UMTRI-2004-24

A Study of Michigan Safety Belt Use Surrounding the May Mobilization, 2004

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August 2004

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTRI-2004-24		

4. Title and Subtitle A Study of Michigan Safety Belt Use Surrounding the May Mobilization, 2004	5. Report Date August 2004 6. Performing Organization Code
7. Author(s) David W. Eby, Jonathon M. Vivoda	8. Performing Organization Report No. UMTRI-2004-24
9. Performing Organization Name and Address The University of Michigan Transportation Research Institute 2901 Baxter Road Ann Arbor, MI 48109	10. Work Unit No. (TRAIS) 11. Contract or Grant No. PT-04-21
12. Sponsoring Agency Name and Address Michigan Office of Highway Safety Planning 400 Collins Road, PO Box 30633 Lansing, MI 48909-8133	13. Type of Report and Period Covered Final 10/29/03 - 9/30/04 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The study reports the results of an evaluation of the "Click It or Ticket: Buckle Up or Pay Up" safety belt mobilization campaign in Michigan centered around Memorial Day of 2004. The study consisted of three survey waves: Two full statewide surveys (one conducted as a baseline before the campaign and one conducted as a post campaign measure) and one "mini" statewide survey conducted to assess the media and enforcement components of the campaign. All survey waves were conducted statewide on front-outboard occupants traveling in four vehicle types (passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks). Belt use was estimated for all commercial/ noncommercial vehicle types combined (the statewide safety belt use rate) for each survey wave. Additional analyses were conducted on the two full statewide surveys (baseline and post) because of the larger sample sizes. Statewide safety belt use was approximately 84 percent prior to the mobilization campaign, 82 percent during the media and enforcement period, and nearly 87 percent during the post survey wave. This was a statistically significant increase in belt use from both the baseline and media/enforcement waves to the post wave. In addition, the use rate for the post survey, of 86.8 percent, was the highest ever found in Michigan. The study results suggest that: Michigan should continue to participate in the national efforts to raise safety belt use; safety belt enforcement zones were successful as implemented in Michigan and should be continued; the CIOT model as implemented in Michigan was successful; and the expanded efforts that were employed during this year's mobilization have resulted in an even larger belt use increase than has been observed in the past.

17. Key Words	18. Distribution Statement
Motor vehicle occupant restraint use, safety belt use, seat belt survey, direct observation survey, occupant protection	Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	63	

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This report was prepared in cooperation with the
Michigan Office of Highway Safety Planning
and
U.S. Department of Transportation
National Highway Traffic Safety Administration
through Highway Safety Project #PT-04-21

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ACKNOWLEDGMENTS

We express our thanks to several individuals who were essential to the completion of this project. Steven Guerriero, Christa Harrison, John Henion, Robert Kraft, Joshua Lipton, Ian Raymond, David Szilagyi, and Brandon Zwagerman conducted field observations. Judy Settles and Mary Chico coordinated administrative procedures for the field observers. Mary Chico provided valuable comments on a previous version of this report. Special thanks to the Michigan Office of Highway Safety Planning for its support.

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August 2004

INTRODUCTION

In March 2000, Michigan implemented a change to the enforcement provision of the statewide safety belt law. This change, from secondary to primary (standard) enforcement, allows police officers to more easily stop and cite motorists for failure to wear a safety belt. The net result of this change was a dramatic increase in safety belt use all across the state (Eby & Vivoda, 2001). In order to maintain this high rate of belt use, and continue to increase it, a public information and enforcement program called "Click It or Ticket" (CIOT) was adopted in Michigan (Michigan Office of Highway Safety Planning, OHSP, 2004a). This program, based on a Selective Traffic Enforcement Program (STEP) developed in Canada, had been shown to be successful at increasing safety belt use in other parts of the U.S. A CIOT campaign is essentially a highly publicized law enforcement effort (Buckle Up America, 2004). These programs are recognized as one of the most effective ways to increase safety belt use. The critical elements of a successful CIOT program are a highly visible increase in police enforcement of the belt use law; effective media messages from various sources informing the public of the efforts; and a component to evaluate the program's effectiveness, usually consisting of safety belt surveys conducted before, during, and after the program.

A large scale, nationwide CIOT mobilization took place during May 2003. Across the U.S., this effort involved nearly $25 million of purchased media, including television and radio advertisements, mainly focused on 18-34 year old males (Solomon, Chaudhary, & Cosgrove, 2003). These advertisements made the point that police agencies were serious about enforcing the safety belt law. Law enforcement agencies in 44 states reported issuing more than 500,000 safety belt citations during the mobilization (Solomon, Chaudhary, & Cosgrove, 2003). In the past, these mobilizations have been timed to coincide with the Memorial Day and Thanksgiving holidays.

In 2002 in Michigan, the average number of traffic crash related deaths was 3.50 per day. However, during holiday periods, the average was 5.06 crash-related deaths per day (OHSP, 2003). To help address this issue by increasing safety belt use across the state, Michigan received funding to participate in the 2003 May Mobilization effort. As part of this program, OHSP developed a new slogan to go along with CIOT: “Buckle Up or Pay Up.” This slogan emphasized the police enforcement aspect of the campaign. Nearly 500 law enforcement agencies across the state participated, with 109 receiving additional funding for overtime enforcement activity. A new enforcement strategy, “safety belt enforcement zones,” was also implemented during this mobilization. Each safety belt enforcement zone was clearly marked by a sign denoting the start of the zone. A spotter near the sign then looked for motorists that were not buckled-up and radioed that information ahead to other police officers in vehicles further into the zone (OHSP, 2004b). The evaluation of this program included four direct observation survey waves: a full statewide baseline wave, a mini wave during the media component, another mini wave during the media+enforcement component, and a full post wave. The mobilization effort resulted in a significant increase in belt use from the media wave to both the media+enforcement and post waves. In fact, the rate observed during the post survey wave (83.9 percent), was the highest statewide use rate observed in Michigan at the time (Eby, Vivoda, & Spradlin, 2003a).

Michigan has also received funding for the current year to participate in the 2004 May Mobilization effort. Given the success of the 2003 mobilization and the additional increase in belt use (to 84.8 percent) noted during a subsequent study conducted in September 2003 (Eby, Vivoda, & Spradlin, 2003b), OHSP decided to expand the mobilization efforts even more for 2004. These efforts included about 700 safety belt enforcement zones in 48 counties across Michigan, generating about 21,000 safety belt citations. Additional police enforcement from the “Law Enforcement Challenge” resulted in another 12,000 safety belt citations written during this time period. During the media component of the mobilization, $800,000 was spent on paid advertising including television and radio spots. Five media events were also conducted, in Detroit, Lansing, Holland, Traverse City, and Escanaba, to highlight the enforcement zone activity. Additionally, general press releases regarding the mobilization, as well as 82 press releases targeted to specific local areas were generated.

To properly understand the effects of this large effort to increase safety belt use across the state, three direct observation surveys of safety belt use in Michigan were conducted. The first was a full statewide survey that provided baseline safety belt use information before the mobilization began; the second was a mini survey that assessed use during the media and enforcement components of the campaign, and the third was another full survey that provided use rates after the mobilization ended.

METHODS

Sample Design

The current study consists of three survey waves: Two full statewide surveys (one conducted as a baseline before the campaign and one conducted as a post campaign measure) and one "mini" statewide survey conducted to assess the media and enforcement components of the campaign. The sample design for the full statewide survey was closely based upon the one used by Streff, Eby, Molnar, Joksch, and Wallace (1993), while the mini survey consisted of a subsample of the full survey. The entire sampling procedure is presented here for completeness, with modifications noted. Procedures for selecting the subsample are detailed at the end of this section.

The goal of this sample design was to select observation sites that accurately represent front-outboard vehicle occupants in eligible commercial and noncommercial vehicles (i.e., passenger cars, vans/minivans, sport-utility vehicles, and pickup trucks) in Michigan, while following federal guidelines for safety belt survey design (NHTSA, 1992, 1998). An ideal sample minimizes total survey error while providing sites that can be surveyed efficiently and economically. To achieve this goal, the following sampling procedure was used.

To reduce the costs associated with direct observation of remote sites, NHTSA guidelines allow states to omit from their sample space the lowest population counties, provided these counties collectively account for 15 percent or less of the state's total population. Therefore, all 83 Michigan counties were rank ordered by population (U.S. Bureau of the Census, 1992) and the low population counties were eliminated from the sample space. This step reduced the sample space to 28 counties. In order to account for shifts in the population of Michigan counties (U.S. Bureau of the Census, 2003), three additional counties were added to the present design bringing the total number of counties in the sample space to 31.

The original counties were then separated into four strata. The strata were constructed by obtaining historical belt use rates and vehicle miles of travel (VMT) for each county. Historical belt use rates were determined by averaging results from three previous

University of Michigan Transportation Research Institute (UMTRI) surveys (Wagenaar & Molnar, 1989; Wagenaar, Molnar, & Businski, 1987b, 1988). Since no historical data were available for six of the counties, belt use rates for these counties were estimated using multiple regression based on per capita income and education for the other 22 counties (r^2 = .56; U.S. Bureau of the Census, 1992).[1] These factors have been shown previously to correlate positively with belt use (e.g., Wagenaar, Molnar, & Businski, 1987a). Wayne County was chosen as a separate stratum because of its disproportionately high VMT, and because we wanted to ensure that observation sites were selected within this county. Three other strata were constructed by rank ordering each county by historical belt use rates and then adjusting the stratum boundaries until the total VMT was roughly equal within each stratum. The stratum boundaries were high belt use (stratum 1), medium belt use (stratum 2), low belt use (stratum 3), and Wayne County. The additional counties for the present survey became part of stratum 3 and all sites in this stratum were reselected and rescheduled following the procedures described below. The counties comprising each stratum can be found in Table 1.

