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A MOTORIST AND PEDESTRIAN BEHAVIORAL ANALYSIS ON SR 7

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16. ABSTRACT

The objective of this project was to evaluate motorist and pedestrian behavioral changes resulting from federally funded engineering treatments on SR 7 in Pierce County. The project installation included a median with a pedestrian refuge island, allowing pedestrians to cross one direction at a time. Nearby transit stops were also relocated to concentrate pedestrians at a single crossing point. The goal of the project was to increase safety for pedestrians, with particular focus on pedestrians and motorists over the age of 65.

A before-and-after analysis was conducted at S. 180th Street on SR 7. The main performance measures included pedestrian crossing locations, wait times, changes in pedestrian behaviors, and changes in motorist behaviors. The safety treatments did not have the expected positive effect of encouraging pedestrians to use the median refuge for crossing. Pedestrians were more likely to use the marked crosswalks in the *before* phase than the median refuge in the *after* phase. Motorist yielding also decreased after the median installation.

The true effects of the median installation may have been limited because of equipment constraints and project schedule. In addition, the sample size was small, particularly during the *after* phase, because of a low crossing rate at the site. This particular median design could potentially be more effective at a location with more frequent crossings.

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EXECUTIVE SUMMARY

The objective of this project was to evaluate motorist and pedestrian behavioral changes resulting from federally funded engineering treatments on SR 7 in Pierce County. The location was designated for a pilot project because of an at-risk population of older road users. The project installation included a median with a pedestrian refuge island, allowing pedestrians to cross one direction at a time. Nearby transit stops were also relocated to concentrate pedestrians at a single crossing point. The goal of the project was to increase safety for pedestrians, with particular focus on pedestrians and motorists over the age of 65.

A before-and-after analysis was conducted at S. 180th Street on SR 7. The main performance measures included pedestrian crossing locations, wait times, changes in pedestrian behaviors, and changes in motorist behaviors. The safety treatments did not have the expected positive effect of encouraging pedestrians to use the median refuge for crossing. Pedestrians were more likely to use the marked crosswalks in the *before* phase than the median refuge in the *after* phase. Motorist yielding also decreased after the median installation.

The true effects of the median installation may have been limited because of equipment constraints and project schedule. In addition, the sample size was small, particularly during the *after* phase, because of a low crossing rate at the site. This particular median design could potentially be more effective at a location with more frequent crossings.

WSDOT should review the findings of the before-and-after analysis to determine the most effective roadway treatments for pedestrian safety at the project site, as well as at other pedestrian crossing locations around the state.

SECTION ONE
PROJECT OVERVIEW

Over the past eight years, 262 collisions involving "older" motorists (254) and pedestrians (eight) occurred on a 1-mile section of State Route 7 through Spanaway in Pierce County[1]. Especially important in this area is pedestrian safety, as many trips in this community begin or end as pedestrian trips. School children and transit riders rely on safe walking routes to their bus stops. Pierce Transit reports that more than 220 transit riders board buses within 1 mile of the 1-mile study area per day. In particular, the SR 7 corridor has a high proportion of older road users (age 65 and older) who are dependent on good pedestrian walkways.

To address the safety issues in this corridor, a federally funded pedestrian safety project was initiated. This project applied the measures detailed in FHWA's *Highway Design Handbook for Older Drivers and Pedestrians*. The goal of the project was to increase safety for older pedestrians and decrease the number of pedestrian and motor vehicle accidents among older drivers. The approach was to increase safety for the general population, assuming that this would also increase safety for the subset of older road users. If these proposed solutions proved successful, they could be replicated at other pedestrian accident locations on state routes.

The highway improvement project focused on safety conditions for pedestrians and motorists between South 176th Street and South 189th Street along SR 7 in Spanaway. This report evaluates the pedestrian improvement on SR 7 near S. 180th Street. The improvement included concentrating pedestrians at a single crossing point and relocating bus stops closer to where pedestrians will attempt to cross the main street. Also, because SR 7 is a heavily traveled street, a median was built with a pedestrian refuge island to allow pedestrians to cross the traffic one direction at a time.

[1] FHWA Cooperative Agreement "Highway Improvements on State Route 7 to Aid Older Road Users"

SITE DESCRIPTION

South 180th Street intersects with SR 7 from the east. The study area contains no signalized intersections. Before the pedestrian improvements of this project, there were marked crosswalks to the north and south of S. 180th Street. The roadway consists of two general-purpose lanes in each direction, with a center left-turn lane. The posted speed limit for the corridor is 40 miles per hour. The fence for the Fort Lewis Military Reservation borders the west side of the roadway. The east side contains numerous driveways to commercial shops. There are no sidewalks, only shoulders. Transit stops are located in both directions. The average daily traffic volume for the area is approximately 40,000, as recorded in the *WSDOT 2003 Annual Traffic Report*.

