

1. Report No. FHWA/TX-12/5-5470-01-1	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle SCHOOL TRAFFIC WORKSHOP: DEALING WITH TEXAS-SIZED PROBLEMS AROUND SCHOOLS		5. Report Date October 2011 Published: January 2012	6. Performing Organization Code
7. Author(s) Scott A. Cooner, Marcus A. Brewer, and Kay Fitzpatrick		8. Performing Organization Report No. Report 5-5470-01-1	
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135		10. Work Unit No. (TRAIS)	11. Contract or Grant No. Project 5-5470-01
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office P.O. Box 5080 Austin, Texas 78763-5080		13. Type of Report and Period Covered Technical Report: January 2010–August 2011	
15. Supplementary Notes Project performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration. Project Title: Dealing with Texas-Sized Problems around Schools URL: http://tti.tamu.edu/documents/5-5470-01-1.pdf		14. Sponsoring Agency Code	
16. Abstract This report summarizes the series of “Traffic around Schools” workshops conducted throughout the state of Texas to familiarize TxDOT employees and partner agencies with two key products from previous research projects (0-4286 and 0-5470) and other tools and guidance that are available for dealing with problems around schools. The research team held half-day workshops in Austin, El Paso, Houston, Pharr, San Antonio, and Dallas that were attended by over 150 participants representing 36 agencies. The workshops were well received and helped to highlight and emphasize the important of multi-agency/multi-disciplinary cooperation in the planning, design, and operation of school sites in order to provide safe and efficient transportation access. One of the focus areas of the project and associated workshops was how agencies can effectively deal with the use of reduced speed school zones around schools. Researchers solicited and synthesized feedback from workshop participants in order to be able to update existing guidance. The research team developed three primary recommendations following the completion of this implementation project: <ul style="list-style-type: none"> • Extend workshop series to other areas and/or to audiences more focused on ISD personnel. <ul style="list-style-type: none"> ○ Pursue ongoing workshop support through the TxDOT Human Resources Division training section. ○ Pursue non-TxDOT sponsorship opportunities (e.g., Texas Education Agency Regional Service Centers). • Expand workshop content to a full day and increase interactivity by adding more group exercises, case studies, and the use of other interactive media such as video. • Pursue additional school-related research projects on speed issues around schools. <ul style="list-style-type: none"> ○ Speed compliance with beacons and without and speed/delay in school zones with no reduced speed. 			
17. Key Words School Zones, Safety, Site Design, School Bus, Workshop		18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service Alexandria, Virginia 22312 http://www.ntis.gov	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 130	22. Price

SCHOOL TRAFFIC WORKSHOP: DEALING WITH TEXAS-SIZED PROBLEMS AROUND SCHOOLS

by

Scott A. Cooner, P.E.
Research Engineer
Texas Transportation Institute

Marcus A. Brewer, P.E.
Assistant Research Engineer
Texas Transportation Institute

and

Kay Fitzpatrick, P.E.
Senior Research Engineer
Texas Transportation Institute

Report 5-5470-01-1

Project 5-5470-01

Project Title: Dealing with Texas-Sized Problems around Schools

Performed in cooperation with the
Texas Department of Transportation
and the
Federal Highway Administration

October 2011

Published: January 2012

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The engineer in charge of the project was Scott A. Cooner, P.E. #86225.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

ACKNOWLEDGMENTS

This project was conducted in cooperation with TxDOT and FHWA. The authors thank Flor Tamez of the Traffic Operations Division for serving as the project director and to Wade Odell of the Research and Technology Implementation Office for his oversight and direction. There were a number of TxDOT staff members that contributed to the success of the workshops by inviting participants and assisting with logistics:

- Jacqueline Potts, Human Resources Division.
- Lolly Hepburn, Human Resources Division.
- Nancy Herrera, El Paso District.
- Elizabeth Halliburton-Riddick, Houston District.
- Ruben Alonso, Pharr District.
- Jesus Leal, Pharr District.
- Diane Zaruba, San Antonio District.
- Kenneth Michalik, San Antonio District.
- Ricardo Castaneda, San Antonio District.
- Emma McKee, Dallas District.

In addition to the authors, there were also several staff members at the Texas Transportation Institute (TTI) who made significant contributions in the preparation of course content and materials, including:

- Christy Harris, Administrative Coordinator, Arlington office.
- Diana Wallace, Programmer/Analyst II, Arlington office.
- Colleen Dau, Lead Office Assistant, College Station.
- Greg Larson, Student Worker IV, College Station.
- Ivan Lorenz, Research Specialist, College Station.

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SCHOOL TRAFFIC WORKSHOPS

OVERVIEW

This report provides a review of workshops presented as part of TxDOT Implementation Project 0-5470-1: “School Traffic Workshop: Dealing with Texas-Sized Problems around Schools.” The research team conducted these workshops to familiarize TxDOT employees and partner agencies with two key products from previous research projects (0-4286 and 0-5470) and other tools and guidance that are available for dealing with problems around schools.

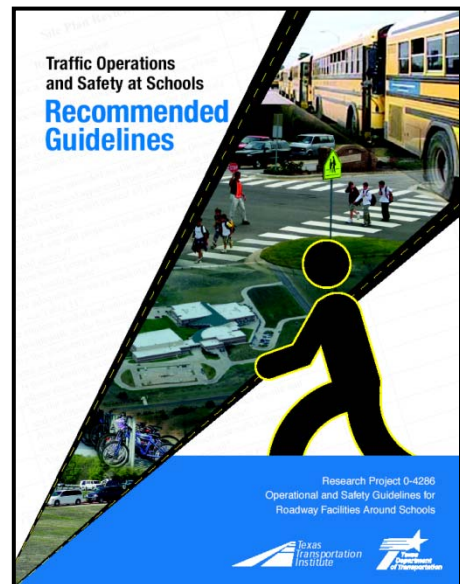
Background

One of the five primary goals of TxDOT is to enhance safety of the transportation system. The State of Texas has experienced considerable population growth, particularly in large urban areas, which makes achieving this safety enhancement a challenge. One of the areas that have significantly been affected by the population growth is the need for educational facilities. Texas has been one of the top three states in the building of elementary and secondary school campuses in the United States during the last decade. Many of these schools are located on sites near highways or other state roadways, some designed for low volumes and high speeds. Another ongoing trend is the higher proportion of children being transported to and from schools in private vehicles. These realities and many of the other issues associated with traffic around schools make it important to consider the design and operation of roadways within and around schools to ensure the safest possible environment. Equally important is the consideration of the location and design of the school site, preferably during the planning stages, in order to establish safe and efficient operations. TxDOT has funded two research projects focused on school area transportation that have helped to develop further understanding of typical issues and guidance for dealing with these issues.

Previous Research

In the last decade, TTI researchers have performed two research projects for TxDOT dealing with transportation around schools. The first project, 0-4286 “Operational and Safety Guidelines for Roadway Facilities around Schools,” developed guidelines and good examples for the design and operation of roadway facilities within and around schools in order to improve safety and reduce local congestion. Researchers focused this guidance into nine categories, including:

- Site selection criteria.
- General site requirements and design.
- Bus operations.
- Parent drop-off/pick-up zones.
- Bicycle/pedestrian access.
- Driveways.
- Turn lanes.



- Traffic control, signing, and pavement markings.
- Parking requirements and design.

A second project, 0-5470 “Comprehensive Guide to Traffic Control near Schools,” reviewed existing practices and developed suggested guidelines for traffic control devices, including school speed zones, near schools in Texas. The guide focused on seven major topics, including:

- Definitions.
- School location.
- School speed zone characteristics.
- Pavement markings.
- Crosswalks.
- School entrances.
- Conditions for removing a school speed zone.



This research also developed a preliminary product, 0-5470-P1 *Dealing with Texas-Sized Problems around Schools: Tools Available within TxDOT*, that put together a basic training module. As part of the 5-5470-1 implementation project, this research team has further developed and broadened this deliverable into the product for this current project, a “Traffic around Schools” workshop.

Project Work Plan

The research team developed a project work plan containing four tasks to guide the “Traffic around Schools” workshop implementation project:

- Task 1: Develop traffic around schools workshop materials.
- Task 2: Perform pilot Traffic around Schools Workshop.
- Task 3: Perform statewide workshops.
- Task 4: Develop final workshop materials and document project results.

Researchers present the project results in the following section, Summary of Project Results.

SUMMARY OF PROJECT RESULTS

This section provides a brief summary of the key activities and outcomes of the implementation project.

Task 1: Develop “Traffic around Schools” Workshop Materials

Drawing upon the materials developed in 0-4286 and 0-5470 and other recent studies, the research team developed drafts of all necessary “Traffic around Schools” workshop materials. Researchers organized the workshop similar to ones offered by the National Highway Institute

(NHI), where content is developed into modules with learning outcomes designed to promote interaction between and engagement of the participants. The research team planned the “Traffic around Schools” workshop as a half-day (either from 8:00 a.m. to 12:00 p.m. or 1:00 to 5:00 p.m.) session for 20 to 30 participants.

Workshop Agenda

The research team organized the half-day workshop into five modules. [Table 1](#) provides a brief synopsis of each module, including the title, learning outcomes, and basic content description.

Table 1. “Traffic around Schools” Workshop Overview.

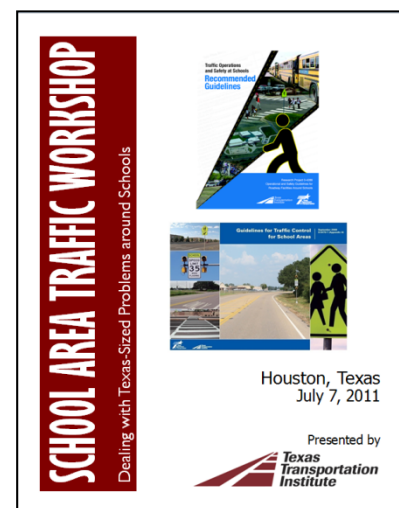
Module	Learning Outcomes	Description
#1 Introduction/ overview	1. Understand learning outcomes. 2. Workshop is designed for interactivity. 3. Questions and input are encouraged.	This module is the basic introduction of the workshop, encouraging participants to learn from each other.
#2 Typical school traffic concerns	1. Understand key stakeholders. 2. Relate to typical problems. 3. List two school programs.	This module covers typical problems at schools and presents two programs that are designed to deal with them.
#3 Site-based guidance	1. Identify school site guideline categories. 2. Detect problems using a checklist. 3. Develop ideas for improving site design.	This module focuses on providing guidance on issues within the school site itself.
#4 Zone guidelines	1. Understand procedures for school zones. 2. Discuss common school zone problems. 3. List conditions for school zone removal.	This module concentrates on giving guidance on off-site issues, with a focus on reduced speed zones.
#5 Discussion of local issues	1. Discuss local issues and concerns. 2. Use case studies to apply knowledge.	This module allows participants to discuss local issues and apply knowledge from previous modules.

Participant Workbook

Researchers created a participant workbook designed to help workshop attendees stay engaged with the instructors. The participant workbook consisted of five elements:

1. Cover.
2. Agenda.
3. Module PowerPoint® slides (see [Appendix B](#)).
4. Evaluation form.
5. Compact disc (CD).

The research team also created an instructor’s guide with speaker’s notes. The CD provided participants with electronic files for all of the supporting references used in the workshop development, an Adobe portable document format (PDF) file of the module slides, and materials used in Module 5 (see [Appendix C](#) for list of CD contents).



Task 2: Perform Pilot “Traffic around Schools” Workshop

The second task in the implementation project involved holding a pilot “Traffic around Schools” workshop to test the course materials and gather feedback. The research team worked closely with the TxDOT Project Director and selected the Austin District as the location for the pilot workshop. The research team assisted TxDOT by inviting participants from stakeholder agencies. The pilot workshop had 30 total attendees representing the following agencies:

- TxDOT.
- Freese & Nichols.
- City of Austin.
- Capital Area Council of Governments.
- Capital Area Metropolitan Planning Organization.
- Grant Development Services.
- Sheldon Independent School District (ISD).
- Dell Children’s Medical Center.
- HDR Engineering, Inc.
- Alliance Transportation Group.
- LJA Engineering.
- Parsons Brinckerhoff.
- Atkins Global.
- URS Corporation.
- Gullett Elementary Parent Teacher Association (PTA).

The pilot workshop provided a good mixture of perspectives and interactivity. [Table 2](#) shows the workshop evaluation results.

Table 2. Workshop Evaluation Summary—Austin District Pilot: June 6, 2011.

Evaluation Element	Excellent (5 pts)	Very Good (4 pts)	Average (3 pts)	Fair (2 pts)	Poor (1 pt)	Average Rating ¹
M1: Introduction	3	13	4	0	0	3.95
M2: Typical school traffic concerns	3	16	1	0	0	4.10
M3: Site-based guidance	2	16	2	0	0	4.00
M4: Zone-based guidance	3	16	1	0	0	4.10
M5: Local issues	1	12	6	1	0	3.65
Instructor 1: Scott Cooner	4	13	2	1	0	4.00
Instructor 2: Marcus Brewer	3	17	0	0	0	4.15
Length	4	11	3	1	1	3.80
Interactivity	10	7	2	1	0	4.30
Participant workbook	7	12	1	0	0	4.30
TOTAL²	20%	66.5%	11%	2%	0.5%	X

¹ Average rating based on 20 completed evaluation forms.

² TOTAL calculated as percentage of total responses in each rating category.

Overall, the pilot workshop received good ratings with almost 87 percent of the elements evaluated receiving an Excellent/Very Good response. The evaluation form also asked participants to provide additional written feedback, including what they like best, what they would change (if anything), and any other comments on how to improve the workshop for future implementation. A synthesis of the written feedback for the Austin pilot workshop follows:

The part I liked best about the workshop was:

- Interactive discussion/open participation (seven responses).
- Nothing written (four responses).
- Module 4 (zone-based guidance) (three responses).
- Learning about other states (two responses).
- Open nature of leadership, which encouraged networking and creative problem solving.
- Discussion of site planning, proper use of school zones.
- Well organized.
- Instructor knowledge of materials.
- Very informative—great for multiple agencies and the public.
- I learned a lot of new information and the presenters and audience seemed knowledgeable
- Module 5 (local issues).

If I could change something about the workshop, it would be:

- Nothing (10 responses).
- Shorter breaks.
- Introduction module—need to present the issues and problems
- Provide webinar access.
- More independent examples of good and bad designs and discussion.
- More strict with time allocation.
- Add something more interactive.
- A little clearer about what the Texas policy is...Marcus could be louder; the participants had their personal input.
- Increase emphasis on Safe Routes to School Program.
- Keep stats to Texas only since the problems we wish to address and correct are in Texas.
- I didn't know in advance that this focused primarily on new schools. Would like to see more information about existing schools. Regarding school zones, there should probably be a discussion of exceptions to the rule...regarding the need for school zones at signalized intersections. (There are several places in Austin where particularly dangerous signalized intersections exist—especially for young, unattended child pedestrians.)
- Present this at Texas Association of School Board Officials (TASBO) and at colleges and universities that have architecture colleges.

Other feedback about how to improve the workshop for future implementation:

- Module arrangement—Move zone-based guidance (Module 4) to the beginning (two responses).
- Possibly small discussion groups on issues.
- Thanks for forwarding to Austin ISD groups.
- Data in the first section was not as well presented as it could be, and the instructor needs to better familiarize himself with the data presented.
- Add school site team.
- Public should be informed by media/brochures about the rules they need to follow in a school zone. Like the white stripe on pavement means “End of School Zone.” These brochures should be available at Department of Public Safety (DPS)/TxDOT offices also at new schools where parents need to be educated about how school zones work. Many tickets would be avoided.
- More questions or some type of trivia/game to increase participation (could be five minutes every hour to keep the audience alert and motivated).
- Have more ISDs attend.
- Get more physical education teachers involved to encourage bicycling and walking to school.

Based on this feedback, researchers started to refine and optimize the workshop content in preparation for the series of statewide workshops following the Austin pilot.

Task 3: Perform Statewide Workshops

The research team planned and conducted an additional five “Traffic around Schools” workshops throughout the state in the following locations:

- El Paso District (June 29, 2011).
- Houston District (July 1, 2011).
- Pharr District (July 20, 2011).
- San Antonio District (August 2, 2011).
- Dallas District (August 16, 2011).

Figure 1 shows the attendance figures at these workshops, with the pilot workshop attendance also included. The workshop in the Pharr District had the lowest number of participants (13), while the San Antonio District had the highest (37). A total of 155 attendees throughout the state (representing 36 agencies) participated in the “Traffic around Schools” workshops.

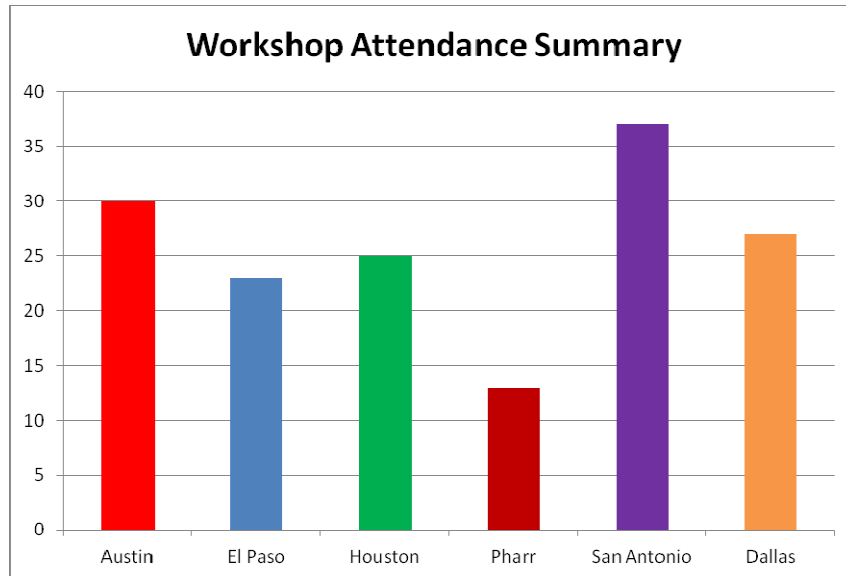


Figure 1. Summary of Traffic around Schools Workshop Attendance.

El Paso District Workshop Summary

The research team conducted the first statewide workshop at the TxDOT El Paso District building on June 29, 2011. This workshop had 23 attendees representing four agencies, including:

- TxDOT.
- City of El Paso.
- City of Socorro.
- Horizon City.

The El Paso District workshop was interactive and also provided a good mixture of agency perspective and input. [Table 3](#) shows the workshop evaluation results.

Table 3. Workshop Evaluation Summary—El Paso District: June 29, 2011.

Evaluation Element	Excellent (5 pts)	Very Good (4 pts)	Average (3 pts)	Fair (2 pts)	Poor (1 pt)	Average Rating ¹
M1: Introduction	4	13	0	0	0	4.24
M2: Typical school traffic concerns	4	13	0	0	0	4.24
M3: Site-based guidance	4	13	0	0	0	4.24
M4: Zone-based guidance	2	15	0	0	0	4.12
M5: Local issues	1	15	1	0	0	4.00
Instructor 1: Scott Cooner	6	11	0	0	0	4.35
Instructor 2: Marcus Brewer	6	11	0	0	0	4.35
Length	4	10	3	0	0	4.06
Interactivity	4	12	1	0	0	4.18
Participant workbook	4	11	2	0	0	4.12
TOTAL²	23%	73%	4%	0%	0%	X

¹ Average rating based on 17 completed evaluation forms.

² TOTAL calculated as percentage of total responses in each rating category.

Overall, the El Paso District workshop received good ratings with approximately 96 percent of the elements evaluated receiving an Excellent/Very Good response. The evaluation form also asked participants to provide additional written feedback, including what they liked best, what they would change (if anything), and any other comments on how to improve the workshop for future implementation. A synthesis of the written feedback for the El Paso District workshop follows:

The part I liked best about the workshop was:

- Nothing written (11 responses).
- Modules 3 and 4 (site-based and zone-based guidance).
- School zone guidelines.
- Examples of schools with layouts that should be avoided or implemented.
- Hands on approach was excellent, and interaction from all agencies about ordinances and regulations was very helpful.
- Site guidance, which is something the City of El Paso is already doing. All the reference information provided.
- Great examples.
- Brief and concise—right to the point.
- Butler Elementary School—Arlington school parking discussion.
- Texas Manual on Uniform Traffic Control Devices (MUTCD) vs. national MUTCD.
- Very well organized. The visuals (site plans) were self explained.
- Zone-based guidance—good recommendations.
- Modules 4 and 5.
- Research on other states’ methods of addressing issues.

- School traffic concerns.
- Best practice samples.

If I could change something about the workshop, it would be:

- Provide example of schools in urban condition/layout (11 responses).
- Nothing (Six responses).
- Provide more legible slides on the manual—especially the ones that have web links or other references.
- More examples on pedestrian-friendly guidelines.
- This is more of a facility comment—the presentation room was too bright. A bit difficult to view the presentation slides.
- More case studies.
- Add the site photos for the examples in addition to the sketches.
- Add the last example in the book (Butler Elementary School).
- Include pedestrians and other technologies with statistical data.
- Increase length to a one-day workshop to provide hands-on participation. Maybe two or three individual or group assignments.
- Make us be more involved with workshop instead of being asked.

Other feedback about how to improve the workshop for future implementation:

- Nothing written (10 responses).
- More examples of good and bad setups and hands-on exercise on improving school sites.
- It is my opinion that more examples of urban conditions should be provided. All pictures and conditions appeared to be in a rural setting. Ideas on how to retrofit existing school conditions.
- Include design workshop.
- Keep doing your great job.
- Have more research on other states.
- Include more school district staff. It would help to strengthen partnership.