Table 1: Listing of Michigan Counties by Stratum

Stratum Number	Counties
1	Ingham, Kalamazoo, Oakland, Washtenaw
2	Allegan, Bay, Eaton, Grand Traverse, Jackson, Kent, Livingston, Macomb, Midland, Ottawa
3	Berrien, Calhoun, Clinton, Genesee, Ionia, Isabella, Lapeer, Lenawee, Marquette, Monroe, Muskegon, Saginaw, Shiawassee, St. Clair, St. Joseph, Van Buren
4	Wayne

To achieve the NHTSA required precision of less than 5 percent relative error, the minimum number of observation sites for the survey (N = 56) was determined based on within- and between-county variances from previous belt use surveys and on an estimated 50 vehicles per observation period in the current survey. This minimum number was then increased (N = 168) to get an adequate representation of belt use for each day of the week and for all daylight hours.

[1] Education was defined as the proportion of population in the county over 25 years of age with a professional or graduate degree.

Because total VMT within each stratum was roughly equal, observation sites were evenly divided among the strata (42 each). In addition, since an estimated 23 percent of all traffic in Michigan occurs on limited-access roadways (Federal Highway Administration, 1982), 10 of the sites (24 percent) within each stratum were freeway exit ramps, while the remaining 32 were roadway intersections.

Within each stratum, observation sites were randomly assigned to a location using different methods for intersections and freeway exit ramps. The intersection sites were chosen using a method that ensured each intersection within a stratum an equal probability of selection. Detailed, equal-scale road maps for each county were obtained and a grid pattern was overlaid on each county map. The grid dimensions were 62 lines horizontally and 42 lines vertically. The lines of the grid were separated by 1/4 inch. With the *3/8 inch:mile* scale of the maps, this created grid squares that were .67 miles per side. (Because Marquette County is so large, it was divided into four maps and each part was treated as a separate county.) Each grid square was uniquely identified by two numbers, a horizontal (x) coordinate and a vertical (y) coordinate.

The 42 sites for each stratum were sampled sequentially. The 32 local intersection sites were chosen by first randomly selecting a grid number containing a county within a stratum.[2] This was achieved by generating a random number between 1 and the number of grids within the stratum. So, for example, since the high belt use stratum had four grid patterns overlaying four counties, a random number between 1 and 4 was generated to determine which grid would be selected. Thus, each grid had an equal probability of selection at this step. Once the grid was selected, a random x and a random y coordinate were chosen and the corresponding grid square identified. Thus, each intersection had an equal probability of selection. If a single intersection was contained within the square, that intersection was chosen as an observation site. If the square did not fall within the county, there was no intersection within the square, or there was an intersection but it was located one road link from an already selected intersection, then a new grid number and x, y coordinate were randomly selected. If more than one intersection was within the grid

[2] It is important to note that grids were selected during this step rather than counties. This was necessary only because it was impractical to construct a single grid that was large enough to cover all of the counties in the largest stratum when they were laid side by side.

square, the grid square was subdivided into four equal sections and a random number between 1 and 4 was selected until one of the intersections was chosen. This happened for only two of the sites.

Once a site was chosen, the following procedure was used to determine the particular street and direction of traffic flow that would be observed. For each intersection, all possible combinations of street and traffic flow were determined. From this set of observer locations, one location was randomly selected with a probability equal to 1/number of locations. For example, if the intersection, was a "+" intersection, as shown in Figure 1, there would then be four possible combinations of street and direction of traffic flow to be observed (observers watched traffic only on the side of the street on which they were standing). In Figure 1, observer location number one indicates that the observer would watch southbound traffic and stand next to Main Street. For observer location number two, the observer would watch eastbound traffic and stand next to Second Street, and so on. In this example, a random number between 1 and 4 would be selected to determine the observer location for this specific site. The probability of selecting an intersection approach is dependent upon the type of intersection. Four-legged intersections like that shown in Figure 1 have four possible observer locations, while three-legged intersections like "T" and "Y" intersections have only three possible observer locations. The effect of this slight difference in probability accounts for .01 percent or less of the standard error in the belt use estimate.

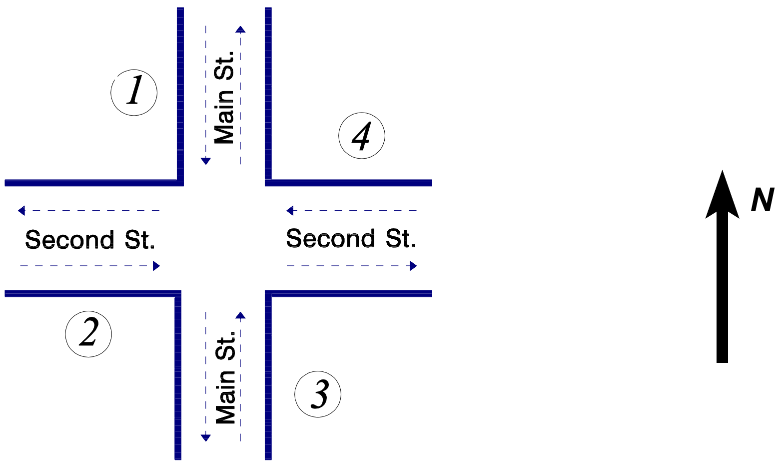

Figure 1. An Example "+" Intersection Showing 4 Possible Observer Locations.

For each primary intersection site, an alternate site was also selected. The alternate sites were chosen within a 20 x 20 square unit area around the grid square containing the original intersection, corresponding to a 13.4 square mile area around the site. This was achieved by randomly picking an *x*, *y* grid coordinate within the alternate site area. Grid coordinates were selected until a grid square containing an intersection was found. No grid squares were found that contained more than one intersection. The observer location at the alternate intersection was determined in the same way as at the primary site.[3]

The 10 freeway exit ramp sites within each stratum also were selected so that each exit ramp had an equal probability of selection.[4] This was done by enumerating all of the exit ramps within a stratum and randomly selecting without replacement 10 numbers between 1 and the number of exit ramps in the stratum. For example, in the high belt use stratum there were a total of 109 exit ramps. To select an exit ramp, a random number

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[3] For those interested in designing a safety belt survey for their county or region, a guidebook and software for selecting and surveying sites for safety belt use is available (Eby, 2000) by contacting UMTRI-SBA, 2901 Baxter Rd., Ann Arbor, MI 48109-2150, or accessing http://www-personal.umich.edu/~eby/sbs.html/.

[4] An exit ramp is defined here as egress from a limited-access freeway, irrespective of the direction of travel. Thus, on a north-south freeway corridor, the north and south bound exit ramps at a particular cross street are considered a single exit ramp location.

between 1 and 109 was generated. This number corresponded to a specific exit ramp. To select the next exit ramp, another random number between 1 and 109 was selected with the restriction that no previously selected numbers could be chosen. Once the exit ramps were determined, the observer location for the actual observation was determined by enumerating all possible combinations of direction of traffic flow and sides of the ramp on which to stand. As in the determination of the observer locations at the roadway intersections, the possibilities were then randomly sampled with equal probability. The alternate exit ramp sites were selected by taking the first interchange encountered after randomly selecting a direction of travel along the freeway from the primary site. If this alternate site was outside of the county or if it was already selected as a primary site, then the other direction of travel along the freeway was used. If the exit ramp had no traffic control device on the selected direction of travel, then a researcher visited the site and randomly picked a travel direction and lane that had such a device.

The day of week and time of day for site observations were quasirandomly assigned to sites in such a way that all days of the week and all daylight hours (7:00 am - 7:00 pm) had essentially equal probability of selection. The sites were observed using a clustering procedure. That is, sites that were located spatially adjacent to each other were considered to be a cluster. Within each cluster, a shortest route between all of the sites was decided (essentially a loop) and each site was numbered. An observer watched traffic at all sites in the cluster during a single day. The day in which the cluster was to be observed was randomly determined. After taking into consideration the time required to finish all sites before dark, a random starting time for the day was selected. In addition, a random number between 1 and the number of sites in the cluster was selected. This number determined the site within the cluster where the first observation would take place. The observer then visited sites following the loop in either a clockwise or counterclockwise direction (whichever direction left them closest to UMTRI at the end of the day). This direction was determined by the project manager prior to sending the observer into the field. Because of various scheduling limitations (e.g., observer availability, number of hours worked per week) certain days and/or times were selected that could not be observed. When this occurred, a new day and/or time was randomly selected until a usable one was found. The important issue about the randomization is that the day and time assignments for observations at the sites were not correlated with belt use at a site. This quasirandom method is random with respect to this issue.

The sample design was constructed so that each observation site was self-weighted by VMT within each stratum. This was accomplished by selecting sites with equal probability and by setting the observation interval to a constant duration (50 minutes) for each site.[5] Thus, the number of vehicles observed at a site reflected safety belt use by VMT; that is, the higher the VMT at a site, the greater the number of vehicles that would pass during the 50-minute observation period. However, since all vehicles passing an observer could not be surveyed, a vehicle count of all eligible vehicles (i.e., passenger cars, vans/minivans, sport-utility vehicles, and pickup trucks) on the traffic leg under observation was conducted for a set duration (5 minutes) immediately prior to and immediately following the observation period (10 minutes total).

Table 2 shows descriptive statistics for the 168 observation sites for the two full statewide surveys: Wave 1 (Baseline) conducted between 4/15/04 - 4/28/04 and Wave 3 (Post) conducted between 6/10/04 - 6/26/04. As shown in this table, the observations for both surveys were fairly well distributed over day of week. Observations were also well distributed by time of day except for the latest time period. Note that an observation session was included in the time slot that represented the majority of the observation period. If the observation period was evenly distributed between two time slots, then it was included in the later time slot. This table also shows that nearly every site observed in both surveys was the primary site, and that observations were mostly conducted during sunny and cloudy weather conditions. Very few observations were conducted in rainy or snowy conditions for the baseline survey, while about one quarter were conducted during rain in the post survey.

[5] Because of safety considerations, sites in the city of Detroit were observed for a different duration. See data collection section for more information.