The *before* analysis focused on the marked crosswalks to the north and south of S. 180th Street. Figure 1 displays the camera view looking north. The crosswalk to the north of S. 180th Street is approximately 400 feet from the camera. The driveway near the crosswalk enters and exits a Kmart parking lot. Bus stops are on both sides of the crosswalk. The nearest signalized intersection is one quarter mile north at S. 176th Street.

Figure 1. Camera view north of S. 180th Street

Figure 2 displays the camera view looking south. The crosswalk to the south of S. 180th Street is approximately 660 feet from the camera. The crosswalk is at the intersection of SR 7 and S. 182nd Street. There are bus stops on both sides of the crosswalk.

Figure 2. Camera view south of S. 180th Street

REPORT PURPOSE AND APPROACH

The objective of this project was to evaluate motorist and pedestrian behavioral changes as a result of the engineering treatments. A before-and-after analysis was conducted at S. 180th Street. The main performance measures included pedestrian crossing locations, wait times, changes in pedestrian behaviors, and changes in motorist behaviors. An evaluation of these factors could help the Washington State Department of Transportation (WSDOT) determine the successful elements of safety treatments and could be used in designing future pedestrian improvements.

REPORT CONTENT

This report documents the project tasks and findings as follows:

Section 2 – Research approach

SECTION TWO
RESEARCH APPROACH

The main tasks of the project were the following:

- administer data collection
- perform the before-after analysis
- document project findings and recommendations.

These tasks are described in more detail in this section.

ADMINISTER DATA COLLECTION

Video Technology

The project planned for data on motorist and pedestrian movements to be collected with a video image detection system marketed by Digital Traffic Systems, Inc. (DTS). The DTS system was designed to allow automated monitoring of pedestrian and vehicular movements in the roadway. This image tracking technology would enable the researchers to conduct cost effective, long-term data collection that would increase the statistical reliability of the analysis. The goal of the project was to use the advanced system to improve the state's ability to test the effectiveness of a wide variety of safety treatments, beginning with safety on the SR 7 corridor.

WSDOT staff built a self-contained system at S. 180th Street alongside SR 7 that included a cabinet assembly with six batteries, a camera controller, and two digital video recorders (DVR). The cabinet was connected to a pole with two solar panels and two dome cameras attached. The cameras collected over 200 hours of video data for each of the nearest crosswalks to the north and south of S. 180th Street.

The video device exhibited many problems during *before* data collection. Difficulties arose in maintaining the power level to keep the cameras and DVRs operating. In addition, problems with obtaining permission to place the cameras on

existing power poles resulted in placement of the system on a temporary pole. The height of that temporary pole caused some problems in the image detection software, which could not be calibrated to accurately detect pedestrian crossings. In fact, the software rarely identified pedestrians and was inconsistent for vehicle movements as well. Consequently, the data were reduced manually to determine pedestrian and vehicle behaviors at the crosswalks, including crossing location, yielding, wait time, conflicts, and various other measures. Manual data reduction required a significant amount of time and eliminated the potential for using performance measures related to vehicle speeds and speed changes.

Continual problems with the original equipment prompted purchase of a new video data collection system for the *after* analysis. In collaboration with WSDOT's Northwest Region Signals Shop, a new system was put together to improve the process. A new battery cabinet was designed, and a new DVR system was purchased. These products had been tested by the Northwest Region for other projects and were deemed successful. The new equipment eliminated the power problem encountered in the *before* phase of the project. However, the *after* data still had to be analyzed manually because the problems with the image detection software had not yet been resolved. Because of the software's potential to help researchers more cost effectively conduct these kinds of studies, its use will continue to be explored in future projects.

Observation Boundaries

The range of observations for the site is displayed in Figure 1 and Figure 2 in Section One. The observation boundaries for *before* data were limited by the available location for camera placement. During the *after* analysis, the camera was placed to the south of S. 180th Street, facing north. Figure 3 displays the observation boundaries for the *after* data collection.

Figure 3. Observation boundaries for *after* data collection

Observation Periods

Pedestrian and vehicle behavior at the study locations were observed between 6:00 AM and 7:00 PM on all days, including weekends. Analysis of the *before* data showed minimal relationship between day of week and pedestrian crossings. Crossings were identified by time and classified as AM peak (6:00 AM to 9:00 AM), midday (9:00 AM to 3:00 PM), or PM peak (3:00 PM to 7:00 PM). Table 1 outlines the observation periods for the before-and-after analysis. The sample size consists of "crossing events," as opposed to the total number of pedestrians. If two or more pedestrians crossed the road as a group, this was considered to be one crossing event because pedestrian and motorist reactions were the same for all members of the group.

