

DESCRIBE LOCATION:

B — MY VEHICLE

DRIVER: DRIVER'S FULL NAME | ADDRESS | CITY | STATE | ZIP CODE | INJURY CODE*

DRIVER'S LICENSE NUMBER | CLASS | STATE OF ISSUE | DATE OF BIRTH | SEX

VEHICLE: OWNER'S FULL NAME | ADDRESS | CITY | STATE | ZIP CODE

LICENSE PLATE NUMBER | YEAR | STATE OF ISSUE | PARTS OF VEHICLE DAMAGED | ESTIMATE COST TO REPAIR $

TYPE (CAR, PICKUP, VAN, SUV, MOTORCYCLE, TRUCK, ETC.) | MAKE | MODEL | YEAR | COLOR | # OF OCCUPANTS

INSURANCE: GIVE FULL LIABILITY INSURANCE INFORMATION OR IT WILL BE ASSUMED YOU DID NOT HAVE INSURANCE

PLEASE COPY FROM POLICY — NAME OF INSURANCE COMPANY (NOT AGENCY) _____

Automobile Insurance POLICY NUMBER _____ Policy Period: from MONTH | DAY | YEAR to MONTH | DAY | YEAR

Name of Policy Holder _____ Address _____

Your Signature X _____

* SEE CODES ON REVERSE SIDE

C — OTHER VEHICLE

OTHER DRIVER: FULL NAME | ADDRESS | CITY | STATE | ZIP CODE | INJURY CODE*

DRIVER'S LICENSE NUMBER | CLASS | STATE OF ISSUE | DATE OF BIRTH | SEX

OTHER OWNER: FULL NAME | ADDRESS | CITY | STATE | ZIP CODE

LICENSE PLATE NUMBER | YEAR | STATE OF ISSUE | PARTS OF VEHICLE DAMAGED | ESTIMATE COST TO REPAIR $

TYPE (CAR, PICKUP, VAN, SUV, MOTORCYCLE, TRUCK, ETC.) | MAKE | MODEL | YEAR | COLOR | # OF OCCUPANTS

IF MORE THAN TWO VEHICLES - FILL IN SECTION "C" ON SEPARATE FORM AND ATTACH

ENTER NUMBER FOR CORRECT RESPONSE IN EACH BOX BELOW

TYPE ACCIDENT | COLLISION WITH FIXED OBJECT | MANNER OF COLLISION

YES NO — WORK ZONE RELATED (IF CORRECT RESPONSE) — DID THE DRIVER OCCUR IN A WORK ZONE?

YES NO — IF YES, WERE WORKERS PRESENT?

SPEED LIMIT: ENTER POSTED SPEED LIMIT (NOT YOUR TRAVEL SPEED)

ROAD SURFACE | WEATHER | LIGHT CONDITION

TRAFFIC CONTROL DEVICE | ROAD CHARACTER

ACTIONS / MANEUVERS PRIOR TO ACCIDENT | DIRECTION OF TRAVEL, BEFORE ACCIDENT

CONTINUE REPORT ON OTHER SIDE

WAS THERE A PEACE OFFICER AT THE SCENE? ☐YES ☐NO

IF YES, WHAT DEPARTMENT (NAME OF CITY, COUNTY OR STATE PATROL) _____

As required by Minnesota Data Privacy Act you are hereby informed that the information requested on this form is collected pursuant to statute to provide statistical data on traffic accidents. The time and place of the accident, names of parties involved and insurance information may be disclosed to any person involved in the accident or to others persons as specified by law. This written report cannot be used against you as evidence in any civil or criminal matter and your version of how the accident happened is confidential.

SEAT
OCCUPANT SEAT POSITION CODES

1 - DRIVER
(INCLUDE MOTORCYCLE DRIVER)
2 - FRONT CENTER
3 - FRONT RIGHT
4 - SECOND ROW SEAT LEFT
5 - SECOND ROW SEAT CENTER
6 - SECOND ROW SEAT RIGHT
7 - THIRD ROW SEAT LEFT
8 - THIRD ROW SEAT CENTER
9 - THIRD ROW SEAT RIGHT
10 - OUTSIDE OF VEHICLE
11 - TRAILING UNIT
12 - PICKUP TRUCK BED
13 - TRUCK CAB SLEEPER SECTION
14 - PASSENGER IN OTHER POSITION
(INCLUDE MOTORCYCLE PASSENGER)
15 - PASSENGER IN UNKNOWN POSITION
16 - FRONT LEFT (NON-DRIVER)

TYPE
SAFETY EQUIPMENT TYPE CODES

1 - NO SAFETY EQUIP IN PLACE

2 - LAP BELT
3 - SHOULDER BELT
4 - LAP & SHOULDER BELT
5 - CHILD SAFETY SEAT
6 - CHILD BOOSTER SEAT

98 - NOT APPLICABLE
(MOTORCYCLE, SNOWMOBILE, ECT)

USE
RESTRAINT DEVICE USED CODES

1 - BELT NOT USED
2 - LAP BELT ONLY USED
3 - SHOULDER BELT ONLY USED
4 - LAP AND SHOULDER BELT USED

5 - CHILD SEAT NOT USED
6 - CHILD SEAT USED IMPROPERLY
7 - CHILD SEAT USED PROPERLY
8 - BOOSTER SEAT NOT USED
9 - BOOSTER SEAT USED IMPROPERLY
10 - BOOSTER SEAT USED PROPERLY

11 - HELMET NOT USED
12 - HELMET USED

AIR BAG
SAFETY EQUIPMENT USED CODES

1 - DEPLOYED - FRONT
2 - DEPLOYED - SIDE
3 - DEPLOYED - FRONT AND SIDE
4 - NOT DEPLOYED - SWITCH ON
5 - NOT DEPLOYED - SWITCH OFF
6 - NOT DEPLOYED - UNKNOWN IF SWITCH ON OR OFF

98 - OTHER DEPLOYMENTS
99 - NOT APPLICABLE
(MOTORCYCLE, SNOWMOBILE, ECT)

EJECT
EJECTION CODES

1 - TRAPPED, EXTRICATED (BY MECHANICAL MEANS)
2 - TRAPPED, FREED BY NON-MECHANICAL MEANS
3 - PARTIALLY EJECTED
4 - EJECTED

5 - NOT EJECTED OR TRAPPED

INJURY
INJURY CODES

K - KILLED
A - INCAPACITATING INJURY
B - NONINCAPACITATING INJURY
C - POSSIBLE INJURY
N - NO APPARENT INJURY

MY VEHICLE: DRIVER AND PASSENGERS INFORMATION:

			DATE OF BIRTH (OR AGE)	SEX	SEAT	TYPE	USE	AIR BAG	EJECT	INJURY
DRIVER >>>>>>>>>>>>>>>>>>>										
PASSENGER NAME	CITY	STATE	DATE OF BIRTH (OR AGE)	SEX	SEAT	TYPE	USE	AIR BAG	EJECT	INJURY
PASSENGER NAME	CITY	STATE	DATE OF BIRTH (OR AGE)	SEX	SEAT	TYPE	USE	AIR BAG	EJECT	INJURY
PASSENGER NAME	CITY	STATE	DATE OF BIRTH (OR AGE)	SEX	SEAT	TYPE	USE	AIR BAG	EJECT	INJURY

DESCRIBE ACCIDENT IN SUFFICIENT DETAIL BELOW TO DISCLOSE CAUSES.

DESCRIBE WHAT HAPPENED:

DIAGRAM WHAT HAPPENED:

INDICATE NORTH BY ARROW

DAMAGE TO PROPERTY OTHER THAN VEHICLES: (MAILBOX, FENCE, SIGNPOST, GUARDRAIL, ETC.)

DESCRIBE PROPERTY DAMAGED:	NAME OF PROPERTY OWNER:	ESTIMATE COST OF REPAIR: $

SIGN HERE X _____
SIGNATURE OF PERSON SUBMITTING REPORT IS REQUIRED

ADDRESS

DATE OF REPORT

MAIL THIS REPORT TO:
DVS / ACCIDENT RECORDS
445 MINNESOTA STREET, SUITE 161
ST. PAUL, MN 55101-5161

DO NOT DETACH

THIS SECTION IS TO BE FILLED OUT BY THE HOME OFFICE OF THE INSURANCE COMPANY ONLY

(Commissioner of Public Safety to forward this form to Insurance Company for verification)

ATTENTION INSURANCE COMPANY: PLEASE RETURN THIS FORM TO THE ADDRESS BELOW WITHIN 15 DAYS **ONLY IF POLICY WAS NOT IN EFFECT AT THE TIME OF THE ACCIDENT.**

To: **Department of Public Safety**
Driver and Vehicle Services
Accident Records
445 Minnesota Street, Suite 181
St. Paul, Minnesota 55101-5181

We hereby advise you that the policyholder named on the reverse side did **NOT** have a policy in effect at the time of accident.

Date:_____ By:_____

Authorized Representative of Insurance Company

DO NOT FILL OUT SHADED BOX ABOVE - COMPLETE ALL INFORMATION ON SHEET BELOW.

DRIVER'S TRAFFIC ACCIDENT REPORT E-form available at www.mndriveinfo.org DO NOT DETACH

A TIME - PLACE

DATE OF ACCIDENT: MONTH / DAY / YEAR | DAY OF WEEK | TIME ☐ AM ☐ PM | TOTAL # OF VEHICLES INVOLVED | COUNTY | NAME OF CITY OR TOWNSHIP ☐ CITY ☐ TWP

ACCIDENT OCCURRED (Choose an answer box below and proceed to the right)
- ☐ AT INTERSECTION →
- ☐ NOT AT INTERSECTION →
- ☐ IN PARKING LOT →

LOCATION OF ACCIDENT: ON: _____ (Street Name or Road Number) AT: _____ (Street Name or Road Number)

LOCATION OF ACCIDENT: ON: _____ (Street Name or Road Number) DISTANCE _____ (Number) ☐ MILES ☐ FEET DIRECTION ☐ N ☐ E ☐ S ☐ W FROM: _____ (Street Name or Road Number)

DESCRIBE LOCATION:

B MY VEHICLE

DRIVER

DRIVER'S FULL NAME | ADDRESS | CITY | STATE | ZIP CODE | INJURY CODE*

DRIVER'S LICENSE NUMBER | CLASS | STATE OF ISSUE | DATE OF BIRTH | SEX

VEHICLE

OWNER'S FULL NAME | ADDRESS | CITY | STATE | ZIP CODE

LICENSE PLATE NUMBER | YEAR | STATE OF ISSUE | PARTS OF VEHICLE DAMAGED | ESTIMATE COST TO REPAIR $

TYPE (CAR, PICKUP, VAN, SUV, MOTORCYCLE, TRUCK, ETC.) | MAKE | MODEL | YEAR | COLOR | # OF OCCUPANTS

INSURANCE

GIVE FULL LIABILITY INSURANCE INFORMATION OR IT WILL BE ASSUMED YOU DID NOT HAVE INSURANCE

PLEASE COPY FROM POLICY

NAME OF INSURANCE COMPANY (NOT AGENCY) _____

Automobile Insurance POLICY NUMBER _____ Policy Period: from MONTH / DAY / YEAR to MONTH / DAY / YEAR

Name of Policy Holder _____ Address _____

Your Signature X _____

Appendix C. Explanatory factors used in the regression analysis

The following identifies the location of necessary data and explains the procedures to attach value to the explanatory factors.

Length of road: Obtain a GIS shapefile that contains roads in Hennepin County (roads file) from Mn/DOT. Intersect the roads file with the grid cell layer, which ensures no road segment is in more than one grid cell. Use GIS to spatially join the roads file and grid cells. As an output GIS returns the sum of the length of the roads in the grid cells.

Length of on-street bicycle facilities: Uses the same process as *Length of Road*.

Length of off-street bicycle facilities: Uses the same process as *Length of Road*.

Average speed limit of the roads in the grid cell: The previously mentioned roads file divides roads into three categories: highways, county roads, and local streets. Highways include all Minnesota state highways and US highways. County roads include the county network, and local streets contain all remaining roads. In Hennepin County, most local arterials are county roads. Determine the length of each road classification within each grid cell. Each category is given an average speed, 55 mph for highways, 45 mph for county roads and 30 mph for local streets. The following equation shows the average speed calculation.

$$\text{Average speed limit for roads in the grid cell} = \frac{(L_h * 55 \text{ mph}) + (L_c * 45 \text{ mph}) + (L_l * 30 \text{ mph})}{(L_h + L_c + L_l)}$$

Where:

L_h = Length of Highway in Grid Cell

L_c = Length of County Road in Grid Cell

L_l = Length of Local Street in Grid Cell

Mean AADT of roads in the grid cell: Multiply the length of the road segment in the grid cell by the AADT for each road segment. Sum this value for all road segments in the grid cell and divide by the total length of road in the cell. In equation form:

$$\text{Mean AADT of roads in the grid cell} = \frac{\sum (\text{AADT for road segment} * \text{length of road segment})}{\text{Length of road in Grid Cell}}$$

Number of intersections: Use the original roads file, prior to intersecting it with the grid cells, to determine the number of intersections within each grid cell. Divide the roads file into road segments wherever roads intersect. Identify the beginning and end-points of each of these road segments, then count and record the number of road segments that converged at that location. If the number of meeting road segments is three or greater, define that location as an intersection. If the number of road segments is two, consider that location either a bend in the road or some other function of creating the map. If there is only one road segment, the location is a cul-de-sac. Define the number of intersections in a grid cell as the intersection of three or more roads segments.

Number of cul-de-sacs: Obtain the number of one-road segments in each grid cell from the *number of intersections* procedure.

Population density: Population density is from 2000 Traffic Analysis Zone (TAZ) data. This data contains the population for the TAZ, as well as the retail and non-retail employment. In order to determine density, assume population, retail employment, and non-retail employment are uniformly distributed across the TAZ, intersect the TAZ data shapefile (TAZ file) with a shapefile containing all of the lakes and rivers in Hennepin County. This

removes any part of the TAZ that includes water from future calculations. Calculate the area of each TAZ and then divide the population by the area to obtain the TAZ population density.

Population Density for the TAZ = Population / (Area of TAZ – Water)

The final step in determining population density is to account for grid cells that contain more than one TAZ. To do this, use the mean of the population densities for each TAZ. To determine the mean population density for each grid cell, divide the number of TAZ in the grid cell by the sum of the population densities for the TAZ in the grid cell.

$$\text{Population Density} = \frac{\sum \text{Population Density for the TAZs in Grid Cell}}{\text{\# of TAZs in Grid Cell}}$$

Retail employment density: Use the same process as *population density*.

Non-retail employment density: Use the same process as *population density*.

Number of neighborhood retail stores: Count the number of neighborhood retail stores in the grid cell (grocery stores, restaurants, and clothing stores).

Dummy variables for location: Assign each grid cell a category based on its location in Hennepin County (See Figure 6). A few rules exist for cells that border two categories. Code a grid cell that borders Minneapolis and an inner ring suburb as part of Minneapolis. Similarly, code a cell that borders an inner ring and outer ring suburb as an inner ring suburb. In addition, code unincorporated parts of Hennepin County, Minneapolis/St. Paul Airport (south eastern portion of the county) and Hassan Township (northwest corner of the county) as outer ring suburban.

Appendix D. Transcript from Symposium *New Dimensions in Pedestrian and Bicycle Crashes in Minnesota*

April 14, 2006

Bob Johns: Good morning, everyone. I'm Bob Johns. I'm director of the Center for Transportation Studies here at the University of Minnesota, and want to welcome you all to this symposium.

Before I start in on any welcoming words, since it's a small, select group here, we should hear who's here. If we could go around, strand up and say you name and organization, as a starting point that would be great.

[Nearly all self-introductions inaudible, without microphone]

Respondent: I'm [inaudible]. I represent Mn/DOT [inaudible].

Donna Allen: I'm Donna Howard. I'm the director of the office [inaudible], and we are very lucky to have devices and headsets in our group.

Dan Brenner: Dan Brenner, I work for Traffic Safety at Mn/DOT, primarily in [inaudible] zones and school zones.

Darryl Anderson: I'm Darryl Anderson with Mn/DOT, and I'm [inaudible].