Table 2. Descriptive Statistics for the 168 Observation Sites for the Two Full Statewide Surveys: Wave 1 (%) and Wave 3 (%), Respectively.											
Day of Week			**Time**			**Site**			**Weather**		
Wave	**1**	**3**		**1**	**3**		**1**	**3**		**1**	**3**
Monday	13.7	14.9	7-9 a.m.	8.9	9.5	Primary	99.4	99.4	Sunny	48.2	40.5
Tuesday	13.1	13.1	9-11 a.m.	19.1	21.4	Alternate	0.6	0.6	Cloudy	47.6	36.9
Wednesday	11.3	11.3	11-1 p.m.	18.5	16.7				Rain	3.6	22.6
Thursday	16.7	16.0	1-3 p.m.	23.2	22.6				Snow	0.6	0.0
Friday	17.2	16.7	3-5 p.m.	20.8	20.3						
Saturday	14.3	14.3	5-7 p.m.	8.9	9.5						
Sunday	13.7	13.7	7-9 p.m.	0.6	0.0						

Mini Survey Subsample Selection

The purpose of the mini survey was to quickly determine the overall statewide safety belt use rate with a limited number of sites without the requirements of providing safety belt rates by day of week, time of day, or demographics of occupants. As described earlier, to achieve the required precision of less than 5 percent relative error, the minimum number of observation sites for the survey was determined to be 56 sites, 14 in each stratum. To begin the subsample selection, all of the freeway sites within each stratum of the full statewide survey were assigned a number 1-10. Since 24 percent of the sites within each stratum of the full sample were freeway exit ramps (to match the freeway travel in Michigan), it was necessary for two of the subsample strata to have 3 freeway sites and the other two strata to have 4. To randomly determine which strata would have 3 freeway sites, two random numbers between 1 and 4 were generated to correspond with the stratum numbers. Random numbers corresponding to the freeway sites were then generated until the proper number had been chosen for each stratum. The remaining intersection sites within each stratum were assigned a number 1-32, and then a random number was generated between 1 and 32 for Stratum 1. The site that corresponded to that number was chosen as a site for the subsample. Random numbers continued to be generated without replacement until all 14 sites had been chosen within the stratum. This site selection process was repeated for each of the remaining 3 strata until all 56 sites had been sampled from the original 168. The scheduling of the sites for the mini survey was completed using the same clustering procedure described above.

Table 3 shows descriptive statistics for the 56 observation sites for the mini statewide survey: Wave 2 (media & enforcement), conducted between 5/17/04 - 5/23/04. As stated earlier, the purpose of this phase of the study was to provide only an overall estimate of statewide safety belt use in Michigan. Given the compressed schedule that was necessary to complete this survey, and the small number of sites relative to the full statewide survey, an even distribution of observations over day of week and time of day was not possible. As such, observations were not well distributed over day of week or time of day (see Table 3). This table also shows that nearly every site observed was the primary site and that observations were mostly conducted during cloudy weather conditions, with smaller percentages conducted during sunny and rainy weather. No observations were conducted during snowy conditions.

Table 3. Descriptive Statistics for the 56 Observation Sites for the Statewide Mini-Survey: Wave 2 (%).

Day of Week		Time		Site		Weather	
Monday	19.6	7-9 a.m.	10.7	Primary	98.2	Sunny	23.2
Tuesday	16.1	9-11 a.m.	25.0	Alternate	1.8	Cloudy	58.9
Wednesday	10.7	11-1 p.m.	21.4			Rain	17.9
Thursday	8.9	1-3 p.m.	23.2			Snow	0.0
Friday	14.3	3-5 p.m.	16.1				
Saturday	12.5	5-7 p.m.	3.6				
Sunday	17.9						

Data Collection

Trained field staff observed shoulder belt use, sex, age, vehicle type, and vehicle purpose (commercial or noncommercial) of drivers and front-right passengers during daylight hours only. Motorists traveling in passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks were included. Observations were conducted when a vehicle came to a stop at a traffic light or stop sign.

Data Collection Forms

Data were collected during the mobilization using personal digital assistants (PDAs). For a more detailed description of the PDA data collection process, see Appendix C. Two electronic forms were developed for data collection: a site description form and an observation form. For each site surveyed, separate electronic copies of the site description form and observation form were created in advance. The site description form allowed observers to provide descriptive information including the site location, site type (freeway exit ramp or intersection), site choice (primary or alternate), observer name, date, day of week, time of day, weather, and a count of eligible vehicles traveling on the proper traffic leg. A place on the form was also furnished for observers to electronically sketch the intersection and to identify observation location. Finally, a comments section was available to identify landmarks that might be helpful in characterizing the site (e.g., school, shopping mall) and to discuss problems or issues relevant to the site or study.

A second electronic form, the observation form, was used to record safety belt use, passenger information, and vehicle information. For each vehicle surveyed, shoulder belt use, sex, and estimated age of the driver and the front-outboard passenger were recorded along with vehicle type. Children riding in child restraint devices (CRDs) were recorded but not included in any part of the analysis. Occupants observed with their shoulder belt worn under the arm or behind the back were noted but considered belted in the analysis. Based upon NHTSA (1999) guidelines, the observer also collected data from commercial vehicles, and noted this in the electronic form. A commercial vehicle is defined as a vehicle that is used for business purposes and may or may not contain company logos. This classification includes vehicles marked with commercial lettering or logos, or vehicles with ladders or other tools on them.

Procedures at Each Site

All sites in the sample were visited by one observer for a period of 1 hour, with the exception of sites in the city of Detroit. To address potential security concerns, these sites were visited by two-person observer teams for a period of 30 minutes. Observations at other sites scheduled to be observed on the same day as Detroit sites were also completed by two observers. Because each team member at these sites recorded data for different lanes of traffic, the total amount of data collection time was equivalent to that at one observer sites.

Upon arriving at a site, observers determined whether observations were possible at the site. If observations were not possible (e.g., due to construction), observers proceeded to the alternate site. Otherwise, observers completed the site description form and then moved to their observation position near the traffic control device.

Observers were instructed to observe only the vehicles in the lane immediately adjacent to the curb, regardless of the number of lanes present. At sites visited by two-person teams, team members observed different lanes of the same traffic leg with one observer on the curb and one observer on the median (if there was more than one traffic lane and a median). If no median was present, observers were instructed to stand on diagonally opposite corners of the intersection.

At each site, observers conducted a 5-minute count of all eligible vehicles in the designated traffic leg before beginning safety belt observations. Observations began immediately after completion of the count and continued for 50 minutes at sites with one observer and 25 minutes at sites with two observers. During the observation period, observers recorded data for as many eligible vehicles as they could observe. If traffic flow was heavy, observers were instructed to record data for the first eligible vehicle they saw, and then look up and record data for the next eligible vehicle they saw, continuing this process for the remainder of the observation period. At the end of the observation period, a second 5-minute vehicle count was conducted at one observer sites.

Observer Training

Prior to data collection, field observers participated in 5 days of intensive training, including both classroom review of data collection procedures and practice field observations. A couple observers were added as replacements during the course of the three surveys. All observers participated in another complete training session prior to the third survey wave. Each observer received a training manual containing detailed information on field procedures for observations, data collection forms, and administrative policies and procedures. A site schedule identifying the location, date, time, and traffic leg to be observed for each site was included in the manual (see Appendix A for a listing of the sites).

After intensive review of the manual, observers conducted practice observations at several sites chosen to represent the types of sites and situations that would actually be encountered in the field. None of the locations of the practice sites were the same as sites observed during the study. Training at each practice site focused on completing the site description form, determining where to stand and which lanes to observe, conducting the vehicle count, recording safety belt use, and estimating age and sex. Observers worked in teams of two, observing the same vehicles, but recording data independently on separate data collection forms. The forms were then compared for accuracy. Teams were rotated throughout the training to ensure that each observer was paired with every other observer. Each observer pair practiced recording safety belt use, sex, and age until there was an interobserver reliability of at least 85 percent for all measures on drivers and front-right passengers for each pair of observers.

Each observer was provided with an atlas of Michigan county maps and all necessary field supplies. Observers were given time to locate their assigned sites on the appropriate maps and plan travel routes to the sites. After marking the sites on their maps, the marked locations were compared to a master map of locations to ensure that the correct sites had been pinpointed. Field procedures were reviewed for the final time and observers were informed that unannounced site visits would be made by the field supervisor during data collection to ensure adherence to study protocols.

Observer Supervision and Monitoring

During data collection, each observer was spot-checked in the field on at least two occasions by the field supervisor. Contact between the field supervisor and field staff was also maintained on a regular basis through telephone calls to report progress and discuss problems encountered in the field, e-mails to the field supervisor from each observer's PDA containing data from the preceding day, text messages to the observer's PDAs to alert them to any important information, and visits to the UMTRI office to deliver expense forms and timesheets. Field staff were instructed to call the field supervisor's home or cellular phone if problems arose during evening hours or on weekends.

Incoming data files were examined by the field supervisor and problems (e.g., missing data, discrepancies between the site description form and site listing or schedule) were noted and discussed with field staff. Comments on the site description form about site-specific characteristics that might affect future surveys (e.g., traffic flow patterns, traffic control devices, site access) were noted.

Data Processing and Estimation Procedures

The accuracy of electronic data was verified by checking for inconsistent codes (e.g., the observation end time occurring before the start time; "no passenger" marked, when passenger data were present) and missing data. Any errors noted during this process were corrected.

For each site, a computer analysis program determined the number of observed vehicles, belted and unbelted drivers, and belted and unbelted passengers. Separate counts were made for each independent variable in the survey (i.e., site type, time of day, day of week, weather, sex, age, seating position, and vehicle type). This information was combined with the site information to create a file used for generating study results.