Table 1. Observation periods

	Before	After
Description	Two marked crosswalks near bus stops to the north and south of S. 180th St.	Bus stops moved to proximity of new pedestrian refuge island at S. 180th St.
Total Sample Size (N)	220 (N=164 to north, N=56 to south)	74
Hours of Observations	550 hours (230 to north, 220 to south)	161 hours
Date of Observation	March-May 2004	July 2005

Data Elements

Data analysis was conducted to determine pedestrian and motorist safety-related behaviors. Table 2 outlines the performance measures collected from the video. An example of the data collection sheet is included in Appendix A.

Table 2. Performance measures

Pedestrian events	• Date and time • Direction of crossing
Pedestrian crossing locations	• Record locations outside crosswalk
Transit origin or destination	• Determine if the pedestrian is using transit
Pedestrian delay	• Amount of time pedestrian waited in shoulder to cross • Amount of time pedestrian waited in center lane
Pedestrian behavior while crossing	• Pedestrian feels pressured to run so vehicles do not have to yield or to minimize time of yielding
Occurrence of vehicle/pedestrian conflicts	• Pedestrian evasive action: Pedestrian had to jump or suddenly step back • Vehicle evasive action: Motorist had to engage in abrupt braking or had to change lanes suddenly to avoid a pedestrian • Near miss: a pedestrian/vehicle collision almost occurred
Vehicle yielding behavior	• Number of vehicles that passed before one stopped and waited for pedestrians to cross the street
Shielding conflicts	• Vehicle in the lane closest to the pedestrian yields while vehicles in the adjacent travel lane still proceed

PERFORM BEFORE-AFTER ANALYSIS

Data elements collected before and after the safety treatment had been implemented were then processed and summarized to better understand the crossing

behaviors and patterns and to determine the treatment's effectiveness in improving pedestrian crossing safety.

DOCUMENT PROJECT FINDINGS AND RECOMMENDATIONS

The following sections of this report outline the results of the evaluation and can be used as guidelines for future treatments on SR 7, as well as other pedestrian projects in the state.

SECTION THREE
SAFETY TREATMENT EVALUATED IN THE STUDY

The corridor being studied has a history of pedestrian crossing concerns. The area has a growing population of "older" drivers, pedestrians, and transit users that is expected to continue to increase. Most crossing pedestrians observed at the study locations showed extreme caution, even when they were crossing in a legal marked crosswalk. Pedestrians tended to wait a long time for a gap in the traffic to cross the street. Many had to stop in the center lane and cross one direction at a time.

In response to this behavior, WSDOT traffic engineers built raised median channelization for the left-hand turn from SR 7 onto S. 180th Street. Figure 4 displays the median.

Figure 4. Pedestrian refuge islands at S. 180th Street and SR 7

A benefit of using a raised median channelization is the inclusion of a refuge for pedestrians. This median refuge can particularly aid older pedestrians who have slower walking speeds and thus have trouble crossing the road in one movement. Pedestrians can cross one direction of the roadway at a time and wait in the refuge for a break in

traffic in the other direction. In addition, the channelization for left turns can make drivers feel safer because they do not have to worry about other traffic in the center lane.

The safety treatment at S. 180th Street also included new transit stop locations. Before the treatment, bus stops were located on each side of the marked crosswalks to the north and south of S. 180th Street. Figures 1 and 2 display the transit stop locations. With the installation of the new median, the four transit stops were consolidated to two stops on either side of the median. Figure 5 shows the locations of the bus stops in relationship to the median. The path across the roadway utilizes the refuge space in the median.

Figure 5. Transit stop locations at S. 180th Street and SR 7

WSDOT held several meetings to discuss the potential treatments for the crossing. Although the original plan proposed crosswalk striping at the median, project engineers suggested a modification to eliminate the striping for safety reasons. The *WSDOT*

Design Manual currently does not support striping of mid-block crossings at locations on State Route 7. However, the *WSDOT Design Manual* is being updated, and changes to these standards are being considered. WSDOT has not decided what type of crossing treatments to apply at the other mid-block crossings along the corridor at S. 184th and S. 188th streets, but it will make safety improvements. It will evaluate the findings of this report to help make its final decision on crosswalk striping at S. 180th Street, as well as the type of treatments to apply at the other two locations.

SECTION FOUR
BEFORE-AND-AFTER ANALYSIS

This section presents the motorist and pedestrian behavioral changes observed as a result of the roadway design improvements. The studied treatments were intended to encourage pedestrians to cross at one central location, using the median refuge. The median and pedestrian crossing signs were meant to increase the probability that motorists would yield to crossing pedestrians. The findings are grouped as follows:

- a comparison of *before* and *after* data characteristics to determine if the samples are similar
- a description of observed changes in pedestrians' crossing paths.; this examines the level of change in pedestrians' crossing locations (e.g., whether pedestrians used the crosswalks before the safety treatments and the median pedestrian refuge area after it was installed)
- a discussion of the level of change in pedestrian and motorists' behaviors related to pedestrian safety (e.g., the willingness of drivers to stop for crossing pedestrians before and after the implementation of the median, pedestrian and vehicle conflicts, and wait times).