Houston District Workshop Summary

The research team conducted the second statewide workshop at the TxDOT Houston District building on July 7, 2011. This workshop had 25 attendees representing five agencies, including:

- TxDOT.
- Deer Park Police Department.
- Harris County.
- Fort Bend County.
- City of Houston.

The Houston District workshop provided a good mixture of perspectives and interactivity and was the first to involve representation from a law enforcement agency. Table 4 shows the workshop evaluation results.

Table 4. Workshop Evaluation Summary—Houston District: July 7, 2011.

Evaluation Element	Excellent (5 pts)	Very Good (4 pts)	Average (3 pts)	Fair (2 pts)	Poor (1 pt)	Average Rating ¹
M1: Introduction	8	13	2	0	0	4.26
M2: Typical school traffic concerns	8	13	2	0	0	4.26
M3: Site-based guidance	11	11	1	0	0	4.43
M4: Zone-based guidance	9	13	1	0	0	4.35
M5: Local issues	9	10	1	0	0	4.40
Instructor 1: Marcus Brewer	13	10	0	0	0	4.57
Instructor 2: Kay Fitzpatrick	12	11	0	0	0	4.52
Length	7	16	0	0	0	4.30
Interactivity	9	13	0	0	0	4.41
Participant workbook	7	12	3	0	0	4.18
TOTAL²	41%	54%	5%	0%	0%	

¹ Average rating based on 23 completed evaluation forms.

² TOTAL calculated as percentage of total responses in each rating category.

Overall, the Houston District workshop received good ratings with approximately 95 percent of the elements evaluated receiving an Excellent/Very Good response. The evaluation form also asked participants to provide additional written feedback, including what they liked best, what they would change (if anything), and any other comments on how to improve the workshop for future implementation. A synthesis of the written feedback for the Houston District workshop:

The part I liked best about the workshop was:

- Nothing written (five responses).
- The site-based guidance was beneficial (four responses).
- Everything.
- Length.
- School site plans.
- Interaction between law enforcement and city/state engineers.
- Discussion of issues.
- Pictures and examples of what and what not to do.
- The class is interactive; the instructors encourage participation and answer questions clearly.
- Information as a result of research.
- Listing and brief explanation of research reports and developed recommendations.
- Determining the start and end of a school zone.

- Handouts and CD. Continue to provide handouts, PowerPoints for presentations in local community leaders.
- Great resource. Good information that I can take back to my agency (police department) as a stakeholder.
- Module 4 (buffer zone).
- Good discussion among the group and makeup of attendees.

If I could change something about the workshop, it would be:

- Nothing (11 responses).
- Include more school district staff in the workshop (five responses).
- Forward workshop information to all school districts in Texas electronically to help facilitate discussion with transportation officials.
- Add roadway design consideration to improve existing conditions.
- Additional/larger diagrams in the workbook.
- More local issues.
- Some of the important slides (i.e., 77–79) show full size in an Appendix for future reference, so information can be read.
- Please show a video related to school traffic design.
- Add appropriate contact numbers for follow-up questions in different areas (e.g., handouts.)
- Continue to invite traffic management, school districts, and law enforcement.
- Try to come up with ways to fix existing problems. You show examples of problems, so during design you can try to avoid these, but not on how to fix.


Other feedback about how to improve the workshop for future implementation:

- Nothing written (17 responses).
- Slide 23—proposed construction number should be in billions (not millions).
- Provide a copy of the guidelines (Module 3) or just the checklist (Module 3) to look at during presentation.
- I would try to incorporate more examples.
- Great work.
- More participation by school districts.
- Have it as an option to go out to communities and put on to all stakeholders in a specific community.

Pharr District Workshop Summary

The research team conducted the third statewide workshop at the TxDOT Pharr District building on July 20, 2011. This workshop had 13 attendees representing TxDOT. The Pharr District workshop was a relatively small group that may have encouraged additional interaction. It was notable that this was the only workshop where all participants were from TxDOT, and this made it difficult to consider and accurately discuss the perspective of outside agencies and stakeholders. [Table 5](#) shows the workshop evaluation results.

Table 5. Workshop Evaluation Summary—Pharr District: July 20, 2011.

Evaluation Element	Excellent (5 pts)	Very Good (4 pts)	Average (3 pts)	Fair (2 pts)	Poor (1 pt)	Average Rating ¹
M1: Introduction	4	6	0	0	0	4.40
M2: Typical school traffic concerns	5	5	0	0	0	4.50
M3: Site-based guidance	7	3	0	0	0	4.70
M4: Zone-based guidance	6	4	0	0	0	4.60
M5: Local issues	4	6	0	0	0	4.40
Instructor 1: Scott Cooner	7	3	0	0	0	4.70
Instructor 2: Kay Fitzpatrick	7	3	0	0	0	4.70
Length	5	4	1	0	0	4.40
Interactivity	5	5	0	0	0	4.50
Participant workbook	5	5	0	0	0	4.50
TOTAL²	55%	44%	1%	0%	0%	

¹ Average rating based on 10 completed evaluation forms.

² TOTAL calculated as percentage of total responses in each rating category.

Overall, the Pharr District workshop received good ratings with approximately 99 percent of the elements evaluated receiving an Excellent/Very Good response. The evaluation form also asked participants to provide additional written feedback, including what they liked best, what they would change (if anything), and any other comments on how to improve the workshop for future implementation. A synthesis of the written feedback for the Pharr District workshop follows:

The part I liked best about the workshop was:

- Nothing written (one response).
- The course was very well explained and very informative.
- Information.
- Consideration of warrant possibilities or at least provide a criteria for school zones.
- The bus traveling in which direction exercise, and all of it was very informational and useful.
- The interactivity is valuable to the workshop to learn from others' experience and knowledge. Also learning about criteria and guidelines that are looked at and reviewed as per school zone requests.
- All of information given in this workshop was updated and had a lot of good information.
- Good and bad examples.
- It was very basic but very informative. Very good examples and ideas to improve design.
- The reference material and copies of studies.

If I could change something about the workshop, it would be:

- Nothing (five responses).
- Less breaks.
- Add a few exercise problems and have a group activity to provide a solution to the problems.
- Length—make it a full day.
- If any, see if there is any bus route sign for our roads.
- More handouts included in workbook.

Other feedback about how to improve the workshop for future implementation:

- Nothing written (five responses).
- Excellent course—very informative.
- Get city officials, school officials, and parents.
- Would like to learn about actual reviews for school zone speed limits that are conducted due to actual events where concerns have been raised by parents, schools, political officials, law enforcement, etc.
- Possible exercises on how to address problems followed by discussion on possible solutions.
- It is good to get ideas from other states and compare and improve.

San Antonio District Workshop Summary

The research team conducted the fourth statewide workshop at the TxDOT San Antonio District building on August 2, 2011. This workshop had 37 attendees representing three agencies, including:

- TxDOT.
- Bexar County.
- City of San Antonio.

The San Antonio District workshop provided a good mixture of perspectives (TxDOT had representation of three districts and multiple disciplines including safety, traffic, planning, design, and construction) and interactivity. [Table 6](#) shows the workshop evaluation results.

Table 6. Workshop Evaluation Summary—San Antonio District: August 2, 2011.

Evaluation Element	Excellent (5 pts)	Very Good (4 pts)	Average (3 pts)	Fair (2 pts)	Poor (1 pt)	Average Rating ¹
M1: Introduction	10	18	0	0	0	4.36
M2: Typical school traffic concerns	8	17	3	0	0	4.18
M3: Site-based guidance	11	15	2	0	0	4.32
M4: Zone-based guidance	12	14	2	0	0	4.36
M5: Local issues	6	18	3	1	0	4.04
Instructor 1: Scott Cooner	13	13	2	0	0	4.39
Instructor 2: Marcus Brewer	13	14	1	0	0	4.43
Length	12	10	5	1	0	4.18
Interactivity	8	15	5	0	0	4.11
Participant workbook	10	12	5	1	0	4.11
TOTAL²	37%	52%	10%	1%	0%	X

¹ Average rating based on 28 completed evaluation forms

² TOTAL calculated as percentage of total responses in each rating category

Overall, the San Antonio District workshop received good ratings with approximately 89 percent of the elements evaluated receiving an Excellent/Very Good response. The evaluation form also asked participants to provide additional written feedback, including what they liked best, what they would change (if anything), and any other comments on how to improve the workshop for future implementation. A synthesis of the written feedback for the San Antonio District workshop follows:

The part I liked best about the workshop was:

- Nothing written (seven responses).
- Many good and bad examples (three responses).
- The research data and list of references (three responses).
- The data presented.
- The overall topic and things to look for in traffic/school operations.
- Seeing and discussing live case scenarios.
- Well-organized, structured, and presented. The school speed limit guidance (and signing) was a good review and had some information I had not heard about.
- Site-based guidance.
- Visual presentation.
- Interaction with city, county, and states—different views.
- The feedback received from some of the “students” in the class with experience in the area.
- Gave a very good overview of school traffic issues and possible solutions.
- The examples shown for guidance in different applications of school zones.
- Local problem discussions.
- Interaction with students.

- Very good information for future design projects.
- Rules of thumb in common applications.
- Instructors welcomed class participation/questions.

If I could change something about the workshop, it would be:

- Nothing (17 responses).
- More practice examples/exercises (four responses).
- Time—day long (a lot of information packed into four hours) (three responses).
- Start time of 10:00 a.m. and 3:00 p.m. end time.
- Submit specific situations from participants ahead of time for discussion.
- More interaction with agencies and more presentation of new rules, regulations and approaches to subject.
- Larger print, larger PowerPoint presentation, all recent research.
- Decrease the length or include more lively content examples, maybe some video or captured instances where you could pause it right when something is going to happen... would allow class time to reflect on the real life issues.

Other feedback about how to improve the workshop for future implementation:

- Nothing written (21 responses).
- Invite school officials for their feedback (two responses).
- More case study information or results (two responses).
- Continue to give valuable links to the information.
- Send out workbooks the day before class starts.
- Somewhat lacking excitement—dry presentation.

Dallas District Workshop Summary

The research team conducted the fifth and final statewide workshop at the TxDOT Dallas District building on August 16, 2011. This workshop had 27 attendees representing eight agencies, including:

- TxDOT.
- City of Frisco.
- Garland ISD.
- North Central Texas Council of Governments.
- RLK Engineering.
- Irving ISD.
- Richardson ISD.
- City of Richardson.

The Dallas District workshop provided a diverse mixture of perspectives (law enforcement, ISD, planning, design, construction, and traffic) and interactivity and also had the most representation of any workshop with three different school districts in attendance. [Table 7](#) shows the workshop evaluation results.

Table 7. Workshop Evaluation Summary—Dallas District: August 16, 2011.

Evaluation Element	Excellent (5 pts)	Very Good (4 pts)	Average (3 pts)	Fair (2 pts)	Poor (1 pt)	Average Rating ¹
M1: Introduction	6	13	4	1	0	4.00
M2: Typical school traffic concerns	7	14	4	0	0	4.12
M3: Site-based guidance	7	16	2	0	0	4.20
M4: Zone-based guidance	9	15	1	0	0	4.32
M5: Local issues	7	12	5	0	0	4.08
Instructor 1: Scott Cooner	9	12	3	0	0	4.25
Instructor 2: Marcus Brewer	8	15	0	0	0	4.35
Length	5	16	3	0	0	4.08
Interactivity	7	14	2	1	0	4.13
Participant workbook	4	18	2	0	0	4.08
TOTAL²	28%	60%	11%	1%	0%	

¹ Average rating based on 25 completed evaluation forms.

² TOTAL calculated as percentage of total responses in each rating category.

Overall, the Dallas District workshop received good ratings with approximately 88 percent of the elements evaluated receiving an Excellent/Very Good response. The evaluation form also asked participants to provide additional written feedback, including what they liked best, what they would change (if anything), and any other comments on how to improve the workshop for future implementation. A synthesis of the written feedback for the Dallas District workshop:

The part I liked best about the workshop was:

- Nothing written (six responses).
- School zones (five responses).
- The pace of the class was very good. Enough information was provided for the time frame (no rushing through material).
- Resource material, group discussion, and ability to ask questions.
- Attentiveness to needs of schools.
- The examples and example specific to Texas and what we see driving.
- Interactivity.
- Directly discussed real-world issues and not theoretical problems.
- Small class and good speakers.
- The question and answers between the staff and attendees.
- Examples from other states/jurisdictions.
- Module 2 and Module 4.
- Everything including participant discussion was excellent.
- The CD included with the manual.
- Having multiple municipalities present to hear how they are handling school zones.
- Assignment at the end of class (length).

- The participants are a very diverse group, and the instructors are knowledgeable.
- Traffic school concerns (Module 2).
- Variety of participants was great: ISD, cities, police departments, COG, TxDOT, and consultants.

If I could change something about the workshop, it would be:

- Nothing (14 responses).
- To create better slides/improve visuals—we have become too dependent on PowerPoint (two responses).
- Make modules longer—felt kind of short on time.
- More real-world examples.
- Better exercise at the end.
- Longer length, extended to one day duration.
- Include more recent research such as innovative techniques for school setting.
- The map in Module 5 was too small.
- Provide operations layout of the school for Module 5, so when doing the checklist, more information is provided
- Add a field trip to visit several sites in the afternoon (schools, school zones, adjacent roadway network).

Other feedback about how to improve the workshop for future implementation:

- Nothing written (22 responses).
- Maybe more real-life examples, would also like to talk more about ways to improve existing sites (maybe a different workshop).
- More interaction.
- The four hour class is a good length.

Task 4: Develop Final Workshop Materials and Document Project Results

The final task for the research team involved finalizing the workshop materials and documenting the project results. Researchers met with TxDOT staff in Austin to wrap-up the implementation project and discuss the workshop outcomes and key findings.

SCHOOL ZONE WORKSHOP FEEDBACK

The research team also paid particular attention to soliciting and documenting feedback from workshop participants during Module 4, related primarily to the use of reduced-speed school zones (RSSZ). The next section of this report outlines the notable discussion items from the six statewide workshops conducted during the 5-5470 implementation project. The final section summarizes the changes to the product of the 0-5470 conventional research project that was originally published in February 2009 and now revised in September 2011.

Notable Workshop Discussion Items

The research team developed the following list of notable discussion items based on feedback during the six statewide workshops regarding the use of RSSZs:

- Definition of a school.
 - Why not include pre-kindergarten or post-12th education activities conducted by school districts (e.g., Head Start programs, continuing education, etc.)?
 - The University of Texas at El Paso (UTEP) has at least one RSSZ on their university campus.
 - Does the current definition of a school include private schools? (The answer is yes.)
- Motivation for RSSZ.
 - Pedestrian (and crossing pedestrian) traffic.
 - Two “commuter campuses” in Mesquite have no RSSZ.
- School zone duration.
 - City of San Antonio has an existing ordinance to have 7:00 a.m. to 9:00 a.m. and 2:00 p.m. to 4:00 p.m. as the active times.
 - 45 minutes before and 15 minutes after school are common durations in Texas.
 - How are special events (e.g., football games or other athletic events) handled by agencies?
- School zone length.
 - No substantial comments—some just asked how recommended values were derived.
- Uniformity among jurisdictions.
 - ISDs commonly overlap city boundaries and this can become complex of multiple sets of local ordinances apply.
- Signing.
 - There is concern in San Antonio regarding the addition of signs downstream of intersections for vehicles turning on the main road.
 - Is there a need for END SCHOOL ZONE signage if there is no reduced speed?
 - Texas MUTCD shows an option for Monday–Friday plaque; what if there is school on Saturday?

Summary of Changes to Product 1 ([Appendix A](#)) of TxDOT Report 0-5470-1

The research team also produced a summary of changes to Product 1 ([Appendix A](#)) of the existing TxDOT Report 0-5470-1 *Guidelines for Traffic Control for School Areas* originally published in February 2009. The following list summarizes the proposed changes:

- Introduction.
 - Updated website addresses for TMUTCD and *Procedures for Establishing Speed Zones*.
- Definitions.
 - Modified definitions of School, School Area, and School Zone to reflect the language in the August 2011 draft TMUTCD. The text of definitions from 0-5470 was not substantially different from the draft TMUTCD but consistency will be better served by using the newer text.
- School Area.
 - [Table A-1](#) has been updated to reflect distances shown in draft TMUTCD, including the addition of a category for 75 mph roadways.
- School Speed Limit Zone.
 - The original version of [Figure A-1](#) included what was then expected to be the recommended signage for the downstream end of a school speed limit zone. The figure has been updated to remove the signs and associated note, based on discussions with workshop participants and with PMC members.
 - The bullet list on page A-6 has been updated to show the current signing components shown in the draft TMUTCD, replacing what were the then-anticipated components.
 - A category for 75 mph has been added to [Table A-2](#).
 - [Figure A-2](#) has been modified to replace outdated information. The figure included what was then expected to be the recommended signage for the downstream end of a school speed limit zone, and the note included the expected language for the cell phone ban. The examples of signs and the accompanying notes have been updated to show current information.
 - [Figure A-3](#) has revisions similar to those in [Figure A-2](#).
- School Buffer Zone.
 - A category for 75 mph has been added to [Table A-4](#), and the columns of values have been rearranged to show them in increasing order by posted or 85th percentile speed.
 - [Figure A-4](#) has revisions similar to those in [Figure A-2](#).
- School Speed Limit Zone Marking.
 - The option of a 12-inch solid white transverse line has been removed to be consistent with the language in the draft TMUTCD.

- School Marked Crosswalk.
 - The text has been revised to better reflect the language in the draft TMUTCD. No major changes were made, but the text was reorganized and strengthened from the original version. The guidelines are now easier to read and comprehend, and they incorporate changes offered for the new TMUTCD.
 - A category for 75 mph has been added to [Table A-5](#).
- School Entrance Warning Assembly.
 - A category for 75 mph has been added to [Table A-6](#), and distance values have been updated to reflect those shown in the draft TMUTCD.

PROJECT RECOMMENDATIONS

Researchers developed three primary recommendations following the completion of the 5-5470 implementation project:

- Extend workshop series to other areas and/or to audiences more focused on ISD personnel.
 - Pursue ongoing workshop support through the TxDOT Human Resources Division training section.
 - Pursue non-TxDOT sponsorship opportunities (e.g., Texas Education Agency Regional Service Centers).
- Expand workshop content to a full day and increase interactivity by adding more group exercises, case studies, and the use of other interactive media such as video.
- Pursue additional school-related research projects on speed issues around schools.
 - Speed compliance with beacons and without.
 - Speed/delay in school zones with no reduced speed.

APPENDIX A:
GUIDELINES FOR TRAFFIC CONTROL FOR SCHOOL AREAS
OF

TXDOT REPORT 0-5470-1: *SPEEDS IN SCHOOL ZONES*

Project 0-5470
Project Title: Comprehensive Guide to Traffic Control Near Schools

Performed in cooperation with the
Texas Department of Transportation
and the
Federal Highway Administration

September 2008
Published: February 2009
Revised: September 2011

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

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INTRODUCTION

To achieve uniformity of traffic control in school areas, comparable traffic situations need to be treated in a consistent manner. Part 7 of the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) (http://www.dot.state.tx.us/txdot_library/publications/tmutcd.htm) provides information on traffic control devices related to schools. The Texas Department of Transportation (TxDOT) manual on *Procedures for Establishing Speed Zones* (<http://onlinemanuals.txdot.gov/txdotmanuals/szn/index.htm>) provides information on school speed zones. A recent TxDOT project (0-5470) investigated school speed zones and developed the *Guidelines for Traffic Control for School Areas* contained in this appendix. The purpose of these *Guidelines* is to augment the TMUTCD by providing additional background and information to assist in the traffic control device applications. The *Guidelines* are not intended to establish policy or procedures; rather they are to give typical guidance. Although the text may contain the words “shall,” “should,” or “may,” it is not intended that these words or their usage have the same implications as in the TMUTCD. An engineering and traffic investigation should be conducted to determine the need for a school speed limit as well as all appropriate traffic control devices.

SCHOOL LOCATION

A previous TxDOT research project developed recommended guidelines regarding traffic operations and safety at schools (available at: <http://tti.tamu.edu/documents/4286-2.pdf>). An initial principle developed and emphasized in several discussions is the desire to have schools located with appropriate accessibility from the adjacent roadway network based on the type of school. One of the prominent site selection criteria was to avoid locations with direct access to high-speed roadways (e.g., trunk highways and frontage roads). Locations should be chosen on roadways with the lowest speed limit and/or lowest average daily traffic. Also suggested was to locate a school so that students approaching on foot would not have to cross main traffic routes and to consider locating schools adjacent to other community facilities where there is potential for shared-use parking (e.g., parks, churches, etc.).

Maintaining contact with school officials can help TxDOT become aware of proposed school site designs at an early stage. When proposed building plans are known, suggestions on access points can be made that could minimize future problems. Also the installation of appropriate safety and traffic control devices can be scheduled to be in place when needed. An engineering and traffic investigation should be conducted to determine the need for traffic control devices.

DEFINITIONS

Following are definitions for use with these *Guidelines*.

School = a public or private educational institution recognized by the State education authority for one or more grades Kindergarten through 12 or as otherwise defined by the State.

School Area = an area adjacent to a roadway that includes school buildings or grounds, a school crossing, or school-related activity.

School Zone = a designated roadway segment approaching, adjacent to, and beyond school buildings or grounds, or along which school-related activities occur.

School Speed Limit Zone = a defined portion of the roadway where a school speed limit is present.

School Speed Limit = a speed limit posted in a school zone that is lower than the regulatory speed limit in that zone and is applicable during specific times of day on school days, when children are present, or when beacons are flashing.