As mentioned earlier, our goal in this safety belt survey was to estimate belt use for the state of Michigan based on VMT. As also discussed, the self-weighting-by-VMT scheme employed is limited by the number of vehicles for which an observer can accurately record information. To correct for this limitation, the vehicle count information was used to weight the observed traffic volumes so they would more accurately reflect VMT.

This weighting was done by first adding each of the two 5-minute counts and then multiplying this number by five so that it would represent a 50-minute duration.[6] The resulting number was the estimated number of vehicles passing through the site if all eligible vehicles had been included in the survey during the observation period at that site. The estimated count for each site is divided by the actual number of vehicles observed there to obtain a volume weighting factor for that site. These weights are then applied to the number of actual vehicles of each type observed at each site to yield the weighted N for the total number of drivers and passengers, and total number of belted drivers and

[6] As mentioned previously, the Detroit sites were visited by pairs of observers for half as long. For these sites, the single 5-minute count was multiplied by five to represent the 25-minute observation period.

passengers for each vehicle type. Unless otherwise indicated, all analyses reported are based upon the weighted values.

The overall estimate of belt use per VMT in Michigan was determined by first calculating the belt use rate within each stratum for observed vehicle occupants in all vehicle types using the following formula:

$$r_i = \frac{\textit{Total Number of Belted Occupants, weighted}}{\textit{Total Number of Occupants, weighted}}$$

where r_i refers to the belt use rate within any of the four strata. The totals are the sums across all 42 sites within the stratum after weighting, and occupants refers to only front-outboard occupants. The overall estimate of belt use was computed by averaging the belt use rates for each stratum. However, comparing total VMT among the strata, one finds that the Wayne County stratum is only 83 percent as large as the total VMT for the other three strata. In order to represent accurately safety belt use for Michigan by VMT, the Wayne County stratum was multiplied by 0.83 during the averaging to correct for its lower total VMT. The overall belt use rate was determined by the following formula:

$$r_{all} = \frac{r_1 + r_2 + r_3 + (0.83 \times r_4)}{3.83}$$

where r_i is the belt use rate for a certain vehicle type within each stratum and r_4 the Wayne County stratum.

The estimates of variance and the calculation of the confidence bands for the belt use estimates are complex. See Appendix B for a detailed description of the formulas and procedures. The same use rate and variance equations were utilized for the calculation of use rates for each vehicle type separately.

RESULTS

As discussed previously, the current study of safety belt use in Michigan reports results from three direct observation survey waves. The first full statewide survey wave was conducted to determine baseline safety belt use prior to the campaign. The second survey wave was a mini survey conducted to assess the media and enforcement components of the campaign. The third survey wave was a full statewide survey conducted to assess the effects of the campaign immediately after the campaign ended. Note again, that with a mini-survey, it is only possible to determine an overall statewide safety belt use rate, stratum use rates, and rates by seating position. However, it is possible to determine use rates by several other categories using data gathered during the full statewide surveys. Given this, the categories of belt use common to all three survey waves will be discussed first, followed by a comparison of belt use within the other categories for only the two full statewide surveys (waves 1 and 3).

Overall Safety Belt Use

Table 4 shows the statewide safety belt use rates and unweighted number of front-outboard occupants (N) for the three survey waves. The "±" value following the use rate indicates a 95 percent confidence band around the percentage. This value should be interpreted to mean that one can be 95 percent sure that the actual safety belt use rate falls somewhere inside the band created by these percentages. As shown in this table, statewide safety belt use was approximately 84 percent prior to the mobilization campaign, around 82 percent during the media and enforcement phase, and rose to almost 87 percent during the post survey (wave 3). This change in belt use represents a statistically significant increase from waves 1 and 2 to wave 3. Furthermore, the belt use rate from wave 3 (86.8 percent) is the highest rate of statewide safety belt use ever observed in Michigan.

Table 4: Overall Safety Belt Use and Unweighted N by Survey Wave			
Survey	**Statewide Use Rate**	**Unweighted N**	**Relative Error**
Baseline (full)	83.8 ± 1.4%	11,543	0.85%
Media/Enforcement (mini)	81.9 ± 2.3%	4,669	1.43%
Post (full)	86.8 ± 1.2%	12,082	0.68%

Safety Belt Use by Stratum

Estimated safety belt use by stratum and survey wave is shown in Table 5. This table shows that safety belt use increased significantly from the baseline to the post survey for only stratum 3. Between the media/enforcement and the post survey waves, belt use increased significantly only in stratum 2. There was no statistically significant change in belt use from the baseline to the media/enforcement survey wave.

Table 5: Safety Belt Use and Unweighted N by Stratum and Survey Wave			
	Baseline	**Media/ Enforcement**	**Post**
Stratum 1	86.0 ± 2.3% (3,669)	81.2 ± 5.2% (1,607)	89.1 ± 2.8% (3,596)
Stratum 2	87.4 ± 2.3% (2,125)	83.0 ± 2.4% (707)	88.7 ± 1.2% (2,206)
Stratum 3	79.7 ± 3.8% (1,334)	81.9 ± 5.7% (860)	86.4 ± 2.0% (1,767)
Stratum 4	81.8 ± 2.1% (4,415)	81.6 ± 4.2% (1,495)	82.3 ± 3.1% (4,513)

Safety Belt Use by Seating Position

Estimated safety belt use by position in vehicle and survey wave is shown in Table 6. This table shows that safety belt use for drivers was slightly higher than use by front-right passengers for all survey waves. Belt use for both drivers and passengers increased in the post survey when compared with both the baseline and media/enforcement waves. Belt use increased more for passengers than for drivers.

Table 6: Safety Belt Use and Unweighted N by Stratum and Survey Wave

	Baseline	Media/ Enforcement	Post
Driver	84.5 (9,136)	82.2 (3,716)	87.1 (9,415)
Passenger	80.0 (2,407)	80.5 (953)	85.6 (2,667)

Safety Belt Use by Subgroup (All Vehicle Types Combined)

Statewide safety belt use rates by site type, time of day, day of week, weather, occupant sex, and age group are shown in Table 7 by survey wave. Recall that use rates for the subgroups could only be calculated for the full statewide surveys (baseline and post).

Site Type

As is typically found (Eby, Molnar & Olk, 2000), safety belt use was higher for limited access exit ramps than for non-limited access intersections. Both site types showed increased safety belt use in the post survey when compared to the baseline survey.

Time of Day

For both surveys, safety belt use was relatively high during the morning commute. This was the only time period where belt use did not increase from the baseline to the post survey. Since safety belt use was particularly low during the evening commute of the baseline survey wave, the largest increase from baseline to post was observed during this time period.

Day of Week

As is commonly found, there were no consistent trends in belt use by day of week. Comparing between the surveys, however, showed that safety belt use was higher during the post survey for all days of the week.

Weather

Safety belt use did not systematically vary by weather condition. Comparison between surveys on this variable shows belt use increases in both sunny and cloudy weather. Few observations were conducted during rain in the baseline survey and no observations were conducted during the snow in the post survey. Therefore, comparisons of safety belt use between surveys by these weather conditions is problematic.

Sex

Again, as is typically found in Michigan (see e.g., Eby, Fordyce, & Vivoda, 2000; Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, 2002), safety belt use was higher for women than for men in both surveys. Safety belt use for both sexes was higher during the post survey with a greater belt use increase found for males than for females.

Age Group

Because of the low number of occupants under age 16 riding in the front-outboard passenger position, use rates for the two youngest age groups should be interpreted with caution. Excluding these age groups, we found that safety belt use generally increased with age, as has been found in the past (see e.g., Eby, Fordyce, & Vivoda, 2000; Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, 2002). In all age groups, safety belt use increased from the baseline survey to the post survey.

Table 7. Percent Shoulder Belt Use and Unweighted N by Subgroup and Survey (All Vehicles Combined)				
	Baseline		**Post**	
	Percent Use	**N**	**Percent Use**	**N**
Site Type				
Intersection	82.5	7,552	85.5	8,111
Exit Ramp	85.9	3,991	89.2	3,971
Time of Day				
7 - 9 a.m.	91.7	1,058	86.4	1,361
9 - 11 a.m.	84.2	1,681	86.3	1,978
11 - 1 p.m.	82.0	1,367	85.4	1,563
1 - 3 p.m.	83.0	2,863	87.7	2,462
3 - 5 p.m.	83.2	3,057	86.5	3,088
5 - 7 p.m.	65.2	1,517	89.1	1,630
Day of Week				
Monday	83.5	1,695	86.9	2,265
Tuesday	83.3	1,623	87.8	1,620
Wednesday	88.4	856	90.3	1,001
Thursday	83.8	1,833	85.7	1,756
Friday	83.6	2,380	86.5	2,401
Saturday	84.9	1,569	86.3	1,478
Sunday	86.0	1,587	89.7	1,561
Weather				
Sunny	84.7	6,243	86.8	5,282
Cloudy	82.4	4,903	87.2	4,332
Rainy	83.0	295	86.8	2,468
Snowy	82.4	102	---	0
Sex				
Male	79.7	6,176	83.9	6,498
Female	88.5	5,359	90.4	5,572
Age				
0 - 3	50.1	26	75.9	12
4 - 15	81.6	315	88.1	426
16 - 29	81.1	2,669	85.1	3,124
30 - 59	84.4	6,742	87.4	7,266
60 - Up	86.2	1,785	87.4	1,252

Safety Belt Use by Subgroup and Vehicle Type

Safety belt use rates and unweighted Ns by vehicle type and subgroup can be found in Tables 8a (passenger cars), 8b (sport-utility vehicles), 8c (van/minivans), and 8d (pickup trucks).

Vehicle Type

Safety belt use rates for passenger cars, sport-utility vehicles, and van/minivans were roughly the same, while belt use for pickup truck occupants was significantly lower than these other vehicle types for both surveys. Low safety belt use in pickup trucks has been found previously in Michigan for both commercial and noncommercial light vehicles (see e.g., Eby, Fordyce, & Vivoda, 2000; Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, 2002). Comparisons within vehicle type across surveys showed that safety belt use was higher in the post survey, with the greatest percentage point increase found for pickup truck occupants.