SAMPLE COMPARISON

Descriptive characteristics of the *before* and *after* data were compared to determine whether the samples were statistically related. Table 1 in Section 2 displays the number of hours of video collected at the site during the before and after testing. The table also includes the number of crossings recorded in that time frame. These values were used to compute the average number of crossings per hour at the site before and after the treatment. Table 3 shows these results. The difference between the *before* treatment and the *after* treatment is not statistically significant.

Table 3. Average crossings per hour

	Before	After
Description	Two marked crosswalks near bus stops to the north and south of S. 180th St.	Bus stops moved to proximity of new pedestrian refuge island at S. 180th St.
Average Crossings/hour	0.40 crossings/hour	0.46 crossings/hour

The *before* and *after* data were also analyzed for the time of day that crossings occurred. Although a significantly higher number of midday crossings occurred with the *before* treatment, it is important to note that the number of hours of video for each time period was not necessarily equal for the two phases. It is possible that the higher number of midday crossings was due to a greater amount of *before* video for the midday hours. Therefore, these data were not used to compare the samples.

The data were also compared for transit related trips. The majority of pedestrian crossings at the site are transit related. Pedestrians either cross the street westbound to get to the transit stop, or they arrive on a bus and cross the street eastbound. Many of the non-transit related trips are cyclists. Figure 6 displays the proportion of transit related trips in the *before* and *after* data. The difference between the *before* treatment and the *after* treatment is not statistically significant.

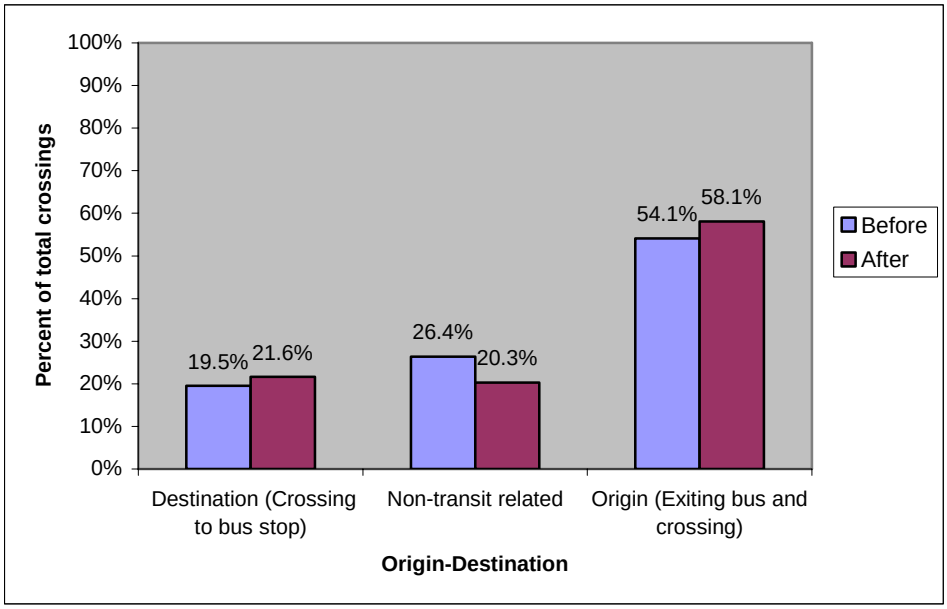

Figure 6. Percentage of transit related crossings

PEDESTRIAN CROSSING PATHS

The study results revealed that pedestrians were less likely to use the median refuge after implementation than to use the marked crosswalks before the changes. A majority of pedestrians utilized the median refuge, but a large proportion crossed randomly north and south of the median.

The *before* study showed that the majority of pedestrians crossed within the marked crosswalks. Over 85 percent of the crossings to the north of S. 180th Street were within the crosswalk. Over 65 percent of the crossings to the south of S. 180th Street were within that crosswalk. When the crossing data for both directions were combined, over 80 percent of the crossings were within the two marked crosswalks. Figures 7 and 8 display the crossing paths of the pedestrians in the *before* study.

Figure 7. Pedestrian crossing paths to the north of S. 180th Street

Figure 8. Pedestrian crossing paths to the south of S. 180th Street

The paths are labeled with the number of crossings at that location. If a path is not labeled, it means that only one crossing occurred there. The factors that affected how pedestrians crossed included the origins and destinations of the observed pedestrians and whether there was a gap in traffic for crossing.

The installation of the pedestrian refuge did not funnel pedestrians to that crossing location. After the treatment had been implemented, about 60 percent of pedestrians used the median refuge area. Figure 9 displays the crossing paths after installation of the median. Note that an additional 15 percent of the crossings occurred just to the south of the median (path labeled "11 crossings" in Figure 9). The transit stop on the west side of street is not parallel with the refuge area, and these additional 11 crossings occurred at the point where the pedestrians exited the bus. These pedestrians were protected somewhat by the median but did not follow the designated refuge path.