School Buffer Zone = a defined portion of the highway in advance of and/or following a school speed limit zone where a school buffer speed limit is present.

School Buffer Speed Limit = a speed limit posted in a school zone that is lower than the regulatory speed limit in that zone but higher than the school speed limit, used to provide a transition between higher posted speed and school zone speed; it is applicable during the same time periods as the associated school speed limit.

School Entrance Warning Assembly = combination of signs warning drivers of the presence of a school entrance. The combination may be accompanied by an advisory speed plaque.

School Route Plan (also known as School Route Map) = a plan developed in a systematic manner by the school, law enforcement, and traffic officials responsible for school pedestrian safety. It consists of a map showing streets, the school, existing traffic controls, established school walk routes, and established school crossings. See the TMUTCD or Safe Routes to School website (<http://www.saferoutesinfo.org/>) for additional discussion. School speed limit zones shall only be located along child access routes as indicated on the school route plan.

Traffic Control Devices = all signs, signals, markings, and other devices used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, pedestrian facility, bikeway, public facility, or private property open to public travel by authority of a public agency or official having jurisdiction.

SCHOOL AREA

Some jurisdictions find it beneficial to advise road users that they are approaching a school that is adjacent to a highway, where additional care is needed, even though no school crossing is involved and the speed limit remains unchanged. The area adjacent to a roadway that includes school buildings or grounds, a school crossing, or school-related activity can be defined as the “school area,” while a school zone is a designated roadway segment approaching, adjacent to, and beyond school buildings or grounds, or along which school-related activities occur. The School (S1-1) sign can be used to warn road users that they are approaching a school area. [Table A-1](#) lists suggested dimensions for the spacing distance for the S1-1 sign; an example of signing for a school area is shown in [Figure A-1](#).

Table A-1. Suggested Dimensions for Distance d in Figure A-1.

Posted or 85 th percentile speed (mph)	25	30	35	40	45	50	55	60	65	70	75
Distance (d) between School (S1-1) sign and school driveway (ft)	100 to 325	100 to 460	100 to 565	125 to 670	175 to 775	250 to 885	325 to 990	400 to 1100	475 to 1200	550 to 1250	650 to 1350

SCHOOL SPEED LIMIT ZONE

A school speed limit zone can be considered for the following conditions:

- School-age pedestrians are crossing the major roadway going to and from school.
- School is located adjacent to highways or is visible from highways.

School speed limit zones are typically not used at signalized or stop-controlled intersections because their traffic control creates gaps that can be used by school-age pedestrians to cross a roadway. A school speed limit zone may be installed, or may be allowed to remain, at a roundabout, signalized, or stop-controlled intersection as a mitigation measure for concerns related to sight distance, grade, or other critical issues, as determined by an engineering study.

The school speed limit zone is to be shown on the School Route Plan.

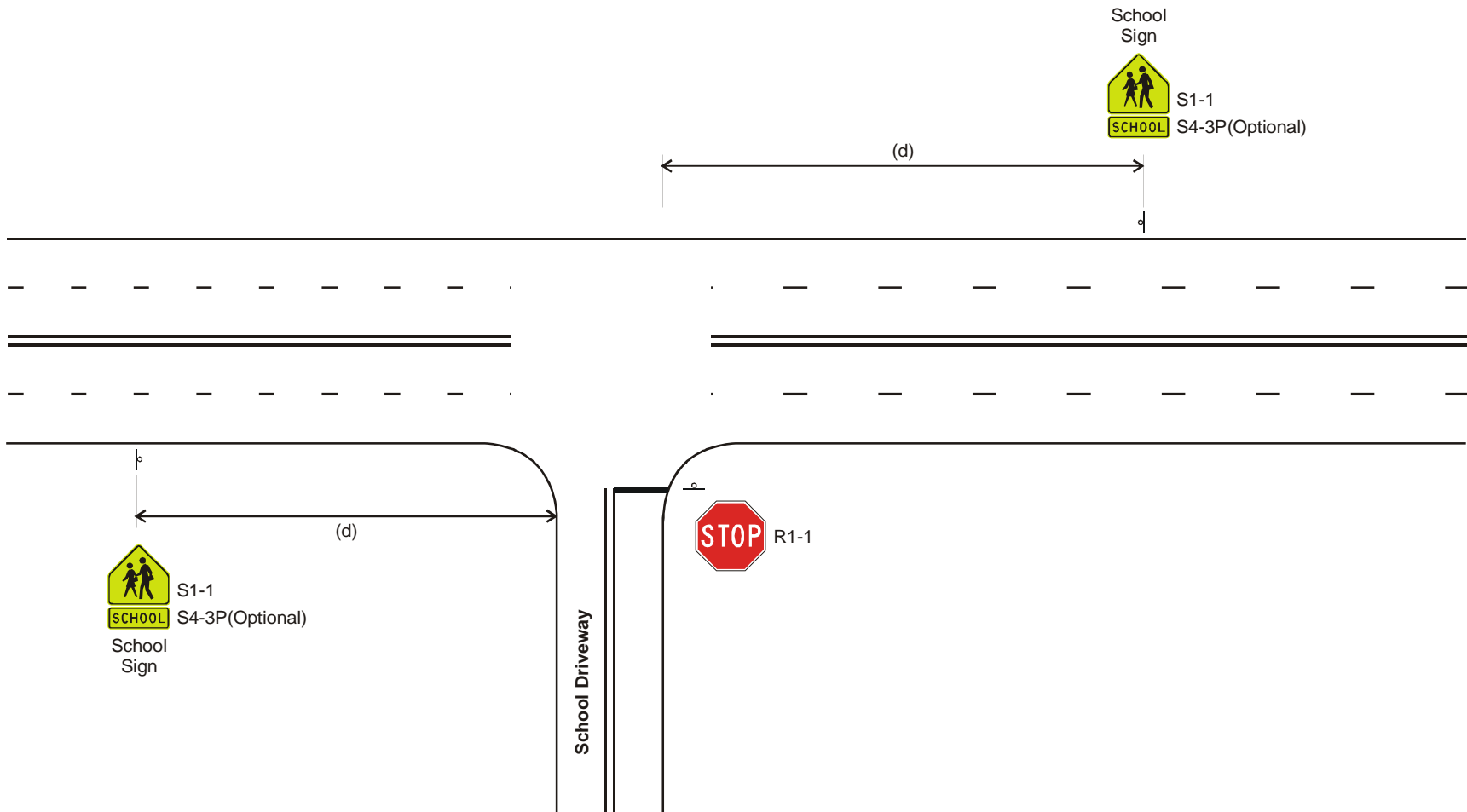


Figure A-1. Typical School Area Signing.
 (See [Table A-1](#) for Suggested Dimensions for Distance d.)

A speed zone strip map should be prepared if a reduced school speed limit is planned. A regular speed zone must not change within the limits of a school speed zone since posting of a Speed Limit (R2-1) sign would prematurely terminate the school speed zone. Speed limits remain fixed until a revised limit is encountered.

The signing and markings for a school speed limit zone can include the following:

- the Reduced School Speed Limit Ahead (S4-5, S4-5a) sign (if used),
- the School Advance Crossing assembly (if used),
- SCHOOL marking on pavement (if used),
- the School Speed Limit (S5-1) sign,
- the School Crossing assembly (if included) and marked crosswalk (if used),
- the solid white school speed limit zone marking (if used),
- the appropriate Speed Limit (R2-1) sign,
- the End School Zone (S5-2) sign or (S5-2aP) plaque or the End School Speed Limit (S5-3) sign, and,
- the Cell Phone Use Prohibited (S7-1T) sign (if used).

Table A-2 includes the suggested dimensions for distance d1, d2, and d3, which are shown in Figure A-2 and Figure A-3 in typical signing and pavement marking examples for a school speed limit zone.

Districts should initiate the installation of school speed limit signs and flashers immediately after submitting the request to the Traffic Operations Division (TRF) for Commission action or city ordinance approval. These signs should be in operation as soon as practical after the minute order is approved by the Transportation Commission or the city ordinance is approved by the city. If, for some reason, there is a delay in the installation of a school flasher, other static signs for school zones can be installed as temporary measures after the minute order or city ordinance is enacted.

Table A-2. Suggested Dimensions for Distances in Figure A-2 and Figure A-3.

Posted or 85th Percentile Speed (mph)	25	30	35	40	45	50	55	60	65	70	75
Distance (d3) between Reduced School Speed Limit Ahead (S4-5) sign (optional) and School Advance Crossing assembly (ft)	100	120	160	240	320	400	500	600	700	800	900
Distance (d2) between School Advance Crossing assembly and School Speed Limit (S5-1) sign (ft)	100	120	160	240	320	400	500	600	700	800	900
Distance (d1) between School Speed Limit (S5-1) sign and school driveway or marked crosswalk (and School Crossing assembly, when appropriate) (ft)	200	200	200	300	300	400 ¹	400 ¹	400 ¹	400 ¹	400 ¹	400 ¹
Minimum length of solid white lane line in advance of marked crosswalk or school driveway (ft)	200	200	200	300	300	400 ¹	400 ¹	400 ¹	400 ¹	400 ¹	400 ¹
¹ On higher-speed roadways a system of treatments is needed for pedestrians—a marked crosswalk should not be used without additional pedestrian treatments. The installation of a marked crosswalk and pedestrian signs does not necessarily result in more vehicles stopping for pedestrians. Therefore, treating a location to improve pedestrian access or safety should include several components. For example, in addition to traffic control devices, geometric improvements may be used to shorten the crossing distance. Traffic calming may be used to slow vehicle speeds near the pedestrian crossing. Additional traffic control devices may be needed.											

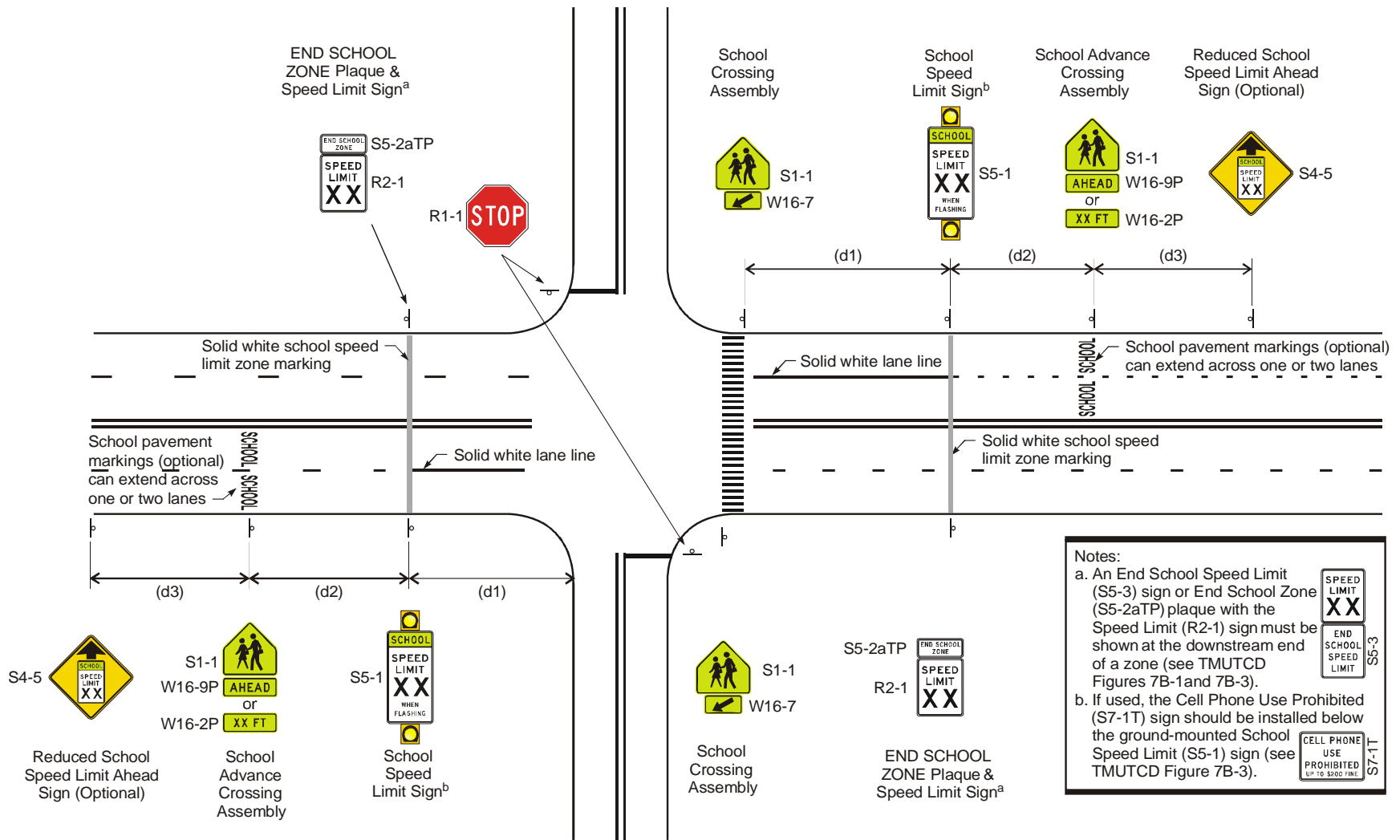


Figure A-2. Typical School Speed Limit Zone with Marked Crosswalk at a Two-Way Stop-Controlled Intersection. (See Table A-2 for Suggested Dimensions for Distances d1, d2, and d3.)

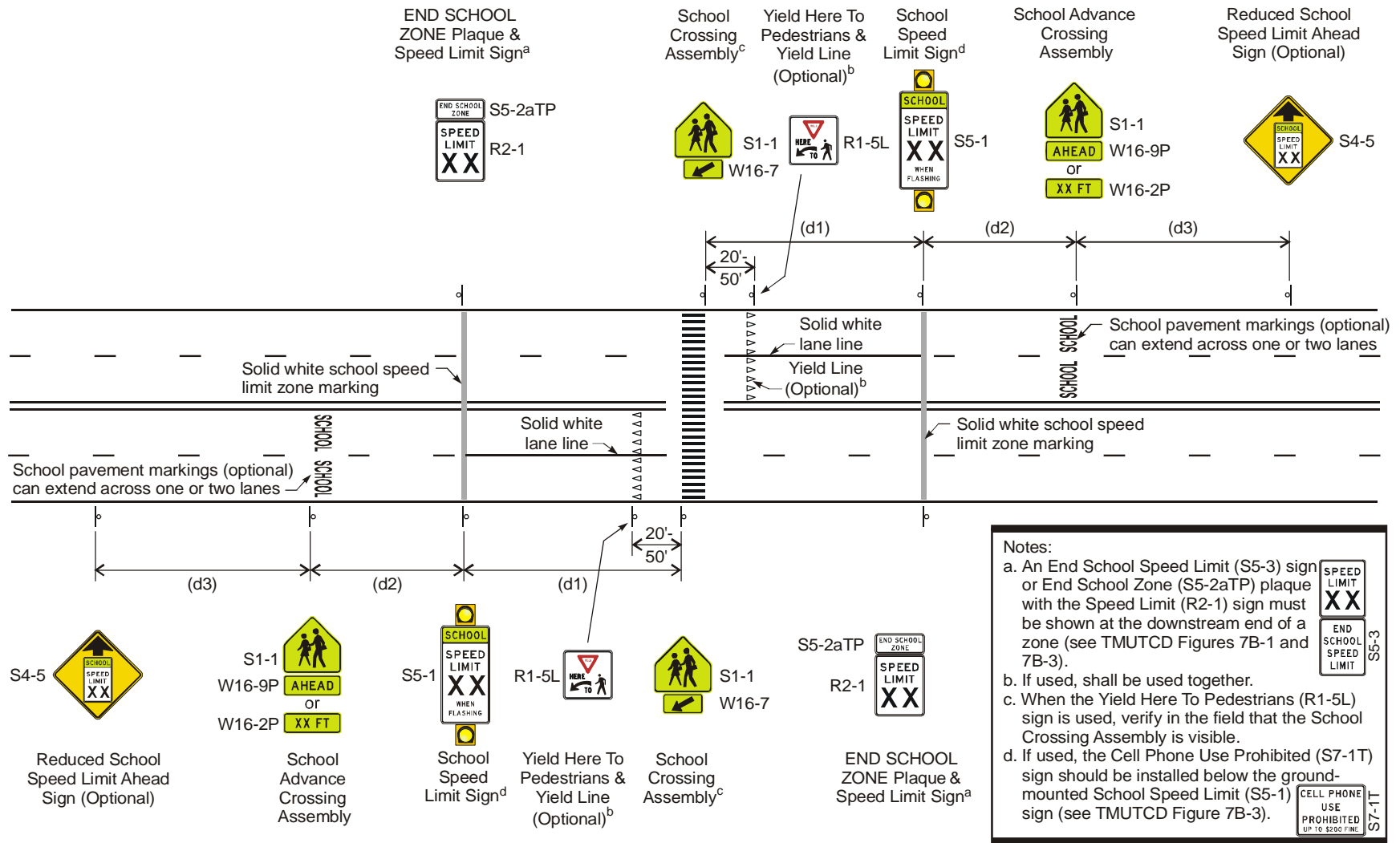


Figure A-3. Typical School Speed Limit Zone with Marked Crosswalk at Midblock.
 (See [Table A-2](#) for Suggested Dimensions for Distances d1, d2, and d3.)

SCHOOL SPEED LIMIT ZONE CHARACTERISTICS

School Speed Limit Value

The suggested value for the school speed limit is listed in [Table A-3](#). Speed studies provide a sound basis for selecting the proper speed limits for school zones. While it is not common practice to set speed limits significantly lower than the 85th percentile speed for regulatory speed zones, exceptions to this practice are often found at school zones.

Table A-3. Suggested School Speed Limit Based on 85th Percentile Speed.

85th Percentile Speed	Suggested School Speed Limit
Below 55 mph	Not more than 15 mph below 85th percentile speed or posted speed. Not to exceed a 35 mph school speed limit.
55 mph	20 mph below the 85th percentile speed or posted speed
Greater than 55 mph	Use buffer zone to transition to a 35 mph school speed limit

Factual studies, reason, and sound engineering judgment, rather than emotion, should govern the final decision on the maximum deviation from the 85th percentile speed that will provide a reasonable and prudent speed limit.

It is not advisable to set a school speed limit above 35 miles per hour in either rural or urban areas. Lower school speed limits should be considered when the 85th percentile speed is below 50 miles per hour.

School Speed Limit Zone Beginning Location

The proposed 2011 TMUTCD states that the beginning point of a reduced school speed limit zone should be at least 200 feet in advance of the school grounds, a school crossing, or other school related activities; however, this 200-foot distance should be increased if the reduced school speed limit is 30 mph or higher. Researchers suggest having the beginning of the School Speed Limit Zone based upon the school speed limit as follows:

School Speed Limit (mph)	Distance to Crosswalk or First Driveway (ft)
20	200
25	200
30	300
35	400

The location of the beginning and end of a school speed limit zone should be based on engineering judgment rather than the exact location of the school property line or fence. A practice in Texas is to end the school speed limit zone at the same location as the opposing school speed limit zone begins and to use a transverse solid white line across all travel lanes to mark the beginning and ending of a school speed limit zone.

School Speed Limit Zone Length

The school speed limit zone should be centered at the location(s) where school-age pedestrians are crossing the roadway or where school-related traffic is leaving and entering the roadway. The beginning and ending points should be selected with appropriate consideration for the location of other traffic control devices and/or features that could impact the effective implementation of the school speed limit zone.

School speed limit zones in urban areas where speeds are 30 mph or less may have school zones as short as 400 ft.

School speed limit zones in rural areas where regulatory posted speeds are typically 55 mph or more will have longer school zones. The suggested length for zones in rural areas is 1000 ft.

Research has shown that speeds are approximately 1 mph higher for every 500 ft driven within a school zone; therefore, longer school zones are associated with greater speed variability within the zone.

When the speed reduction between the regulatory speed limit and the selected school speed limit is greater than 20 mph, a buffer zone is to be used (see following section on School Buffer Zones). Buffer zones are typically 500 ft in length.

School Buffer Zone

Any roadway with an 85th percentile speed greater than 55 mph is to have a buffer zone to transition to a 35-mph school speed limit. Buffer zones permit motorists to travel at the higher posted speeds through both zones when slower speeds are not necessary. An example of a buffer zone is where the regulatory posted speed limit is 70 mph and the school speed limit is 35 mph. In this case a buffer zone of 55 mph can be used on the approach and departure sides of the 35-mph school speed limit zone. [Table A-4](#) includes the suggested dimensions for the distances associated with buffer zone signing, an example of which is shown in [Figure A-4](#).

The basic design for a Buffer School Zone (S5-1) sign is the same as for a regular School Speed Limit (S5-1) sign. The SCHOOL SPEED LIMIT XX WHEN FLASHING sign should be used where TxDOT is responsible for signing school speed limit zones and school buffer zones. The buffer zone beacons can be activated up to 5 minutes earlier than the school speed limit zone to eliminate drivers who pass through the buffer zone while it is inactive seeing active beacons only in the lower speed zone.

Table A-4. Suggested Dimensions for Distances in [Figure A-4](#).