Herby Beck: I'm Herby Beck. I'm a retired from the Minneapolis Police and do a lot of bike training for police here and in different places throughout the country.

Pat Haralson: Pat Haralson and I'm from the Minneapolis Police Department.

Respondent: I'm [inaudible] with the police department, and I also do [inaudible]

Thomas Smith: I'm Thomas Smith and [inaudible]

Respondent: [inaudible]

Respondent: I'm [inaudible] and work in the research department, and I'm filling in for [inaudible], who is one of the projects.

Respondent: Good morning, I'm [inaudible] and work for the Minnesota [inaudible] Council and [inaudible]

Michelle Cook: I'm Michelle Cook. I went to [inaudible]

Respondent: [inaudible]

Respondent: I'm [inaudible], director of research [inaudible].

Susan Foret: Hi, I'm Susan Foret, and I teach and work here at the Humphrey. I commute to work three days, and I nearly had an accident this morning with my ride in. It was very close.

Johns: You found the right symposium to come to.

Steve Martin: I'm Steve Martin, traffic engineer for the City of St. Paul.

Ed [inaudible]: Ed [inaudible] with the [inaudible] police working in traffic.

Ben [inaudible]: Ben [inaudible] with the Minnesota Department of Natural Resources [inaudible]

Tim [inaudible]: Tim [inaudible], Federal Highway Administration.

Lynette Rochelle: Lynette Rochelle, Mn/DOT [inaudible]

Respondent: [inaudible], Metropolitan Council.

Don [inaudible]: Don, Department of Public Works.

Respondent: [inaudible], downtown Minneapolis [inaudible]

Respondent: [inaudible], traffic engineer with the City of Rochester.

Respondent: [inaudible]

Respondent: [inaudible]

Respondent: [inaudible]

Respondent: [inaudible]

Paul [inaudible]: Paul [inaudible], Department of Planning, University of Toronto.

Steve Clark: I'm Steve Clark, one of the managers of the new Walking and Bicycling program of the Transit [inaudible] in the City of St. Paul.

Respondent: [inaudible], University of Minnesota light sports coordinator.

Dan [inaudible]: Dan [inaudible], DNR metro waterways and CT Metro [inaudible]

Respondent: [inaudible]

Tom Borton: Tom Borton, [inaudible]

Respondent: [inaudible]

Johns: Great, what a great group. There are engineers, safety people, there are enforcement people, and at all levels of government, and the research community is here, so a great interdisciplinary group here to talk about Bikes and Peds.

Just a little background on CTS, we try to advance transportation knowledge through research education outreach here at the University of Minnesota, which is a land grant university. It's a pretty big week for Bikes and Peds because we had one of our major outreach events on Sunday and Monday with our Oberstar Forum, which focused on non-motorized transportation, and some of you were there.

If you heard his speech, he talked about the tsunami that's coming. There is this trend that is not seen get, a wave below the surface transit, with biking and walking. I don't know if that is true yet, but he had a lot of passion, and if that is the case, certainly a gathering like this is forward looking to the future of this growth and popularity, in the growth and interest in these other modes. And that growth makes safety an important issue, so what you are addressing today and will hear about is evidenced by our guests back there—it's growth and importance.

We work with different academic departments. The University of Minnesota is a large research university and there are a lot of resources to call on for transportation related research. We work with over 25 different departments in a variety of disciplines, with strong partnership with the Humphrey Institute here, and strong workings with the Institution of Technology and Engineering, but also others, economics, geography, natural resources and many different groups.

What we are trying to do is what the University does best, is not necessarily create the final solution. It's trying to create knowledge and get that knowledge out to people like you because you are the ones implementing innovations, new problem solving approaches and so on. So what you will hear today is a lot of knowledge, through the research not only of our researchers but from other universities, and then have some dialogue, so that you will go away smarter and you can address issues in safety with Bikes and Peds.

Our recent emphasis at CTS is we work with individual researchers, and we're trying to attract funding, but our recent emphasis has been to create and foster programs, which are a series of research projects. What we try to do when working jointly with an academic department is bring in not only fostering research, which researchers do so well with out graduate students and bringing funding to help support them, but also, to provide some coordination services, some relationships with different sponsors, leveraging other funds and then a strong role in outreach. So putting on events like this, like the Oberstar Forum, as well as newsletters, web and so on, and many of you get that information. When we work with these programs, we are trying to enlarge the university role on important issues.

This symposium this morning intersects with three programs that we have going on that some of you may have heard about, and I thought I would just describe them because you will be hearing more about them.

One is the Access to Destinations Program, which is an interdisciplinary program sponsored by Mn/DOT, my Hennepin County, and also, by the McKnight Foundation, to look at accessibility. It is on our website if you want to read in more depth, and Kevin is a primary researcher on that. We are trying to develop accessibility measures that supplement the congestion measures that you are all familiar with. TTI every year puts out congestion measures, Mobility Measures, they call that. Our researchers think that needs more information to really tell how the transportation system is working. In fact, how well the transportation and land use system is working.

What our researchers plan to do is develop a number of tables or maps that have rows as modes, auto, transit, biking and pedestrian, and the last two are very important for this symposium, and then the columns are destination activities. These include employment, shopping, schools, recreation and entertainment and so on. In the cells are accessibility measures saying "For this location in the metro area, how accessible by this mode are you to this destination activity?"

They will track that for the last ten years because in the last ten years we have increased congestion remarkably, but we don't know how land use has changed, how people in their residences have adjusted to that congestion, and particularly, how businesses and destinations have changed given that congestion.

We think a primary purpose of the transportation system is to provide that accessibility and it needs to be coordinated with that land use changing. So we anticipate a new set of knowledge, particularly in the Bikes and Peds area give some information that can be compared to auto and transit, on what the level of accessibility in different parts of our region and how is it changing. It then helps drive the decision makers like yourselves, to ask where we need to invest, in different modes, to improve accessibility, or where we need to try and influence land use to improve destination and their connections to transportation.

That is one big program that you will hear more about that is very relevant to the Bikes and Peds discussion today.

Another big joint program we have is with the Humphrey Institute and is on rural safety. Through SAFETEA-LU, we received funding for a Rural Safety Center of Excellence, the state and local policy program headed by Lee Munnich here, will lead that effort, and we will be in close partnership with him and his staff and researchers. It is looking at safety more from a policy perspective, but trying to incorporate what we know about technology and human factors and how we can accelerate and improve safety through research throughout the region and through other activities. Certainly, bicycle and pedestrian safety will be a component of that, so you will hear more about that.

And finally, the third one is a partnership more that we have with the Department of Public Safety and Minnesota DOT, and you will hear later from Cathy Swanson, if not others, about that program. It is the Toward Zero Deaths Program, which I think may of you are familiar with.

Our role on that is trying to bring to bear the research that we already have going on, and we have federal funds for ITS institute that is researching technologies to enhance safety, and also, behavior, Human Factors research, through our drivers simulation lab of the Human's First program. Trying to bring those findings to bear to programs and policies that Mn/DOT and the Department of Public Safety can foster with the legislature, with the administration, to enhance safety, so Bike and Ped will play a role in that as well.

Those are three big programs that intersect with this event today that you will be hearing more about. Steve is here from Transit-Livable Communities. They have a big grant on non-motorized transportation, one of four metropolitan areas in the country on SAFETEA-LU, and we anticipate helping out on that as well. That is still to be defined by the four communities and FHWA, but that could be another program that intersects here.

So if that tsunami comes, we are well positioned. We have excellent research capabilities here at the University, and we have strong support of state agencies and a strong interest by several of the others of you, who are very important stakeholders in this effort.

With that, I'll turn things over to Darryl Anderson, who will pinch hit for Julie Skallman this morning because she has the flu.

Darryl Anderson: It has been a wild week, starting with the Oberstar Forum and now this group. We learned a lot in the Oberstar Forum and had lots of interactions, but this is my size of group and the kind of environment where I like to see that I like to see these kinds of discussions take place.

When I took this Bike-Ped job four or five years ago, I set out four goals for myself. Of course, I didn't tell anybody what those goals were because I like to be subversive, and then if I don't meet them, I'm not held accountable.

One was to get our internal design guidance together. We had a lot of good guidance within the department and from FHWA, but it was here and there and was scattered. It was different vintages and some of the wine was turning bad. We are well on our way now, with *Bob Works and our great staff of getting that guidance just about all up to date and in place.

Another endeavor was starting some active promotional activities, promoting bike commuting and safety, and we are well on our way to doing that, with Donald *Enberg's help and Donna Allen's, who has a good core group of materials that we can use for dissemination amongst the public.

A third goal was to get the state bicycle advisory committee in a good position and empower them and make them the single point of contact statewide, and many members of that committee are here this morning and many of us were in the department late last night with our bimonthly meeting, so I thank you for your continued support on that.

The fourth goal I had was to try and see if there was someway—I'm an ex-researcher from the University, in one of my distant pasts, and I have a passion for research and I have a passion

for students and where they go after they are students. I had this notion, can we somehow get something going at the University that helps supports non-motorized effort in transit? There was some smattering of activity over here, but it didn't have a focus, so in a subversive way, we started to get some funding to come here.

Kevin and I had a lunch together out here in the foyer, maybe four years ago, when you first came to Minnesota. We started the discussions, and now his program has grown to 12 past and active projects. A couple of early works on economic impact of bicycling were done by his associate, Gary Barnes, under Lee Munnich, and I'm extremely proud of what you folks have done.

That is just a little of where we were coming from, or I was coming from in trying to promote non-motorized transportation in the state, so it is especially humbling to me today to see the research thing really take hold and all of you here.

Safety Rule is the national transportation funding authorization, and the key word there is *Safety.* This is what it is all about. That is the highest priority for the transportation agencies around the country is the safety on roadways. Our transportation organizations are increasingly coming to the realization that bikes and peds are legal activities on our roads and throughout our system, and they need to be as concerned about the safety of those non-motorized transports as they are with vehicle transports. That is what this is all about today, to try and find some answers to some tough questions.

How this project came to be was I was standing outside Donna Allen's office, one of my many good bosses in the department, and she had just returned from a meeting, and apparently something came up about ped and bike safety and she didn't have the answer, so she comes out with 'what is the answer?' Well, we don't have answers, Donna, I'm sorry. We've got good data on fatalities—we don't get it collected and discriminated right away—and serious crashes, but all the rest of the stuff, the property damage is fairly low, so it's under the radar of the data collection systems.

So she directed my, why don't you do something about that, Darryl.

So we checked with Sue Lodahl group, and we were just at the end of the solicitations cycle for projects, which the department does annually for small research grants, and we slipped in, with Mary Jackson's help and a few others, a problem statement on bike and ped safety. And low and behold, with a little of behind the scenes effort, it got funded and here we have the work today, so, Kevin, thanks for picking up on that, and I hope this is the first in a continuation of investigations on what's going on with bike and ped safety because we need to be concerned about that, and the better we can make that understood, the more cycling and walking and things will happen around the state, and become a national leader.

Thanks to all of you for being here.

One more thing, besides being a new father, the other thing that bonded us is he is a high grade triathlete. He's finished very high in the Hawaiian Ironman.

Kevin Krizek: Thanks, Darryl. That was a previous life, before I actually had to become a faculty member here. Thanks, Bob. Thanks, Darryl. I appreciate the comments. So, yes, 60 or so of us are gathering this morning to discuss a relatively narrow topic, but a really important topic.

As we just heard, the policy significance focusing on these modes is really increasing. There are a variety of different reasons why people bicycle or don't bicycle or walk or don't walk, and safety is primary among them. So to the extent that we can focus our efforts on this and get a more mature understanding of these issues, we can hopefully induce higher rates of such.

Just a couple of administrative things before I get started here. You have the agenda in front of you. We will have a morning, a break and a late morning session. We will try and talk and share the bulk of what we know about this information in three or four different presentations. I'll speak for 20 minutes and turn it over to my associate Gavin Poindexter, who will provide you with some more details about such. And then, because we want to try and expand the sphere of what we know about these topics, we invited two outside experts, primarily focusing on pedestrians, Kelly from the University of Maryland in Baltimore, and Paul from the University of Toronto, who will be focusing on some work in Seattle, to share with you some of their insights about these issues. Then we will break and have a more open discussion with some key people leading the panel.

We will proceed according to the schedule. We may run a little over here and there. So in the event that you have questions, feel free. I think we are a small intimate group and wouldn't mind interruptions. One thing we do, in the interest of posterity, we are recording this, so could be make certain that every person's comment is mic'd. We have mics up here and that way we can track the flow of the conversation.

Finally, there was a wonderful email that went out to the Humphrey community earlier in the week. As you know, we are in a large building on an institutional setting. As you know, the season is changing, and as you know, it's very warm in here. So for that we apologize, but until we are assured that there will be no more freezing days, they can't actually turn the air-conditioner on, so we will just have to bear with it, and that is one of the reasons why we will try and break and can have our lunches outside, and have the afternoon free and go watch Bob's daughter play golf.

The broad topic here is new dimensions in pedestrian and bicycle crashes in Minnesota. The first have of what we would like to share with you this morning, focuses on the following issues: the standards, best practices and reporting for bicycle and pedestrian crashes, basically sharing what we know here in Minnesota about these issues.

As Darryl mentioned, this fits into the larger package of research projects and programs that we have going on here at the Humphrey Institute, with the department of civil engineering, the department of geography, and the state and local policy program. This is a quick list of the current, ongoing, past and future projects that we have been focusing our efforts on, leading the charge here with the Active Communities Transportation Research Group.

The first one is a major report that we just finished, sponsored by the National Cooperative Highway Research Program, focusing on the economic benefits and costs of bicycle facilities. This report just came out. I can bring copies after the break of the report to share with you. It has a website, which I can share with you later in the afternoon.

An important part of that project is the safety benefits, and, as Darryl mentioned, this is something that we don't know a lot about, thus it spawned our interest in this second part on safety in Minnesota. In the other projects, you'll notice, we are talking generally about bicycle and pedestrian, primarily bicycle, but use and preferences and tastes. What can we do to get more people to bicycle? This is our only project that focuses on safety, and for that I just wanted to more tightly constrain the topic of today's discussion.

Today's purpose is to understand safety for bicycling and walking, not necessarily what we can do to encourage more or why the policies don't exist for such, or anecdotes about how cycling was trumped over by other considerations in a recent city council meeting. But what do we know about safety and how can we improve our understanding of such? The outcome, if you might want to think in terms of that, is to increase our awareness, motivate discussion, and lay foundations through more thorough reporting of these issues.

That is what we want to try and accomplish by the end of the day is a more mature understanding of these things, increase our collective knowledge, know what we need to do a better job of, in terms of reporting the types of crashes that happen from a bike/ped standpoint—and we are fortunate to have some law enforcement officials with us—and then, quickly, to discuss some next steps. That is enough of what we will be doing.

In the event that you don't have hard copies of the PowerPoint, they are outside, and we also have some additional copies. If you raise your hand, Gavin might be able to facilitate such, or you can pick them up at the break.

We want to go over rates of pedestrian and cycling, generally, what we know in Minnesota, talk about this on a micro scale, talk about it on a macro scale, and focus some discussion on the reporting requirements of such. The policy and motivation of this has been largely covered. I'll not spend too much time on this, other than to say it is a major element of our recently passed, last August, transportation legislation, in the axis of $280 million. A major component of this was safe routes to schools. Of course, safe routes to schools just focuses on one portion of the population, relatively, school aged children, an important part of the population, but there is a lot more in that bill that is very safety oriented.

More locally, Mn/DOT and GPS have their initiative, known as Toward Zero Deaths, primarily oriented towards rural counties, but statewide as well. But there are other issues.

One thing that many of us heard at the Monday session at the Oberstar Forum, and a reoccurring theme, was we really need to be focusing on the livability aspects, focusing on increased quality of life that increased safety and pedestrian improvements will make towards a livability component. There are others that most of us are well aware of.

We have to understand at the outset that we are dealing with a relatively rare phenomenon. This shows in a recent Bureau of Transportation statistic survey that in the year 2000, 2002, 2003, the number of pedestrians, at least the number of people who walk, ran or jogged outside for at least ten minutes, self-reported data, in July, hovered around 150 million people in the country. Now, if we assume that we have a population of 293 million, we are talking bout just over half of one percent of the population is actually walking or running or jogging outside for at least ten minutes in a summer month. Why is that such a low number? There are myriad reasons, and safety might be primary among them.