Figure 9. Pedestrian crossing paths after median treatment

Table 4 shows the percentage of pedestrian crossing events in which pedestrians used the crosswalks or median for crossing during the two study phases. The difference between the *before* treatment and the *after* treatment based on the chi-square statistic was significant.

Table 4. Use of the crosswalks and median refuge

	Before (N=220)	**After (N=74)**
Used crosswalk / median	81.4% (179)	62.2% (46)

CHANGES IN PEDESTRIANS' AND MOTORISTS' BEHAVIOR

Effect of Median on Yielding Behavior

The raised refuge island was designed to change pedestrians' behavior by improving their crossing environment. However, the analysis detailed in the previous

section revealed that installation of the median did not increase pedestrian usage of designated crossing zones. Further analysis was conducted to determine the effect of the median on the yielding behavior of vehicles.

Higher motorist yielding rates were observed during the *before* phase than after installation of the median. Motorists in both the southbound and northbound directions yielded more frequently before installation of the median. Table 5 displays the percentage of crossings when a vehicle traveling in the specified direction yielded for a pedestrian. After the median installation, yielding compliance decreased nearly 20 percent.

Table 5. Percentage of crossings when vehicles yielded for pedestrians

	Before (N=220)	**After (N=74)**
Southbound vehicle yielding	23.6% (52)	5.4% (4)
Northbound vehicle yielding	45.5% (100)	23.0% (17)

Shaded area – The change between the *before* phase and the *after* treatment phase was significant at the 0.05 level based on the chi-square statistic.

The response of vehicles to each crossing event was analyzed with additional detail. Vehicles were tracked to determine how many vehicles passed a pedestrian before either one or more yielded, or a break in traffic opened for the pedestrian to cross. Table 6 presents the average number of vehicles that did not yield per crossing event. This value was also determined for each direction of traffic. The average number of vehicles that did not yield significantly increased after median installation.

Table 6. Average number of vehicles that did not yield per crossing event

	Before (N=220)	**After (N=74)**
Southbound vehicles	2.97	7.43
Northbound vehicles	1.75	5.72

Tables 7 and 8 consider the effect of the crossing paths of pedestrians on vehicle yielding. The percentage of crossing events when a vehicle yielded was compared to whether the pedestrian crossed in the designated crossing area before and after the treatment. For the *before* data, the designated crossing area was considered to be the marked crosswalks. For the *after* data, the designated crossing area was the path that included the median refuge. Tables 7 and 8 show that vehicles were significantly more likely to yield to pedestrians if they were in the marked crosswalk. For example, in the southbound direction before the treatment, almost 28 percent of vehicles yielded for pedestrians in the crosswalk, whereas only about 5 percent yielded when a pedestrian was outside of the crosswalk.

Table 7. Percentage of southbound vehicles yielding based on crossing paths

	Before Treatment	**After Treatment**
Used Crosswalk/Median	27.9%	8.7%
Crossed outside designated area	4.9%	0%

Table 8. Percentage of northbound vehicles yielding based on crossing paths

	Before Treatment	**After Treatment**
Used Crosswalk/Median	53.1%	23.9%
Crossed outside designated area	12.2%	21.4%

The results demonstrate that motorists were more likely to yield to pedestrians crossing in designated crossing areas. Also, these data suggest that vehicles on SR 7 were more compliant when pedestrians crossed in the marked crosswalk than when they used the new median refuge island.

Shielding Conflicts

A shielding conflict occurs when a vehicle in the lane closest to a pedestrian yields while vehicles in adjacent travel lane(s) continue to proceed. In general, no significant changes in the frequency of shielding conflict occurred after the installation of the median at S. 180th Street.

Pedestrian Delay

Because SR 7 is a heavily traveled corridor and vehicle yielding was limited, pedestrians often had to wait for an extended period before beginning to cross the roadway. These waiting times were measured from the time the pedestrian appeared to commit to crossing the roadway to the time the pedestrian actually began crossing. Figure 10 displays the wait times of the pedestrians before and after the installation of the median