Posted or 85th Percentile Speed (mph)	60	65	70	75
School Speed Limit (mph)	35	35	35	35
Suggested Buffer Speed Limit (mph)	50	50	55	55
Distance (d1) between School (S1-1) sign and School Buffer Speed Limit (S5-1) sign (ft)	600	700	800	900
Distance (d2) between School Buffer Speed Limit (S5-1) sign and School Speed Limit (S5-1) sign (ft)	500			
Distance (d3) between School Speed Limit (S5-1) sign and school driveway (ft)	400			
Distance (d4) between school driveway and School Buffer Speed Limit (S5-1) sign (ft)	Same as d3			
Distance (d5) between School Buffer Speed Limit (S5-1) sign and Speed Limit (R2-1) sign (ft)	Same as d2			

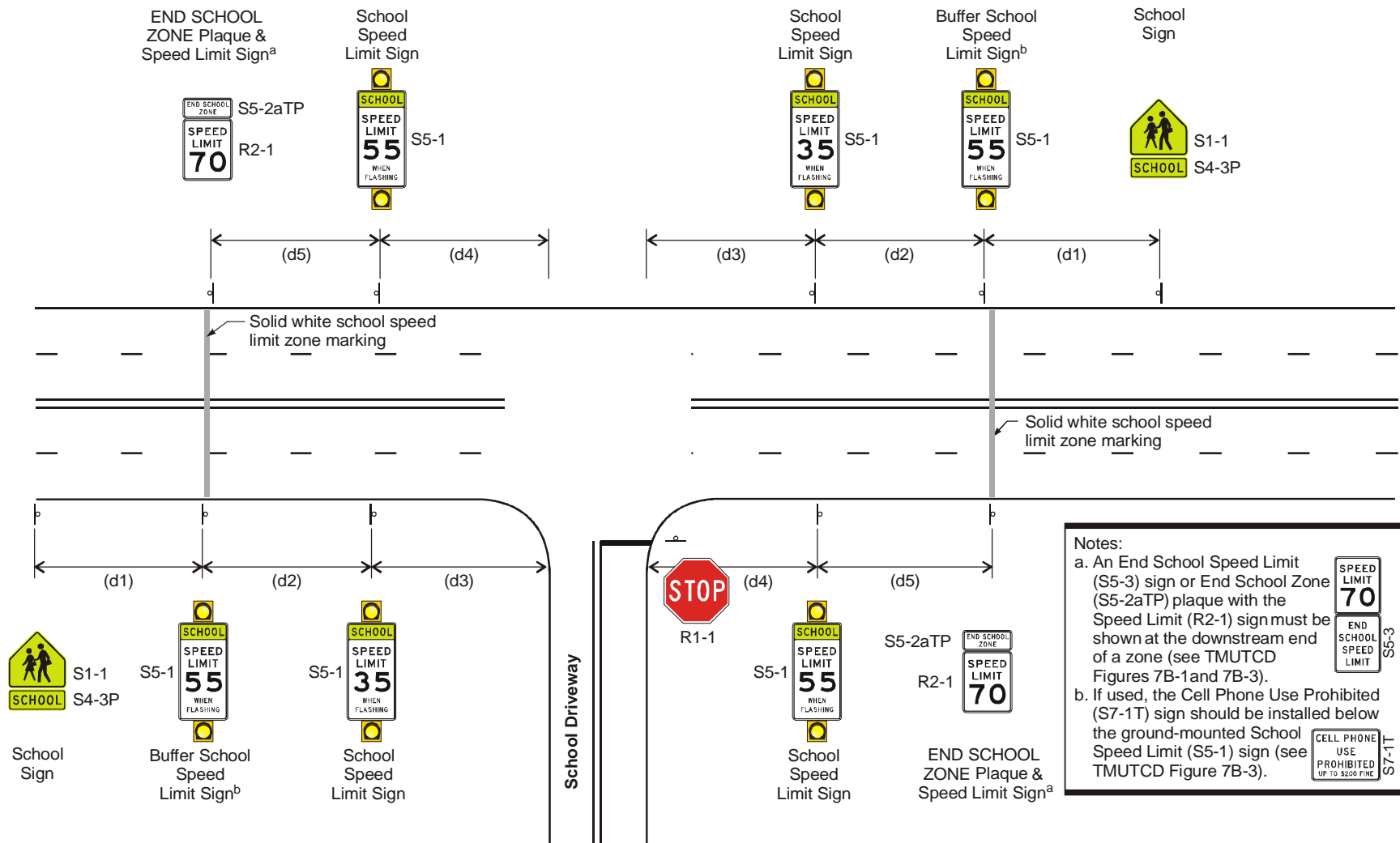


Figure A-4. Typical School Speed Limit Zone with School Buffer Zones, Example Shown for Posted Speed of 70 mph. (See Table A-4 for Suggested Dimensions for Distances d1, d2, d3, d4, and d5.)

Active Times

Generally, the zones indicated on the signs should be in effect only during the following specified intervals:

- from approximately 30 minutes before and 5 minutes after classes begin,
- from the beginning to the end of the lunch period for open campuses, and
- from approximately 5 minutes before and 30 minutes after classes end.

The intervals of operation of the flashing beacons on the school speed limit assemblies may be extended or revised for school events as mutually agreed upon by the school district and the entity responsible for the operation of the flashing beacons. In this case, the flashing beacons should only be operated when there is an increase in vehicular activity and/or pedestrian traffic in and around the roadway associated with the school event.

Research has shown that operating speeds in an active school speed zone are at their lowest close to the start time or end time of the school day. Approximately 20 minutes before or after the start of school, speeds are 1 mph higher and increase as time increases away from the start or end bells.

School Speed Limit Zone Marking

Where greater emphasis is needed to indicate the beginning and ending points of an established school speed limit zone, an 18-inch solid white transverse line may be used. The transverse line shall be located immediately adjacent to the School Speed Limit assembly or School Speed Limit sign.

SCHOOL PAVEMENT MARKINGS

The SCHOOL pavement marking is used to supplement signs and provide additional emphasis. The SCHOOL word marking width may either be the width of one lane or can extend to the width of two approach lanes. When extended to two approach lanes, the markings are 10 ft (3 m) or more in height.

SCHOOL MARKED CROSSWALK

Crosswalk markings provide guidance for pedestrians who are crossing roadways by defining and delineating paths on approaches to and within signalized intersections, and on approaches to other intersections where traffic stops. In conjunction with signs and other measures, crosswalk markings help to alert road users of a designated pedestrian crossing point across roadways at locations that are

not controlled by traffic control signals or STOP signs. At non-intersection locations, crosswalk markings legally establish the crosswalk. When crosswalk lines are used, they shall consist of solid white lines that mark the crosswalk. They shall not be less than 6 inches or greater than 24 inches in width.

Because non-intersection marked pedestrian crossings are generally unexpected by the road user, warning signs should be installed for all marked school crosswalks at non-intersection locations and adequate visibility should be provided by parking provisions. Additional treatments include high-visibility markings as a minimum, but they can also include school crossing guards or pedestrian-activated treatments. Adequate visibility of students by approaching motorists and of approaching motorists by students should be present.

Warrants have not been established for pedestrian crosswalks in the TMUTCD or the MUTCD; however, guidance material is available, including in the following reports:

- TCRP Report 112/NCHRP Report 562, *Improving Pedestrian Safety at Unsignalized Crossings*, 2006. Available at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf
- FHWA-RD-04-100, *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations Final Report and Recommended Guidelines*. Full report available at: <http://www.tfhrc.gov/safety/pubs/04100/04100.pdf>. Summary report available at: http://drusilla.hsrc.unc.edu/cms/downloads/Effects_Un_MarkedCrosswalks_Summary.pdf

The TMUTCD (Section 3B.18 of the proposed 2011 Edition) includes the following guidance based on information presented in the above FHWA report:

“Crosswalk lines should not be used indiscriminately. An engineering study should be performed before a marked crosswalk is installed at a location away from a traffic control signal or an approach controlled by a STOP or YIELD sign. The engineering study should consider the number of lanes, the presence of a median, the distance from adjacent signalized intersections, the pedestrian volumes and delays, the average daily traffic (ADT), the posted or statutory speed limit or 85th percentile speed, the geometry of the location, the possible consolidation of multiple crossing points, the availability of street lighting, and other appropriate factors.

According to the findings from the FHWA project on crosswalks (*Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations Final Report and Recommended Guidelines*):

“Marked crosswalks alone, without other substantial measures designed to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, should not be installed across uncontrolled roadways where:

- A. The speed limit exceeds 60 km/h (40 mph);

- B. The roadway has four or more lanes of travel without a raised median or pedestrian refuge island and an ADT of 12,000 vehicles per day or greater; or
- C. The roadway has four or more lanes of travel with a raised median or pedestrian refuge island and an ADT of 15,000 vehicles per day or greater.”

Research has shown that the installation of a pedestrian crossing treatment alone does not necessarily result in more vehicles stopping for pedestrians unless that device shows a red indication to the motorist. Therefore, treating a location to improve pedestrian access or safety should include several components. For example, in addition to traffic control devices such as signs or markings, geometric improvements (e.g., refuge island, roadway narrowing, and curb extensions) may be used to shorten the crossing distance (and hence the exposure time for the pedestrian). Traffic calming may be used to slow vehicle speeds near the pedestrian crossing.

Following are general suggestions regarding the use of crosswalk markings and signs; in all cases, engineering judgment should be used in selecting a specific device for installation.

Except as noted below, a school crosswalk should not be installed within 300 ft of another school crosswalk, or a marked pedestrian crosswalk, on the same roadway. The 300 ft spacing requirement shall not apply to another crosswalk at the same intersection, or to crosswalks on legs of intersecting roadways.

A school crosswalk should not be installed at any location that has inadequate stopping sight distance, as indicated in the most recent edition of the *Texas Roadway Design Manual*.

The School Crossing assembly shall not be installed on approaches controlled by a STOP sign. The School Crossing assembly shall not be used at crossings other than those adjacent to schools and those on an established school pedestrian route of a School Route Plan.

The signing for a school marked crosswalk not located on a stop-controlled approach includes:

- the School (S1-1) sign (if used),
- the School Advance Crossing (S1-1 with W16-9P or W16-2P or W16-2aP) assembly (if used), and
- the School Crossing (S1-1 with W16-7P) assembly.

[Table A-5](#) lists suggested dimensions for use with School Crossing and School Advance Crossing assemblies. Signing and pavement markings for a school crosswalk zone are shown in [Figure A-5](#) for two-way stop control, [Figure A-6](#) for all-way stop control, and [Figure A-7](#) for signal control. Additional information on signing and marking crosswalks is contained in the TMUTCD.

Table A-5. Suggested Dimensions for Distances in Figure A-5, Figure A-6, and Figure A-7.

Posted or 85th Percentile Speed (mph)	25	30	35	40	45	50	55	60	65	70	75
Distance (d) between School Advance Crossing assembly to marked crosswalk (and School Crossing assembly, when appropriate) (ft)	250	325	400	475	550 ¹	NA ¹	NA ¹	NA ¹	NA ¹	NA ¹	NA ¹
Minimum length of solid white lane line in advance of marked crosswalk (ft)	150	150	200	250	250 ¹	NA ¹	NA ¹	NA ¹	NA ¹	NA ¹	NA ¹
¹ On higher-speed roadways a system of treatments is needed for pedestrians—a marked crosswalk should not be used without additional pedestrian treatments. The installation of a marked crosswalk and pedestrian signs do not necessarily result in more vehicles stopping for pedestrians. Therefore, treating a location to improve pedestrian access or safety should include several components. For example, in addition to traffic control devices, geometric improvements may be used to shorten the crossing distance. Traffic calming may be used to slow vehicle speeds near the pedestrian crossing. Additional traffic control devices may be needed.											

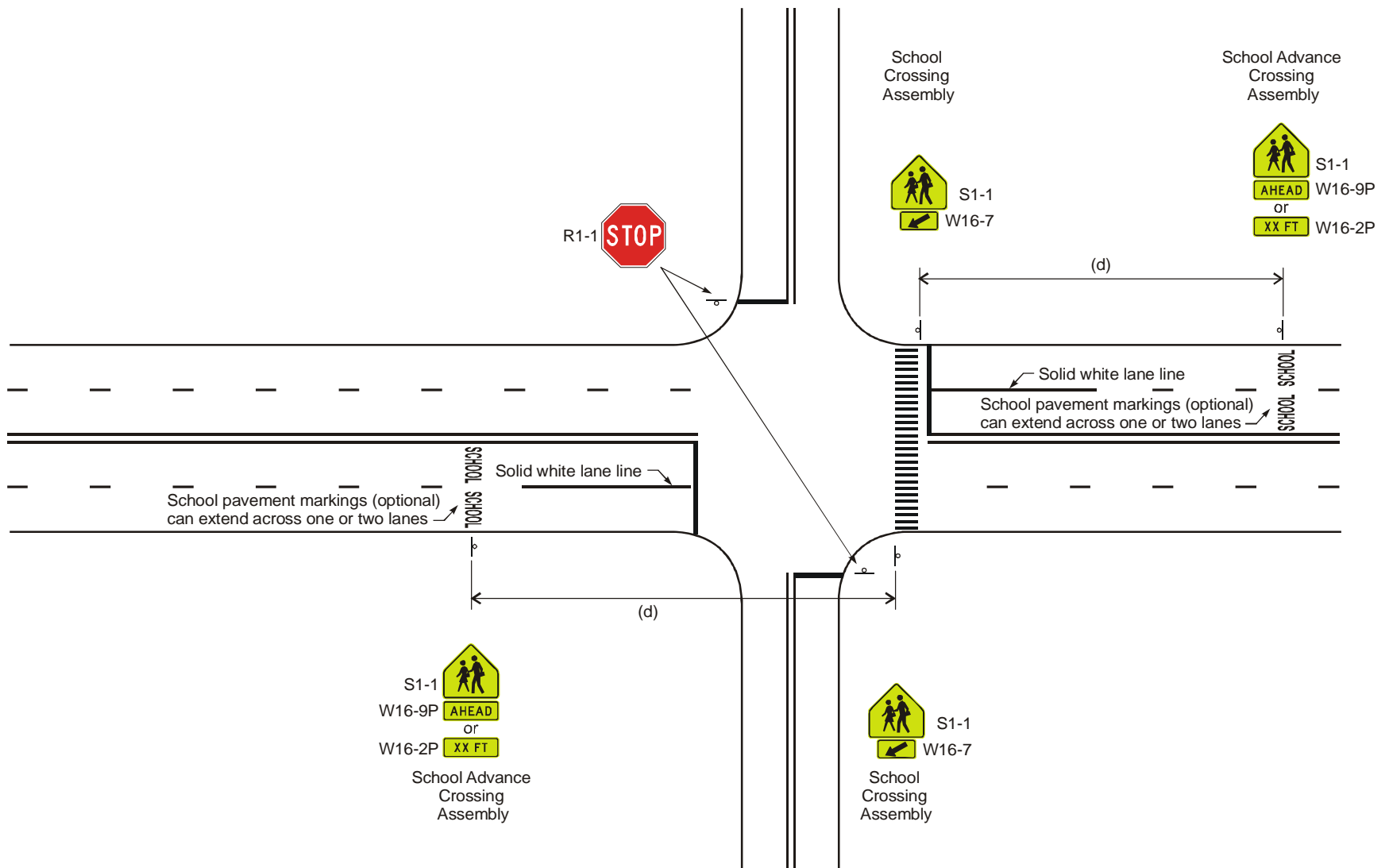


Figure A-5. Typical School Signing for Marked Crosswalk at a Two-Way Stop-Controlled Intersection.
 (See [Table A-5](#) for Suggested Dimensions for Distance d.)

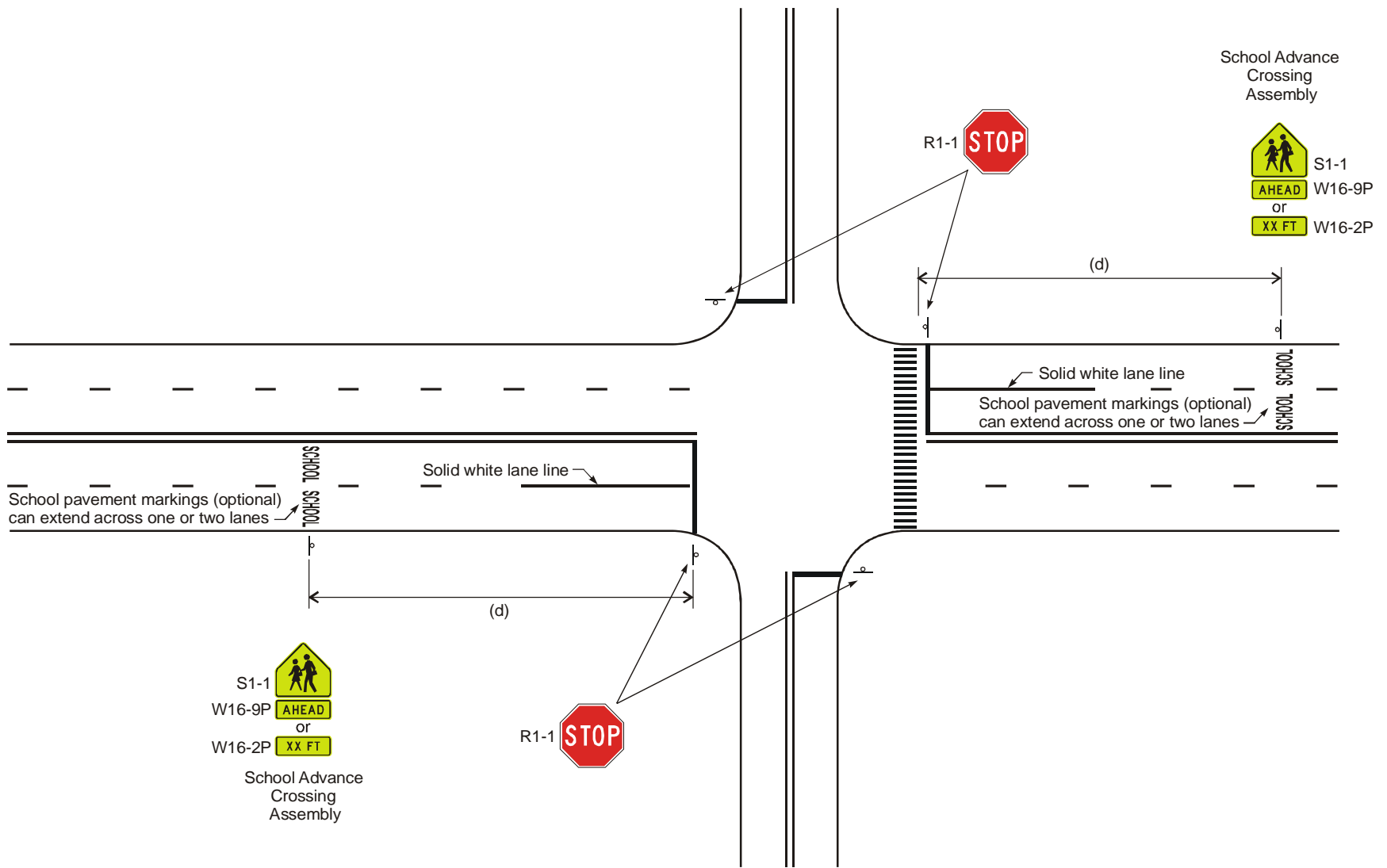


Figure A-6. Typical School Signing for Marked Crosswalk at an All-Way Stop-Controlled Intersection.
 (See [Table A-5](#) for Suggested Dimensions for Distance d.)

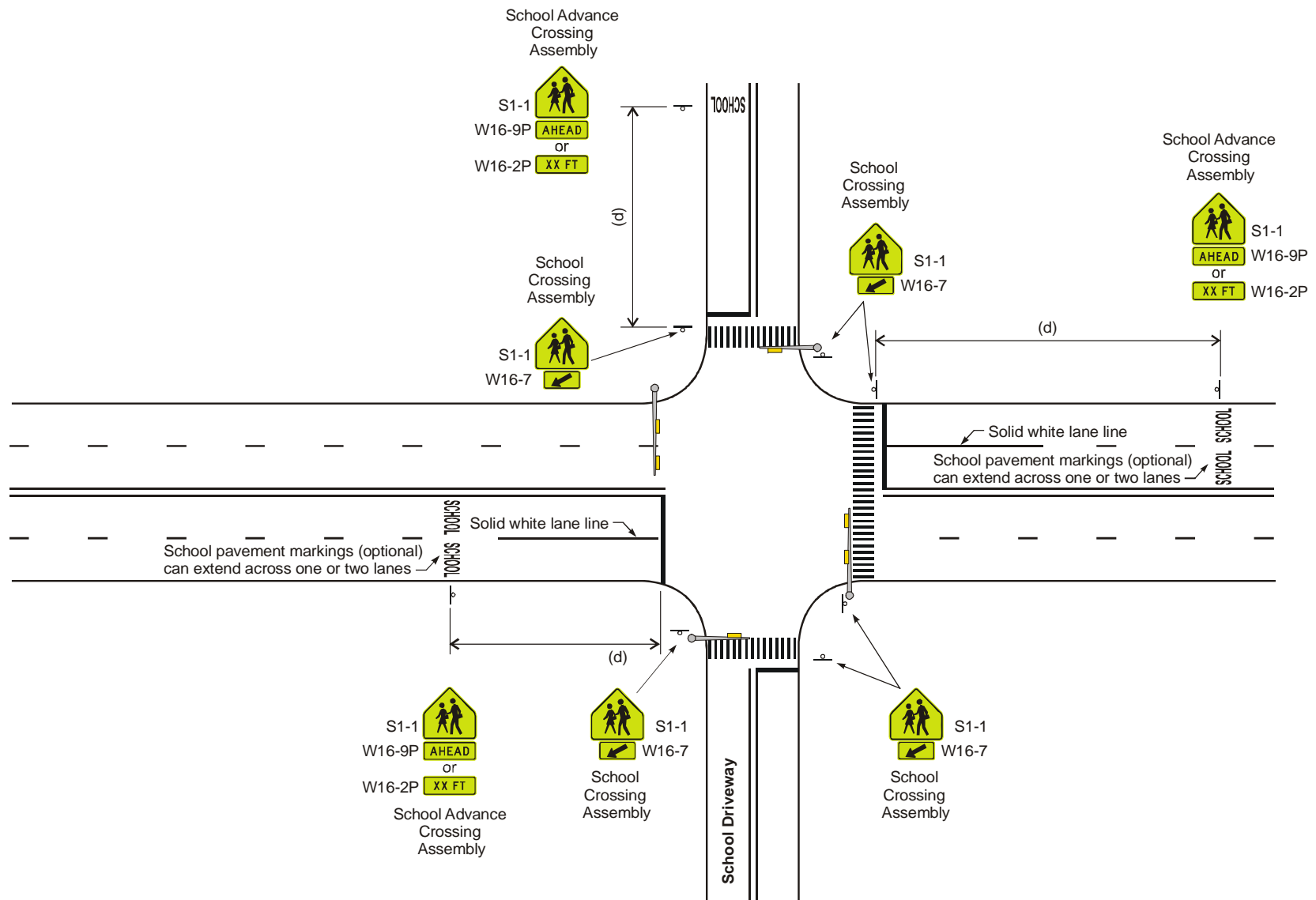


Figure A-7. Typical School Signing for Marked Crosswalk at a Signalized Intersection.
 (See [Table A-5](#) for Suggested Dimensions for Distance d.)