Anecdotally, I can tell you that the reason we see a significantly lower curve for cycling is related to safety concerns. Here we are talking about the number of people who actually rode a bicycle in July, and see that this trend is downward sloping just ever so slightly, but this hovers around 13% of the population. We would like to think there is a latent demand, a pent up demand for these particular types of activities, should they become more available to us in the form of safety.

Towards this end, we have been investing a lot in these resources, in these types of facilities, this in large part from Ice Tea, T21, and SAFETEA-LU, is the increase in billions of dollars spent on bicycle and pedestrian improvements. Now let's get to the crash aspect of it.

When something almost happened this morning with one of our attendees, other than the 60 of us in this room, we never learn about that. We never learn about the near misses. In the event that there is a minor fender bender and a bicycle runs into a car door, do we learn about that? We tend not to learn about that either. There are a lot of near misses, there are a lot of very small interactions that go unreported, almost unnoticed, and other than the two people that are trying to sort it out themselves, it gets washed away in the wind.

The only way that we ever know, as researchers in the larger community, about a bicycle or pedestrian crash, is when it gets reported through one or two of the following means, through a police report, which was have several people in the room that are more aware of the requirements that are needed to satisfy for such, but, basically, $1000 of damage or significant bodily injury. How those are defined I would like to hear more about. Then thee are the citizen reports. These are the reports that are used, either completed by the police officer or the citizen.

Once we have this information, then this gets reported and transferred up the road to Mn/DOT and whatnot, and then we can have this data. So this is the data on which we are basing our knowledge. Gavin will talk about the nuances of this reporting system, and this will be the focus of our discussion in the alter part of the morning, but I want to make it clear that this is the information that we as researchers are dealing with. So how do we rank in Minnesota?

We rank pretty well. Of the fifty states, this is the total number of fatalities. This is the resident population. This is the pedestrian fatalities percent of total traffic fatalities, and this is the key column here—pedestrian fatalities per million population. Now, we could have a lot of fatalities, but we also have a lot of people in these geographic regions, so this is an attempt to

control for the per capita. We see that 10% of the pedestrian fatalities per million of the population comes in at Minnesota, ranking 13th overall. So we are not at the low end, where North Dakota and New Hampshire are, but we are certainly not down were New Mexico and Florida are either.

Bicycles are reasonably the same story. This is cycling fatalities per million population, and we rank around 16th here. There are a lot of reasons why we are doing pretty well in this respect. I don't want to go over all of them because I think the focus of who we compare to other states will be covered in our discussion. But if we look at this over time and see some trends, we are doing pretty well, at least we are not increasing in our overall numbers. These are statewide numbers, these are pedestrian crashes. These are the five years that we've analyzed. We have fatalities, injuries and property damages. This is bicycle. So we have fatalities, injuries and property damages. Now, the blue bars decreasing in size represent a relatively good trend, so we are doing better, but we still have almost 2000 injuries per year in one way, shape or form, in the form of pedestrian and bicycle. This represents relatively encouraging data, but I think many of us agree that we could be doing more.

Now where are these crashes occurring? That has been a lot of the focus of what we've been trying to hone in on. One thing you will find from this previous slide is that over all, and I found this very interesting, that the number of pedestrian crashes and the number of bicycle crashes in the aggregate, the total number, is roughly 50:50. We see that these numbers are pretty similar. But we know, as I talked about before, that there are a heck of a lot more people that are walking, which means that the crashes per capita of cyclists that cycling is a considerably more unsafe activity than walking is. So that is one kind of major takeaway point that we have reasonably the same number of crashes, percentage-wise, happening between bicycle and pedestrian.

But a closer inspection shows that of our 1000 or so crashes, almost half of them are occurring in Hennepin County, here, just in Minnesota. We look at all of them statewide and of 1000 crashes, 426 of those 1000 bicycle crashes were in Hennepin County, and 467, in excess of 1100 pedestrian crashes.

One way to control further for this element of how many people are doing it is to look at the crashes per 10,000 commute trips. This is a very important issue. Many of you may be aware that I usually bike everywhere I go. I tend not to drive. I have a drivers license, but maybe I'll drive once or twice a month. So when I go out driving with my wife, I tend to be the driver now, and I say I'll drive because I'm safer. She says, what do you mean you are safer? I say I don't have any traffic tickets. I haven't been in any accidents. I haven't been doing anything wrong as far as the police are concerned. I don't have any infractions on my record, which squeaky clean, as opposed to her. She drives to work and has a speeding ticket here or a run stoplight there. And she says that's not fair. You don't drive and of course you don't have tickets. I say, well, I'm still safer.

What we are talking about here is the importance of trying to control for exposure, and that little anecdote just provides some sort of reinforcement about how important it is. I don't have

tickets because I'm not driving. Am I a safer driver? No, not necessarily. In fact, I may be a more careless driver because I'm out of practice, perhaps, one could argue.

What this attempts to do is control for a theme that will be reoccurring through the morning, and that is that in order to have a robust understanding of bicycle and pedestrian activity, we need to know how much of that activity is happening at a particular area. We need to be accounting for exposure. I know Paul and Kelly will talk about this, and providing us with more robust ways of measuring. This is just a crude measure showing that yes, indeed, bicyclists are more prone per exposure to a crash.

The locations of these, the bulk are in Hennepin County, 41% and 40%, and for that reason and because that is where we have the richest of data, and that is where we have focused most of our effort. We want to be careful not to dismiss any attention being devoted to these safety efforts in other portions of the population. It's just that we are dealing with such low numbers in out-state Minnesota about this activity that it is hard for us to make some generalizations. In order for us to steer this resource towards that way so we can better understand it, that is where we focus most of our effort, on Hennepin County.

We have taken a look at where the locations of the crashes are, the types of crashes, where the concentrations of these activities are, and the links between what we are calling urban formed physical environment and the crashes.

We took all the crashes from Loran Hill's database that he has compiled with others, and many of you were part of this reporting protocol as well. We grouped them into 300 member grid-cells, so think of three football fields by three football fields. We asked how many crashes are happening in this particular area. We did this over five years 1998-2002, and we did it for bicyclists and pedestrians.

I'll blitz right though these next five slides, and what this shows is that this is Hennepin County. This is downtown Minneapolis, here's Calhoun and here's Harriet, and Minnetonka didn't make it on this map, but we wanted to focus on where the bulk of the activity is going.

The reasons we see the higher peaks in downtown Minneapolis is where more pedestrians are. Does that mean it is more unsafe? Not necessarily. Here is `98 and here is `99, here 2000, 2001 with interesting peaks for that particular year, and here is 2002.

I'll do this once again. There is pedestrian only. You will notice that there are higher peaks and roughly the same overall number, and I'll tell you the bicycle ones in a second, but there are lower ones in the outlying areas. Here are the pedestrian crashes in `99, 2000 and here are the peaks and I'll be interested to know what is going on in 2001 that we have these little peaks going on, and here is 2002.

Now I'll switch to bicycle. You notice that the peaks are generally lower and more dispersed. Once again, there is high concentration around the Uptown area, but these are all crashes of any type, in `98, `99, 2000, 2001, 2002. We're trying to see if there is an association or correlation between where these peaks are occurring and some of the urban form features.

The usual suspects that we went out and collected data on are: what is the average annual daily traffic? How much retail activity is there? What is the average speed of the bulk of the roadways in each of these grid cells? And other types of information.

And this is how we are trying to better understand this. There's a group cell in downtown Minneapolis; average speed of the roads; the length of the roads. The grid cells that have more roads, are they more prone to crashes and the population density, neighborhood retain? We mapped each of these variables. For example, this is where the retail activity is distributed across Hennepin County. This is the cul-de-sacs. Cul-de-sacs are largely considered to be safer because there is less through traffic, so do we see that there are lower crashes where there are cul-de-sacs? Here is non-retail employment, and I can bore you with several other maps if you want, but just to give you an idea of the types of maps that we are looking at.

Here's the bottom line. The bottom line is that pedestrian crashes—and I could talk about bicycles, but in the interest of parsimony—pedestrian crashes would found are correlated with higher average speed limit, with more intersections. Where there are more roads there are more pedestrians. Where there are more on-street bicycle facilities, there tend to be more pedestrian crashes. There might be something going on there.

But there are other things, more retail activity, more population density, the more non-retail employment density, these are all things that are more highly correlated with pedestrian crashes.

The reason why we threw all these variables in is we were trying to figure out which ones might stand out in explanatory power, or once we controlled for something, say population density, to see if another variable told us an interesting story. The bottom line is that all these are important.

What is a conclusion? If we want to decrease the number of pedestrian crashes, we should decrease pedestrian density, decrease the number of non-retail, and decrease the neighborhood retail, but that is not very feasible. Once again, what we are seeing is that pedestrian crashes are happening where people are traveling, and unfortunately, we don't quite have the detailed urban form data to drill down much further. I'll turn this over to Gavin in a second and he will be able to show you some of the information that we can share, but it is hard for us to know if it is because there is no striping, or because of lack of signage, or because of a bad right turn arrow. We don't have data on that, so it is hard for us to know what's going on over the area.

What I will do now is turn it over to Gavin Poindexter. Gavin has been wonderful in organizing this symposium, and he will share with you some of the microscopic data that we have been trying to understand for pedestrian crash, and then he'll turn it back.

[non-mic'd] Question: Here is a slide on pedestrian crash rate in the US. Do you have any idea how California ranks on that list?

Kevin Krizek: We didn't put in the slide, in the interest of saving space and I don't know off the top of my head. We might be able to dig that up after the break.

[non-mik'd] Steve: [inaudible] is missing the number of pedestrian [inaudible] without doing ample [inaudible].

Kevin: Steve, you are putting your finger on a major issue. It is hard for us to know reliably what's going on unless we have exposure measures. Kelly will talk about that and Paul.

Steve: You mentioned that it looks like cycling was less safe than walking, and that is true in terms of numbers of pedestrians compared to numbers of bicycles, but you also have to consider the miles traveled; whereas, the bicycle my have more because they are traveling greater distances.

Kevin: True. That is another nuance of understanding these measures of exposure. That is another good point. Loren.

Loren: [inaudible]

Kevin: The length of road is the intensity of the road structure in that grid cell, how many roads, how many miles of road in that grid structure.

[non-mik'd audience question or comment]

Kevin: This model is for pedestrians.

Speaker: For pedestrians, is that moving the light pulled out [inaudible]

Kevin: No, what this is saying is that where there are grid cells that have a higher amount of off-street facilities, we see lower rates of pedestrian crashes. So pedestrians appear to like those off-street facilities, from a safety perspective.

I'll turn it over to Gavin for 15 or so minutes, and he will provide a more detailed examination of some of these crashes we have been exploring.

[End of side A, tape 1]

Gavin Poindexter: Pedestrian crash studies and research got started around 1970 when a report came out that looked at crash typing and tried to figure out these different types of crashes. It was done again in the early `90 with crashes in five different states, and they determined that about a third of the pedestrian crashes were happening at or near intersections, and about a quarter of them were happening mid-block.

Here in Minnesota we tracked them a little differently, based on the behavior of the people in the crash, and our results seemed similar. We have a lot of crashes where the people are crossing the street, a similar thing, especially crossing where there is no signal and vehicles are

going straight ahead, as well as crossing with the signal when vehicles are making a left turn. Keep this last one in mind, and as far as bicycle crashes, the same study looked at it totally different. For bicycles they found around the country that 12% of the crashes involved vehicles turning, where about 7% the bicyclists were going in front of the motor vehicle.

Here in Hennepin County, what our data showed is that a very large number of the crashes involved bicyclists riding across the road. That could be either be at an intersection or cutting across mid-block, if they were hit by a car coming the other way. So they were crossing in front of a car. The other two major ones were riding with traffic or against it.

The next thing we did was focused on more focused areas. We selected 12 grid cells in Hennepin County to look at. For this we looked at grid cells that had high concentrations of pedestrian crashes, high concentration of bicycle crashes and high concentration of pedestrian and bicycle crashes. We did this both for urban and suburban. Our urban is only in Minneapolis, and in suburban we wanted to expand what we were looking at to make sure it's not just the urban from Minneapolis and get a wider variety of areas.

When we did this, for reasons of time for this presentation, we will cut it down and only look at four of these grid cells.

The first of these is right downtown in the heart of downtown Minneapolis, at the intersections of Hennepin and 7th St. As you can tell, in this 300 meter grid cell, which is the shaded in area here, there were large numbers of pedestrian crashes during this five-year time span. You can also tell that at certain intersections there were extremely large amounts of crashes. This is possibly due to geometry, exposure and some of those other things that Kevin was talking about.

One thing we noticed was that very large numbers of them involved vehicles making left-hand turns. This is especially true in areas where there are high concentrations of crashes, such as this one. These are just the crashes that involved a vehicle making a left-hand turn. The action by the pedestrians varied, whether that was crossing with the signal, crossing against the signal, crossing outside of the crosswalk, but they all involved vehicles turning left at some point along the way.

In this group there were also large numbers of bicycle crashes. The crashes were occurring in the same areas. You can tell that the intersection here at Hennepin and 7th was once again a very large generator of crashes. Once again, vehicles making a left turn, which are the green triangles, were the primary action by the vehicle leading to the crash. This indicates that at least in this area, this part of downtown, that vehicles making a left turn seem to be a large problem.

Also, one thing that should be noted is that in downtown most of the streets are one-way streets. However, Hennepin is not; it is a two-way street, so most of the vehicles driving around it are on one-way roads, with drivers used to being on a one-way street, and all of a sudden, they are on a road with two-way traffic, with the same or similar amount of traffic density, with the same pedestrian density, but they have to look at one more element.

Looking at another grid cell, which is in the Uptown area, looking at the pedestrian crashes, you have large numbers of pedestrian crashes in Uptown, especially at the intersection of Lake and Hennepin. For those of you familiar with that area, it is a very large pedestrian oriented neighborhood.

Again, looking just at the crashes where the vehicles were making a left-hand turn, large numbers of them were crossing where there were six marked grid cells. They were crossing in marked crosswalks with the signal. Looking at Hennepin County as a whole for crashes, where are the crashes of people making a left-hand turns concentrated? 18% of all crashes in Hennepin County involved a vehicle making a left-hand turn. Of the six selected grid cells, it goes up to 30%, and of the two I just showed you, right around 50% of all pedestrian crashes were vehicles making a left-hand turn. Looking at just the crashes where people were making left-hand turns, they were very concentrated in these areas, and possibly we should be looking at targeting something for those areas, such as adjusting the signals for the intersection so there is possibly an all-red cycle, where just pedestrians and bicycles can cross the street, no cars are moving, just at selected intersections, such as along Hennepin Ave. in downtown and Hennepin Ave. in Uptown, where there are large numbers of bicycle and pedestrian crashes.

It would also be important to increase signage at these key intersections, pointing out to drivers and pedestrians alike, that there is high concentration of crashes and they need to be more cautious, so watch out a little bit better, also, looking more out at the pedestrian areas, or, suburban areas looking at pedestrian crashes.

Three out four pedestrian grid cells we looked were involved in a freeway and a freeway off ramp. This one is Portland and 494, down in the Bloomington/Richfield area. As you can tell there is a large concentration of crashes. What you have in the area north of 494 is a dense residential area and those in the south are more retail areas,

Question: The downtown crashes were vehicles making left turns, if you look at signal phasing for those left turns, whether permissive only or protective/permissive or protected only, did you try to correlate the crashes with that?

Gavin: As to whether or not they were crossing with the signal, do you mean, like did the pedestrian have a walk signal, is that what you are asking?

Question: No, the vehicle left turn, are they turning left on a green ball or are they turning left on a green arrow and then a green ball?

Gavin: That information is not provided in the reports that we had to go off of. That is one of the reporting things. We have that they had the green of some sort. We don't know if it was a green arrow or a green for general traffic. At all three of these, retail was at one side, and on the other side was residential property.