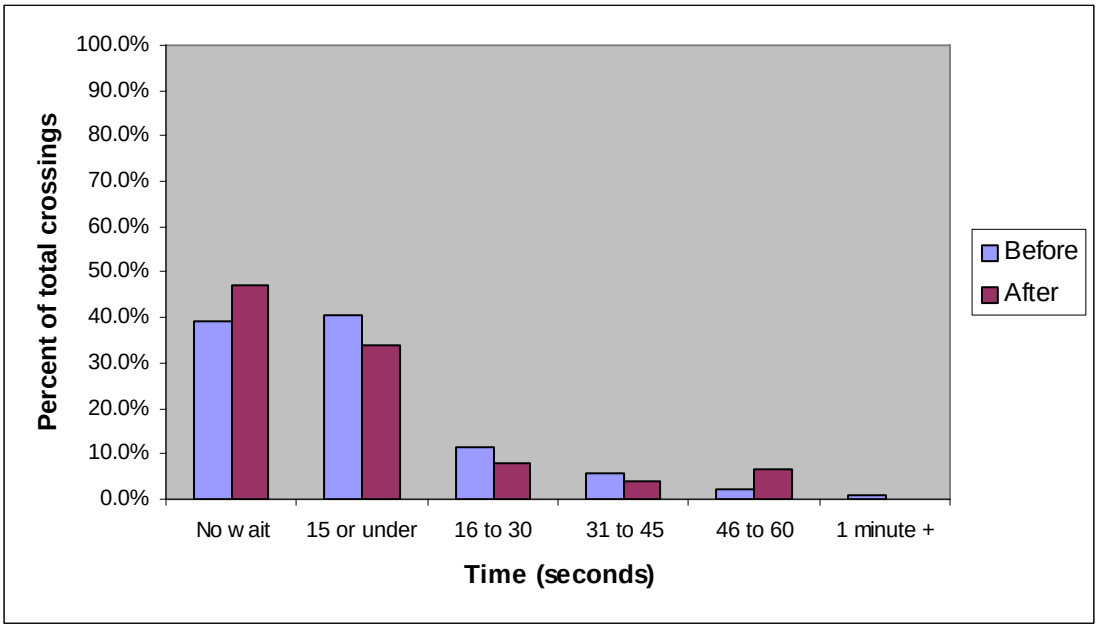

Figure 10. Pedestrian wait time before crossing

The wait times are comparable for the two data sets. Before installation of the improvements, the average wait before crossing was just over 9 seconds. After the

median had been installed, the average wait time was about 10 seconds. This increase can be attributed to the higher percentage of outlying wait times between 46 and 60 seconds in the *after* study. However, the installation of the median does not appear to have affected the initial waiting time of pedestrians.

The significant number of vehicles in both directions made it difficult for pedestrians to get completely across the roadway in one motion. Occasionally, pedestrians were required to wait in the center lane or in the median refuge before completing their crossing. Figure 11 displays pedestrian wait times in the center lane or median.

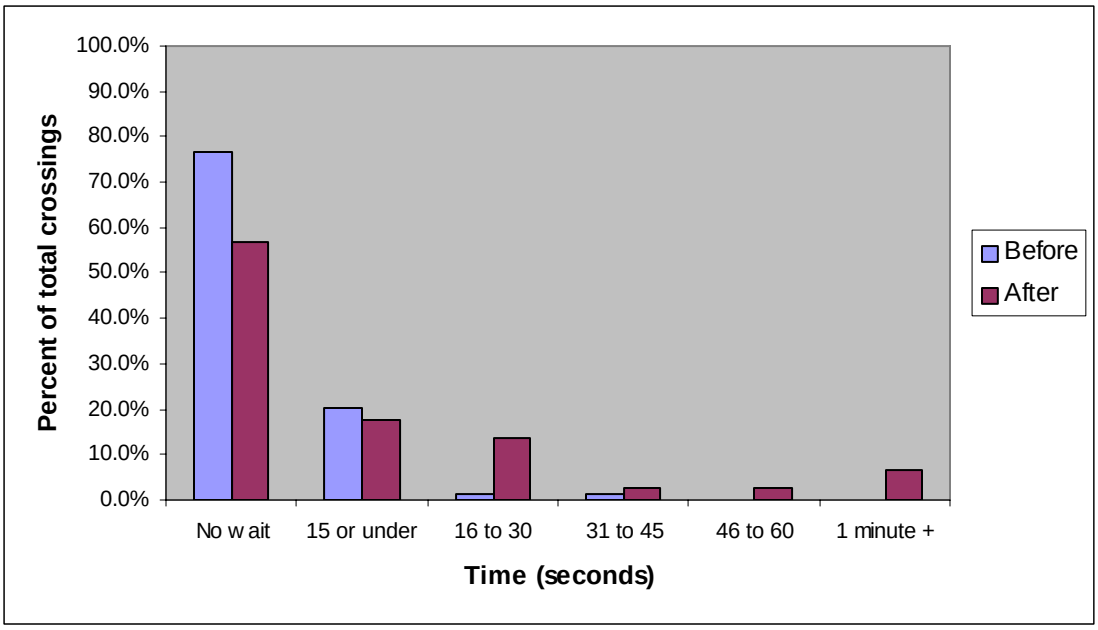

Figure 11. Pedestrian wait time in the center lane / median

The installation of the median resulted in a statistically significant increase in mid-crossing delay: the average wait time increased from approximately 2 seconds to about 15 seconds. Note that a few outliers in the *after* data may have skewed the average value, but when it is calculated without wait times over 1 minute, the average delay is still over 7 seconds. The statistically significant increase in the percentage of pedestrians who had to wait in the center lane or median after the median installation may correspond

to a decrease in motorist yielding in the *after* phase. It is also possible that some pedestrians felt more comfortable taking their time while waiting in the median refuge than while standing in the center lane.