SCHOOL ENTRANCE WARNING ASSEMBLY

A School Entrance Warning assembly is used to inform drivers of the presence of a school driveway. It should not be used if a school speed limit zone is present. The decision to use a School Entrance Warning assembly should be based on engineering judgment.

Conditions at the site could include the following:

- Crash records involving vehicles entering or leaving the school entrance during normal school hours indicate a need to advise drivers to reduce speed.
- The majority of students are transported to and from school by bus and/or private vehicles.
- No provisions are made for students to walk to and from school.
- There are no left- or right-turn lanes on the highway at the school driveway, or queue spillover caused by turning vehicles is present, or measures to address the spillover have not corrected the situation.
- The entrance is not controlled by traffic signals.

A school entrance warning advisory plaque can be included at up to 15 mph below the normal posted speed limit.

Table A-6 shows the suggested dimensions for the distances of a School Entrance Warning assembly, an example of which is shown in Figure A-8.

Table A-6. Suggested Dimensions for Distances in Figure A-8.

Posted or 85th Percentile Speed (mph)	25	30	35	40	45	50	55	60	65	70	75
Distance (d) Between Advance Entrance Warning Assembly to School Driveway (ft)	325	460	565	670	775	885	990	1100	1200	1250	1350

CONDITIONS FOR REMOVING A SCHOOL SPEED ZONE

Conditions for considering removal of a school speed zone include the following:

- if a traffic signal or all-way stop is installed at the entrance of a school, creating a controlled environment for both vehicle entrance and exit and a controlled pedestrian crossing;
- if a school speed limit zone was previously established based on vehicles stopped in the lane of traffic for left and right turns into the school and left- and right-turn bays have been added to adequately separate the stopped vehicles from the through traffic;
- if a school speed limit zone was previously established based on a limited sight distance on the highway approaching the entrance to the school and a highway improvement project has removed the sight distance restriction; and
- if pedestrian patterns have changed due to changes in walking behavior or changes in bus ridership.

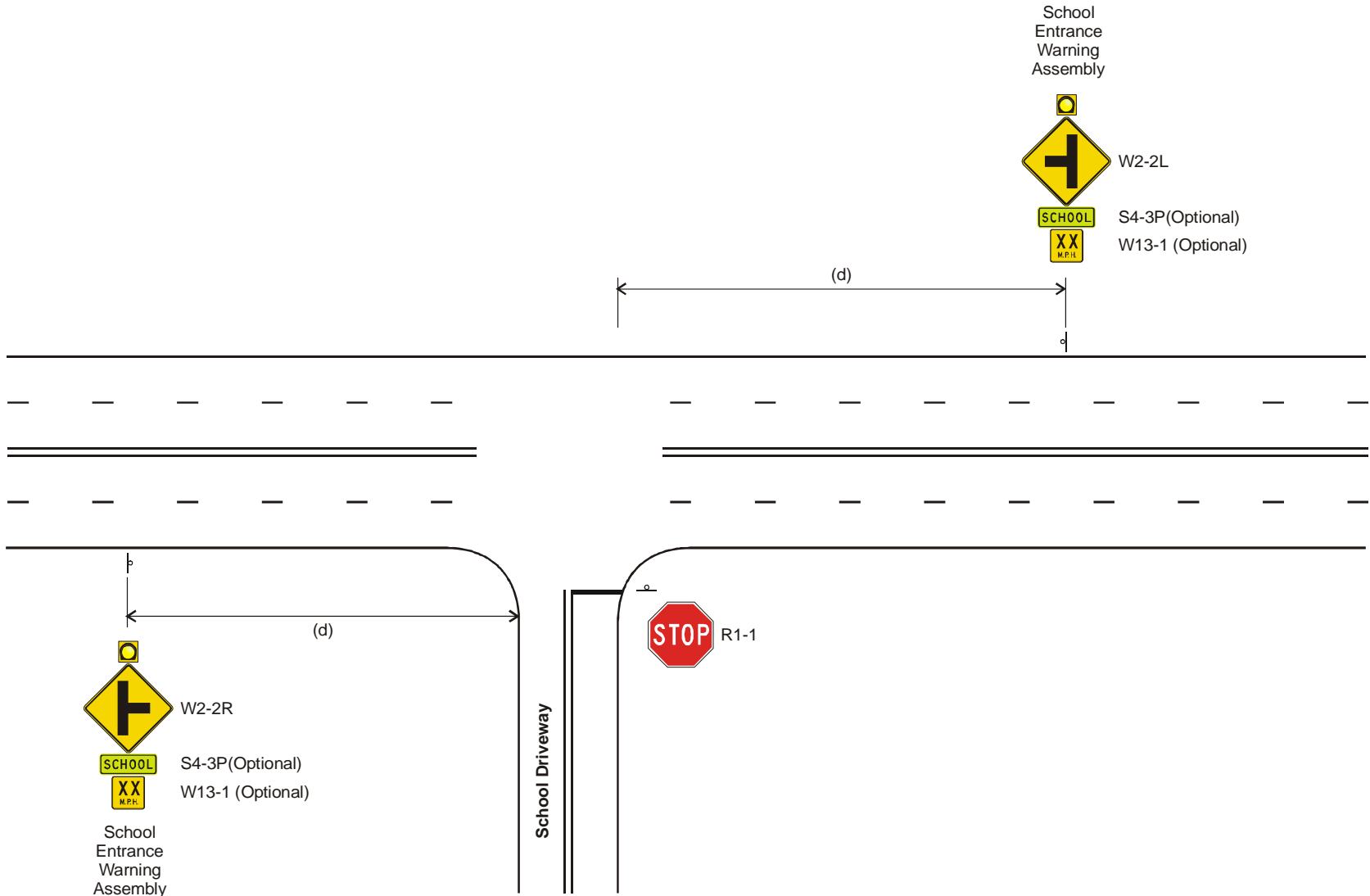


Figure A-8. School Entrance Warning Assembly Example.
 (See [Table A-6](#) for Suggested Dimensions for Distance d.)

APPENDIX B: WORKSHOP SLIDES

School Traffic Workshop:

Dealing with Texas-Sized Problems around Schools

Dallas, TX
August 16, 2011



MODULE 1

INTRODUCTION & WORKSHOP OVERVIEW

Introductions

- Instructors
 - Scott Cooner, P.E. (s-cooner@tamu.edu)
 - Program Manager/Research Engineer
 - Research & Implementation Division, Arlington
 - Marcus Brewer, P.E. (m-brewer@tamu.edu)
 - Assistant Research Engineer
 - Roadway Design Program, College Station
 - Kay Fitzpatrick, P.E. (k-fitzpatrick@tamu.edu)
 - Program Manager/Senior Research Engineer
 - Roadway Design Program, College Station
- Participants
 - Name, agency, job



Sign-in Sheet

- Pass it around
- Certificates

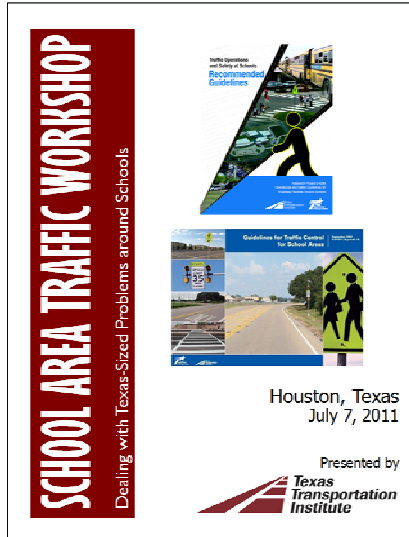


SIGN IN SHEET		
School Traffic Workshop: Dealing with Texas-Sized Problems around Schools		
Date + Location, TX		
Name	Job Title	Organization



Workbook Orientation

- Agenda
- Module slides
- Evaluation form
- Compact disc
 - Supporting references
 - Module slides



5

Learning Outcomes

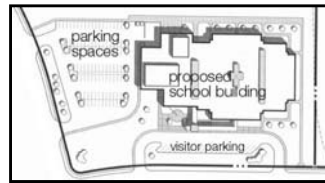
- Each module will have specific items we want you to learn
- Workshop is designed for interactivity
 - You learn from us
 - We learn from you
- Questions and input are encouraged



6

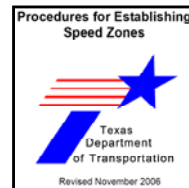
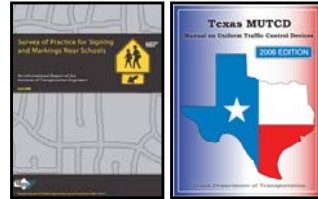
Workshop Background

- *Precious Cargo* support
 - TxDOT Dallas District
- Project 0-4286
 - Focus on school site
- Project 0-5470
 - Focus on school speed limit zones



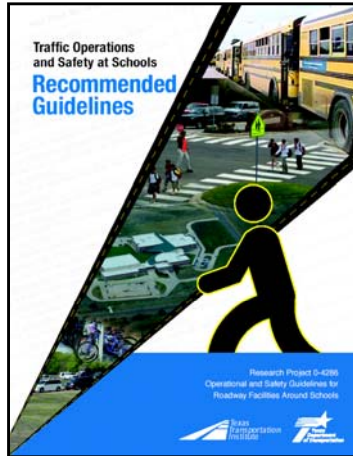
Research Components

- Review of existing materials
 - Literature and other states
- Conduct surveys & interviews
 - TxDOT districts, cities, etc.
- Field studies
- Develop recommend guidance



4286-2 Report

<http://tti.tamu.edu/documents/4286-2.pdf>



- Categorized
- Text box, table or figure with the guideline
- Supporting references
- Example to avoid
 - Text description
 - Picture from field study
- Good example
 - Text description
 - Picture from field study

Appendix A of 5470-1 Report

<http://tti.tamu.edu/documents/0-5470-1-AppendixA.pdf>



Photo: Marcus Brewer, TTI

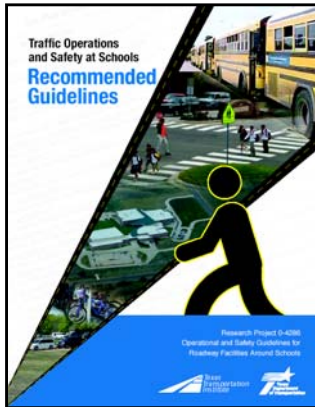


Photo: Marcus Brewer, TTI

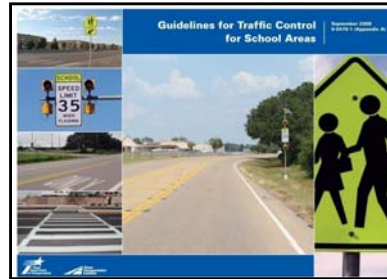
- Guidance regarding
 - School speed limit zones
 - Traffic control devices near schools
- Augments TMUTCD
- Provides additional background and information
- Typical signing and marking layouts

Guidance Categories

- "Site Guidelines"






- "Zone Guidelines"



MODULE 2

TYPICAL SCHOOL TRAFFIC CONCERNS

Learning Outcomes

- At the completion of this workshop module, you will be able to:
 - ➔  Understand who key stakeholders are
 - ➔  Relate to some typical problems at schools
 - ➔  List two existing programs targeted at addressed typical school traffic concerns

School Traffic Congestion

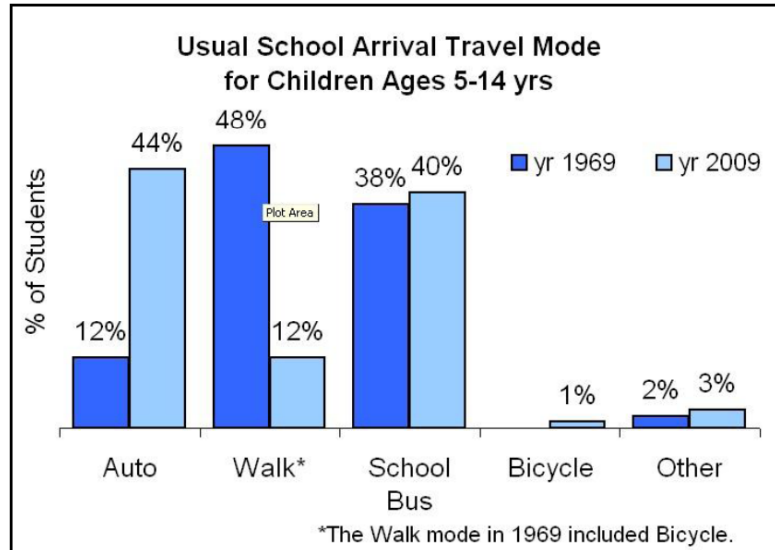
- Definition: *Overcrowding and blocking of streets on or near school property that is typically associated with car transportation of children to and from school.*

Source: Center for Problem-Oriented Policing, *Traffic Congestion Around Schools*

<http://www.cops.usdoj.gov/files/ric/Publications/e080724100.pdf>

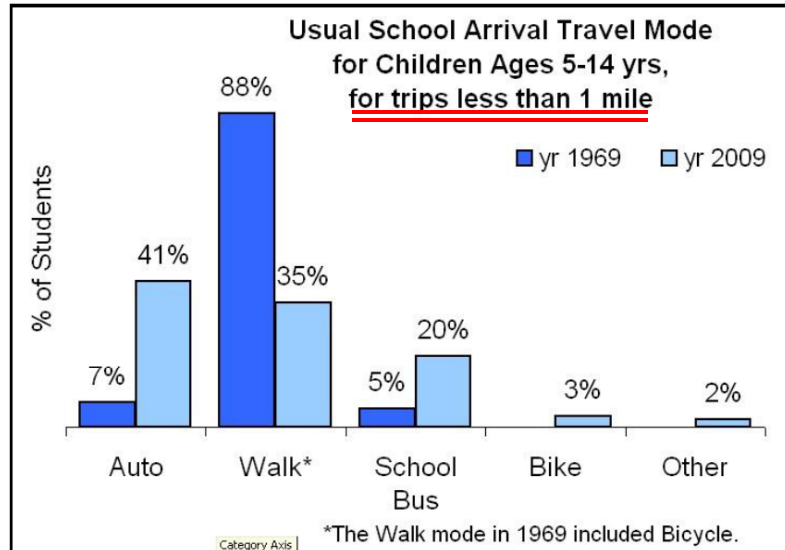


Changes in School Arrival Mode



Graphic: Courtesy of National Center for Safe Routes to School
<http://www.nh.gov/dot/org/projectdevelopment/planning/srts/documents/Declineneewsrelease040810.pdf>

Changes in School Arrival Mode



Graphic: Courtesy of National Center for Safe Routes to School
<http://www.nh.gov/dot/org/projectdevelopment/planning/srts/documents/Declineneewsrelease040810.pdf>

Stakeholders for School Traffic

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____

Walk to school is a big worry for parents

It's only a minute from Jane Smith's home, but every morning she walks her son to his second-grade class. Smith and other parents who escort their children to the school say it's too risky to let them walk on makeshift paths during rush-hour traffic.

Why kids don't walk to school

The harmless adventure of walking to school has turned potentially treacherous, and in many places, walking to school is a thing of the past.

School Traffic: 'A hassle'

It's 8:10 a.m., and the line of automobiles waiting to drop off children for the start of another school day

Walking to school is for the brave

Congested roads mean even short trips from school are best attempted in a

School officials looking for solutions to traffic problems

A recent traffic accident in front of the Elementary School in which a grandmother was injured after dropping off her grandchildren has underscored the potential dangers of rush-hour congestion in the area.

Traffic jams at schools get attention

Growing congestion at schools

Start of school snarls traffic

State transportation workers today warn of a study of traffic delays where classes

Major Traffic Congestion Plagues Two Schools

Traffic jams occurred on the opening day of school. Both are located in high traffic areas.

Traffic jam at school

Cars have lined NC 58 during the school rush this week. Traffic flow problems are spilling out of the school driveway into the entire area surrounding the school. Drivers - who gave up before making it onto the school grounds - parked on the side of the road and crossed over with their children.

Traffic problems won't go away

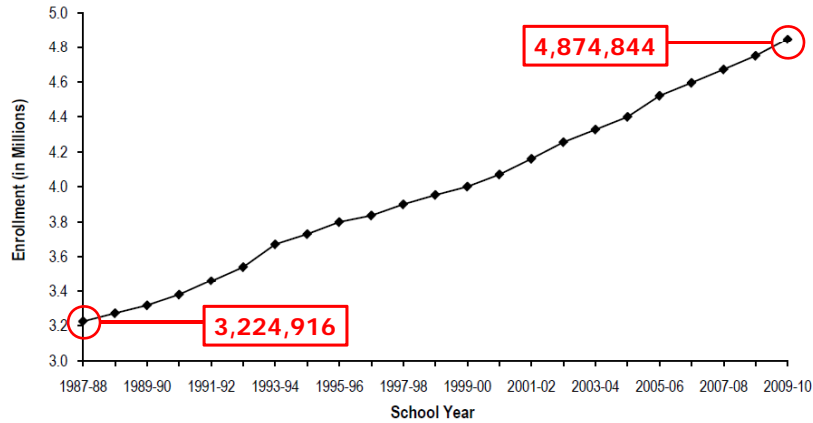
Traffic problems in school zones have frustrated teachers. The rural setting of the school causes problems for traffic flowing through the area. The speed of those vehicles and the students trying to get to and from the school. Police are doing everything they can to help

Traffic concerns school principal

A lot of schools just don't have adequate storage for parent drop-off.