However, there is some good news, two out of those three intersections have been rebuilt since our study took place, as freeway intersections were redone. The other one was 494 and

Penn, and Hwy 100 and 42nd, a little north in Robbinsdale. Those have been redone, and an interesting study would be to see if the changes have increased safety for pedestrians at those intersections.

Looking at bicycle crashes, both in Minneapolis and in suburban Hennepin County, several of the crash grid cells either contained a school or in the neighboring grid cell there was a school. One interesting thing was they weren't elementary and middle schools; they were colleges, universities and high schools. We have school zones set up around elementary schools; however, we don't have similar things around high schools and colleges. Possibly this is a factor of the drivers, which is why those were happening, or younger more inexperienced drivers, it could also be there were more people going to and from the school. The slide we just had up here is Kennedy High School down in Bloomington. All of the crashes in this grid cell involved, all pedestrians and bicyclists were under the age of 18. These are still people going to and from school, most likely, who still need to have the same protections as elementary school students.

Next we'll go into the reporting and the forms that you were asking about. This is a police form that Kevin briefly showed you earlier. It has several parts including a diagram, all the necessary information about those involved in the crash and details about the crash.

Similar information is collected on the Citizen Report. These are often used to supplement the police report. The area in blue is detailing the pedestrian and bicycle crashes that differentiate the acts by the pedestrians and bicyclists. Minnesota is leading the area in that because the amount of detail that we provide the police officers and citizens in filling out those reports is better than the national standard incurred.

For instance, in Minnesota, looking at pedestrian, the actions while crossing the street for pedestrians, we give with and against signal, crossing where there is no signal or crosswalk, starting off into traffic and some other improper way of crossing the street. Whereas, accounts entered in other states, such as Oregon, are crossing intersection, or with crosswalk or crossing mid-block. The amount of detail that this provides to researchers is valuable and allows them to get much more.

[non-mic'd] Question: Could you give me some sense of the bias in reporting. In other words, how many incidents occurred [inaudible], and the accuracy [inaudible] in this report? Other than the police report [inaudible] by profession.

Kevin: We might have people in the audience that might be able to inform that better than we can because we just get the data on the other side.

Audience response: The comment I would make about the citizen report form is for the database that we analyze, when there is a police report form for that same crash, the police report is used. The citizen report is used when there is no police report. That happened increasingly in large cities, where the police departments have determined that filling out property damage crashes is not a key part of their duties, and so they ask the citizens involved in the crashes to fill out those reports.

So that varies a lot from city to city. There are some cities that are more notorious than others for saying we are not investigating property damage crashes anymore. In those cases we are stuck with using the citizen reports, and yes, there is undoubtedly some bias in them. The crash coders, if there are two citizen reports, do what they can to make sense of the crash as a whole and put in what appears to be the most accurate understanding of that crash.

Again, the citizen report is relied on for data analysis only when there is no police report.

Loren, you might have something you want to add?

Loren: Yes, I would say we are fortunate in Minnesota that we do have this. It kind of goes to the near-misses. This is compared to a lot of other states. It is required by insurance by statute. I don't have one of these very often, so if I were to fill out that form, I might take a little more time than an officer, who has a thousand things to do. I might take an hour to fill out this damn form, and you guys don't have that [time]. I might be a little biased. I might say I wasn't speeding, etc., but I may make a nice diagram, so it is a wonderful tool to have, instead of nothing.

Question: It's great to see that crash report and that citizen report because it shows how much data is collected. That is cool, but it looks like the Minnesota form doesn't have a choice for crossing at an unmarked crosswalk, unless I'm reading that wrong: crossing at unmarked crosswalk and crossing…

Gavin: Crossing where there is no signal or crosswalk.

Cont: Yes, but you can cross the street at an intersection with no marked crosswalk. Am I reading that wrong.

Gavin: Yes, but in the description of the location, they would get whether it is at an intersection or mid-block.

Cont: So there are other ways to identify that.

Gavin: Yes, you can figure out pretty precisely where it happened. That is how we are able to get the points plotted on the maps as to where they were. So it's not a checkbox. Well, it is on the citizen report, but it's not on the police report.

Another way that pedestrian/bicycle crashes are tracked is through hospital records. This is primarily done through the department of health. These records provide extensive detail about injuries, but they have some drawbacks.

They are not linked to where the crashes are occurring other than possibly by county or city, but depending on where it is, the county is as much of a geographic area as you will get. If you are trying to do the level of analysis that we were, such as what the geometry of the road is,

the urban form characteristics of where the crashes are occurring, county level detail is not sufficient.

Question: Have the HIPA requirements affected your access to these data?

Gavin: Yes.

Question: What does HIPA stand for?

Kevin: HIPA stands for Health Insurance Portability and Accountability Act. In general, if Gavin were to go directly to the closest hospital and say he's a researcher from the U. and would like to access their records and do a study on bike or ped crashes, then HIPA would say, sorry, Dr. Poindexter, no, can't have it. However, in the aggregate form, with looking at hospital admission and/or emergency department data, it's not a problem because under state health department statutes for public health surveillance, we are exempted. So we can collect the data, aggregate it, provide it to him and actually to all of you by county and age group analysis, and so that is not a problem. You can get it, but at this juncture by special request for analyzing down to the zip code level, but from the health department level, we look at it by residence of the person versus Loren's focus on where the event happened. Somehow bringing those together to intersect those will be an important piece. We have excellent data on the person and their injuries sustained, but we focus more on the person and where their residence is, and we can go down to zip code level, as opposed to where the event occurred.

Mark Kinde: There is something I wanted to point out for those of you who might not be aware of it. That police report is only done if it involves a pedestrian or bicycle and a motor vehicle. If you have two bicyclists that crash into each other and somebody is killed, it doesn't count. It's not up there anywhere. It is very difficult to report.

Another anomaly in this whole thing is roller-bladers. Where do roller-bladers fit into this? Unfortunately in Minnesota they are not yet counted as vehicles except in civil cases. They meet the definition there, but they are an absolute anomaly in terms of reporting those things. We don't know where they are at. I wish we could get that straight. But people need to consider that when they are looking at that data.

Except the beauty in this slide—sorry, my name is Mark Kinde from the state health department. The beauty of this is we can for the bike-bike interactions or the bike-tree interaction or the ped-ped interactions or the roller-blade, we can pick those numbers up. We don't have a police report that goes with it, but we do have the hospital data.

Response: But roller-blades are so dangerous.

Mark Kinde: That is where we are getting the data that roller-blade crashes are so predominant that they has passed bikes and peds. But the issue there is looking at the exposure as well. So we have numerator data, but we're weak on the expose. Because if our denominator is huge, then we may give a recommendation that everyone should go in-line skating because it is safer if you calculate the rates.

Gavin: This discussion about the link between hospital and police records is very interesting. Currently there is a project called CODES, which is Crash Outcome Data Evaluations System. This is a joint effort trying to blend the police records with the Department of Health records, trying to figure out where some of these crashes are occurring. There are still some issues that we have already discussed, so I don't think we need to iterate them.

There are the various types of crashes and how they are reported. There are police records and citizen reports that we have already discussed, and hospital records, and finally, bicycle records, bicycle advocacy groups that are trying to track some of those near misses that we were saying, and earlier we really didn't have any information on. However, this is a totally voluntary level of reporting, and the accuracy of their total numbers is probably not all that great.

Question: Since you bring it up, are there any pedestrian advocacy groups?

Gavin: There are, but they are not nearly as many, correct? Kevin is a much better one to speak on this than I.

Going back to some of the differences in reporting between the Department of Health and the Department of Public Safety, which are records used by Mn/DOT as well, the Department of Health seems to have different numbers of crashes than the Department of Public Safety, whether it be bicycle or pedestrian crashes, and these are trying to match up for it. The only ones included here are, in the Department of Health Records, are ones involving a motor vehicle. The only ones included here or by the Department of Public Safety are ones that involve a personal injury or fatality. So we did try to cross out the property damage and the bicycle to bicycle or someone tripping and falling on their shoelace.

I will turn it over to Kevin now, to wrap up some of these things and to go over some of the conclusions.

Kevin: Thanks, Gavin. The discussion and debate that has been ensuing here is wonderful. This is exactly the type of interaction that we wanted, primarily, to reserve our later morning part for. In the interest of getting through and getting our coffee before break, I wanted to set the table for some issues and then we can go at it and put our kid gloves on after the break, once we hear about more of the methodological things coming from Paul and Kelly.

Basically, this is summed up in the following. There are a variety of enhancements that we can talk about, which I want to set the stage for and get you thinking about these things. These include possibly working more closely with the Department of Health, hospitals and other medical providers to increase the reporting. Possibly, with the increasing technology development in an online version and do not have to be held so strictly accountable to the paper and pencil method. That is one thing to think about.

Possibly, we might want to think about supplementing the existing crash data with data from other sources. Obviously, as Steve mentioned, where the bicyclists are bicycling, where the

pedestrians are walking is critical information, and once we could have better data about this, then we would be able to more reliably assess 'is this area, overall, safer or less safe?' I know that Kelly will talk about that. That also might be an expanded role for either bicycle or pedestrian advocacy groups.

There are more pedestrian advocacy groups. There is Walk Austin, there is Walk Boston, and there is Walk Atlanta. We know of these walking advocacy groups that exist. Steve, you might have more understanding of these things. My understanding is that the bicycling groups tend to be a little more specific in their focus, articulating where the rides are and possibly having a safety component in the form of awareness, as opposed to Walk Boston that is primarily mapping routes and trying to further Boston, or any other city, as a major walking destination. But there may be an extended role for advocacy groups.

But where does all this leave us? We know some information. We know that there are some limitations. We want to know how to correct or better enhance on these types of information. Towards this endeavor, I have asked two close colleagues in the field, who primarily focus on walking, to share with us some of their research, some of their expertise about ways of accounting for these various types of issues.

First up will be Kelly Clifton. Kelly is an assistant professor at the University of Maryland with the National Center for Smart Growth. She has been doing a lot of work on walking issues. She was formerly a faculty member at the University of Iowa an has now been at Maryland for three years.

Then we will hear from Paul Hess. Paul finished his PhD at the University of Washington in 2001. He has since been at the University of Toronto, focusing on urban form characteristics in walking. Some of the research that he will share with us focuses on some of the applicability to transit corridors and walking.

I have asked each of them to provide us with some outside knowledge, and without further ado would like to turn it over to Kelly.

Kelly Clifton: I know the break is not scheduled until after our talks, but I know there is a time in the morning when you are wishing to get up and stretch. So as a person that has been involved in a lot of health research, if you want to do that, I'm not going to be offended. So if you would stand up and stretch and get the blood flowing. So don't fall asleep on me.

I was recently in a conference in San Diego on physical activity in an adult environment and they did a 15-minute stretch with a leader, and it really made a huge difference on my ability to pay attention.

I want to thank Kevin for inviting me here, and particularly, inviting me here in April instead of February, when we first talked about this. As Kevin said, I was at the University of Iowa for three years before moving to Maryland, and I have to admit, the cold was a little bit of an impetus for the move.

Also this morning, Kevin encouraged us to mike here, so we all rode on the trail over here from St. Paul, and I have to compliment and applaud you for some wonderful bicycle facilities. Those are unique and rare for an urban environment. Coming from Baltimore, we do not have that level of facility. While I'm sure you have your problems, but they vary from state to state.

My focus is on pedestrians, and it's not that I neglect bicyclists, but it does point to one of the big issues, which is a lack of data. In the most recent Baltimore metropolitan travel survey data, they only recorded 27 bicycling trips, so that is not a lot to work with in bicycle demand, so you can't do any statistical analysis there. This certainly does not mean it is not important, but it does make it hard to get research in that area.

Today I want to talk about some analysis I did with pedestrian crashes in Baltimore City. My coauthor is my PhD student Carolina Bernia, The focus of our efforts is obviously to create a safe environment for pedestrian and bicycle travel, and the most pervasive obstacle we see is the automobile. The challenge confronting us then is how do we reduce the conflicts that we see between pedestrians and automobiles, without an overall decline in the mobility of either because we know that the public doesn't like to let go of their cars as much as we would like them to.

Having just reported that crashes are on the decline, and that is also a national trend that we see, why is this important? It would appear that our programs are successful in reducing the number of crashes and improving safety. One reason is this increasing automobile orientation of cities; and this is evidenced by the overall decline in walking, which segues into another area of my research. This, again, in looking at overall levels of physical activity and health, which is pathetic. The other reason why this is important, and despite the fact that crashes are on the decline, we are seeing an increase in the number of fatalities and the severity of injuries in the crashes.

Despite the fact that there are declining numbers, the affects could be more severe, and because fewer people are walking, this issue of exposure so we could actually see more crashes per pedestrian. So I probably don't need to tell you this that our policy approaches have tended to focus on what they call the four E's: enforcement, encouragement, education and engineering. And there is a new one now, which is emergency response, with the interest in homeland security.

What I will talk about today focuses on engineering treatments, or, from my field of study, which is urban planning.

There are two pervasive questions. One is, how do you incorporate demand? And there is a long history of research here in how to estimate pedestrian demand, but most crash analyses ignore it all together in the analysis. This is brought about mostly because we don't have the data, so we don't have count data or we have it inconsistently; we don't have it area-wide, we don't have it for the same days and so on, so it tends not to be collected in the same way that we focus on automobile counts, but it is still an important component and will be a theme, I

think, of the next two talks. So as we figure out, it's not just the crashes, but crashes per pedestrian that are important.

Another pervasive question is how does urban form matter? There is this long history of research in figuring out what the connections are between transportation and land use, and a focus on how urban form affects mode choice and how it affects trip generation rates for pedestrians. But again, it is not the focus of a lot of research. We tend to focus more on pedestrians and driver behaviors. So what are the problems with the pedestrians or the problems with the driver? But this is important if you design some sort of engineering intervention. You do need to know something about urban form and at least physical built environment.

The objective of our study was to take a first crack at looking at the influence of these environmental factors, and there include both the physical environment and the social environment on crashes and crash risk.

This is our conceptual model. Historically, we focused on the characteristics of the driver, especially this issue of behavior. Are they compliant with the traffic laws? Do they have some sort of impairment? What is the severity of injury? And also, the issues between age, gender and race and so on. Also there is this aspect of what's going on at the time of the crash, so what time of day. Was it evening, dusk, or during the middle of the day? What were the weather conditions and what were the conditions of the roadway for the driver?

This is our area of emphasis here, so again, looking at what the various land use characteristics are. We define that by access to commercial and transit, level of mixed use, and parks. We think parks are important because they are a big pedestrians generator. There is the density of roads, population and housing, and the level of employment, which is an indicator of mixed use in the area.

In terms of social characteristics, we are interested in both in medium income rates and the number of children in an area. There is a huge variation in Baltimore. As it is gentrifying, a lot of the more affluent areas have fewer children because empty nesters of young people without kids are moving into intercity neighborhoods; but the lower income areas have larger numbers of children present.

What is our approach? We hope to do a statistical analysis of using *risk exposure* as our dependent variable and as a function of area characteristics and land use variables, and our level of analysis is the intersection. Because we are looking at risk exposures at the intersection, we then lose through aggregation all of that detailed information about what was going on with each specific crash. We then don't have information about driver behavior, pedestrian behavior, time of day and so on. That is one limitation, but our real focus was to try to understand, at least at a very crude level, what the effect is of land use.

The location is Baltimore City, which is where I live. It is a city that like most older east coast cities, we have an urban form, at least in the core, that is what we like to think is very compatible to walking. We have the inner harbor that has a lot of tourists. As we move

outward from the central city, we see a more suburban/urban form. It is a city that has a very high rate of poverty, high rate of unemployment, and the population is in a majority African American.

Here is a map of the pedestrian/vehicular collisions. From 2001 to 2003, we had 3500 pedestrian/vehicular collisions that were recorded in those years, so a very high number. You can see some of the spatial distributions. You clearly see some trends along the major arterials, and you can identify where the major arterials are by the corridors where we tend to see a lot of crashes.

We talk a lot about risk exposure and the importance of it, so how do we evaluate crashes per unit demand. Often, because we don't have count data, we proxy demand by the overall population of the area, which doesn't tell us how many of the population are walking, but it is at least one measure, anyway, of crashes per capita.