Pedestrian and Vehicle Evasive Behavior

Pedestrian evasive behavior is defined as pedestrians jumping or stepping back to avoid a vehicle, or running to avoid being struck. Vehicle evasive action is defined as vehicles abruptly braking or swerving to avoid striking a pedestrian. Pedestrians in this corridor were generally cautious about crossing the street, and most pedestrians crossing at the study locations showed extreme caution, even when they were crossing in a legal unmarked crosswalk. Many waited for a gap in traffic to cross the street without stopping at the center turn lane; others crossed one lane-direction at a time, waiting in the center turn lane for another gap to complete the crossing. Therefore, pedestrian and vehicle evasive behaviors were relatively infrequent during the study.

Another commonly observed behavior is classified as "pedestrians pressured to run." This performance measure was recorded when a pedestrian appeared anxious about a crossing and ran across the street, even if vehicles yielded for the crossing. Another performance measure is called a "near miss," i.e., when a pedestrian-vehicle collision almost occurs. Fortunately, no "near misses" or collisions were observed during the data period.

Figure 12 displays the percentage of occurrences of these performance measures per total pedestrian crossings.

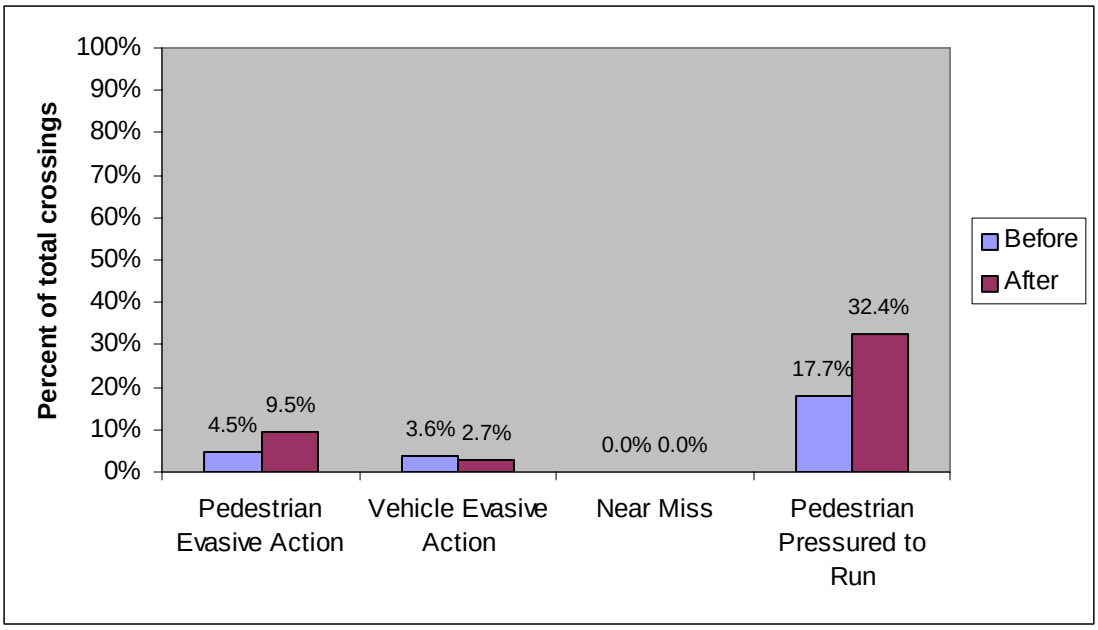

Figure 12. Pedestrian and vehicle evasive action

The results in Figure 12 are also summarized in Table 9. This table also shows when the differences between the *before* and *after* phases were statistically significant. As mentioned, pedestrian and vehicle evasive actions were relatively infrequent because pedestrians were very cautious. The data suggest that pedestrians felt more pressured to run after the median was installed.

Table 9. Pedestrian and vehicle evasive action

	Before (N=220)	After (N=74)
Pedestrian evasive action	4.5% (10)	9.5% (7)
Vehicle evasive action	3.6% (8)	2.7% (2)
Near miss	0% (0)	0% (0)
Pedestrian pressured to run	17.7% (39)	32.4% (24)

Shaded area – The change between the *before* phase and the *after* treatment phase was significant at the 0.05 level based on the chi-square statistic.

SECTION FIVE
DISCUSSION AND CONCLUSIONS

The intent of this evaluation was to examine the effects of a pedestrian safety improvement. The improvement included concentrating pedestrians at a single crossing point with a pedestrian refuge island and relocating bus stops closer to where pedestrians would attempt to cross the street. A before-and-after analysis was conducted to evaluate motorist and pedestrian behavioral changes at the study site at S. 180th Street on SR 7 in the City of Spanaway. The key findings are listed below.