Texas Student Population

Statewide Enrollment, Texas Public Schools, 1987-88 Through 2009-10



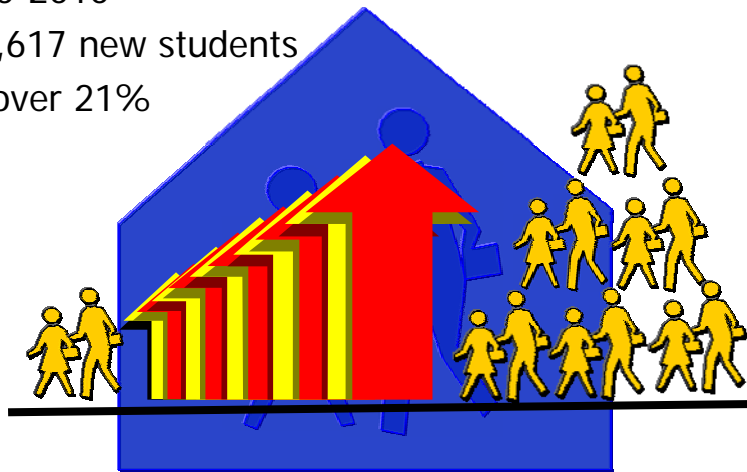
Source: Texas Education Agency, Enrollment in Public Schools, 2009-10
http://www.tea.state.tx.us/acctres/Enroll_2009-10.pdf



19

Texas Student Population

- 2000-2010
- 845,617 new students
- Up over 21%



Source: Texas Education Agency, Enrollment in Public Schools, 2009-10
http://www.tea.state.tx.us/acctres/Enroll_2009-10.pdf



20

Dallas ISD Student Population

- 2010-2011 school year

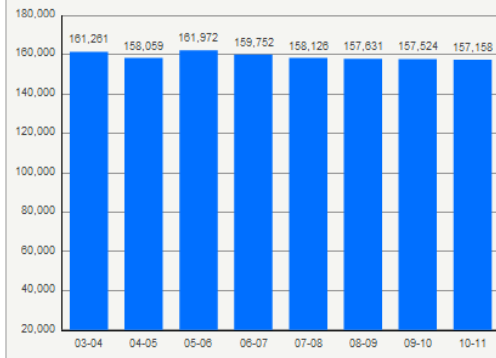
- 157,158 students

- 2003-2011

- -4,103 (-2.5%)

- 154 elementary

- 71 secondary

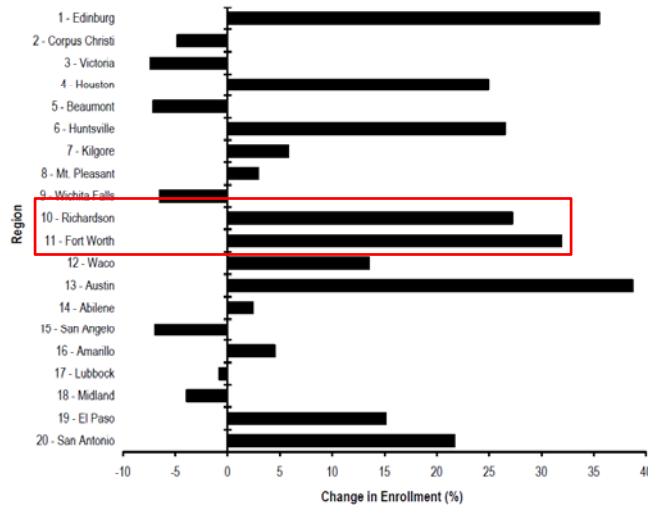


Source: Per District Fact Sheet data



Region 10/11 Service Centers

Change in Enrollment Within Education Service Centers, Texas Public Schools, 1999-00 to 2009-10



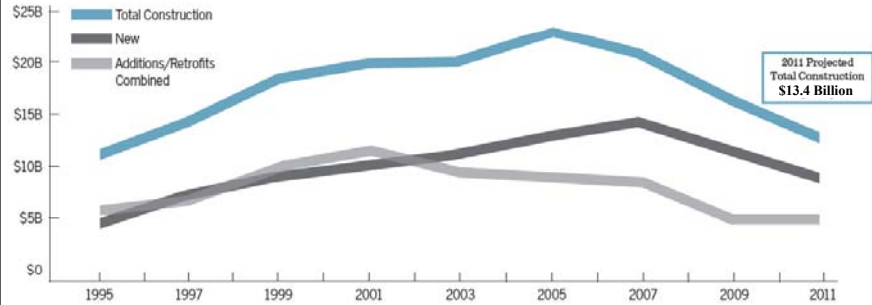
Source: Texas Education Agency, Enrollment in Public Schools, 2009-10
http://www.tea.state.tx.us/acctres/Enroll_2009-10.pdf



School Construction: US

(K-12 Facilities)

SCHOOL CONSTRUCTION COMPLETED, 1995 THROUGH 2011 (PROJECTED)



Source: School Planning & Management – The 2011 School Construction Report
<http://www.peterli.com/spm/pdfs/SchoolConstructionReport2011.pdf>

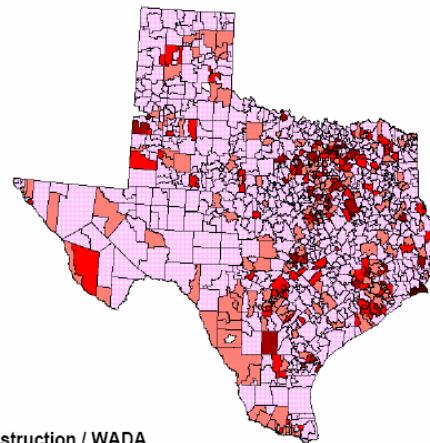


School Construction: Texas

- 2000-2010
- \$2 billion/year
- Texas leads



Photo: Courtesy of TTI



2002 Construction / WADA



School Construction: Dallas ISD

- Voters approved \$1.35B bond in May 2008
 - New schools:
 - 8 Elementary
 - 4 Middle
 - 2 High
 - Additions:
 - 177 classroom @ 13 campuses
 - 19 science labs @ 6 campuses
 - Renovations:
 - \$521 million
 - 200 schools



Source: Dallas ISD- Bond Program Page
<http://www.dallasisd2008bond.org/>



School Type & Size

Type	Typical Grades	Avg. Size ¹	Biggest Local
Elementary	K-6	476	905
Secondary	7-12	703	1997

¹ Source: National Center for Education Statistics

Growth in Size of Texas Schools: 1987-88 to 1997-98

Type	# of Students	% Increase ²
Elementary	900+	30
Middle	900+	53
High	2,000+	35

² Source: TEA, *School Size & Class Size in Texas Public Schools*
<http://ritter.tea.state.tx.us/research/pdfs/pr12.pdf>



Typical Problem: Speeding



Dave Pappas



Mike Cynocki



Dan Burden



Typical Problem: Queue Spillback



Photo: Courtesy of TTI



Photo: Courtesy of TTI



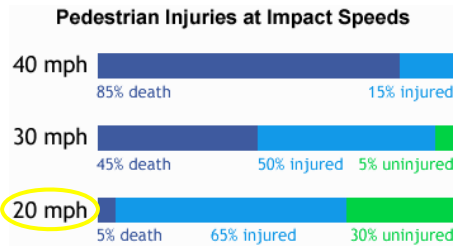
Photo: Courtesy of TTI



Typical Problem: Pedestrian/Bicycle Safety



Photos: Courtesy of Joel Cranford, North Carolina DOT



Source: UK Department of Transport Traffic Advisory Leaflet 7/93 (TAU, 1993)
<http://www.nhtsa.gov/people/injury/research/pub/hs809012.html>

Other Typical Problems?

1. _____
2. _____
3. _____
4. _____



Existing TxDOT Programs: Safe Routes to School

www.saferoutestx.org



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Existing TxDOT Programs: Safe Routes to School

- Federally funded
- Texas distributed \$54.1 million to fund 200 projects in more than 73 communities
 - Infrastructure projects
 - Construction project to improve bike/ped. safety in K-8 within 2-mile radius of school
 - Non-infrastructure project
 - Activities to encourage walking and bicycling to school
- Local examples: Sidewalks, curb ramps, and school zone flashers, pedestrian bridge improvements, and SRTS program development

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Existing TxDOT Program: *Precious Cargo*

The Goal

To advance traffic safety through effective and ongoing communication between school districts and TxDOT during the earliest planning stages of new school construction.



Existing TxDOT Program: *Precious Cargo*

TxDOT can...

- Provide comprehensive and thorough initial site plan reviews
- Identify possible traffic control devices
- Discuss planning for future roadway improvements
- Share existing traffic safety education material








Module Review

- Stakeholders
- Typical Problems
- Existing Programs:
 1. _____
 2. _____

MODULE 3

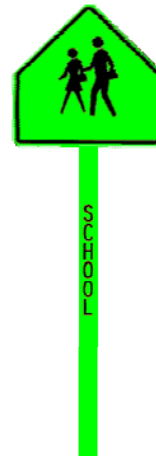
SITE-BASED GUIDANCE

Learning Outcomes

- At the completion of this workshop module, you will be able to:
 - ➔  Identify school site guideline categories
 - ➔  Detect problems using a checklist
 - ➔  Develop suggestions for improving internal school site design and layout

Site Guideline Categories

- Site selection
- General site requirements and design
- Bus-related design and operations
- Parent zone design and operations
- Pedestrian and bicycle
- Access driveways
- Turning lanes
- On-site traffic control
- Parking



Site Selection Guidelines

- Location
 - Where to put new schools?
- Accessibility
 - How are students going to get to the site?
- Site size
 - How big does the site need to be to handle all needs, including transportation?
- Building setback
 - How is the building situated on the property?

School Location

- Challenges with:
 - High speed
 - Rural/suburban
 - Frontage roads
 - Railroads
- Better sites:
 - Neighborhood
 - Connectivity



Source: TTI, 4286-3 report



Source: TTI, 4286-3 report

LOCATION: Avoid locations with direct access to high speed roadways.

Example to avoid

Site



Photo: Courtesy of TTI

Site with new school



Photo: Courtesy of TTI

New school is planned for a site located on a high-speed two-lane roadway with no turning lanes. This is a typical example of a situation that is becoming more common in Texas, particularly in suburbs located on the fringe of rapidly growing metropolitan areas.

ACCESSIBILITY: Provide access from more than one direction to the immediate vicinity of the site, and provide access to the site from at least two adjacent streets.

Example to avoid



School on right has access from more than one direction (west and south) while the school on the left only has access from the north

Good example



ACCESSIBILITY: Site should be situated where the road alignment provides good visibility.

Example to avoid



Driveway located only 150 feet from sharp Horizontal curve – inadequate sight distance.

Good example



Photo: Courtesy of TTI



Photo: Courtesy of TTI

Views looking both directions from driveway – adequate sight distance.



SITE SIZE: Recommended minimum site sizes based on the Council of Educational Facility Planners International guidelines.

School Type	Number of Acres Required
Elementary (K – 6)	10 ¹
Middle (5 – 8)	20 ¹
Junior High (7 – 9)	20 ¹
Senior High (9 – 12)	30 ¹
Vocational Center	10 ¹

¹ Plus one acre per 100 students on maximum projected enrollment



BUILDING SETBACK: School buildings should be setback on the site a sufficient distance from adjacent roadways to ensure safe & adequate site storage for stacking of loading & unloading vehicles.

Example to avoid



Good example



School on right has ~ 350ft more stacking space by being pushed back (*Rockwall ISD*)



Prototype School

Example to avoid *Mansfield ISD* Good example



■ Front: 275 ft of storage

■ Front: 630 ft of storage

■ Back: 1100 ft of storage

■ Back: 1300 ft of storage



General Site Requirements and Design

- Separation of transport modes
 - How to keep them apart?
- Service, delivery & maintenance issues
 - Where do they occur?
- Emergency access
 - What are local fire codes and standards?
- Weather protection
 - When is it provided?
- General site design
 - How and when are site plans coordinated and reviewed?



SEPARATION: The physical routes provided for the basic modes (buses, cars, pedestrians/bicycles) of the traffic pattern should be separated as much as possible from each other.

Example to avoid



Photo: Courtesy of TTI

Cars

Buses

Good example



Photo: Courtesy of TTI

Buses-only

Methods to Accomplish Separation of Modes

- Physical
 - Design
 - Access control/restrictions



Photo: Courtesy of TTI



Photo: Courtesy of TTI

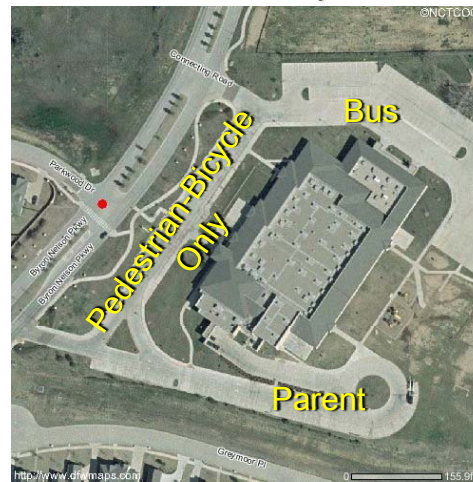
- Temporal
 - Hold back walkers and cyclists until all private vehicle pick-ups are complete (ensures no conflicts)
 - Release walkers and cyclists first and hold back vehicle pick-ups (encourages walking and biking)

Aerial Photos Illustrating Separation of Modes

Example to avoid



Good example



WEATHER PROTECTION: All primary building entrances for students shall be weather protected by overhead cover or soffit.

Good example

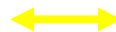


Photo: Courtesy of TTI

Covered walkway adjacent to the parent loading zone
(Keller ISD)

GENERAL SITE: The site and proposed plans should be reviewed by the proper roadway agency.

Good example



Site Plan Checklist Example

Guideline #	Review Question	Answer		Comments
		Yes	No	
1	Is the building setback a sufficient distance to provide adequate site storage?			
4	Is the school site situated where the road alignment provides good visibility?			
5	Are the physical routes provided for the basic modes separated from each other?			
9	Is there adequate driveway stacking length for lining up vehicles on site?			
Etc.	Etc.			

Bus Operations: Staging Method

Single file right wheel to the curb is the preferred staging method for buses.



Potential conflict areas between buses

Parent Drop-Off/Pick-Up Zone Design & Operations Guidelines

- No backward movement by vehicles
- One-way in counterclockwise direction
- Loading location
- Loading space
- Loading method
- On-site stacking length
- Minimize pedestrian-vehicle conflicts
- Student safety patrols

LOADING SPACE: Maximize fronting curb space as loading zone.

Example to avoid



Photo - Courtesy of Joel Cranford, North Carolina DOT

LOADING LOCATION: Students should be unloaded on the right side directly to the curb/sidewalk.

Examples to avoid



Good examples



LOADING LOCATION: Loading should occur in designated zones to minimize pedestrian/vehicle conflicts.

Examples to avoid



LOADING METHOD: Student safety patrols can be used to assist children in and out of vehicles and should **wear safety vests** to provide visibility.

Example to avoid



Good example



LOADING METHOD: Single lane queues minimize pedestrian/vehicle conflicts.

Example to avoid



Good examples



Parent Zone: Stacking Lengths

*** Objective = store all school traffic on-site ***

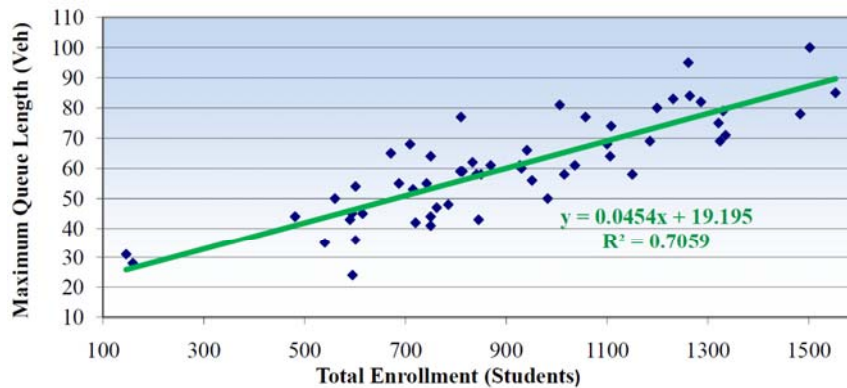
School Type	Student Population	Loop Drive Stacking Length (ft)
Elementary	Less than 500	400 – 750
	500 or more	750 – 1500
Middle	Less than 600	500 – 800
	600 or more	800 – 1600
** High **	400 – 800	800 – 1200
	800 – 2500	1200 – 1500

Note: For high school populations greater than 2500, consider two separate student drop-off/pick-up loops

Parent Zone: Stacking Lengths

- 55 *Elementary* schools in Texas

Rule-of-thumb: Maximum queue length (veh.) = 6% of student enrollment



Source: D. Qualls, *Strategies for the Greening of Student Pick-up During School Dismissal*, January 2010

Case Study: Landholt E.S. Clear Creek ISD, Friendswood

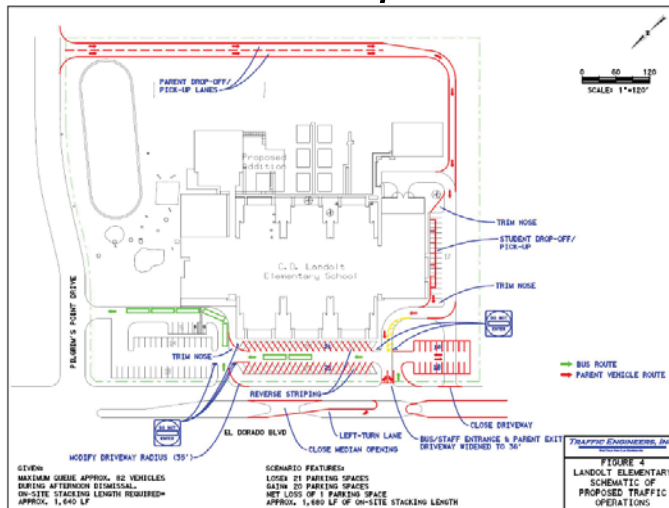
Eliminate off-site vehicle queue

- Study by **TRAFFIC ENGINEERS, INC.**
INNOVATIVE TRANSPORTATION SOLUTIONS
- Existing conditions (2007)
 - Enrollment = 1,200 students
 - On-site storage for 8 vehicles in queue
 - Max. observed queue = 82 vehicles
 - Through lanes of Eldorado Blvd. (adjacent major arterial) blocked repeatedly



Source: D. Qualls, *Strategies for the Greening of Student Pick-up During School Dismissal*, January 2010

Case Study: Landholt E.S. Clear Creek ISD, Friendswood



Source: D. Qualls, *Strategies for the Greening of Student Pick-up During School Dismissal*, January 2010

Pedestrian and Bicycle Guidelines

- Provide safe crosswalks with crossing guards
 - Do you have enough bikes and walkers?
- Standard and well-maintained sidewalks and/or a designated safe path leading to the school
 - Where and are they needed?
- Provide bicycle access and storage facilities
 - What are design standards?
- Pedestrians should not have to cross school drives to reach the school building

SAFE CROSSWALKS: Provide safe crosswalks with crossing guards.

Examples to avoid



Good examples



SIDEWALKS: There should be standard and well-maintained sidewalks and/or a designated safe path leading to the school.

Example to avoid



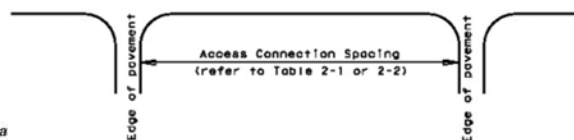
Good example



Guidelines for School Access Driveways

- Number
 - How many driveways are needed for each school type?
- Spacing
 - How far apart do they need to be?
- Location
 - What is the proximity to intersections?
- Layout and design
 - What are design standards?

Source: TxDOT Access Management Manual, 2009 - <http://onlinemanuals.txdot.gov/txdotmanuals/acm/acm.pdf>



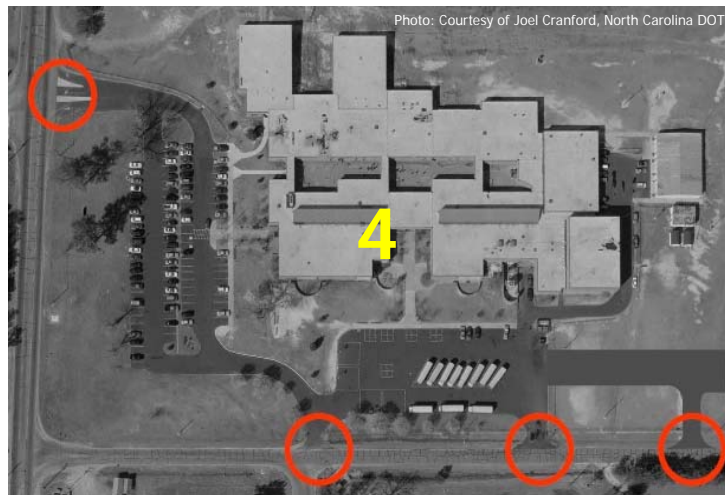
NUMBER OF DRIVEWAYS: Recommended number of driveways to adequately service the school site.

School Type	Number of Driveways
Elementary	2 – 3
Middle	2
High	3 - 4

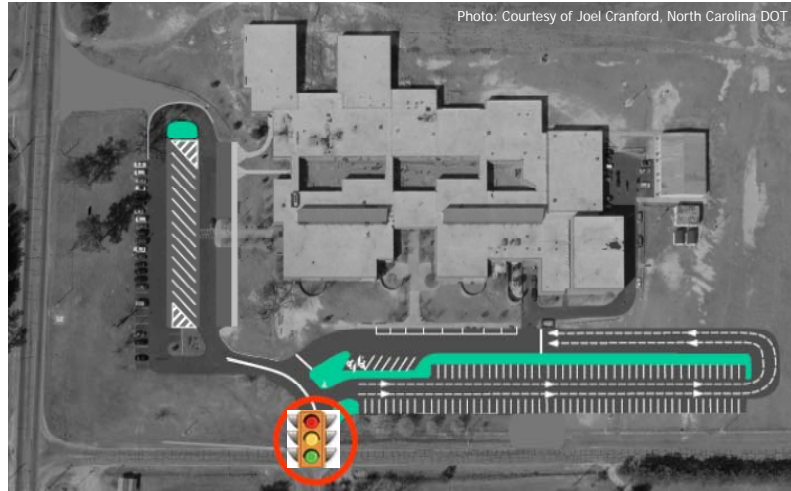
Sources:

- TTI 4286-2 report, <http://tti.tamu.edu/documents/4286-2.pdf>
- South Carolina DOT Guidelines for School Transportation Design, http://www.scdot.org/doing/pdfs/SchoolTrans_Design.pdf

School Driveways: Number



School Driveways: Number



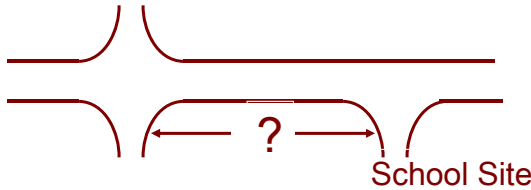
Source: NorthCarolina_STI5.pdf

DRIVEWAY SPACING: The spacing between school access driveways should desirably be 300 feet with 600 feet being desirable for left-turn lane development.

Example to avoid



DRIVEWAY LOCATION: School driveways should conform with the minimum offset distances to the nearest intersection contained in state or local access management guidelines or manuals.



Source: TxDOT Access Management Manual, 2009 - <http://onlinemanuals.txdot.gov/txdotmanuals/acm/acm.pdf>

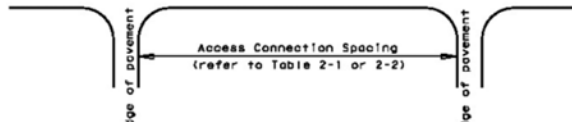


Table 2-2: Other State Highways Connection Spacing Criteria

Other State Highways Minimum Connection Spacing ⁽¹⁾⁽²⁾⁽³⁾	
Posted Speed (mph)	Distance (ft)
≤ 30	200
35	250
40	305
45	360
≥ 50	425

(1) Distances are for passenger cars on level grade. These distances may be adjusted for downgrades and/or significant truck traffic. Where present or projected traffic operations indicate specific needs, consideration may be given to intersection sight distance and operational gap acceptance measurement adjustments.

(2) When these values are not attainable, refer to the variance process as described in Chapter 2, Section 5.

(3) Access spacing values shown in this table do not apply to rural highways outside of metropolitan planning organization boundaries where there is little, if any, potential for development with current ADT levels below 2000.