Some try to get at the number of walkers by using walk-to-work from the census, as a measure of pedestrian demand. That tells us something about the walking environment, but we know that walking to work is such a rare event and the ability for people to walk to work is such a small portion of overall walk trips that it is also probably not a very good proxy.

Then, the best would be to have some actual pedestrian demand data, so counts at intersections. But, at least in the City of Baltimore, they are not doing that with any consistency. We have some counts. I have counts for five or six hundred intersections across the city, but often what has happened there is that that count was prompted by a crash, so it is not very objective. It is certainly correlated with the numbers of crashes, so we can't use it very reliably and certainly can't use it for all locations where there are crashes.

So what did I do rather than wait for the City of Baltimore to decide it would be proactive about counting pedestrians? I developed a model to predict them. I have developed a demand model to estimate pedestrian intersection counts, which is based on the regional 4-step transportation modeling process, but scaled down to the pedestrian environment. That is a whole other topic to spend a lot of time on, so I will just give you a very brief overview, and if you would like to know more, I can provide you with more information.

What do we include in the model? We have a trip generation piece. The city is divided, or the area that we estimated the model for, we used block faces as essentially a TAZ. I you know anything about regional travel demand modeling, at least for the DC region we end up with something like 2000 TAZ's for that entire metropolitan region. For the area where we did our model in Baltimore, when you use each block face as a traffic analysis zone, we ended up with 6000 TAZ's, so we really pushed the limit of the TP Plus and its capability to handle TAZ's. If each block face is a traffic analysis zone, we looked at all the land use on that block face and used that to estimate the trip generation.

So how many trips are produced and how many are attracted to that location? We had 12 different trip purposes, so six trip purposes, both for home-based and non-home-based trips. We were sensitive to the local land use and the demographics. To estimate the models, we

based it on data from the New York metropolitan region, the 27 county region in New York because they had a large number of pedestrian trips. You say, New York, Manhattan, what does that have to do with Baltimore? Because it was a 27 county area, we had a huge amount of variation by land use that we felt fairly comfortable applying the model in Baltimore.

The second step distribution, once we know how many trips there are, we want to know where they are going. We used the traditional gravity model, again, scaled down to the pedestrian environment. We didn't do a mode choice because we just focused on pedestrian trips, so it is a 3-step model. The last step was network assignment, allowing us to choose what path, so we used minimum travel time, but made it a stochastic process by allowing some variation in the travel time per link. If you don't know anything about travel modeling, don't worry about it. But one of the unique features of the model is we allowed estimates of how long it takes to cross a facility, how long it takes to wait for a signal to change, and also, we allowed pedestrians to jaywalk if it was a shorter path than walking to the end of the block and waiting for a light.

It is much more complicated than that, but this was roughly ten square miles that we applied the model in Baltimore, so again, that really was maxing out TP Plus, which is modeling software. It allowed us to estimate the pedestrian demand at the intersection level and on links. This is the area and bigger dots are higher volumes. And to focus in on this little square—if you have ever looked at a traffic count map from the CDOT, it would look similar to this, where we would have a volume here on the like, and also, a volume associated with the intersection.

These are estimated demands that I'm using in my model. They were calibrated against counts that we did. There are 400 counts that we had. But it was my attempt to try including some measures of exposure in our crash analysis. In the bigger scale, this is area we focused on. We tried to avoid the inner harbor because at least in trip generation there is a lot of tourism, and so those are unusual generators or trips. We wanted to focus more on residential-commercial environment.

The analysis used exposures as the dependent variable, so we took a 1000 times the log of the exposure, so the number of crashes at the intersection divided by the overall demand that I estimated for that intersection, as a function of these various land use and social environmental factors. So there is housing unit density, employment density, income, percentage of park land, access to commercial facilities, access to transit, the overall population density, the percentage of children living in the buffer zone around the intersection, and the percentage of non-white persons living in the buffer zone around the intersection. There is the level of education, which I believe is a binary variable, with a one if you have a high school education or not. There is the percentage of population in a buffer zone around the intersection that own vehicles, density of roads within a buffer zone, and a measure of mixed use.

This is a detailed description of each of those, if you are interested in knowing how we have operationalized each of those variables.

Here are the model results. In terms of the land use variables that we are interested in, we see population density. The only things that weren't significant were employment density and education. Everything else was significant, but the interesting thing is the sign or the direction of influence for each of the variables, and I'll just give you the upshot, an overall for those intersections.

In that study area where I estimated the demand, we ended up examining 480 intersections. One of the issues with this model is for intersections that don't have any crashes, where you had zero crashes and you have demand, you still have zero, so it becomes problematic in doing the analysis or being able to garner any information.

What is the upshot? First, I think it is important to consider demand, and again, that is a theme throughout the day, because it gives us more information about how to prioritize our investment. So a location that has ten crashes per hundred pedestrians is a much more unsafe location than a place that has, perhaps, ten crashes per thousand pedestrians.

The urban areas with higher household and road density and greater commercial access, seems to be negatively correlated with overall risk exposure, but areas with greater transit access, mixed use and parks, are positively associated with risk exposure.

What does this mean? I think we need to think very carefully about how we interpret these results in terms of investment, but at the first cut, it seems like we were going to invest in areas with transit, with destinations that have mixed use and have park land. Another way to look at this is if we reduce the transit accessibility so everyone is in their cars, reduce the level of mixed use and get rid of parks, we'll reduce the number of people walking and therefore it will be a much safer environment for pedestrians because no one will be walking.

So how you craft a policy response to these results is where you really need to be careful in thinking about interpreting the findings.

Some of the limitations in what we've done, first of all, the crash information has some limitations. Each of our crashes were geo-coded to an intersection, and we know that some of them occurred at the mid-block. So that is something we can find in the data, but we don't know which mid-block. If it is a 4-way intersection, we don't know if it's on the major arterial or minor arterial, which then makes it hard to include other data. As was said in the previous presentation, we don't have any information about non-injury crashes or near misses, so we need more information or ways to incorporate that.

In this analysis because it was aggregated, we lost all that information about pedestrian behavior or vehicular behavior. We have those data from the crash reports, but we couldn't include them because they are aggregated. The land use measures we used are very macro level land use measures and we need more micro-scale information. So information about lighting, about sidewalk quality, about crosswalks, about signal timing and traffic volumes would make this so much more robust analysis.

[End side B, tape 1]

Kelly Clifton (cont.): …for the entire City of Baltimore.

What are we going to do next? Well, do a citywide analysis. We will collect more information about these micro-scales and design features. I'm trying very hard to get the City of Baltimore to conduct more pedestrian counts or give me access to more pedestrian counts because I think those are better than my estimation, and also, information about where and why people are walking because not all crashes are created equal. Perhaps people who are walking for leisure have different behaviors than people who are walking for more purposeful transportation purposes.

The other thing is to include information about vehicle and traffic interactions. When we think of expose, we think of crashes per pedestrian. It would be nice to have crashes per pedestrian per vehicle, to then control for how busy the automotive environment is.

This is probably something we should talk about more in the afternoon, but how to use risk exposure in terms of directing safety policies. I think it is a fine measure to use if you have a dense urban area with a larger number of walkers, like we have in downtown Baltimore City or the city itself. But I think when you get into more suburban or rural locations it can lead you to some inconclusive findings because most locations will have very low demand, and therefore have very high risk exposure.

I think the upshot here is thinking about exposures in terms of directing investments where the pedestrians are and where they are experiencing risk, but for suburban and rural areas taking a different approach and looking at just the crash rate.

I'm happy to entertain any questions.

[non-mic'd] Question: What was your rationale for [inaudible] for exposure…?

Kelly: Just the distribution, so the lawn had a nicer, smoother, more linear distribution.

Question: Is it possible that a lot of those variables related to the speeds? It seems to me that the number one variable for reduced exposure would be congested roadways, based on that analysis. And so, alternatively, for increased exposure risk, it would be greater speeds, and all the other variables just become associated with those two central variables.

Kelly: Yes, two things. One is in the analysis that I didn't present was looking at crash severity, which we would assume would increase with vehicular speeds. The other thing is in earlier iterations of the motto, we had controlled for facility types. That didn't get exactly to this, but we were assuming that arterials would have more volume and higher speeds than neighborhood streets, and it was not significant in the analysis. But certainly it is an important thing.

Question: One other question, you calibrated your model against 400 actual real life counts?

Kelly: Yep.

Question: Were those at different intersections, 400 different intersections, or the same intersection 400 times?

Kelly: We calibrated the model for citywide, so we had data citywide, so beyond the area for just this analysis, if I understand your question.

Question: Were the counts taken at different times, at the intersections? I would like to know what kinds of accounts were those that you calibrated your model against?

Kelly: That is a good point. Our pedestrian model, the output, is 24-hour estimated pedestrian count. The data we had from the City of Baltimore were just peak hours, morning midday and evening, so we had to estimate or assume and extrapolate those data to 24-hours. They worked for 480 different intersections in the city, for the same period of time that we have the crash data, so from 2000 to 2002.

There is lots of imitations of the demand model, and the state funded me for a second iteration, so we can make some improvements. The idea is to put it all out of the transportation modeling software and put it into GIS. We think more people who are working on pedestrian issues are more likely to understand GIS than transportation demand modeling.

Question: It is interesting that you found greater transit accessibility and increase of risk exposure. Mn/DOT did a study on metro highways, and all the highest ped crash areas were also transit routes. It is an untested association, but it looks like in future research that transit routes or accessibility to transit should be considered. I'm wondering…

Kelly: That is the segue to the next part.

Question: What is transit accessibility in this study? Is it that it is a transit route or that it has a transit stop on it?

Kelly: The percentage of households within a quarter-mile of the transit stop, so the percentages of housing units that reside within a walking distance of the transit stop, within the buffer zone, and the same thing for commercial access. We define it the same way, so percentage of households within a quarter-mile of land parceled commercial.

Paul Hess: Everyone is supposed to be at the break, so if you want to stretch again that's fine. I'll try to be fairly brief, but I am a professor so I get paid to talk, so we'll see how I do.

It is a very good segue to Kelly's talk. It is about some research I did in Seattle when I was Kelly there. I was out there with Kevin, or maybe he was in Hawaii doing Ironman and I was out in suburban arterials counting pedestrians at transit stops.

This is work I did for the Washington State Department of Transportation about crashes, just in state facilities. But we were particularly interested in the issue of transit, and I want to talk

about the research we did and the model, but also, talk about some of the implications because, I think, for practitioners particularly, the real issue is where to put their limited dollars to make pedestrians or bicyclists safer. It's not the fanciness of the model or exactly what the correlations are or any of those things. It's really the pragmatic kind of outcomes, and in terms of that, I'll take a little bit different take on the issue of exposure, where it is not the most important factor, which is the last thing that Kelly said. So I think Kevin also brought me in to be a little provocative about exposure because exposure is the method that tends to be used in the transportation and public health worlds. I'll take a little different perspective with the research we did out in Seattle.

With traditional pedestrian safety research, a lot of it is behavioral, as Kelly said, but the stuff that has looked at geometrics, particularly, coming out of Charley *Agear's [sp] group and some of the more traditional engineering approaches have been interested in exposure. They want to know how risky an environment is independent of how many pedestrians are there, which makes a lot of sense in a lot of contexts. So it is an interesting geometrics, and typically hasn't looked at land use. So both Kevin and Kelly and Gavin, they have all talked about land use issues, but research that looks at pedestrians and cyclists and land use, looking at these presentations, makes it seem like it is something that has been done for a long time, but that is very much in the early stages. So a lot of the traditional research over the last 15 to 20 years or so haven't particularly looked at land use.

The research we did wanted to look at where the pedestrian generators are and intentionally did not look at exposure, and I'll talk about why we did it that way as we go through the talk.

The data we had was based on this concept of pedestrian accident locations, which is a planning tool of the Washington State Department of Transportation. It's interesting to understand that measurement a little bit just to read the research, but the idea of, as the call them "PALs" was to look at places where lots of accidents occurred, so a certain form of aggregation. In this case, what they would do is look at a tenth-mile segment of their facility. They would count how many accidents were in a tenth-mile segment, and if four pedestrian collisions of crashes had occurred over a six year period—and these are vehicle-pedestrian crashes—they would designate that as a PAL. Then they moved the segment one hundredth of a mile and measured again. If it still was four crashes, they would add that on, so the PALs could grow a little bit. I just diagrammed that here so it is a little easier to understand.

So they take the segment and they measure it. In this case, the first one only has two crashes, so that is not a PAL. And only till you get to this segment that there were four, so that would be designated as a Pedestrian Accident Location or PAL. In some ways it's not a very good way of aggregation. It probably limited the statistical power of the models, but we can talk about that some more as well.

The six-year period in question for this data was 1995 to 2000. PALs contain collisions and had about half the collisions on state routes. Just like in this region, you can see there were 120 PALs and state facilities in the State of Washington, and 48% of those, 57, were in King County, where Seattle is located, so in the most urbanized county in the state. In fact, 33 or

28% were on one facility, SR 99 in King Co. That is what we will mostly talk about in the rest of the presentation.

This breaks down to the collisions within the PALs, fatal injuries or those collisions, disabling injuries, and then they have a cost formula. But however you break it down, King Co. and AR 99, in particular, is where most of the accident locations and collisions are concentrated.

Just looking at a map, you can see that very easily. Seattle is right here in the center. The middle of Seattle does not have a lot collisions on state facilities because they are all limited access highways that go through Seattle, so there is not a lot of opportunity for pedestrian interaction with traffic, and you can see this right along here. That big red line is SR 99. There are a few locations out here in Spokane or in some of the smaller cities in the state, but almost all of them are in urbanized regions. That obviously is an exposure issue. That is where the pedestrians are; that is where the vehicles are.

This is showing you a blow up of the Seattle region, and that is SR 99 here. It comes down into the city and goes into a tunnel and a viaduct. Then it comes out again as a surface road on the other side. Along here it is also limited access, so there are not a lot of pedestrians along here. In the south part of the county, you again see a lot accident locations. There are a few other clusters in the state, particularly here and up here, but most of them are along here.

SR 99 is important to understand what kind of place that is. It was formerly US 99 until it was superseded by I-5 just to the east. It was designed as an interregional facility as a highway, but now it acts, in many ways, as a big suburban arterial and as a commercial corridor, and even as a local main street, a commercial street for a lot of the communities it goes through because that is where people go to shop. That is where people go to take the bus.

Briefly, I don't want to go into any detail with the data and the models, but the actions data was the PAL data we have already discussed. We also had roadway data, just the state network, but also, some data from an ME-2 model that gave us traffic volumes and speeds. There is data from the Puget Sound Regional Council that gave us roadway configurations, particularly numbers of lanes.

We developed some intersection data. We were interested in how connected the areas were. Kevin talked a little about that, or maybe Gavin did, about intersections and pedestrian accidents, so there are a bunch of issues there that are not very clear how they work.

The transit data, that is the one that we really went after to try to get because we were interested in that relationship. We got some automatic passenger count data of Metro, the regional transit agency. They do about six counts a year on different routes. We took data across two years just to try to smooth out some of the variability in the data. We geo-coded that to all the bus stops. They we had some land use data from a set of partial data, and we also looked at school sites.

These are the variable we developed in modeling the data, of whether a place was a PAL or not, we had a variable for whether it was SR 99 of not. The number of people getting on and

off buses within each area that paralleled the side. This says 250, so 250 feet diameter circle. That is about the same area as a PAL, so we are trying to see how many people are in the area getting on and off the bus. Here is retail activity in terms of square foot. Here, the number of housing units, whether there was a grocery store in or near the PAL, and then some highway characteristics, traffic volumes, number of lanes and those kinds of things. So all the kinds of variables we talked about is what we put into our model, and how we developed the model is we were interested in if those variables would predict whether a particular place was a PAL or not.

We took all the PALs, which are shown here in red, so those are all the high frequency accident locations. Then we took sample points to use those controls that were not in PALs and were not too close to PALs to deal with some spatial correlations issues. We wanted to know whether the model would predict whether any point that was in the dataset was the PAL or not.