- **The safety treatments did not have the expected positive effect of encouraging pedestrians to use the median refuge for crossing.**

  During the *before* phase, pedestrians were observed using the marked crosswalks over 80 percent of the time. In the *after* phase, pedestrians used the median refuge only about 60 percent of the time. This suggests that pedestrians may not feel that the median refuge provides an additional margin of safety. Pedestrian crossing at the median may improve as familiarity with the treatment increases. In addition, compliance may increase after all construction on the roadway is completed.

- **Higher motorist yielding rates were observed at marked crosswalks before the median installation.**

  Vehicle yielding was approximately 20 percent higher at the marked crosswalks in the *before* phase than at the new median refuge in the *after* phase. Although the median refuge included pedestrian crossing signs, there was significant decrease in motorist yielding. This decrease in yielding caused longer delays for pedestrians waiting in the median mid-crossing.

- **Motorists often did not yield to crossing pedestrians.**

  Although the majority of motorists did not yield for pedestrians, they were more likely to yield if a pedestrian was crossing in a designated area (i.e., the marked

crosswalk or median refuge). Additional effort is recommended to remind pedestrians to cross in designated areas.

- **The study results do not suggest that pedestrians gained a false sense of security.**

  Observations of pedestrians indicate that most pedestrians were very cautious about watching for coming traffic when crossing the street. There is no strong evidence that pedestrians acted carelessly because they felt more protected in the marked crosswalks or within the median refuge. The length of time pedestrians waited in the median may reflect a better feeling of safety at that location and a resulting willingness to wait for a safe vehicle break before crossing. The lack of change in pedestrian and vehicle evasive behavior also confirms this finding. Even with safety treatments in place, such as marked crosswalks and pedestrian crossing signs, it is also helpful to remind pedestrians to always be cautious about crossing the street.

- **The true effects of the median installation may have been limited at the study site because of equipment constraints, project schedule, and sample size.**

  The timing of various rounds of data collection for this evaluation depended on the schedule of the project implementation. Therefore, it was not possible to separate seasonal and weather effects, as the project timing resulted in *before* data collection in the spring of 2004 and *after* data collection during the summer of 2005. The data collected during this study may or may not portray long-term behavior for the following reasons: First, they are snapshots of pedestrian and motorist behavior that were captured during specific periods after implementation. Second, because of equipment problems and construction timelines, the *after* data sample size was limited.

- **Additional research should study the effectiveness of this type of median at other roadway types.**

  This location was chosen for the pilot project because it had been designated an at-risk location because of its high proportion of older road users. The special circumstances at this site influenced the installation of pedestrian treatments. However, the site characteristics do not meet the standards typically required for this type of treatment. The low rate of pedestrian crossings (less than 1 crossing per hour) may have prevented the median from being effective; the presence of more pedestrians could increase awareness of the median for both pedestrians and motorists. Thus, a location with more pedestrian crossings could produce better results for the median.

- **Additional improvements may be beneficial at this location.**

  The location is currently undergoing roadway improvements that include the installation of pedestrian sidewalks. Once the sidewalks have been installed, additional improvements at the site should be considered, such as crosswalk striping, better signage, overhead pedestrian crossing signs, or pedestrian-activated signals. The *WSDOT Design Manual* is being updated, and the new standards should be considered for the site. Although the design manual does not support striping alone at this location, striping as a supplement to the median could be considered. The draft design manual also specifies that inside incorporated cities, city standards for pedestrian facilities will be used, meaning that, ultimately, the decision to mark crosswalks could reside with the city of Spanaway. Further pedestrian treatment research may help identify effective improvements to accommodate pedestrians.

APPENDIX A

PEDESTRIAN AND MOTORIST OBSERVATION FORM

								Southbound Vehicles			Northbound Vehicles			Conflicts				
Event #	# of Ped	Date	Time	Ped Dir	Transit Origin - Destination	Used Med	Wait before cross	Yielding	# veh no yield to ped	Shielding Conflicts	Yielding	# veh no yield to ped	Shielding Conflicts	PE	VE	CL/M	NM	PPR
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					
				W E	O D NA			Y N		Y N	Y N		Y N					

# of Ped Observed = Assign one number for each group of peds

Transit = pedestrian traveling either to (D) or from (O) adjacent Metro stop

Shielding conflicts = Vehicle yields within 10 ft of the Xwalk while a vehicle in the next lane still proceeds

Pedestrian evasive action (PE) = Pedestrian had to jump or step back or was forced to run.

Vehicle evasive action (VE) = Vehicle had to hit brakes or swerve to avoid striking a ped.

Ped wait in center lane/median (CL/M)= Pedestrian had to stop and wait in CL/median.

Near Miss (NM) = A pedestrian/vehicle collision almost occurred.

Pedestrian Pressured to Run (PPR) = Similar to PE but without noticeable cause