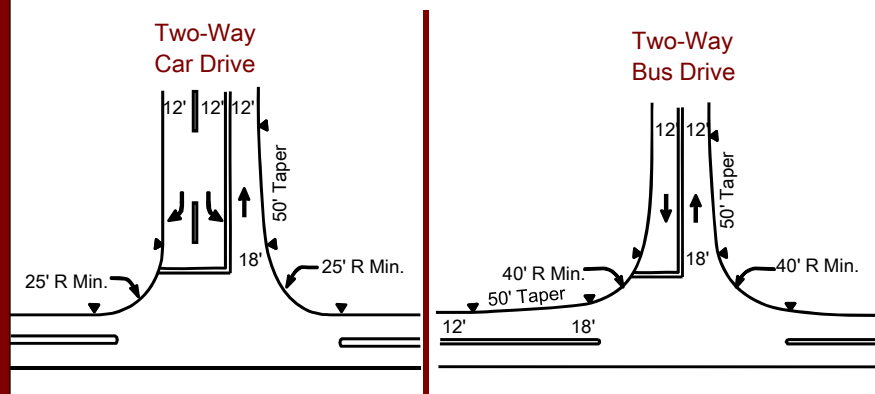
Access connection spacing below the values shown in this table may be approved based on safety and operational considerations as determined by TxDOT.

DRIVEWAY DESIGN AND LAYOUT

- Minimum turning radius
 - 25 foot minimum for cars
 - 40 foot minimum for buses
- Intersection angle – 75 to 90 degrees
- Recommended lane widths
 - 12 feet (increase on curves)
- Two lanes on exit driveways

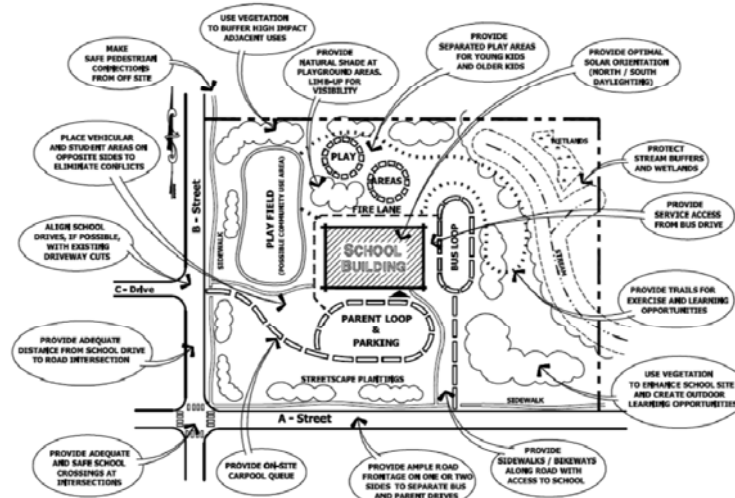


SCDOT Driveway Designs



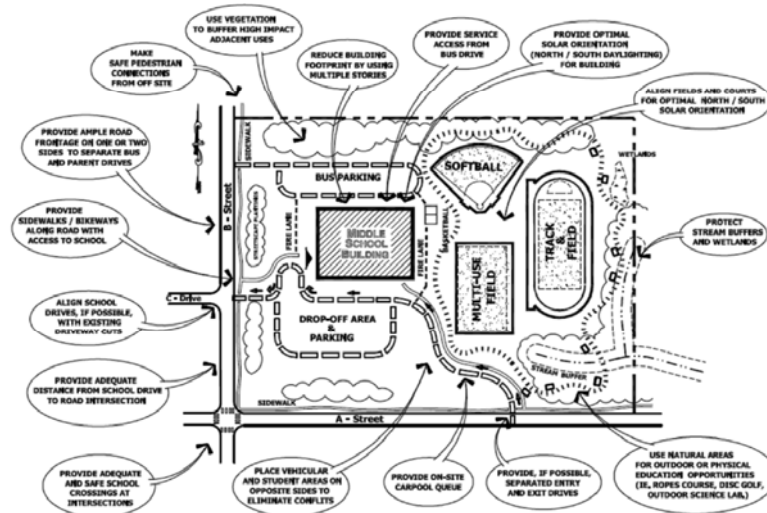
Source: South Carolina DOT *Guidelines for School Transportation Design*
 Available: http://www.scdot.org/doing/pdfs/SchoolTrans_Design.pdf

Elementary School Site Design Diagram



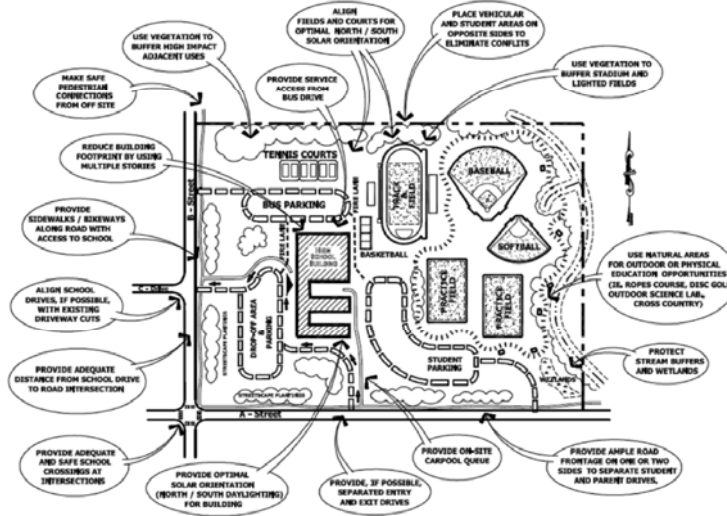
Source: Public Schools of North Carolina – *The School Site Planner*, Feb. 2010
<http://www.schoolclearinghouse.org/pubs/SchoolSitePlanner.pdf>

Middle School Site Design Diagram



Source: Public Schools of North Carolina – *The School Site Planner*, Feb. 2010
<http://www.schoolclearinghouse.org/pubs/SchoolSitePlanner.pdf>

High School Site Design Diagram



Source: Public Schools of North Carolina – *The School Site Planner*, Feb. 2010
<http://www.schoolclearinghouse.org/pubs/SchoolSitePlanner.pdf>



Module Review

- Categories
- Site plan review checklist
- Site plan review exercise:

1. _____




2. _____



MODULE 4

ZONE-BASED GUIDANCE

Learning Outcomes

- At the completion of this workshop module, you will be able to:
 -  Understand procedures for school speed zones
 -  Discuss common school zone problems and issues
 -  List conditions for school zone removal

Overview of Zone Guidelines

- Goal: comparable traffic situations treated in consistent manner
- *Guidelines*
 - Provide additional background
 - Discuss issues/concerns
 - Present typical examples
 - Do not establish policy



Photo: Marcus Brewer, TTI



Photo: Marcus Brewer, TTI

Organization of Zone Guidelines

- Introduction
- School Location
- Definitions
- School Area
- School Speed Limit Zone
- School Speed Limit Zone Characteristics
- School Pavement Markings
- School Marked Crosswalk
- School Entrance Warning
- Conditions for Removing a School Speed Zone



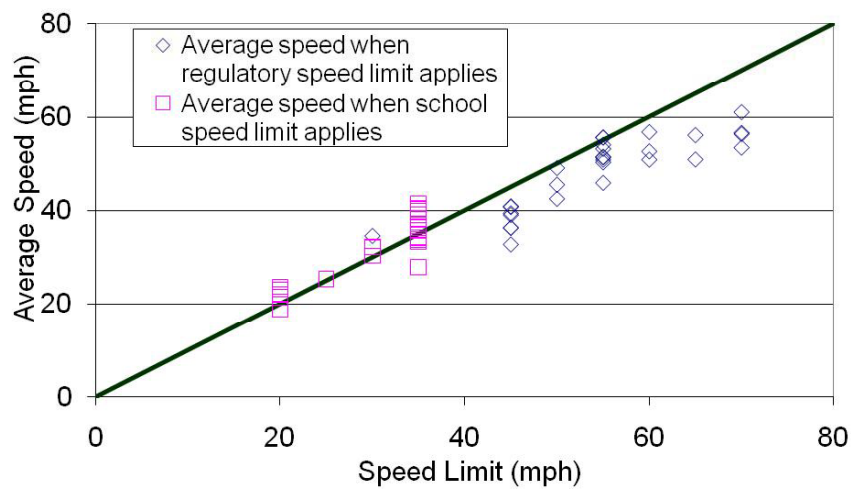
Photo: Marcus Brewer, TTI

Definitions for Zone Guidelines

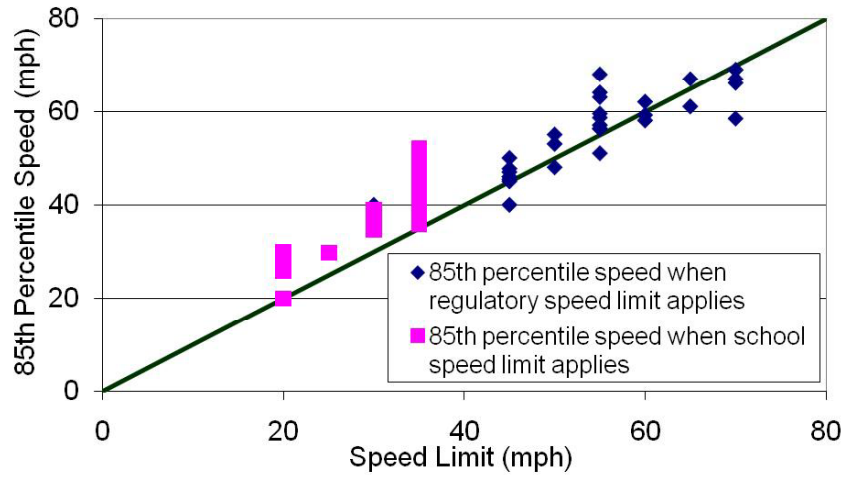
- School = location where children in grades from kindergarten through the 12th grade receive academic instructions
- Other definitions, including:
 - School zone
 - School speed limit zone
 - School buffer zone



Observations of School-Area Traffic



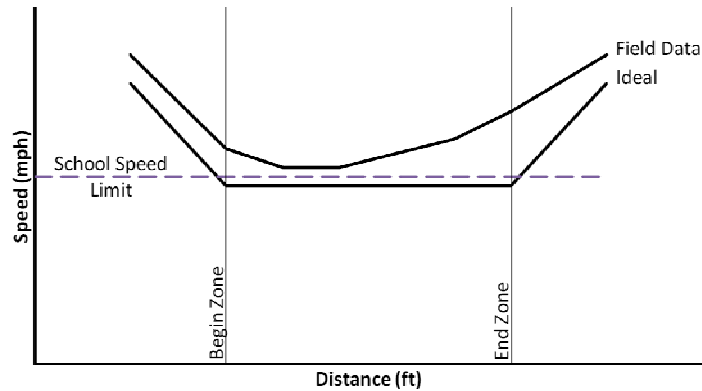
Observations of School-Area Traffic



Observations of School-Area Traffic

School Speed Limit	85 th Percentile Speed
20	26
25	30
30	37
35	43

Observations of School-Area Traffic

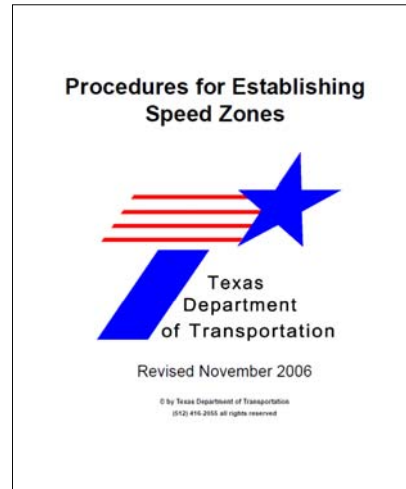


Documents

- TxDOT: Procedures for Establishing Speed Zones (Nov 2006)
- TxDOT: Texas Manual on Uniform Traffic Control Devices (2006)
- FHWA: Manual on Uniform Traffic Control Devices (2009)

TxDOT: Procedures for Establishing Speed Zones (PESZ)

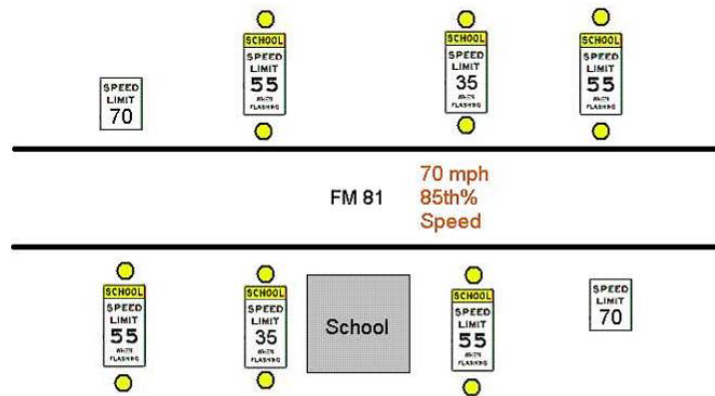
- Chapter 2, Section 4 – School Speed Zones
- Chapter 3, Section 4 – Speed Zone Design (Zone Length)
- Chapter 3, Section 3 – Developing Strip Maps (Schools)



TxDOT: PESZ Chapter 2, Section 4 – General

- No specific warrants or guidelines
 - When children are going to and from school
- Consider “irregular traffic” and pedestrians
 - Pedestrian crossing activity should be primary basis for reduced school speed zones
- Brief discussion on signs, with references to TMUTCD

TxDOT: PESZ Buffer Zone



Source: TxDOT *Procedures for Establishing Speed Zones*, Figure 3-9

TxDOT: PESZ Operation of Buffer Zones

- "In some cases it may be appropriate to operate the buffer zone during the same time periods as the school speed zone."
- "...appropriate to have a school transition speed zone of 55 mph that flashes on the approach and departure side of the 35-mph school zone."

TxDOT: PESZ

Chapter 3, Section 4 – Length

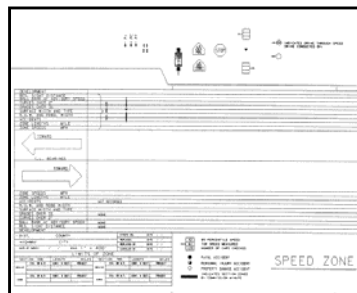
- "...as short as reasonable in urban areas..."
- Urban areas with 30 mph
 - As short as 200 to 300 ft
- No guidance for rural areas

School Speed Limit (mph)	Range of School Zone Length (ft)
20	590 – 775
30	584 – 1600
35 w/o	1454 - 2779
35 w/buffer	3818 - 6534

TxDOT: PESZ

Chapter 3, Section 3 – Strip Maps

- Selecting speed:
 - “Factual studies, reason, and sound engineering judgment, rather than emotion, should govern the final decision...”
 - “Not advisable” to set above 35 mph in either rural or urban area



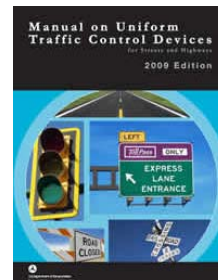
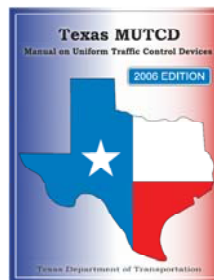
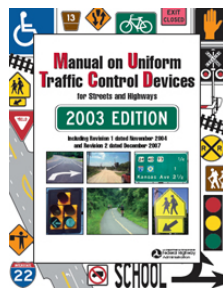
TxDOT: PESZ

Chapter 3, Section 3 – Strip Maps

85% speed	Suggested
< 55 mph	Not more than 15 mph below 85 th or normal posted speed limit
55 mph	20 mph below 85 th (35 mph)
> 55 mph	Use buffer zone to transition to 35 mph

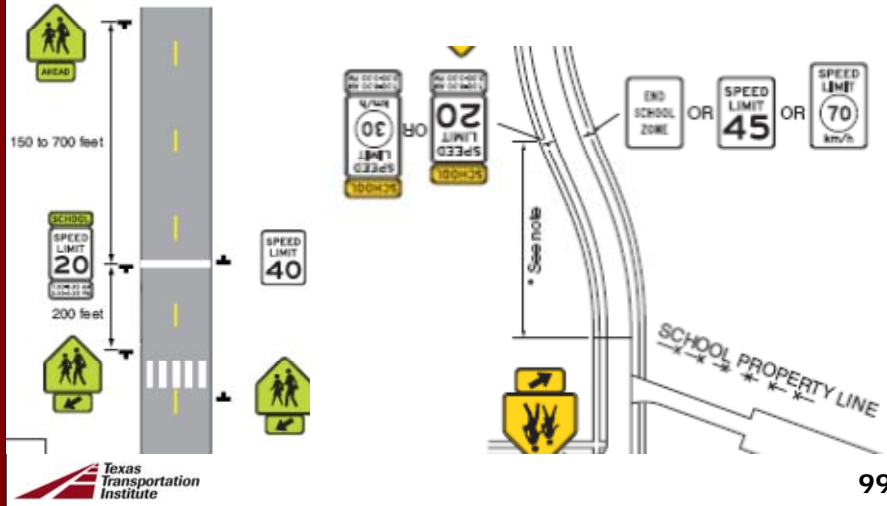
TMUTCD and MUTCD

- Similar, some differences



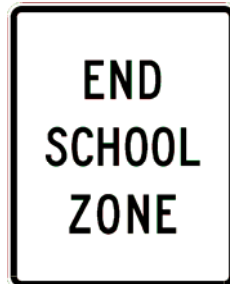
TMUTCD and MUTCD

- Reduced speed zone starting point



TMUTCD and MUTCD

- TMUTCD does not include:
 - Reduced Speed School Zone Ahead
 - End School Zone Sign



TMUTCD and MUTCD

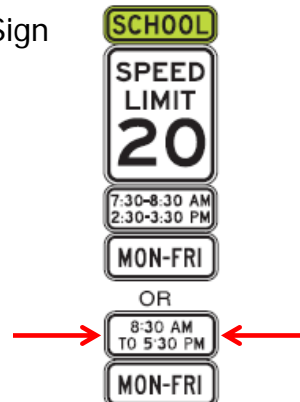
- TMUTCD includes School Speed Limit Markings



Photo: Marcus Brewer, TTI

TMUTCD and MUTCD

- TMUTCD includes
 - Overhead School Speed Limit Sign
 - “All Day” plaque

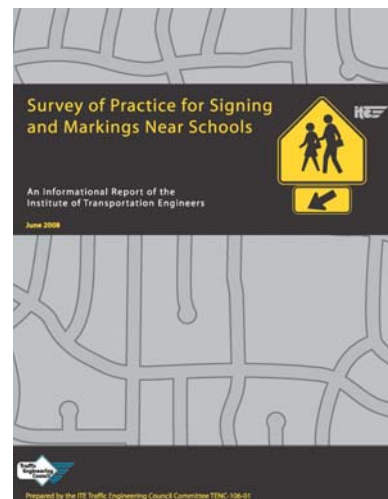


TMUTCD and MUTCD

- MUTCD mandates FYG signs; TMUTCD mandates yellow, allows FYG as an option
 - All example school signs in TMUTCD are shown in FYG



Review of Other States' Practices



Use of SSL In Rural Areas

- Alaska and Florida
 - Use beacons to increase conspicuity
- Massachusetts
 - School zone not less than 850 ft
- Illinois
 - Use larger signs on higher speeds
- Texas
 - SSL = 35 mph



When to Install? Arizona and Utah

- Point system for school crossing warrants
 - Average Time Between Gaps
 - 85th Percentile Approach Speed
 - School Age Pedestrian Volume
 - Average Demand Per Gap



When to Install? Summary

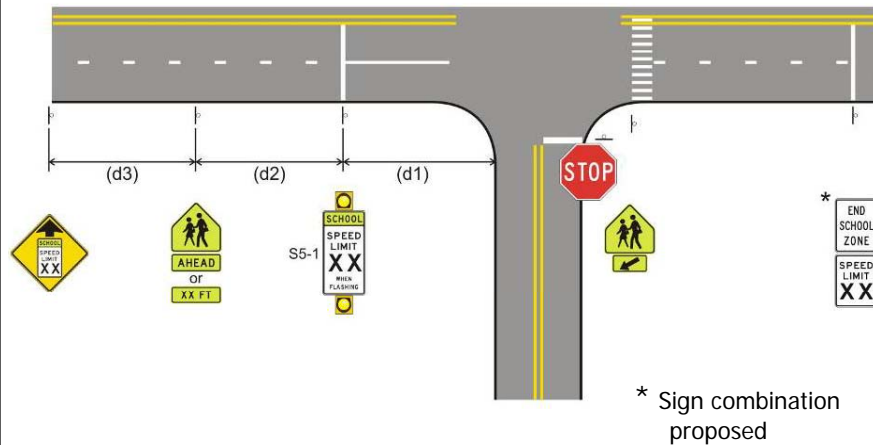
- Children present
- Children crossing
- Insufficient gaps
- Pedestrian demand per gap
- School enrollment
- Presence of crossing guards
- School abutting roadway
- Fence around school property
- Sidewalk presence
- Signal/stop control
- School grades

School Speed Limit Zone

- School speed limit zone considered for:
 - School-age pedestrians crossing major roadway
 - School located adjacent to highway or visible from highway
- Not typically used at:
 - Stop-controlled intersections
 - Signals



Typical Signing and Marking



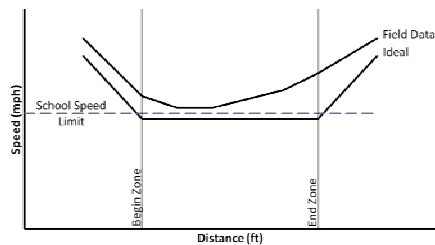
Begin School Speed Limit Zone

- 2006 TMUTCD: 200 ft to crosswalk or first driveway
- 2009 MUTCD: 200 ft, more if 30+ mph
- Research suggests changes – have distance be a function of school speed limit