Site Type

Safety belt use was found to be higher for limited access exit ramps than for non-limited access intersections for all vehicle types and surveys. Comparison across surveys within each vehicle type, show that safety belt use was higher for the post survey for all vehicle and site types. The largest differences are noted in the post survey for pickup trucks and vans/minivans.

Time of Day

Few consistent trends in safety belt use by time of day were found, except that belt use tended to be highest during the morning commute for all vehicle types and surveys except for pickup trucks in the post survey. Safety belt use was particularly low during the evening rush hour for occupants of both passenger cars and pickup trucks. When compared to the baseline survey, safety belt generally increased from the baseline to the post survey.

Day of Week

There were no consistent trends in belt use by day of week for any of the vehicle types. Comparing across surveys, however, showed that safety belt use generally was higher during the post survey for all days of week. The results for all non-passenger car vehicle types should be interpreted with caution due to some small sample sizes.

Weather

Safety belt use did not systematically vary by weather condition. Because of small sample sizes for the rainy and snowy weather conditions, comparisons on these variables are not meaningful.

Sex

For all vehicle types and surveys, safety belt use was higher for women than for men. When compared to the baseline survey, safety belt use for both sexes, was higher for the post survey with greater increases found for men than for women.

Age Group

Again, because of the low number of occupants under age 16 riding in the front-outboard passenger position, comparison of use rates for the two youngest age groups cannot be made. Excluding these groups, we found that in the baseline survey, safety belt use increased with age for occupants of passenger cars and vans/minivans. For the sport-utility vehicle and pickup truck occupants, belt use was lower for the oldest age group than for the 30-59 age group in the baseline survey. During the post survey, safety belt use increased with age for occupants of vans/minivans and pickup trucks. For passenger car motorists, belt use was about the same for those 30-59 and 60 and above. Counter-intuitively, for occupants of sport-utility vehicles belt use seemed to decrease with age. However, these results should be interpreted with caution due to the low numbers of occupants in the 16-29 and 60+ age categories. Comparison between survey waves within each vehicle type, showed that safety belt use was higher for the post survey in most cases.

Table 8a. Percent Shoulder Belt Use and Unweighted N by Subgroup and Survey (Passenger Cars)				
	Baseline		**Post**	
	Percent Use	**N**	**Percent Use**	**N**
Passenger Cars	86.9	5,740	87.9	5,920
Site Type				
Intersection	85.2	3,729	87.2	3,882
Exit Ramp	87.9	2,011	88.7	2,038
Time of Day				
7 - 9 a.m.	92.2	568	93.6	693
9 - 11 a.m.	85.7	739	89.8	865
11 - 1 p.m.	85.5	619	84.8	735
1 - 3 p.m.	86.2	1,401	88.3	1,247
3 - 5 p.m.	86.8	1,582	87.1	1,431
5 - 7 p.m.	68.2	831	87.4	949
Day of Week				
Monday	87.7	983	92.2	1,248
Tuesday	85.2	813	87.5	806
Wednesday	93.4	391	89.2	481
Thursday	89.6	872	86.0	866
Friday	86.7	1,166	89.7	1,180
Saturday	87.7	764	88.4	659
Sunday	87.4	751	91.4	680
Weather				
Sunny	87.7	3,061	87.7	2,601
Cloudy	85.9	2,476	88.4	2,108
Rainy	84.3	162	88.7	1,211
Snowy	85.4	41	---	0
Sex				
Male	83.7	2,685	85.4	2,820
Female	89.6	3,051	90.3	3,097
Age				
0 - 3	74.4	8	70.7	6
4 - 15	87.3	141	86.1	181
16 - 29	82.3	1,650	85.5	1,889
30 - 59	88.0	2,937	89.5	3,155
60 - Up	90.5	1,001	88.0	688

Table 8b. Percent Shoulder Belt Use and Unweighted N by Subgroup and Survey (Sport Utility Vehicles)				
	Baseline		**Post**	
	Percent Use	**N**	**Percent Use**	**N**
Sport-Utility Vehicles	84.2	2,119	88.2	2,271
Site Type				
Intersection	84.5	1,393	86.9	1,505
Exit Ramp	86.6	726	90.7	766
Time of Day				
7 - 9 a.m.	93.9	187	89.0	239
9 - 11 a.m.	86.9	295	83.4	352
11 - 1 p.m.	82.1	263	87.4	293
1 - 3 p.m.	85.1	556	91.4	472
3 - 5 p.m.	81.6	521	88.4	600
5 - 7 p.m.	88.6	297	93.1	315
Day of Week				
Monday	85.7	271	84.8	382
Tuesday	88.4	305	88.4	288
Wednesday	88.4	152	96.3	171
Thursday	83.5	314	90.1	295
Friday	82.1	416	83.8	468
Saturday	86.6	273	85.3	290
Sunday	90.3	388	93.1	377
Weather				
Sunny	84.3	1,177	87.1	1,008
Cloudy	84.1	877	90.0	840
Rainy	81.8	52	87.6	423
Snowy	84.6	13	---	0
Sex				
Male	80.7	995	85.8	1,073
Female	87.5	1,123	90.4	1,195
Age				
0 - 3	50.0	2	---	0
4 - 15	75.8	53	94.3	97
16 - 29	84.6	408	90.3	500
30 - 59	84.6	1,406	88.1	1,501
60 - Up	84.1	249	81.0	172

Table 8c. Percent Shoulder Belt Use and Unweighted N by Subgroup and Survey (Vans/Minivans)

	Baseline		Post	
	Percent Use	N	Percent Use	N
Vans/Minivans	84.0	1,710	87.9	1,804
Site Type				
Intersection	84.0	1,071	86.8	1,228
Exit Ramp	85.4	639	93.0	576
Time of Day				
7 - 9 a.m.	87.0	154	87.4	202
9 - 11 a.m.	86.3	289	88.4	330
11 - 1 p.m.	82.8	216	89.5	261
1 - 3 p.m.	82.0	424	86.2	347
3 - 5 p.m.	80.8	422	87.6	478
5 - 7 p.m.	89.4	205	92.0	186
Day of Week				
Monday	79.3	262	78.6	329
Tuesday	80.6	226	91.9	230
Wednesday	89.1	123	94.0	168
Thursday	85.2	269	82.0	252
Friday	87.1	356	90.3	340
Saturday	88.0	228	89.6	218
Sunday	89.1	246	93.7	267
Weather				
Sunny	85.5	887	88.0	783
Cloudy	80.7	764	87.5	656
Rainy	82.6	35	88.3	365
Snowy	95.8	24	---	0
Sex				
Male	78.7	879	84.4	951
Female	89.6	829	91.7	850
Age				
0 - 3	81.2	9	100.0	1
4 - 15	76.8	74	89.5	98
16 - 29	80.6	200	82.5	282
30 - 59	85.0	1,126	88.7	1,208
60 - Up	86.1	299	89.8	215

Table 8d. Percent Shoulder Belt Use and Unweighted N by Subgroup and Survey (Pickup Trucks)				
	Baseline		Post	
	Percent Use	N	Percent Use	N
Pickup Trucks	74.5	1,974	81.0	2,087
Site Type				
Intersection	72.4	1,359	78.9	1,496
Exit Ramp	78.9	615	86.1	591
Time of Day				
7 - 9 a.m.	81.7	149	67.4	227
9 - 11 a.m.	75.7	358	79.8	431
11 - 1 p.m.	70.1	269	79.4	274
1 - 3 p.m.	71.9	482	82.1	396
3 - 5 p.m.	76.3	532	82.7	579
5 - 7 p.m.	56.0	184	90.0	180
Day of Week				
Monday	73.3	179	82.4	306
Tuesday	76.2	279	85.4	296
Wednesday	76.9	190	83.4	181
Thursday	69.2	378	83.8	343
Friday	72.2	442	75.9	413
Saturday	76.3	304	82.1	311
Sunday	77.1	202	81.3	237
Weather				
Sunny	75.8	1,118	82.7	890
Cloudy	72.3	786	80.4	728
Rainy	77.2	46	80.3	469
Snowy	62.5	24	---	0
Sex				
Male	73.3	1,617	79.4	1,654
Female	79.9	356	87.8	430
Age				
0 - 3	56.0	7	66.7	5
4 - 15	78.6	47	85.5	50
16 - 29	73.9	411	79.4	453
30 - 59	75.2	1,273	80.6	1,402
60 - Up	71.8	236	88.3	177

Safety Belt Use by Age and Sex Combined

Table 9 shows the estimated safety belt use rates and unweighted Ns for age and sex combined for each survey. Again, because of low sample sizes for the two youngest age groups, results for these groups should be considered tentative. For males, safety belt use was higher in the post survey than the baseline survey for the four oldest age groups. For females, safety belt use rates were higher in the post survey for those 16-29. Belt use remained about the same for females over 30 years of age between the baseline and post surveys.

Table 9. Percent Shoulder Belt Use and Unweighted N by Age and Sex (All Vehicle Types Combined)

Age Group	Male		Female	
	Baseline	Post	Baseline	Post
0 - 3	78.8 (15)	75.2 (8)	46.5 (11)	89.4 (3)
4 - 15	77.2 (160)	90.2 (233)	86.1 (155)	85.8 (191)
16 - 29	76.2 (1,400)	80.2 (1,603)	86.2 (1,267)	90.5 (1,520)
30 - 59	80.1 (3,666)	84.7 (3,988)	89.5 (3,070)	90.9 (3,270)
60 - Up	83.4 (934)	86.1 (664)	89.4 (851)	88.9 (588)

DISCUSSION

The estimated statewide safety belt use rates for front-outboard occupants of passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks combined was 83.8 ± 1.4 percent during the baseline survey wave; 81.9 ± 2.3 percent during the media and enforcement component of the campaign; and 86.8 ± 1.2 percent after the campaign (post). These belt use rates illustrate a statistically significant increase from both the baseline and media/enforcement waves to the post wave. While there appears to be a decrease in belt use from the baseline wave to the media/enforcement wave, it is important to note that these two waves employed different survey designs. As mentioned earlier, the baseline and post waves were full statewide surveys, while the media/enforcement wave was a mini wave. While all of these waves represent accurate statewide belt use in Michigan, there are fewer sites and a different data collection schedule in the mini survey. Given these differences, comparisons between the full and mini waves should be made with caution.