To do that, we used the logistics regression, and again, I don't want to go too much into the details, but we developed an SR 99 model. It was a significant model that accounted for about a third of the variation. In terms of whether it was able to predict PALs or not, it correctly predicted 76% of the points, and 89% of the non-Pal points it correctly predicted, versus 60% of the PALs. But of all this whole model and all the variables we looked at, the only variable that was significant was bus stop users. So people getting on and off buses in the PALs or the data points was significant. This is the intercept, which doesn't really mean anything. But the variable here, the number here is interpretable. What that means is for each increase in the variable here, the risks for that flight being a PAL or not goes up by 1.16. This is expressed in 10's of bus users. Every time there are ten additional bus users, there is increased risk that the site would become a PAL.

We also developed a non-SR 99 model. We also developed a combined model. I will not present all three. The non-SR 99 model also showed the number of bus people getting on and off buses as one of the most important and significant variables. But we also had some other ones of whether the PAL was near grocery stores, so that would be a certain kid of pedestrian generator. There was some roadway characteristics. Volumes and numbers of lanes, too, were also significant variables in this model.

This is just to give you an image. This is south King Co. This is SR 99. These little buses show you the volume of bus stop riders, and this is where the PALs are, and they are correlated with where the buses were. Again over here, you can see this, the darker blue here is density, and also with a lot of bus rider-ship here, again you have another cluster of PALs. That is visually reinforcing what the model tells you.

Some of our preliminary conclusions were that just a transit use was a significant predictor of whether a site was a PAL or not, but also, that highways are really important transit routes and activity corridors that you have to deal with in terms of safety. SR 99 goes right into the center of Seattle, the largest employment center in the region. It is one of the few through transit routes that serves the whole region. If people are getting on and off the bus there, if they are commuting into downtown, they are getting onto the highway on one side of the street and

they are getting off from the other side of the street, so at least once a day they are having to cross that highway. So it sets up there the facilities that were designed as highways as places pedestrians are going and having to negotiate if they are going to use transit.

But it also made us wonder why weren't we finding anything else significant on 99. Part of that might be just that some of the variables were pretty crude, things were fairly coarsely aggregated spatially. So maybe if we had a better model, we would have more significant results. But I think there are also some other explanations you can look at, and that is just looking at these environments and what they are like.

If you look at some of the descriptive statistics in terms of SR 99, one of the things you find out is that other than bus stop use—so this is in the PALs that mean bus stop use was about 200 people per day were getting on and off in the areas where PALs were. There is a lot of variation there. This is a non-PAL sample point, but many of the other variables, including the amount of retail, including the number of households, including some of the highway characteristics of volume, speeds, etc., they are very similar as you look statistically along the whole length of the route. In other words, there is not a lot of variation. So does that mean that those are safe places because there are not accidents there? I would argue that if you look at SR 99, the whole thing is dangerous.

So what you are finding in this place is an environment that is essentially dangerous along the whole corridor. We have seen other slides earlier that look just like this, for Minneapolis and from Kelly's slide. From Danburg? But it is the same kind of environment. In Toronto, I had lots of international students from India, from China, from Iran and other places. They look at the slides and they just couldn't believe it. They just did not know what was going on.

We had just spent a while talking about transportation planning. We talked about the idea of a road classification system and issues of access versus mobility. I asked what is wrong with this picture and they say these corridors are supposed to provide mobility are also proving a lot of access to local stores and to bus riders. So that is where the people are going. The highways are designed for cars, and increasingly, for transit vehicles, but they are really not designed for people because that just doesn't fit with the planning model, and this is what you end up with. So where are the accidents?

The accidents are actually where the people are, and where are the people? Mostly, they are at bus stops because that is where they have to go. If they are going shopping, they might come in and might drive to a parking lot, but if they are going to work in a place like downtown Seattle where you can't park or it's expensive, they are getting on the bus, and those are the people that are getting hit.

This is built into our whole suburban development process. This is a part of south King Co. where there are a bunch of PALs. This is in 1965; it is just starting to develop. These are state facilities now. This slide is 30 years later, but now you have about a million square feet of retail space and about 4000 apartments around it. It is a real activity center around what are state facilities that are designed as highways, that are intended to be highways. If you talk to the transportation people at the state DOT, they still say that: those are interregional facilities.

These are not main streets for people. But because of how suburban development works, they actually end up being that way.

They also don't provide a lot of transportation choices. These red lines show the streets that were there in 1965. Only these little yellow ones were added since; so you have added a lot of activity around state facilities and basically no other way to get around locally or to move the buses through these places except on these facilities.

These are the kind of apartments you find in these. These are ubiquitous in US suburbs. We don't tend to think of suburbs as places for multifamily housing, but 20-30% of the housing stock is that, and they tend to be located right around state roadways and large suburban arterials.

This is some images of what those look like. This is the same place I just showed you in aerial photograph. Again, this is a state highway. There is good crossing facilities here, but the next one is probably half a mile up before you can cross legally again. You can see how wide the streets get to move traffic, and of course this ones happens to be a place where there are lots of immigrants, so they have instructions in how to cross the street in four languages. It's always funny in the middle of the suburbs when you see signs in Russian, in Vietnamese and things like that.

Again, some images. Planners are always talking about making the land use transportation link, and that is essentially what we have done in these kinds of places. We have put the land use there to get people out of their cars and circumstances, often to get them using the buses, but we are not giving them the facilities and the infrastructure that they need to make them safe. These are all from apartment areas right by state facilities. I particularly like this one of this sort of informal bridge of plural guys, standing across the drainage ditch. So people are really trying to get around, but are not being proved for.

This is just a land use diagram. This is SR 99. All the brown in there is apartments. The red is commercial. This is the area we were just looking at in the aerial slides. This is a big center here, but this is another state facility that runs up here. There is another here, another one here, another one here. they are ubiquitous, and it has to do with the land development process and how we go about developing the suburbs, and there is a link to that to larger arterials and state facilities that are inherently unsafe.

I will now come to the end and make a few points. In terms of urban land uses, these are places that were intended as highways and have become urbanized, so that they have become main streets in a way. They were designed for mobility, but they are providing access particularly to transit. Pedestrians have to cross these facilities at least once a day if they are using transit. So it is a heavy transit corridor. You know you will have pedestrians crossing dangerous facilities.

Returning these highways, one solution might be to move the bus stops off the highways, but often these are the only ways across large parts of the metropolis, and these are the only through routes. So it is basically where the transit has to go. Changing the land uses, which

I've also heard as a solution, at the very best, is a very long term solution. It will be very slow and very expensive, so we are stuck with these environments for a long time.

So controlling for exposure, or how dumb is this research? This research said that if you want to know where pedestrians are getting killed out in the suburbs, go look for where the pedestrians are. The traditional approach is 'so what—that's doesn't tell you how dangerous the environment is.' My argument is that in areas where there are lots of pedestrians, like in downtown Minneapolis, and there is variation in the environment—different intersections are very safe versus very dangerous compared to other ones, it really makes sense to control for pedestrian demand. You have to target the right places to put your infrastructure in, to improve safety.

But in areas where the environment is relatively uniform and bad, like in the suburbs, who cares about exposure? The whole place is dangerous. If you could possibly find the most risky places independent of pedestrians, you are likely to go put your money into a place that is only going to see a pedestrian once a month. What you want to do is put your money where the pedestrians are and often, that is where the bus stops are.

But there are some institutional issues to overcame because responsibility for these places is really fragmented. I know you all work and know how hard it is to work with other agencies. It takes a lot of effort, and responsibilities are apportioned in ways that often make that more difficult. So departments of transportation are increasingly aware of transit, and I think they are increasingly aware of pedestrians and bicycles, which is good. But in terms of Washington, which is also very progressive for pedestrians, the DOT there has gotten really hip to transit and they are designing their facilities when they rebuild them for transit. They are putting in HOB lanes for buses and that kind of thing, but what they are not thinking about so much is how you get pedestrians to those transit vehicles, and how you get them across the street once you get there.

The TREADs agencies are the same way. They are responsible for the people once they are on their bus, partly for liability issues. They don't want to be responsible once you are off their bus, or coming to the bus. Again, there is no one looking out for the pedestrian, and the local municipalities, which are in charge of developing control and sometimes putting in money for sidewalks are also not paying attention to the state facilities. They see that as a state problem.

You then have these environments that are both dangerous and getting used by pedestrians, but no one is looking out for the pedestrian, and that will take a lot of work, and I'm really glad to see people here that they are starting to do that work.

I don't know this region. Both Tony and I worked for Kevin a little bit, helping him with is research, so we did some preliminary analysis. I just threw this slide together very quickly, but this shows downtown where you can see very heavy concentration of crashes. That is a place I think controlling for exposure makes a lot of sense. But there are these areas out in the suburbs that have much smaller volume of people getting hit, for sure, but they are getting hit. Just a preliminary look at the slides Gavin showed us, we see there are freeway intersections, a lot of them. When I looked at them, I saw a lot of big arterials and a lot of places where you have

pedestrian generators. This is just another argument, in another context that I don't know, but probably what is going on here is transit corridors and pedestrian generators, and that is where pedestrians are getting hit in suburbs. To make the point a final time, if you have limited resources, you want to put those resources where it makes sense.

In suburban locations you don't have to worry too much about controlling for exposure. I think you want to really look for where the pedestrians are because there aren't that many of them and they are in concentrated locations for particular reasons. So let me end it there.

Kevin: Any clarifying questions for Paul. I think we need to get out into the sunshine. We are running a little bit behind. We'll take a quick break, but when we come back, we'll hear some reactions from people who are really close to this information. The sessions is kind of where the pedestrian hits the road, so we will hear from some others.

Why don't we reconvene, and we'll push things back about 20 minutes. We'll have a 10-minute break and reconvene at 11:10.

[Break]

Kevin: We will reconvene now. We have three people close to this deal, where the rubber hits the road, kindly titled "where the pedestrian hits the road." It was a giddy moment when our organizing committee tried to come up with that title.

I would like to ask each of these three experts to do a quick self-introduction, some five to ten minutes reflections of what we have heard and what they think some of the major take away points are. We will open it up for discussion for 20 minutes or so to see what you think about where the resources need to be devoted. Then we will have a couple of wrap up comments.

I will turn it over to Don and he was say something about who he is and his expertise in this area.

Don Pflaum: Good morning, my name is Don Pflaum and I'm with the City of Minneapolis Public Works. Amongst other things, I'm the city's bicycle and pedestrian coordinator. I also work a lot with coordinating transit projects and the city's technical ways on Northstar Commuter Rail central and southwest corridor, and also, Redrock. So the transit interfaces with pedestrians and bicycles is very important to me, and I want to start with one initial reaction.

This seminar should have happened 30 years ago. We are that far behind in pedestrian and bicycle infrastructural planning, issues planning. When you look at the roadway evolution in the United States and even in the region, things like this in the road network were evaluated in the 1950s, and I think people are finally waking up to the fact that bicycles and pedestrians are a legitimate form of transportation, and we need to start spending energy, time and resources into that field. So that is my first reaction.

My second reaction has to do with the work that Kevin and Gavin and others on this project did. It was staggering to me when I saw that Hennepin Co. has half the crashes when it come to bike/ped in the entire state. Now, Hennepin Co. is a quarter of the population, so when you look at the allocation there, there are twice as many bicycle/pedestrian crashes, compared to the population ratio. I guess that makes sense because when you look at bike/ped crashes, and what I see every day, is you see about, per the mode, you see about twice as many crashes bike/ped related as the mode.

In other words, if there is 2% of folks out there biking, you see about 4% of the total crashes being bike related. That is something I noticed, but what was an eye opener for me and something I have to deal with, is I looked at the map and of the crashes in Hennepin Co, 2/3 to 3/4 are in the City of Minneapolis, both bike and ped. So what is going on here?

We are very, very proactive in this city, both with bicycles and pedestrians, but I think it has to do with a number of things. I think this was already said before, but the number of crashes is pretty much directly proportional to those that are out there, and I think that is both true with bicycles and pedestrians. You look at the land use and the type of neighborhoods that exit in Minneapolis, and it is a pedestrian oriented environment compared to a lot of suburban locations, so there are a lot of folks out there walking and biking. Taking a closer look, particularly in the bicycling realm, I have found that is true because we have done counts at specific locations that do correlate very well with the number of users versus the number of crashes. So where does the rubber hit the road, so to speak?

My job is twofold. We have to reduce pedestrian/bicycle crashes amongst other crashes. We want to see crashes going down, which in general they are, but to do that, you can't just sit back and say, okay, let's just watch things happen. You have to invest some resources and try to do some counter-measures and vocations and try to figure out what the problem is and then do something about it. In the engineering realm, it isn't always an infrastructure fix. Sometimes it's an enforcement fix, sometimes it's an education fix, and sometimes it's a combination thereof, where you have to look through a little bit of everything to make things a little bit better.

Those are my initial thoughts. I'm sure I will think of things in the next couple of minutes that I forgot to say, but I really like the statement Paul made with respect to resources. You have to spend them where the people are. We are trying to do that.

Resources is the key dilemma here; there is not enough to go around for everybody and it is pretty fierce competition to get any dollars to do anything these days for any sort of improvements. With that said, I'll turn it over to my colleague here.

Cathy Swanson: I'm Cathy Swanson. I'm the director of the Office of Traffic Safety in the Minnesota Department of Public Safety. Let me tell you a little about my career history, so that you know that research is something that is near and dear to me. I started with the Office of Traffic Safety in 1978 as a research analyst. It was my job to put together our crash textbook, which I still think of as one of the best products that comes out of our office.

The role of the office is to serve as the funnel through which federal funding for changing driver behavior comes into Minnesota. If you see things that say Slow Down, Buckle UP, Drive Sober, Pay Attention, often that is stuff that is supported through or promulgated or distributed or whatever though the Office of Traffic Safety.

One of the things that we are working on currently was something that Bob Johnson mentioned at the beginning, which was the Toward Zero Death Program. In some ways, Toward Zero Death is something that the Office of Traffic Safety has been working on from the very beginning. We have always been dedicated to reducing the number of traffic fatalities and serious injuries down to as close to zero as we can get. But what this newly named Towards Zero Death Program does is to rope in extra partners than we had been working with thirty years ago. We are working so closely now with the department of transportation. It has given us both new energy and new perspectives on how to drive the number of traffic crashes down to zero.

One of the things that my long history in the Office of Traffic Safety does is to give me, on some things, a 30-year perspective as opposed to a 5-year perspective. I'm sorry, (I can't recall) which presenter showed the five or six years of crash statistics and showed that crashes are going down, somewhat slightly, but are going down.

If you go back and look 30 years ago at pedestrian crash fatalities in Minnesota, there were about 157 pedestrians killed each year, 30 years ago. We are now down in the 40 to 50 range, and so there has been tremendous progress. Some of that progress has come from people not wanting to walk as much as they did. I'm sure that is a part of it, but some of it has come from better vehicle design. Even for pedestrians, cars are more forgiving in their design now than they were 30 years ago. There are a wide variety of things that are working together to get that number down. As far as it has [gone down], a wide number of things still need to be employed to drive the number down even farther.

What we are charged with in the Office of Traffic Safety and with these federal funds that we employ is to have data-driven programs. That means we are doing exactly what Paul suggested, putting our limited resources where the problems are. But the databases that we use to make those decisions can be flawed in any number of ways.

Kirby Beck mentioned one of the reasons, the database we use exclusively involves bicycle and pedestrian crashes if they also involve a motor vehicle. So two bicyclists hitting each other, a bicyclist taking out a pedestrian, they are not in our database and we don't have ready access to including them. The Toward Zero Death Project and some of the new partnerships that we are making through that are letting us link into the health databases and some of the other sources of information, and that will give us a richer field of data from which to identify problems and select solutions. But a large part of Towards Zero Death is breaking out of our old habits and finding the new partnerships that we need to find some new solutions.

It is our habit to look at traffic crash data. It is our habit to rely on crash stats. If is our habit to, in my office, talk to the behavioral side of fixing things rather than look at the engineering fixes that could take place. So the focus of Towards Zero Death, in addition to having that

goal of driving fatalities down to zero, is to form those new partnerships and to break out of some of those old habits so that we can make some more progress.