School Speed Limit (mph)	Distance (ft)
20	200
25	200
30	300
35	400

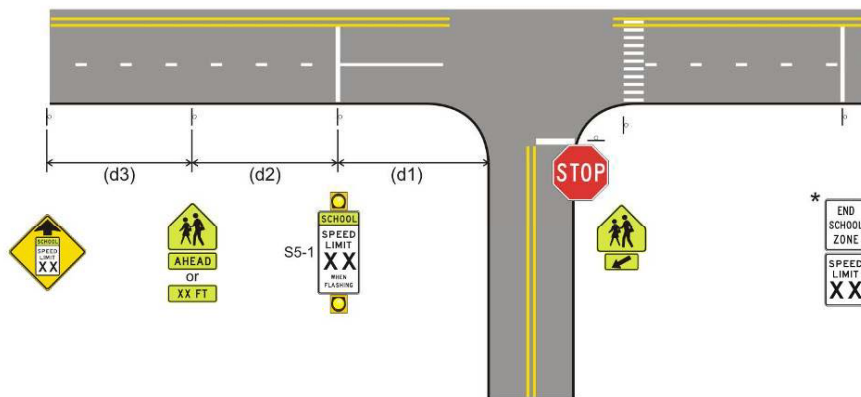
Zone Length

- Research
 - Speeds: 1 mph higher for every 500 ft driven
 - Therefore, longer school zones associated with greater speed variability within zone
 - Measured braking at school zones were used to determine recommendation for buffer zones



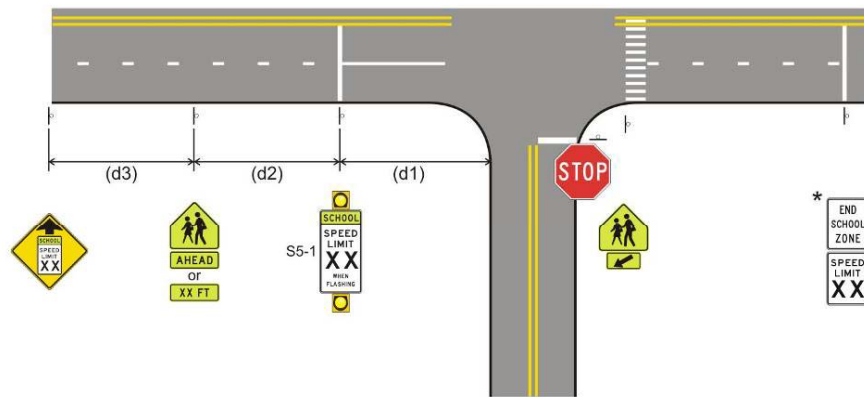
Zone Length

- Urban areas – zones may be as short as 400 ft (d1 = 200 ft)



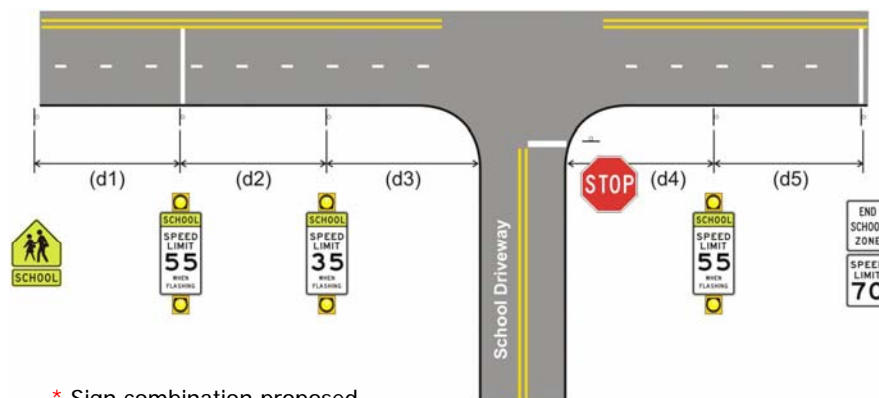
Zone Length

- Rural areas – longer zones than urban, suggested length = 1,000 ft (d1 = 500 ft)



School Buffer Zone

- Recommended distance (d2, d5) – 500 ft
- Overall, adds 1000 ft to reduced speed zone



* Sign combination proposed

School Speed Limit Duration (Active Times)

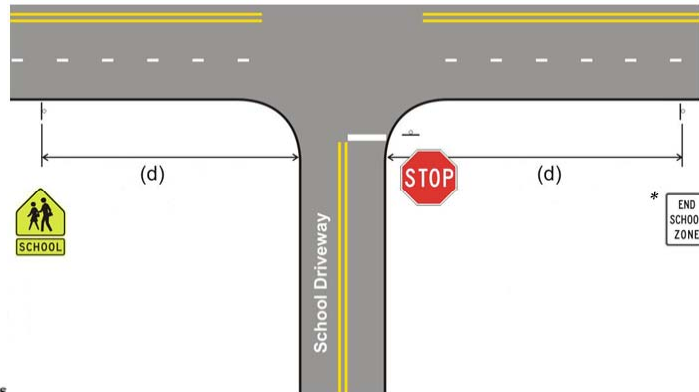
- PESZ
 - AM: 45 min before start of school to 0 min after
 - PM: 0 min before end of school to 30 min after
- Observed
 - AM: 15-90 min before start; 0-75 min after
 - PM: 0-100 min before end; 0-75 min after

School Speed Limit Duration (Active Times)

- Research Findings
 - Speeds – lowest close to start/end time of school
 - 20 min before/after start time – speeds 1 mph higher
- Recommended
 - AM: 30 min before start to 5 min after
 - beginning to end of the lunch period
 - PM: 5 min before end to 30 min after

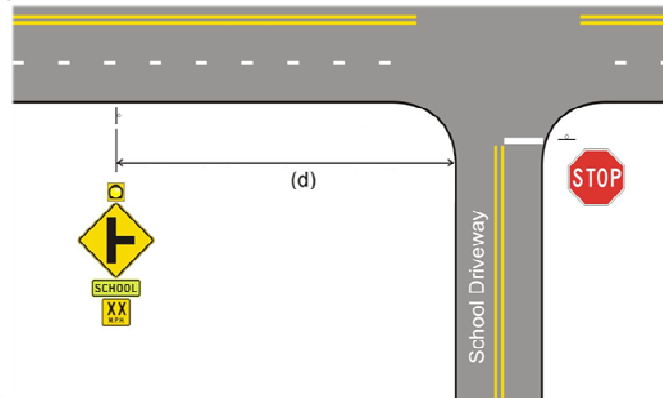
School Area Zone

- No reduced speed limit
- Length (d) based on posted speed limit
 - 25 mph: 100-325 ft
 - 70 mph: 550-1250 ft



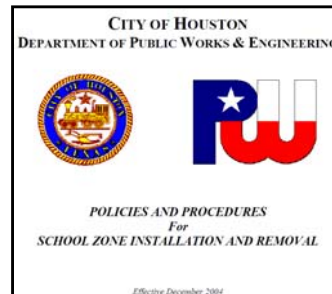
School Entrance Warning

- No reduced speed limit
- Length (d) based on posted speed limit
 - 25 mph: 225 ft
 - 70 mph: 1200 ft



Conditions for Removing Zone

- Can be considered if:
 - Installation of signal or all-way stop
 - Addition of turn bay(s)
 - Correction of sight distance concern
 - Changes in pedestrian walking pattern
 - Changes in bus ridership



Module Review

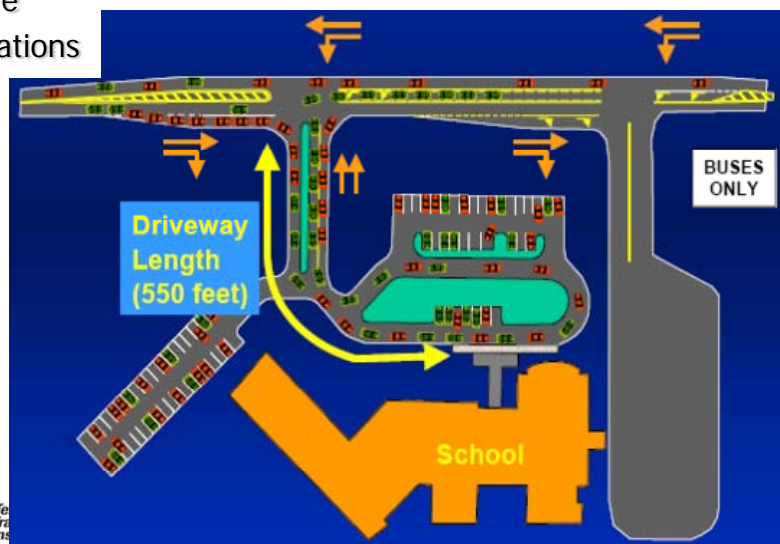
- School zone definitions
- Guidelines for installation and removal
- Current guidance documents in Texas:
 1. _____
 2. _____

MODULE 5

DISCUSSION OF LOCAL ISSUES

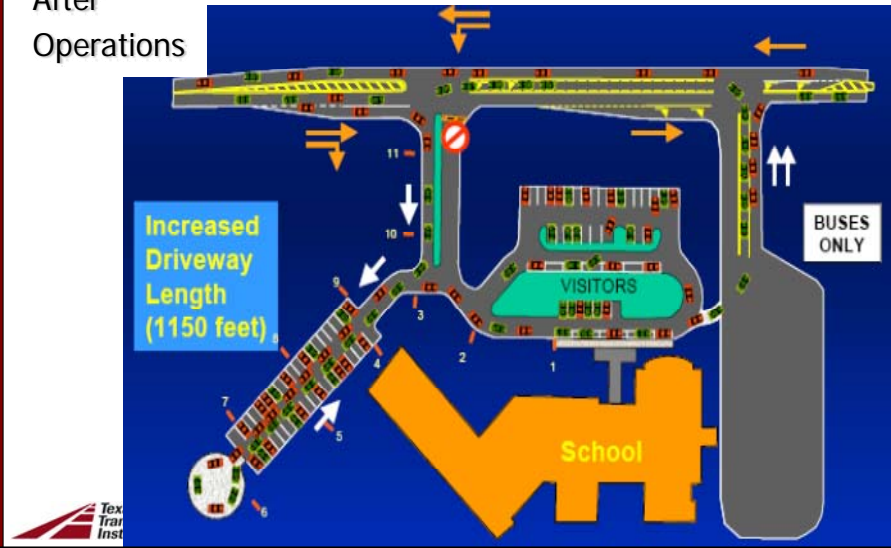
Building Setback – Queue Storage

Before Operations



Building Setback – Queue Storage

After
Operations



WRAP-UP & EVALUATION

Links

- Site Guidelines:
<http://tti.tamu.edu/documents/4286-2.pdf>
- Zone Guidelines:
<http://tti.tamu.edu/documents/0-5470-1-AppendixA.pdf>
- TxDOT Publications:
http://www.dot.state.tx.us/business/manuals_publications.htm

APPENDIX C: LIST OF COMPACT DISC CONTENTS

Each “Traffic around Schools” workshop participant was provided with a CD that contained electronic files of supporting materials used during the class instruction. The list below shows the typical CD contents, divided into the four electronic file folders:

LOCAL INFORMATION FOLDER:

- Newspaper articles on transportation issues around schools from local newspapers.
- Copy of school bond program information and demographic statistics from local school district used as an example during Module 2.
- Local case study information (school site plans, aerial photographs, Google™ Maps, etc.) for use in Module 5.

PEDESTRIAN REFERENCES FOLDER:

- Adobe PDF files of 14 national pedestrian research reports.
- Microsoft Word file containing the following summary of pedestrian reference materials.

NCHRP Report 500: Volume 10: A Guide for Reducing Collisions Involving Pedestrians http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v10.pdf

TRB’s National Cooperative Highway Research Program (NCHRP) Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan Volume 10: A Guide for Reducing Collisions Involving Pedestrians provides strategies that can be employed to reduce the number of collisions involving pedestrians.

Pedestrian & Bicycle Safety

http://safety.fhwa.dot.gov/ped_bike/

This is FHWA’s website that provides links to the following:

- [Pedestrian Safety Strategic Plan](#)
- [Pedestrian Safety Focus States and Cities](#)
- [Crash Facts](#)
- [Tools to Diagnose and Solve the Problem](#)
- [Education and Outreach](#)
- [Pedestrians and Transit](#)
- [Pedestrian Safety in Communities](#)
- [Hispanic Pedestrian and Bicyclist Safety \[En Español\]](#)
- [Legislation and Guidelines](#)
- [Research](#)
- [Order Copies of CD’s, Reports, and Other Resources](#)
- [Webinar Information](#)
- [Related Websites](#)

Pedestrian and Bicycle Information Center

<http://www.walkinginfo.org/about/>

The Pedestrian and Bicycle Information Center (PBIC) is a national clearinghouse for information about health and safety, engineering, advocacy, education, enforcement, access, and mobility for pedestrians (including transit users) and bicyclists. The PBIC serves anyone interested in pedestrian and bicycle issues, including planners, engineers, private citizens, advocates, educators, police enforcement, and the health community.

PBIC Case Study Compendium

http://www.walkinginfo.org/case_studies/

The PBIC Case Study Compendium contains a collection of all of the case studies developed by the Pedestrian and Bicycle Information Center and the Association of Pedestrian and Bicycle Professionals (APBP). The case studies, or success stories, cover pedestrian and bicycle projects and programs from across the United States and abroad, including engineering, education, enforcement, encouragement, planning, health promotion, and comprehensive safety initiatives.

TCRP/NCHRP Report 112/562: Improving Pedestrian Safety at Unsignalized Crossings

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf

As part of this study, the research team developed guidelines for use in selecting pedestrian crossing treatments for unsignalized intersections and midblock locations (*Guidelines for Pedestrian Crossing Treatments*, included in this report as Appendix A). Quantitative procedures in the guidelines use key input variables (such as pedestrian volume, street crossing width, and traffic volume) to recommend one of four possible crossing treatment categories: marked crosswalk; enhanced, high-visibility, or “active when present” traffic control device; red signal or beacon device; and conventional traffic control signal. The guidelines include supporting information for these treatment categories as well as examples and pictures of traffic control devices in each treatment category.

A spreadsheet was developed to automate the calculations associated with the procedure presented in Appendix A of the TCRP/NCHRP Report 112/562 report. The spreadsheet is in beta format but available for testing at <http://tcd.tamu.edu/Documents/Products.htm>

Traffic Safety Facts 2009 Data - Pedestrians

<http://www-nrd.nhtsa.dot.gov/Pubs/811394.pdf>

National Highway Traffic Safety Administration traffic safety factors for pedestrians using 2009 data.

Traffic Safety Facts 2009 Data – School Transportation-Related Crashes

<http://www-nrd.nhtsa.dot.gov/Pubs/811396.pdf>

National Highway Traffic Safety Administration traffic safety factors for school transportation-related crashes using 2009 data.

Pedestrian Safety Guide and Countermeasure Selection System

<http://www.walkinginfo.org/pedsafe/about.cfm>

The Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE) was last published in 2004. The purpose of the PEDSAFE Guide is to provide the most applicable information for identifying safety and mobility needs and improving conditions for pedestrians within the public right-of-way. The printed PEDSAFE Guide and online Guide and tools provide

the user with a list of 47 different engineering treatments along with education and enforcement programs that can be used to improve pedestrian safety and/or mobility at a specific location. For each of the engineering treatments, the Guide provides description, the treatment purpose, considerations, and estimated cost to implement.

The Guide also has details of 71 Case Studies (i.e., success stories) of various treatments that have been implemented primarily in the U.S. For each case study, there is information on the original problem, background, selected solution, the results, and information to talk to the local contact person. There is also PEDSAFE “expert system” software (on a CD inserted in the printed Guide and also on the website) that allows for obtaining a short list of appropriate roadway treatments for a given location, based on inputting the characteristics about a problem location (e.g., number of lanes, speed limit, type of traffic control, types of pedestrians crossing) and the type of problem that exists (e.g., speeds too fast, crossing too wide). The PEDSAFE Guide is intended primarily for engineers and planners, safety professionals, and decision-makers, but it may also be used by citizens for identifying problems and recommending solutions for their communities. The guide is available on-line at www.walkinginfo.org/pedsafe.

AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition

Order from: https://bookstore.transportation.org/item_details.aspx?id=119

The purpose of this guide is to provide guidance on the planning, design, and operation of pedestrian facilities along streets and highways. Specifically, the guide focuses on identifying effective measures for accommodating pedestrians on public rights-of-way. Appropriate methods for accommodating pedestrians, which vary among roadway and facility types, are described in this guide. The primary audiences for this manual are planners, roadway designers, and transportation engineers, whether at the state or local level, the majority of whom make decisions on a daily basis that affect pedestrians. This guide also recognizes the profound effect that land use planning and site design have on pedestrian mobility and addresses these topics as well.

Evaluation of Pedestrian and Bicycle Engineering Countermeasures

See Table B-1 for list of web addresses.

A recent FHWA project evaluated several pedestrian treatments including the pedestrian hybrid beacon and the rectangular rapid flashing beacon. [Table B-1](#) lists the reports that document the findings from those studies.

Table B-1. Evaluation of Pedestrian and Bicycle Engineering Countermeasures Reports	
Topics	Publications
This article provides an overview of a major FHWA project (Evaluation of Pedestrian and Bicycle Engineering Countermeasures) along with key findings.	
Summary Article	Do, A. H., Fitzpatrick, K., Chrysler, S. T., Shurbutt, J., Hunter, W. W., and Turner, S. (2011). "Safety Strategies Study", <i>Public Roads</i> . May/June 2011. Vol. 74, No. 6. http://www.fhwa.dot.gov/publications/publicroads/11mayjun/03.cfm
The following reports provide additional details on each study.	
RRFB	Shurbutt, J. and Van Houten, R. (2010). <i>Effects of Yellow Rectangular Rapid-Flashing Beacons on Yielding at Multilane Uncontrolled Crosswalks</i> , FHWA-HRT-10-043, Washington, DC. www.fhwa.dot.gov/publications/research/safety/pedbike/10043/10043.pdf
	Shurbutt, J. and Van Houten, R. (2010). TechBrief: "Effects of Yellow Rectangular Rapid-Flashing Beacons on Yielding at Multilane Uncontrolled Crosswalks," FHWA-HRT-10-046, Washington, DC. www.fhwa.dot.gov/publications/research/safety/pedbike/10046/10046.pdf
Pedestrian Hybrid Beacons	Fitzpatrick, K. and Park, E. S. (2010). <i>Safety Effectiveness of the HAWK Pedestrian Crossing Treatment</i> , FHWA-HRT-10-042, Washington, DC. www.fhwa.dot.gov/publications/research/safety/10042/10042.pdf
	Fitzpatrick, K. and Park, E. S. (2010). TechBrief: "Safety Effectiveness of the HAWK Pedestrian Crossing Treatment," FHWA-HRT-10-045, Washington, DC. www.fhwa.dot.gov/publications/research/safety/10045/10045.pdf
Shared Lane Markings	Hunter, W. W., Thomas, L., Srinivasan, R., and Martell, C. A. (2010). <i>Evaluation of Shared Lane Markings</i> , FHWA-HRT-10-041, Washington, DC. www.fhwa.dot.gov/publications/research/safety/pedbike/10041/10041.pdf
	Hunter, W. W., Thomas, L., Srinivasan, R., and Martell, C. A. (2010). TechBrief: "Evaluation of Shared Lane Markings," FHWA-HRT-10-044, Washington, DC. www.fhwa.dot.gov/publications/research/safety/pedbike/10044/10044.pdf
Crosswalk Marking	Fitzpatrick, K., Chrysler, S. T., Iragavarapu, V., and Park, E. S. (2010). <i>Crosswalk Marking Field Visibility Study</i> , FHWA-HRT-10-068, Washington, DC. www.fhwa.dot.gov/publications/research/safety/pedbike/10068/10068.pdf
	Fitzpatrick, K., Chrysler, S. T., Iragavarapu, V., and Park, E. S. (2010). TechBrief: "Crosswalk Marking Field Visibility Study," FHWA-HRT-10-067, Washington, DC. www.fhwa.dot.gov/publications/research/safety/pedbike/10067/10067.pdf
Evaluation Methods Report	Chrysler, S. T., Fitzpatrick, K., Brewer, M. A., and M. Cynecki. (2011). <i>Pedestrian and Bicyclist Traffic Control Device Evaluation Methods</i> , FHWA-HRT-11-035, Washington, DC. www.fhwa.dot.gov/publications/research/safety/pedbike/11035/11035.pdf
Summary Report	Fitzpatrick, K., Chrysler, S. T., Van Houten, R., Hunter, W. W., and Turner, S. (2011). <i>Evaluation of Pedestrian and Bicycle Engineering Countermeasures: Rectangular Rapid-Flashing Beacon, HAWK, Sharrow, Crosswalk Markings, and the Development of an Evaluation Methods Report</i> , FHWA-HRT-11-039, Washington, DC. www.fhwa.dot.gov/publications/research/safety/pedbike/11039/11039.pdf

WORKSHOP REFERENCES FOLDER:

- Adobe PDF files for all research reports for the 0-4286 and 0-5470 projects.
- School Traffic calculator Microsoft Excel spreadsheet tool developed by the North Carolina Department of Transportation's Municipal School Transportation Assistance unit.
- Electronic files for 47 supporting references.

WORKSHOP SLIDES FOLDER:

- Adobe PDF file of the workshop slides for Modules 1–4 arranged in three slides per page notes format (see [Appendix A](#)).
- Adobe PDF files of the Module 5 case studies used in class exercises.