However, the use rate for the post survey, which was determined using the full statewide design, revealed the highest safety belt use rate ever achieved in Michigan. This is an important increase, since the highest rate achieved in Michigan prior to this study (84.8 ± 1.6 percent) was just found in September, 2003 (Eby, Vivoda, & Spradlin, 2003b). While these two numbers are not statistically different from one another, they represent the latest in an important upward trend in belt use across the state over the past couple of years. As such, these findings suggest that the present mobilization campaign, focused on the Memorial Day period in 2004, and the other recent safety belt mobilizations have been successful in Michigan at not only maintaining a high belt use rate across the state, but also in continuing to increase this number.

Belt use rates were also analyzed as a function of stratum and survey wave. These analyses showed that increases within each stratum contributed to the overall statewide increase. However, between the baseline and post waves, the largest increase (6.7 percentage points) was noted in Stratum 3. While there were increases noted in the other strata, these differences were not statistically significant.

The study also examined safety belt use by position in vehicle across the three survey waves. For all survey waves, safety belt use was slightly higher for drivers than for front-right passengers. Belt use for both drivers and passengers increased between both the baseline and media/enforcement survey waves and the post wave. There was a greater increase for passengers than for drivers (5.6 and 2.6 percentage points, respectively from the baseline to the post survey) indicating that the campaign may have had a greater effect on passengers. Since driver belt use was already relatively high during the baseline survey, this change may also indicate that as more people buckle-up, the behavior of those that continue to remain unbelted may be the most difficult to change.

The effects of the program on several subgroups could only be investigated by comparison between the baseline and post surveys, where large enough samples were available for subgroup analysis. We found increases in safety belt use for limited access exit ramps, local intersections, nearly all times of day, all days of the week, males, females, all age-groups, and for all vehicle types. Thus, the mobilization generally increased safety belt use within nearly every category and subgroup in Michigan. Further analysis of these data show that many of these subgroups experienced similar belt use increases to one another (about 3 percentage points). These findings were somewhat surprising since the campaign had a special focus on young males. The analysis of belt use by age and sex combined showed that there were similar increases in belt use for both males and females in the 16-29 year old age group. However, within the 30-59 year old age group, nearly all of the increase was found in males rather than females. It should be noted again, that the belt use rate for females in the 30-59 year old age group was quite high even during the baseline survey wave (89.5 percent). In fact, the baseline female belt use rate for this age group was higher than the corresponding male use rate during the post survey. The largest increase (of 6.5 percentage points) was noted for occupants of pickup trucks. While this increase is promising, the use rate of pickup truck occupants (81.0 percent during the post survey) is still far below that of occupants in other vehicle types.

In conclusion, these positive results suggest that: Michigan should continue to participate in the national efforts to raise safety belt use; safety belt enforcement zones were successful as implemented in Michigan and should be continued; the CIOT model as implemented in Michigan was successful; and the previously described expanded efforts that were employed during this year's mobilization have resulted in an even larger belt use increase than has been observed in the past.

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APPENDIX A

Site Listing

Survey Sites By Number

No.	County	Site Location	Type	Str
001	Oakland	EB Whipple Lake Rd. & Eston Rd.	I	1
*002	Kalamazoo	EB S Ave. & 29th St.	I	1
003	Oakland	SB Pontiac Trail & 10 Mile Rd.	I	1
004	Washtenaw	SB Moon Rd. & Ann Arbor-Saline Rd./Saline-Milan Rd.	I	1
005	Oakland	WB Drahner Rd. & Baldwin Rd.	I	1
006	Oakland	SB Rochester Rd. & 32 Mile Rd./Romeo Rd.	I	1
007	Oakland	SB Williams Lake Rd. & Elizabeth Lake Rd.	I	1
008	Ingham	SB Searles Rd. & Iosco Rd.	I	1
*009	Kalamazoo	WB D Ave. & Riverview Dr.	I	1
010	Washtenaw	EB N. Territorial Rd. & Dexter-Pinckney Rd.	I	1
*011	Washtenaw	NB Schleeweis Rd./Macomb St. & W. Main St.	I	1
012	Ingham	NB Shaftsburg Rd. & Haslett Rd.	I	1
013	Oakland	NB Middlebelt Rd. & 9 Mile Rd.	I	1
*014	Washtenaw	WB Packard Rd. & Carpenter Rd.	I	1
015	Ingham	EB Haslett Rd. & Marsh Rd.	I	1
*016	Washtenaw	NB Jordan Rd./Monroe St. & US-12/Michigan Ave.	I	1
017	Washtenaw	SB M-52/Main St. & Old US-12	I	1
018	Kalamazoo	SB 8th St. & Q Ave.	I	1
*019	Washtenaw	WB 8 Mile Rd. & Pontiac Trail	I	1
*020	Oakland	SB Lahser Rd. & 11 Mile Rd.	I	1
*021	Kalamazoo	NB Ravine Rd. & D Ave.	I	1
022	Washtenaw	EB Glacier Way/Glazier Way & Huron Pkwy.	I	1
023	Washtenaw	WB Bethel Church Rd. & M-52	I	1
024	Washtenaw	SB Platt Rd. & Willis Rd.	I	1
*025	Ingham	WB Fitchburg Rd. & Williamston Rd.	I	1
026	Washtenaw	EB Merritt Rd. & Stoney Creek Rd.	I	1
027	Oakland	SB Hickory Ridge Rd. & M-59/Highland Rd.	I	1
028	Kalamazoo	SB Douglas Ave. & D Ave.	I	1
*029	Oakland	WB Walnut Lake Rd. & Haggerty Rd.	I	1
030	Oakland	NB Jossman Rd. & Grange Hall Rd.	I	1
031	Kalamazoo	EB H Ave. & 3rd St.	I	1
032	Kalamazoo	EB TU Ave. & 24th St./Sprinkle Rd.	I	1
033	Oakland	WBD I-96 & Milford Rd.. (Exit 155B)	ER	1
*034	Washtenaw	WBP I-94 & Whittaker Rd./Huron St. (Exit 183)	ER	1
*035	Kalamazoo	SBP US-131 & M-43 (Exit 38B)	ER	1
036	Washtenaw	SBD US-23 & N. Territorial Rd.	ER	1
*037	Kalamazoo	EBP I-94 & Portage Rd.	ER	1
038	Oakland	EBP I-696 & Orchard Lake Rd. (Exit 5)	ER	1
039	Kalamazoo	WBP I-94 & 9th St. (Exit 72)	ER	1
*040	Washtenaw	WBD I-94 & Jackson Rd.	ER	1
041	Kalamazoo	NBD US-131 & Stadium Dr./Business I-94	ER	1
042	Kalamazoo	NBP US-131 & Q Ave./Centre Ave.	ER	1
*043	Livingston	SB County Farm Rd. & Coon Lake Rd.	I	2
044	Bay	WB Nebodish Rd. & Knight Rd.	I	2
045	Macomb	SB Camp Ground Rd. & 31 Mile Rd.	I	2
046	Jackson	SB Benton Rd./Moon Lake Rd. & M-50/ Brooklyn Rd.	I	2
047	Allegan	SB 6th St. & M-89	I	2
048	Kent	EB 36th St. & Snow Ave.	I	2
049	Livingston	EB Chase Lake Rd. & Fowlerville Rd.	I	2
*050	Allegan	WB 144th Ave. & 2nd St.	I	2
051	Livingston	SB Cedar Lake Rd. & Coon Lake Rd.	I	2
052	Jackson	NB Mt. Hope Rd. & Waterloo-Munith Rd.	I	2
*053	Kent	WB Cascade Rd. & Thornapple River Dr.	I	2
*054	Allegan	NB 62nd St. & 102nd Ave.	I	2
055	Kent	SB Meddler Ave. & 18 Mile Rd.	I	2
056	Eaton	SB Houston Rd. & Kinneville Rd.	I	2
057	Macomb	SB M-19/Memphis Ridge Rd. & 32 Mile Rd./ Division Rd.	I	2
*058	Allegan	NB 66th St. & 118th Ave.	I	2
059	Grn Traverse	NB Silver Lake Rd./County Rd. 633 & US-31	I	2
*060	Grn Traverse	EB Riley Rd./Tenth St. & M-137	I	2
*061	Bay	SB 9 Mile Rd. & Beaver Rd.	I	2
062	Kent	SB Ramsdell Dr. & M-57/14 Mile Rd.	I	2
*063	Eaton	NB Ionia Rd. & M-50/Clinton Trail	I	2
064	Macomb	EB 23 Mile Rd. & Romeo Plank Rd.	I	2
*065	Livingston	NB Old US-23/Whitmore Lake Rd. & Grand River Rd.	I	2
066	Jackson	SWB Horton Rd. & Badgley Rd.	I	2
067	Kent	SB Belmont Ave. & West River Dr.	I	2
*068	Eaton	EB 5 Point Hwy. & Ionia Rd.	I	2
069	Allegan	WB 129th Ave. & 10th St.	I	2
*070	Eaton	EB M-43 & M-100	I	2
071	Ottawa	WB Taylor St. & 72nd Ave.	I	2
072	Bay	EB Cass Rd. & Farley Rd.	I	2
073	Allegan	EB 126th Ave. & 66th St.	I	2