I mentioned that if you look at progress over time, we have made some dramatic progress. We have made more progress in the area of reducing pedestrian fatalities than we have made in reducing traffic fatalities as a whole. Again, looking over that same roughly 30 year plan, the highest point per traffic fatalities in Minnesota was in 1967, if I have the year right, when we had 1060 fatalities. We did once in sort of modern times come down to 530, cutting that number in half, and that was back in 1987, or some year like that. But we have in the last five or ten years had a hard time keeping the number under 650.

So the decrease of fatalities as a whole, 1060, compared to about, let's say, 600 and give ourselves a little bit of a break there, that decrease is not anywhere near the magnitude of the decrease in pedestrian fatalities, from about 157, down to about 40 or 50, which is what we currently have.

Bicycle fatalities we have seen the same kind of improvement over that 30 year time span. 30 years ago we had about 25 fatalities a year. Now we have 8 to 10. So in those areas we have cut the numbers down to about a third of where we were 30 years ago, and we have not made that progress in traffic fatalities as a whole.

The one that I'm going to wrap up with…two things I want to say. There was a comment that this conference should have taken place 30 years ago, and on the behavior side, some parts of this conference did take place 30 years ago. It has been a number of years since I've had a chance to see my friend Kirby Beck, as I would like to see him, but 30 years ago we were meeting up at Kragen for the bicycle safety conference and we were talking about the need to do something with bicycle fatalities and were talking about the need to raise awareness of the bike problems listed in Minnesota. Data-driven programs have been important for the progress that we are seeing, but one of the…

[End of side A, tape 2]

Swanson [cont.]: 30 years ago, we had some state funding. 30 years ago we also were able to channel some federal funding into bicycle safety programs. The federal funding went away when we were told to identify our problem area. Our problem areas, year after year after year, are impaired driving, lack of seatbelt use, speeding, and driver inattention.

Bike and pedestrian crashes fall into, of those four categories, probably, the inattention, to some extent the speeding, and once in a while the impaired driving, but it doesn't end up being a focus area on our federal program anymore. Roughly ten years ago the very last of the bicycle safety funding that we were able to get from the state was taken away and diverted to other processes. So some parts of this conference did happen 30 years ago; it's time for it to happen all over again so that some of the resources that we had 30 years ago can be restored to this issue.

The last thing I want to say is we take a little heat for having a goal of Towards Zero Death because people tell us it's not realistic, and we always come a back with, well, what number would you like, a hundred deaths or fifty. We say Towards Zero because it is the only true goal that someone as corny as I can latch onto.

But another goal that a corny person like me latches onto is need to change the world and to change the kind of driving that takes place and to find ways that can move the average driver towards driving in a more mindful way, so that they are mindful of all of the road users, so that they are conscious of the fact that when they make those left-hand turns they need to be looking for the pedestrians, the bicyclist who could be crossing.

I think we are farther away from universal mindful driving than we are from zero deaths, but that doesn't mean we shouldn't hope for it and work for it, too.

Dan Brannan: I'm Dan Brannan. I work in the traffic safety office with Mn/DOT in our traffic engineering section. I also have about 30 years experience in traffic. I think from this conference some of the keys I saw were partnerships, partnerships, partnerships, and that is just what Cathy said, and my partner here.

We probably have done more together with the Towards Zero Death Project, as partners, than we could ever do alone. The pedestrian issues, the more you hear about the more complex it is. It is not just an issue about infrastructure or singular behavior, or I heard a lot of talk today about where the most pedestrians are is where you will find the crashes. Sometimes I'll have to say that.

A few examples I want to give, and some of the downfalls, I think, that our department of transportation has some of the similar weaknesses that were described up here in terms of past policies, manual, guidelines we use. An example is on 100% state-funded job, typically we want the city to pay for the sidewalk. We don't fund that; it is by exception that we do, so there is a policy that could be reversed and be proactive. That is another key word, another partnership and proactive is this pedestrian problem requires proactive solutions, not reactive ones.

In my experience, an example I'll give you, I work in speed zoning and school zones, and you may wonder why they are related. Well, if there is a crash in a school zone, the first call is the police, and then the second call is to my office is to reduce the speed limit. It's kind of a hammer theory. If I gave everybody in this room a hammer, everything you build would be nailed together. Well, every citizen owns a speedometer, so every solution will involve a speed limit, but it doesn't, and that is why experts are called out to look at these.

We did a survey of child/pedestrian crashes, and that is a unique category. We took school aged children during the school year, during the weekdays; we anticipated most of them would be on their way to school. We didn't know for sure. This was not that in-depth of a study. From 98 to 2000, inclusive, there were 546 pedestrian and bike crashes involving that age group, for a three year period. Out of that 547, only 89 were on trunk highways. This shows why Mn/DOT needs partners. Even though that school could have been located on a

trunk highway, these crashes are happening no on a truck highway system but elsewhere on local streets.

Of those 89, only 10 were within 1000 feet of the school. 88% of child-pedestrian crashes occur more than two blocks away from the school. So if you are really going to solve the child-pedestrian crash problem, you don't look where all the children are. You will have to look at the door to door trip, and that is even a more complex issue than what we're talking about today. With transit and other, Hennepin Co. and those areas, you do have groups of pedestrians and you can effectively deal with them, but when you start looking at the child has to walk two miles to school, and I'll mention safer routes to school a little bit here, but with bussing and district budgets the way they are, there are increased walking distances for children. Some are walking, and most are driven to school by their parents, particularly since 9/11, and that is a complicating factor.

I think that security, in a recent survey, showed up as 30% of the respondents said they were worried about their child's security on his walk to school. As if transportation wasn't a bit enough and complex issue, to get into that security issue is even bigger.

Out of these 546 crashes, when we looked at them, less than a half-dozen were at the same location. This means that if you used accident data, like Cathy is talking about, and you reacted and you fixed one intersection and the next year you fixed the other intersection, you would go around fixing 530 intersections and still not know where the next crash is going to happen. You have to be proactive and use all four E's and to solve this problem you can't just chase crashes. So using crash reports probably is not a good measure in treating pedestrian facilities. You have to look at where pedestrians are going.
What they are talking about today is where are destinations, and the one slide I particularly liked was the picture of the elderly gentleman having to cross that drainage ditch and walked through the water. I've got to admit, a little more common sense [is needed]. You don't need tot be a traffic engineer to go out there and see that person needed a better facility. That was pointblank common sense, and I think maybe a lot of desktop designing people aren't walking on out to their field sites and that is really needed. Walk it, and the same thing with the ADA compliance thing. I went to one of Charlie *Agear's classes and 'put yourself in those shoes and it will change the way you design.' So common sense needs to be improved.

But on the school issue it is important to look at the told school route plan for that trial, not just the two blocks round the school where all the kids are. I think with the safe routes to school program, under Donna Allan's office, in her charge right now. I'll throw a little plug in. I believe applications should be ready in May in that, and one of their big E's is encouragement of walking, and I totally support that. Kids should be walking to school, but you should have a walking plan. You should have a school route plan. To the practitioners in this audience, all I have to say is the best thing you can do to take back to your city is develop school route plans, and then see how safe routes to school can help you encourage children to use them.

To capitalize on what Cathy was saying is that behavior is a big issue, empowerment of the pedestrian. A car at 30 MPH on a wet pavement takes 90' to stop, for a pedestrian it takes one step, three feet. The pedestrian has a lot of power and is really in charge of the safety in his

situation. That is an education and behavior issue, but it is a big one. Like Cathy said, I don't think the dollars are there that we are really treating that one. We kind of a short leg on a three-legged stool there and that one is weak.

Those are my observations and comments from our department. Thank you.

Are there questions now?

Julie *Sowert: Hi, I'm Julie *Sowert and I work for Hennepin County Medical Center. My background is I was a critical care nurse in our intensive care unit for several years, and I have been doing our injury prevention at the Trauma Center for about 15 years and have worked a lot with Cathy.

I want to say thank you to all of you, but particularly, Dan, I want to thank you. A lot of the data this morning was a lot over my head. Some of us are talking about it, even though that is what the conference was to discuss. I'm a cover frontline person; I'm out there putting helmets on the kids, trying to get into the schools, which is a challenge these days. It's hard to get in there, trying to figure out how to get the message to them.

I want to iterate a lot of what you had said. Some of the things that came to mind for me is I know funds are tricky, but the more we can partner and get out of the office a literally get with the people, we need to figure out why they are doing their behaviors, why they are making the decisions they are, and doing some kind of social marketing, whatever we can do to get to both parents and kids. It is very frustrating to see them come in day after day after day into our trauma center and think this didn't have to happen. A lot of times it is a behavior thing that either they have either accepted or learned.

One question I had is has anyone been tracking any of the data on distraction by the bicyclists or the pedestrians. I have seen people walk across with the cell phone. I'm driving along, and by no fault of my own, in a very easy, clean intersection, I could be the one who hits that person.

There are a lot of cell phones in cars, but are we talking about it, or the iPods on the bicyclists? I know that is out there, but some social education about what is happening here, and some of that might not even be collected, but if we can get that remarked to us, we can get that into a hospital record. It's an important thing to know that those things…

So some of those things that I think we need to bring to the public beyond the intersection issues or the roadway issues, which I know are a concern to this group. I applaud all that you do. It's mind boggling. So I don't really have so much a question, but it's just those statements to make from those of us that are trying to do the programming on a shoestring and trying to get to people. So if there is anything you can bring to us that we can bring to the community, Aaron with the Safety Council and others of us that are out there doing a little bit more of the direct public information, some practical things that we can bring to them, we would love to have. So we encourage you to share those, and we would love to partner with you.

Dan Brannan: Just a quick response, I just read an article yesterday from, I think, the Insurance Institute that said cell phone use by pedestrians is about the same as drivers in vehicles. In 2000 about 3% of distracted crashes involved a cell phone. They are saying now in 2006 that is up to 6% and was the same percentage with pedestrians, so they are not over or under represented but the same as the drivers. They are both on the cell phone.

Question: I'm just curious if there were any efforts or focus on tracking the safety impacts of last year's change to state law, which allows motorized scooters on multiuse trails and paths? From a local standpoint, we were very concerned with that new law that essentially allows anyone over 14 the use of a motorized scooter on multiuse trails and pathways, both from an enforcement standpoint, on how do you enforce the age requirement, as well as the use of the protective helmet, and then also, the potential for increased crash of bike/scooter type crashes and scooter/ped type crash. Given the current reporting status, is there any way to track the affects of that change in law?

Julie * (Philbrook) Sowert: My sense is that there is not, not a perfect way, at any rate. The database we have tracks only those crashes that happen on public roads, so anything that is happening on a trail doesn't end up in the database that we use. Anything that is happening in a parking lot doesn't end up there. Anything that happens on a sidewalk or in a driveway doesn't end up there.

Those crashes that happen on a public road would end up in the database, but I think that is not going to be the whole section that you would want to identify. It must involve a motor vehicle. I'm not certain, without going back and looking at the law, whether those scooters are classified as motor vehicles or not. There was some exemption if they were classified as motor vehicles and they would require driver licenses and such. I think they may have been exempted from that. It's a complicated thing, sorry.

Thomas Smith: Thomas Smith, Human Factors in the School of Kinesiology, University of Minnesota.

I'm here because we have been funded for a project by the LRV to look at how pedestrians interact with active versus passive warnings at mid-block and un-signalized intersections crosswalks. The aim is to look at active versus passive warnings at these types of pedestrian crosswalks, to see if active warnings really have any affect on pedestrian behavior relative to passive warnings, given the dramatic difference in cost between the two types of warnings.

I wanted to comment on the technology that might be of benefit in terms of pedestrian count. It seems that there is agreement that exposure might be a useful parameter to have for some types of analysis. I know the gentleman earlier commented on, Kevin, in terms of you data, that the major missing link was accurate counts of pedestrian use.

My partner in this project is Nikolao Papanikolopoulos in the Department of Computer Science. I wanted you to know how lucid I was in that pronunciation. It took me about six weeks.

Nikolao has been working for some time on developing software to identify objects in successive frames of video images. Within the last year, he has perfected a software that can take raw images from real world events and compute things like trajectory, velocity, acceleration and so forth, and he is able to do this with pedestrians. In other words, if you had a camera mounted at a sufficient height, panning this room, and we all got up and moved en masse, within the field of view of the camera, he could count everyone of us in this room and could compute the movement dynamics of every one of us in real time with his system.

This is not an abstract academic exercise. The system is currently in use at the Mn/DOT Center for Traffic Management, which is now based in Roseville.

If you have a camera, a pole or at least 30 feet high and an intersection you are interested in, a computer, call Nikolao and he might be able to help you, if you are interested in pedestrian count, not estimates, but actual counts of the particular intersection.

Julie * (Philbrook) Sowert: I would like to say something. I'm not, as you heard from my initial intro here that I work here, I'm a commuter cyclist, but I moved here from Denver. I'm wondering if you compared to other cities and how they handled these issues. In Denver there are a pile of cyclists, just out all the time, but they have a nice network of both on and off-road paths and trails and lanes, and the nice thing about it is you can be zipping along a street and there's a big sign off to your right. We're not in England, but it's off to the right. It says, "I'm on bike route D-10." When I come to the end of this street, my bike lane stops, but it picks up on D-18, and it will show me how to get over to that space.

My issue with living here, and I lived in St. Paul before I moved over here, is that you have one block bike lanes that stop and I have to divert over, and I have no idea what the next safe route is for me to take on the fly. Sure, I've got the big map of the city, with here are the safe routes, here are the pinks streets, here are the red streets, or whatever, but when I'm on the road, I'm not thinking, well, shoot, is Marquette safer than Hennepin or Nicollet. Like in the case of zipping along right across the middle of town, over on Marquette it zips along, and all of a sudden, the lane just completely dies and the road narrows, and suddenly, if I cross the street, I end up in a bus only lane with a curb on my left side. So I'm completely trapped, so my choice is I've got to take 10th St. up and then play chicken with folks on Nicollet.

That is my big issue that maybe more people would cycle and cycle safely if they knew what the routes were or if things were marked, not, hey, here's the bike lane. That's fabulous, but it's a block long.

Thomas Smith: Let me give you a capital example. We have a one block long bike land in front of the state transportation building under the governor's office.

Comment: It's a matter of connecting the dots; you have some here and there.

Kevin: I was just going to suggest that there are a number of signage efforts, and I think that Don can speak to some of these.

Don: First off, how would you like to be on the City of Minneapolis bicycle advisory committee? You are welcome to join. Nick, we have a new member. We'll see you the first Wednesday of the month.

Comment: I would love it.

Don: Thank you for bringing up some of those issues. We're not there yet; we're working on it. We're doing the best we can, and sometimes what we have to do in order to get a bicycle facility in place is do it… We would like to do it from one point to the other and do it right, but sometimes you can't. Sometimes there are challenges where you have to do things kind of piecemeal and then wait for the opportunity to come along ten years later to finish the job right. It's a lot of politics. But we are working on something downtown on something called the Minneapolis Transportation Action Plan. We're taking a fresh look at transit downtown. The reason the bike lanes are on the left side is because of conflict with busses, and Metro Transit is a powerful agency in this region and we have had some issues with bicycle/bus conflicts, and we have even had some fatalities. That is why you see the bike lanes on the left side of the road.

What we're looking at with this study is perhaps concentrating the transit routes to a few corridors instead of a lot of corridors, which could reshuffle the bike system, so you don't have the middle of the bike lanes in Hennepin Ave., and you don't have the 2nd and Marquette situation, and then you bring the bikes back on the Mall. It's being talked about right now. With regard to that, we are working on it.

The City of Minneapolis has a $26 million bike program to accomplish in the next five years. These are real dollars in the bank, gonna be done, they are programmed. We are doing the best we can to get infrastructure out there. It takes a tremendous amount of work from a lot of different people working together to get the facilities in place and we are only about half way there.

With respect to the signage, you also bring up another good point that we have been struggling with. I know James McKay from Denver and he has come up with a very good system of kind of what they do with the state trunk highways and with the numbering system, you're on Rt. 23, you're on Rt. 42 and you can figure out where to go. Denver has an advantage over us in the fact that geographically they are bigger and there are not as many suburbs. There are not as many jurisdictional challenges. To do a system-wide signage and way-finding system in this Minnesota metro area would involve about 30 agencies, probably even more than that.