074	Bay	NB Mackinaw Rd. & Cody-Estey Rd.	I	2
075	Jackson	EBD I-94 & Elm Ave. (Exit 141)	ER	2
076	Kent	NBD US-131 & 100th St. (Exit 72)	ER	2
*077	Ottawa	NBD I-196 & Byron Rd.	ER	2
*078	Kent	SBP US-131 & Hall St.	ER	2
079	Macomb	SBP M-53 & 26 Mile Rd.	ER	2
080	Bay	NBD I-75 & Wilder Rd. (Exit 164)	ER	2
081	Livingston	EBD I-96 & Fowlerville Rd. (Exit 129)	ER	2
*082	Macomb	EBP I-94 & 12 Mile Rd. (Exit 231)	ER	2
083	Jackson	WBD I-94 & Sargent Rd. (Exit 145)	ER	2
084	Allegan	NBP US-31/I-196 & Washington Rd./ Blue Star Hwy (Exit 47A)	ER	2
085	Calhoun	EB O Drive N. & 12 Mile Rd.	I	3
*086	Berrien	EB Mayflower Rd. & Chicago Rd.	I	3
*087	Marquette	SWB C.R. 456 & Sporley Lake Rd.	I	3
088	Lenawee	EB Munger Rd. & M-52	I	3
*089	Genesee	EB Pierson Rd. & Elms Rd.	I	3
*090	Clinton	NB Scott Rd. & M-21/State	I	3
091	Calhoun	WB R Dr. S. & 8 Mile Rd./Adolph Rd.	I	3
092	Calhoun	EB V Dr. N. & 20 Mile Rd.	I	3
093	Calhoun	NWB Dickman Rd./M-96 & Avenue A	I	3
094	St. Clair	WB Hewitt Rd. & Fargo Rd.	I	3
095	Monroe	SB Swan Creek Rd. & Labo Rd.	I	3
*096	Muskegon	EB Sweeter Rd. & Maple Island	I	3
*097	Calhoun	SB P Dr. N./Yawger Rd. & Hubbard Rd./5 Mile Rd.	I	3
098	St. Clair	WB Bryce Rd. & Cribbins Rd.	I	3
099	St. Clair	WB Lindsey Rd. & Palms Rd.	I	3
100	Van Buren	SB Broadway/M-140 & Phoenix Rd./BL I-196/C.R. 388	I	3
101	Ionia	SB Fisk Rd./Heffron Rd. & Montcalm Ave.	I	3
102	Clinton	EB Taft Rd. & Shepardsville Rd.	I	3
103	Calhoun	SB S. County Line Rd. & 23 Mile Rd.	I	3
*104	Calhoun	NB Waubascon Rd./4 1/2 Mile Rd. & Baseline Rd.	I	3
105	Monroe	WB Day Rd. & Ann Arbor Rd.	I	3
106	St. Joseph	WB Balk Rd./C.R. 139 & Grim Rd./Sherman Mills Rd.	I	3
107	Lapeer	EB Armstrong/C.R. 7 & M-53/Van Dyke Hwy.	I	3
*108	Saginaw	SB Chapin N./Kane Rd. & Frost Rd.	I	3
109	St. Clair	SB Werner/Ellsworth & Gratiot	I	3
110	Lenawee	NB Ogden Hwy. & US-223	I	3
111	Lapeer	SB Wheeling Rd. & Bowers Rd./M-52	I	3
112	Saginaw	NB Raucholz Rd. & Ithaca Rd.	I	3
*113	Shiawassee	NEB Winegar Rd. & Lansing Rd.	I	3
114	St. Joseph	SB Rosenbaugh Rd./40th St. & Michigan Ave./C.R. 120	I	3
*115	Saginaw	NB East Rd. & Ditch Rd.	I	3
116	Muskegon	EB Heights-Ravenna Rd. & Sullivan Rd.	I	3
117	Saginaw	S/EBD I-675 & Veterans Memorial Parkway (Exit 1)	ER	3
*118	Genesee	NBP I-475 & Bristol Rd./Hemphill/M-121 (Exit #4)	ER	3
119	Calhoun	EBP I-94 & 26 Mile Rd./25 1/2 Mile Rd. (Exit 119)	ER	3
120	Berrien	WBD I-94 & M-239/La Porte (Exit #1)	ER	3
*121	Van Buren	N/EBP US-31/I-196 & M-140 (Exit #18)	ER	3
122	Monroe	NBD I-75 & Huron River Dr. (Exit 26, to South Huron River Drive)	ER	3
123	Genesee	SBD US-23/I-75 & Mount Morris Rd. (Exit #126)	ER	3
*124	Isabella	SBD US-27/US-127 & M-20	ER	3
*125	Genesee	EBD I-69 & Belsay Rd. (Exit #141)	ER	3
126	St. Clair	WBD I-94/I-69 & Water St.	ER	3
127	Wayne	WB 8 Mile Rd. & Beck Rd.	I	4
*128	Wayne	EB Warren Rd. & Wayne Rd.	I	4
129	Wayne	EB McNichols Rd. & Woodward Ave.	I	4
*130	Wayne	NB Canton Center Rd. & Cherry Hill Rd.	I	4
131	Wayne	WB Ecorse Rd. & Pardee Rd.	I	4
132	Wayne	EB Michigan Ave. & Sheldon Rd.	I	4
*133	Wayne	EB Ecorse Rd. & Middlebelt Rd.	I	4
*134	Wayne	NB M-85/Fort Rd. & Emmons Rd.	I	4
135	Wayne	WB Glenwood Rd. & Wayne Rd.	I	4
136	Wayne	NB Haggerty Rd. & 7 Mile Rd.	I	4
*137	Wayne	WB 6 Mile Rd. & Inkster Rd.	I	4
138	Wayne	SB Inkster Rd. & Goddard Rd.	I	4
139	Wayne	SB Merriman Rd. & Cherry Hill Rd.	I	4
140	Wayne	SEB Outer Dr. & Pelham Rd.	I	4
*141	Wayne	NB Meridian Rd. & Macomb Rd.	I	4
142	Wayne	WB Ford Rd. & Venoy Rd.	I	4
*143	Wayne	SWB Vernor Rd. & Gratiot Rd.	I	4
144	Wayne	WB 5 Mile Rd. & Beck Rd.	I	4
145	Wayne	EB 7 Mile Rd. & Livernois Rd.	I	4
*146	Wayne	NB Gunston/Hoover Rd. & McNichols Rd.	I	4

147	Wayne	SB W. Jefferson/ Biddle Ave. & Southfield Rd.	I	4
148	Wayne	EB Goddard Rd. & Wayne Rd.	I	4
*149	Wayne	WB 8 Mile Rd. & Kelly Rd.	I	4
150	Wayne	SB Merriman Rd. & US-12/Michigan Ave.	I	4
151	Wayne	SB Telegraph Rd. & Plymouth Rd.	I	4
*152	Wayne	WB Sibley Rd. & Inkster Rd.	I	4
153	Wayne	NEB Mack Rd. & Moross Rd.	I	4
154	Wayne	WB Annapolis Rd. & Inkster Rd.	I	4
*155	Wayne	SB Greenfield Rd. & Grand River Rd.	I	4
156	Wayne	EB Joy Rd. & Livernois Rd.	I	4
157	Wayne	SEB Conner Ave. & Gratiot Rd.	I	4
158	Wayne	NWB Grand River Rd. & Wyoming Ave.	I	4
159	Wayne	WBP I-96 & Evergreen Rd.	ER	4
160	Wayne	WBP I-94 & Haggerty Rd. (Exit 192)	ER	4
*161	Wayne	NBD I-75 & Gibralter Rd. (Exit 29)	ER	4
162	Wayne	SBP I-75 & Southfield Rd.	ER	4
*163	Wayne	NBD I-275 & 6 Mile Rd. (Exit 170)	ER	4
164	Wayne	NBP I-275 & M-153/Ford Rd. (Exit 25)	ER	4
165	Wayne	NBD I-275 & Eureka Rd. (Exit 15)	ER	4
*166	Wayne	NBP I-75 & Springwells Ave. (Exit 45)	ER	4
167	Wayne	WBD I-94 & Pelham Rd. (Exit 204)	ER	4
168	Wayne	SBD I-75 & Sibley Rd.	ER	4

*Included in the Mini Survey Subsample

APPENDIX B
Calculation of Variances, Confidence Bands, and Relative Error

The variances for the belt use estimates were calculated using an equation derived from Cochran's (1977) equation 11.30 from section 11.8. The resulting formula was:

$$var(r) \approx \frac{n}{n-1} \sum_i \left(\frac{g_i}{\sum g_k}\right)^2 (r_i - r)^2 + \frac{n}{N} \sum_i \left(\frac{g_i}{\sum g_k}\right)^2 \frac{s_i^2}{g_i}$$

where *var(r_i)* equals the variance within a stratum and vehicle type, *n* is the number of observed intersections, g_i is the weighted number of vehicle occupants at intersection *I*, g_k is the total weighted number of occupants for a certain vehicle type at all 42 sites (14 in the mini survey) within the stratum, r_i is the weighted belt use rate at intersection *I*, *r* is the stratum belt use rate, *N* is the total number of intersections within a stratum, and $s_i = r_i(1-r_i)$. In the actual calculation of the stratum variances, the second term of this equation is negligible. If we conservatively estimate *N* to be 2000, the second term only adds 2.1×10^{-6} units to the largest variance (Stratum 4). This additional variance does not significantly add to the variance captured in the first term. Therefore, since *N* was not known exactly, the second term was dropped in the variance calculations. The overall estimated variance for each vehicle type was calculated using the formula:

$$var(r_{all}) = \frac{var(r_1) + var(r_2) + var(r_3) + 0.83^2 \times var(r_4)}{3.83^2}$$

The Wayne County stratum variance was multiplied by 0.83 to account for the similar weighting that was done to estimate overall belt use. The 95 percent confidence bands were calculated using the formula:

$$95\%\ Confidence\ Band = r_{all} \pm 1.96 \times \sqrt{Variance}$$

where *r* is the belt use of interest. This formula is used for the calculation of confidence bands for each stratum and for the overall belt use estimate.

Finally, the relative error or precision of the estimate was computed using the formula:

$$RelativeError = \frac{StandardError}{r_{all}}$$

The federal guidelines (NHTSA, 1992, 1998) stipulate that the relative error of the belt use estimate must be under 5 percent.

APPENDIX C

PDA Data Collection Details

During the current study, all data collection was conducted using Personal Digital Assistants (PDAs). The transition from paper to PDA data collection was made primarily to decrease the time necessary to move from the end of the data collection phase of a survey to data analysis. With paper data, there is automatically two to three weeks of additional time built-in while the paper data are being entered into an electronic format. Before making this transition, a pilot study was conducted to compare data collection by PDA to paper. Several key factors were tested during the pilot study including accuracy, volume (speed), ease of use, mechanical issues (i.e. battery life), and environmental issues (i.e. weather, daylight). The pilot study found PDA use to be equal to, or better than paper data collection on every factor tested. Before making the change to PDA data collection, electronic versions of the *Site Description Form* and *Observation Form* were developed. The following pages show examples of the electronic forms and discuss other factors related to using PDAs for safety belt data collection.

The goal of adapting the existing paper forms to an electronic format was to create electronic forms that were very similar to the paper forms, while taking advantage of the advanced, built-in capabilities of the PDA. As such, the electronic *Site Description Form* incorporated a built-in traffic counter, used the PDA's calendar function for date entry, and included high resolution color on the screens. The first screen of the *Site Description Form* (Figure 2) allows users to type in the site location (street names and standing location). Observers use the PDA stylus to tap on the appropriate choices of site type, site choice, and traffic control. If a mistake is made, the observer can change the data they have input, simply by tapping on the correct choice. All selected choices appear highlighted on the screen.

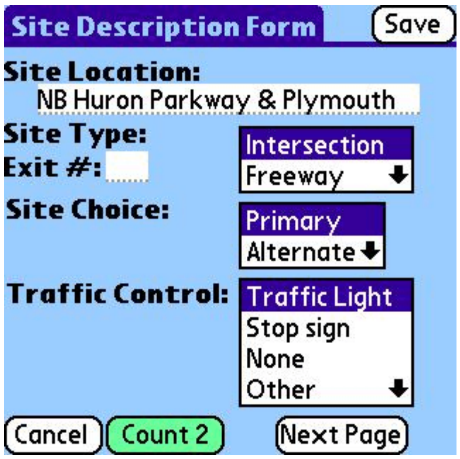

Figure 2. Site Description Form - Screen 1

Screens 2 and 3 are shown in Figure 3. As seen in this figure, observers enter their name, the weather, day of week, and median information, simply by tapping the appropriate choice on the display list. Date is entered by tapping on the "Date" button. This brings up a calendar for observers to tap on the appropriate date. Screen 3 allows users to sketch in the intersection and show where they are standing, and to record the start time for the site.

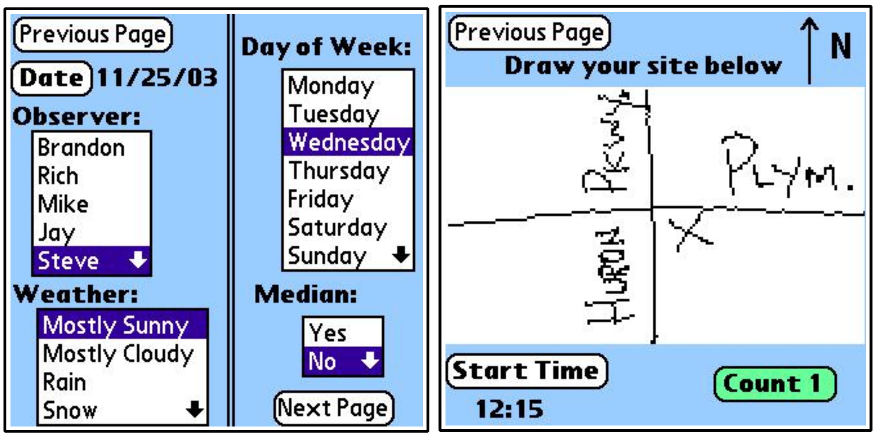

Figure 3. Site Description Form - Screens 2 and 3

In the past, observers had to put away their paper form, get out a mechanical traffic counter, and begin a traffic count after entering the start time. Using a PDA, it is possible to incorporate a traffic counter directly into the *Site Description Form*[7]. Figure 4 shows an example of the electronic traffic counter screen of the *Site Description Form*. To count each vehicle that passes, observers tap on the large "+" button. The size of this button allows the observer to tap the screen while keeping their eyes on the roadway. Each tap increases the count that is displayed at the top of the screen. If a mistake is made, the observer can decrease the count by tapping on the small "-" button on the left of the screen.

[7]The PDA traffic counting method was compared with a mechanical counter during the pilot testing and no difference was found between the two methods.

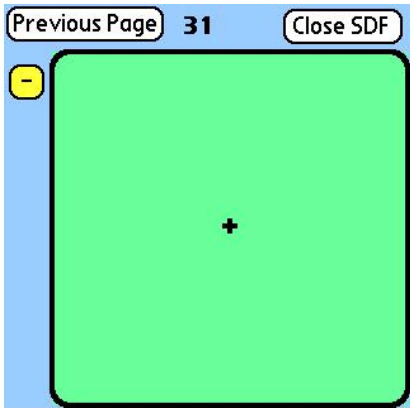

Figure 4. Site Description Form - Traffic Counter Screen

The last screen of the electronic *Site Description Form*, shown in Figure 5, allows the user to enter the end time of the site observation and interruption (if any). Finally, observers can type in any comments regarding the site or traffic flow that may be important.

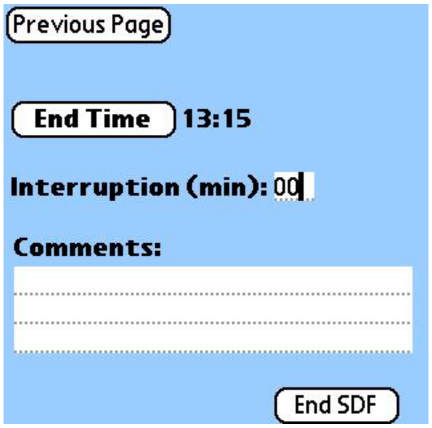

Figure 5. Site Description Form - Final Screen

To allow for easier data entry, the electronic *Observation Form* was divided into three screens, one for driver information, one for front-right passenger information, and one for vehicle information. As shown in Figure 6, each screen is accessible by tapping on the appropriate tab along the top of the screen. The screens have also been designed with different colors, with the driver screen blue, passenger screen green, and vehicle screen yellow. As shown below, the first screen that appears in the form is the driver screen. Each category of data, along with the choices for each category, are displayed on the screen. As in the Site Description Form, users simply tap on the choices that correspond to the motorist that is being observed. These data then appear highlighted on the screen.

Since most motorists are not actively using a cellular phone while driving, “No Cell Phone” is already highlighted as a default. If the motorist is using a cell phone, the proper choice can simply be selected from the list.

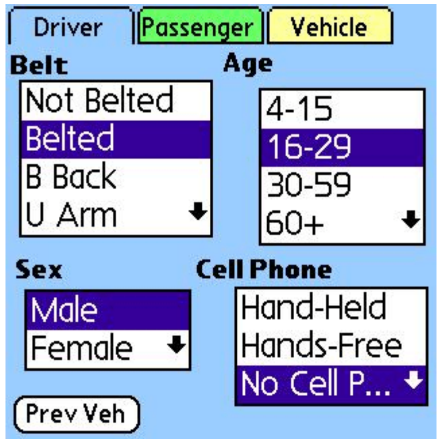

Figure 6. Observation Form - Driver Screen

Figure 7 shows the passenger and vehicle screens from the *Observation Form*. If no passenger is present, users tap on the “No Passenger” area to put a check mark in that box. On the vehicle screen, “Not Commercial” is selected as a default since the majority of observed vehicles are not used for commercial purposes. Once data are complete for one vehicle, observers tap the “Next Vehicle” button to continue collecting data.

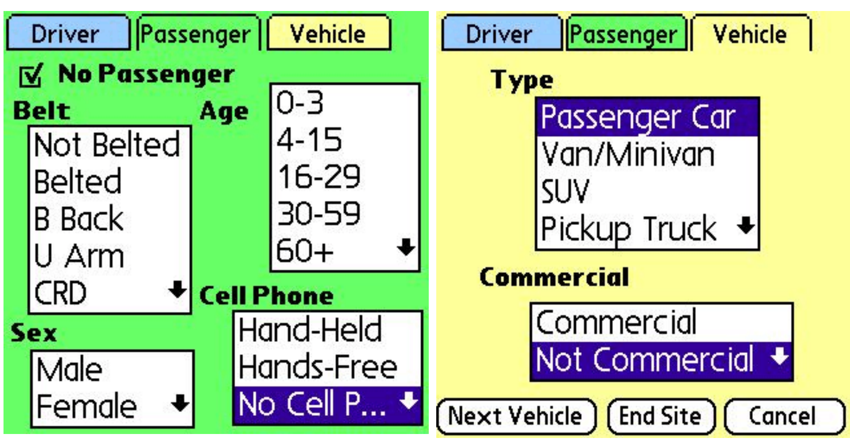

Figure 7. Observation Form - Passenger and Vehicle Screens

Each PDA also had a built-in cellular phone as well as wireless e-mail capability. At regular intervals, usually twice a day, observers e-mailed completed data directly from the PDA to the project supervisor. *Site Description* and *Observation Forms* from completed sites were “zipped,” using a compression program, and then transmitted directly to a pre-determined e-mail account. The e-mailing of data allowed the project field supervisor to immediately check data for errors, and begin to compile a data analysis file as the project progressed. After data transmission, the observer transferred the site data from the internal memory of the PDA to a Secure Digital (SD) memory card.