Minneapolis and St. Paul, the two proper cities, are only a fraction of the total population here. Last time I checked, there was over 190 communities in the metropolitan council seven county area. So for everybody to come up and agree with a systematic approach is tough to do, and they are not there at the federal level either.

I know this is something that the Chapter IX committee of the NETCD, they are the ones that make the rules. They are struggling with this issue too. They want to do something nationwide where there are some nationwide rules for way-finding and so forth. They are working on it,

so there is a long ways to go. We certainly welcome everybody's involvement in trying to come up with creative solutions because we are behind.

And just to build on one comment before I be quiet, I had a conversation with Tom Becker, and I know a lot of you know who he is. He used to be the bike/ped coordinator for the City of Minneapolis traffic engineering. He always used to say that bike and ped issues were cyclical. He said that late 70s we talk about stuff and then it would die off. Then in the early 80s it would come back. Then in the late 80s it would come back. It was somewhat a function of gas prices, somewhat a function of what people's interests were, but I've noticed something different. In the last five years it's not been cyclical. It's been steady, so I think we are at a point now where as long as we can keep going, keep the resources coming, we need to restore some things that were there before, but I think things are different this time than they have been in the past, where it's not cyclical anymore. It's part of mainstream.

Question: I have a question about within the Twin Cities, this central corridor of light rail. Design and planning is moving ahead, but some of the research we've heard seems to indicate that if we put transportation right down the center of what is currently a transportation corridor, University Ave., are we going to be creating an unsafe condition for pedestrians just by that design and should we be looking at possibly changing the design of University Ave. to more of a mixed-mode boulevard, rather than maintaining it as a real transportation corridor for vehicles and putting transit right down the middle of it?

Craig: I'll try to address that. Paul may in the back representing St. Paul, so speak up if I'm out of line here, but I don't believe that LRT will negatively impact the pedestrian environment along University Ave. In fact, I think it will make it better. It will make it better because it will concentrate nodes. You will see different types of development. You'll see more pedestrians, yes, but I think there will be improvements to signalization along the entire corridor. I think it will be a lot more pedestrian friendly environment, where there will be a lot more pedestrians, so people are kind of watching out for them.

But generally speaking, and I'm not sure if a lot of folks know about this, but when they do run light rail down the middle of University, they are going to be some traffic capacity issues. That is why we are looking at a secondary route to help take some of the traffic off of University and that is this *Grainary Rd./Phalen Blvd/Pierce Butler route that we are looking at jointly with the City of St. Paul, which will take a lot of traffic off of University. Some of the places that now have 30,000 or 40,000 cars, we may take 5 or 10,000 cars a day off of that, which may help the situation, and maybe even take some trucks off of University and put them onto that secondary augmented route.

Kirby Beck: I'm Kirby Beck. I remember, Craig. I think your mom used to bring you up after school, didn't she, 30 years ago? Sorry.

I have some comments after working in this for a while. For those of you that are into statistics, what I would suggest you do if you want some accurate data about peds and bikes that don't involve motor vehicles, they are classified as a "public accident." What you may be

able to do is go to police departments, request public accidents and have them do a little search category that talks bicycle.

I remember a case where the bike was coming over the railroad tracks, then a quick release was too loose, the front wheel came off and down he went, and it was nearly a fatal crash. That was referred as a public accident. So more and more police departments are becoming computerized and might be able to give you some data. Although, Minneapolis, good luck. They don't write many reports on anything unless people are getting shot because they are busy working on those things, and I understand why they are as they are.

For engineers, I used to do a class at Dan Byrd, and we have heard him referenced. I used to put this challenge to the engineers. I understand that here I'm talking to the choir, but you have to go back and talk to the dinosaurs in your department. Give them this to think about: is driving a car on a roadway a right or a privilege? In most every state it's a privilege. Yet walking or biking on that public space is a right. So are you building, designing things for the privileged, or are you building and designing things for the right. That picture up there with the old man crossing the creek was just absolutely classic. We are not all going to be able to drive forever, and how are you going to be able to get where you are going when you can't drive anymore, or you end up in the wheelchair? I really believe that engineers have responsibilities to those people too.

I'm trying to hit all the E's here. Education, we looked at how many pedestrians get hit at left turns. Has anybody here ever had training in being a pedestrian, other than your mommy holding your hand and walking across the street? If we were to educate some of these people, instead of just looking at the light, but watch them when they cross. They are looking at the light. It's look left, right, left and keep on looking. Maybe if we put signs up that said "Keep Looking." Or if you want your fancy technology, put a little sign up with eyeballs going back and forth. It will remind you to keep looking. Like you said, it takes one step to stop and you can avoid a lot of trouble. Teach them to dress better so they stand out. There are a lot of different things and we are ignoring that from the education standpoint.

And enforcement, forget it. It just ain't going to happen. I've been working trying to change that paradigm in Minnesota for over 20 years and I might as well hit my head against that wall. It's just not going to happen.

Kevin: We have time for just one or two more questions and then we will have some wrap-up comments.

Thomas Smith: I'm going to follow up this point. I think it is a good follow up. I asked the question about California because for many, many years California has had a rule in place that the pedestrians have an absolute right to cross the road. I lived in California. I won't tell you how many years ago, but there were many, many times that if a pedestrian just lifted his foot off the curb and put one foot into the street, vehicles coming both ways screeched to a stop. That's the absolute truth. Now I don't know if that's still the case, but it was the case when I was there.

I understand that Minnesota has passed a similar law, and in fact, coming up River Rd. this morning, there were three or four cases where vehicles stopped spontaneously, for a pedestrian or for a bike, before they had even entered the street. I also saw Kelly. She was vigorously bicycling. She was keeping up with two young men. I was very impressed.

Kelly: And they made me carry all the stuff.

Thomas Smith: I saw that. You were really loaded.

Comment: She did get the fat tire bike and the other two of us were on the skinny-tired bikes.

Thomas Smith: I was impressed. My question is, and maybe it's too early, has this new law in Minnesota had any measurable of noticeable impact on how vehicles treat pedestrians? The project I described a few minutes ago I wouldn't even apply for that project in California because in this state pedestrians are still fresh meat. They are fair game, at least when I lived there it wasn't true in California.

Julie: I don't know if we have good enough data to be able to tell you that. I'm blanking on what year that law was passed. It wasn't just last year. It was a couple of years back.

The last five years of pedestrian fatalities in Minnesota, going back to 2000, we had 41, 46, 50, 52 and 37. I don't know if I have good enough data to be able to tell you.

Marie Jackson Smith: In today's paper it said "Two St. Cloud pedestrians struck when driver dropped cell phone." I just mention that because pedestrians and cyclists are so much more vulnerable when they are in motorized vehicle traffic. I'm thinking, could we start finding out ways to give pedestrians and cyclists the advantage in a traffic situation, when motor vehicles have to wait or they have to go round a different way, pedestrian traffic signals and things like that? It is not so common here that we have motor vehicles stop and wait for pedestrians to cross. We have transit advantages, something like pedestrian/cyclist advantages in road design.

Moderator: That's a good point. With our out-of-town guests I want to give the opportunity for Kelly to provide us with some quick reflection type comments and then we will turn to some wrap up with comments from two local officials.

[*Speaker]: First I have to apologize. I have been keeping these notes on the fly and they are not very organized, but I'm hoping to hit on what I think are some of the main highlights.

The good news is there's been a convergence of interests in pedestrian and bicycle mode, so there is an interest in it from a mode of transportation, so from the issues of reducing congestion or increasing access to transit. Traditional groups are starting to organize around non-motorized modes. But we are also seeing a lot of interest again from the health community, from this interest in levels of physical activity and leisure time, walking and cycling. There is this issue around quality of life and livable communities. I think that all

bodes well and reflects on the comment that Don made that this seems to be a sustaining interest, that it isn't just the issue of the moment.

That provides us, then, for a lot of opportunity to form these partnerships with groups that have traditionally just looked at one piece of the question. While these issues aren't necessarily incredibly complex, they involve a variety of different pieces to really understand what is going on. There are the behavior issues, the environment issues and the variety of policy treatments.

So this broad interest in design in the built environment, to finding out what sorts of environment support these activities, as well as what are the obstacles and barriers that are important, and understanding the behaviors. So at the end of the day, at least from what I do, understanding how to take all of this research and understanding and put it into practice is really the key of this meeting here today.

There is a growing amount of research, so the three of us here certainly aren't the only ones involved in these activities, but it's really impressive, the effort that going into understanding non-motorized modes, what makes them safe and attractive. Knowledge is the key, but we need to have information, good data, good information, so that we can create good policies and intervention and advance the agenda.

First of all, we need to have good information on pedestrian and cycling demand. So why? This issue of exposure we've talked about in terms of crashes per pedestrian, so we know that crashes are going down, but we don't know if that is a good thing or a bad thing, from the standpoint of are the going down because our treatments are affective, or are they going down because fewer people are walking and cycling, and also, in analyzing crashes at specific locations. As Paul said that is not necessarily everything, but it is one important factor.

The other reason we need to begin is just for planning purposes. So where are the pedestrians? Irrespective of crashes, where are people walking and where are they cycling? We need to know a lot more about how much people are walking and cycling, where they are doing it, when they are doing it, and why. Then there are some inefficiencies in our information about crashes.

We have a lot of detail and it's getting better, but there are missing pieces and parts of the information, and this is an area where partnership can become critical, so merging information from the traditional police reports with hospital records, and increasing our capacity to collect information about non-injury crashes and collisions or near-misses is important, and also, more information about details of the crash itself. Maybe we need some post crash interviews about some motivations about why the person was there.

Again, we should incorporate information about land use and design, micro-scale information about the road facility and the intersection. We seem to have increasing capacity to collect this information, with aerial photographs, and many cities are archiving these data, and it is just a matter of putting all the actors together and finding a way to create a database or merge this information in a way that is helpful to everyone.

Minnesota appears to be fairing fairly well compared to other states. According to Kevin's slides and Kathryn's comments, crashes are going down. A big issue here is to understand why, why are they going down? There is this issue of are there fewer people biking and walking, or are these treatments effective, and we really don't know. So at this point we can focus on the outcome, the crash. But more understanding of the underlying process and what is really effective and what is not.

Gavin provided us a lot of detail about the crashes themselves, the behavior of driver, behavior of pedestrian, and behavior of cyclist. Again, not all crashes are created equal, so that is another thing we need to think about. There is a lot of variation across space and across time, so this is something else we need to think about, to understand the specific circumstances leading to the crashes.

Another key point here is we focused a lot on automobile crashes, but there is a litany of other dangers we need to be considering to increase safety. There are bike to bike crashes, bike to pedestrian crashes, skaters, skate-boarders, cell phones, iPod users and so on. But I still think the 800 pound gorilla for now is the automobile, and if you can increase the demand, increase the number of people who walk and cycle, I think we'll start to see more interest in these other interactions. I don't think they should be forgotten, but I do think the automobile there is a reason why we focus so much on it.

Just to close here, I think a lot of these solutions are relatively simple. Understanding how to fix some of these problems doesn't require millions of dollars of research funding and me standing up here giving you regression results. I think they are quite obvious. Having people spend more time in a community talking to residents and understanding where to target these investments is relatively simple and straight forward, but it will involve a lot of actors and a lot of partnerships.

My final comment is change takes a lot of time. This situation didn't just arrive at our doorstep recently. It is a long complicated process, so it will take a long process to reverse.

Kevin: Before our sessions is punctuated by two final comments from distinguished local officials from Mn/DOT, I wanted to do two things. First, thank you all for participating, contributing and taking some of the information back home to your communities. Second, I wanted you to join me in thanking both Margaret and Gavin for hosting us and putting on this wonderful symposium. Thank to both of you.

So final comments, first from Donna Allen, and then Donna will turn it over to Sue Lodahl, both from Minnesota DOT.

Donna Allen: I'm as surprised today to see myself up here as you might be, but I appreciate the opportunity to say thank you for your participation, and I will try to be really brief.

The emphasis of the whole meeting is on safety, and that is something that we can certainly keep in mind. The story that Darryl told you about our interaction came about as a result—I'm

a transit person---and about three years ago or a little more, we were lucky enough to get bike and ped section assigned to the Office of Transit. That was a really good deal because I think it is a very good marriage. I have heard Transit come up over and over again today, which made me feel a little more comfortable in a bike place.

But I have been trying to learn about bikes, and Bob and Darryl and Michelle and Mary have all had a part in helping that to happen. But the conversation that Darryl and I had came about because I was looking around for both some authority and resources to do bike safety program, an educational kind of program. I was getting a lot of feedback about 'I'm not sure we need this.' We have a lot of needs related to highway; why would we spend it on bikes? I thought I would just go back and tell Darryl that I needed the stats and then we could just move on. That is when I found out that there really wasn't that much data.

I was surprised and Darryl just took it from there and went off, and the result is that we have some really good efforts in both bike safety educational program, the Share the Road program that Bob Works is doing, and we have been engaged, at least in a small way, with the university and the work that Kevin has done.

I should say that I feel really encouraged by what I heard this morning. The work that Kevin and Gavin are doing, I recognize that we don't always have the appropriate statistics and data, but it seems like we are really getting to a place where we will have something specific to work with. The kind of collaboration that is going on is also very encouraging to me, having others here, Kelly and Paul, to share their learning. Even though it might not be directly applicable to our situation, there is always learning from that kind of collaboration—so I am encouraged by that.

I learned to day that we have some statistical data. We have identified the need for other data to make these studies meaningful. We're learning from each other that we have a lot of work to do. I really appreciated Don's comments about coming a little late to this, but I think it is encouraging that we are engaged, and we heard that there are some real resources being put to this effort.

Kathy talked about mindfulness, and I think that is so important on our roads and sidewalks, and again, our Share the Road program from Mn/DOT that has been spearheaded by Bob goes right to that, that drivers and bicyclists have responsibilities.

Also there is Dan's emphasis on partnering and getting some of our non-traditional partners involved, and I have heard some of that today, which again is encouraging.

One of the things I learned that I didn't really know was that fatalities are actually declining, but we know there might be really good reasons for that, and that is there may not be very much activity out…

[End of side B, take 2]

[cont.] …and otherwise, we see a real emphasis on getting people out to get more exercise, not to mention the need to reduce congestion, especially around places like our public school, with a Safe Routes to School program that Congressman Oberstar is so interested in.

Speaking of that, I think that this whole idea that there might be a tsunami coming is not that far out. It might not be a tsunami; it might be a perfect storm or just high seas, but I think we really do have to be ready for it. I think it's coming, and like Don said, we're not seeing those hills and valleys. The interest is steady and rising, even from our elected officials.

So on behalf of Mn/DOT, I won't take any more of your time, but it's been a real learning experience for me today. I thank every one of your for being here and participating and for helping me and others to understand this situation. We have a long way to go, but the best news today is that we are all engaged and we are all on a mission to make our communities safer for people who want to walk and walk to bicycle, so thank you very much.

Sue Lodahl: Hi, I'm Sue Lodahl, also from Mn/DOT and director of research services, and I will be very, very brief because I would like to be a pedestrian or bicyclist, maybe later on today.

This was a great morning, as everybody said. It was information, with lots of interaction. For research services this whole forum was a great success because a lot of times research projects, we get results and they just stop and they get put into a report, maybe get read by a few folks, get looked at and searched on the website. To see that our research results from this particular project actually turn into an outreach effort is a wonderful thing and I thank everyone involved in the research project. Darryl and Gavin, thanks.

I'm going to do a little plug to research. I heard a lot of things like connecting the dots to the existing pedestrian or bicycle facilities. Mn/DOT has an implementation program. It's not necessarily to implement just research that has been done, but it is to get a product out and get information shared to transportation practitioners and professionals. That might be a good opportunity for that particular idea.

On the back table where I was sitting, I just put out some information about our research group at Mn/DOT, who we are, who to contact for necessary information, and what we do. If you want to find out more information on a particular topic, please contact our library. There are some information sheets on the various literature searches, who to call and what they provide. So if there are any questions for me in general, see me at lunchtime. Thank you