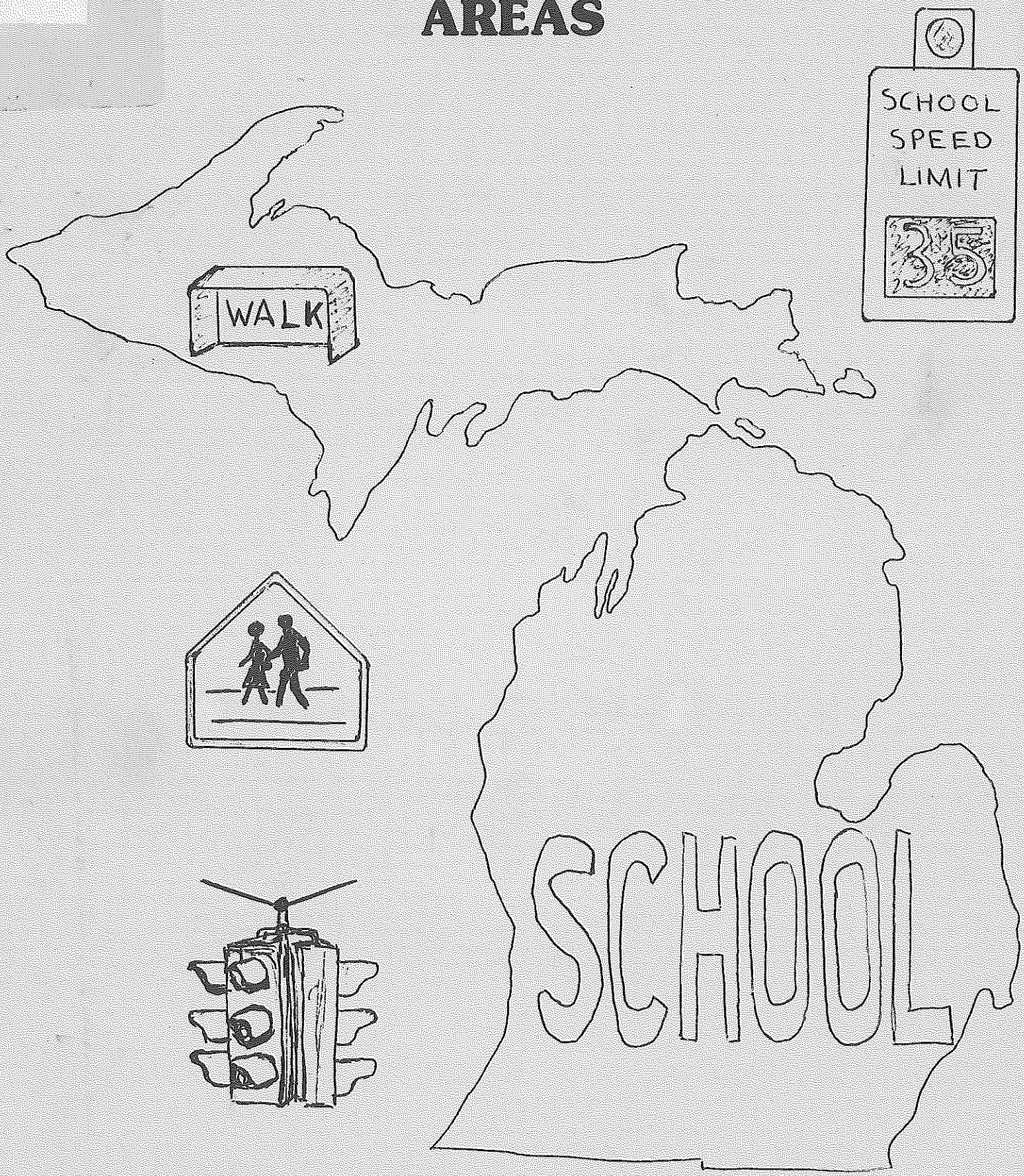
GUIDELINES FOR TRAFFIC CONTROL IN SCHOOL AREAS



MICHIGAN DEPARTMENT OF STATE HIGHWAYS
AND TRANSPORTATION

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GUIDELINES FOR TRAFFIC CONTROL IN SCHOOL AREAS

Provided by:
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7150 Harris Drive, General Office Building
Lansing, Michigan 48913

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FOREWORD

Traffic control in school areas is a highly sensitive subject. The Michigan Department of State Highways and Transportation receives many requests from parents, teachers, and other citizens to provide traffic signals, signs, markings, and speed controls in school areas.

These additional controls are often unnecessary, costly, and, if used, would tend to reduce respect for controls that are warranted. It is therefore important to stress that the safest and most effective traffic control can be obtained through the uniform application of realistic policies, practices, and standards developed through engineering and enforcement studies and experience gained nationwide.

Uniformity of traffic control in school areas is necessary to avoid confusion among pedestrians and drivers, to prevent wrong decisions by either and to avoid accidents.

This guide has been prepared to aid those responsible for traffic control in school areas. It explains and illustrates the steps necessary for the proper control of traffic in school areas. It does not select the device or measure which will best handle a particular situation; instead, a procedure is outlined for the selection of those locations where additional control may be needed. It also provides illustrations of the proper use of traffic control devices.

It is important that experienced professional judgment be used to select the measures and devices that will improve operation at problem locations. This will help to ensure uniformity of application of traffic control in school areas. Assistance with school crossings on state trunklines is available from the district traffic and safety engineers of the Michigan Department of State Highways and Transportation who are located throughout the state (see Appendix D for names and addresses).

The Manual of Uniform Traffic Control Devices published by the U.S. Department of Transportation and A Program For School Crossing Protection, published by the Institute of Transportation Engineers, provide the background for the content of this booklet.

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I. SCHOOL SAFETY PROGRAM

A. Organizing a School Traffic Safety Committee

The first step desirable to provide pedestrian safety in school areas is the organization of a School Traffic Safety Committee. The committee should be composed of representatives from the agencies of the community responsible for engineering, enforcement, and the schools. Representatives of the parent-teacher associations, local safety councils, and other interested groups should be invited to serve on the committee in an advisory capacity.

The duty of this committee is to guide and coordinate all activities associated with the school safety program. These include the following:

1. Establish policies and procedures

2. Review and approve the various phases of the school traffic safety program

3. Review and handle complaints and requests

4. Establish priorities on projects

5. Promote good public relations

6. Take immediate action to correct emergency school traffic safety problems

B. Pedestrian School Route Plan

The initial act of the School Traffic Safety Committee should be the development of a suggested school route plan for each school serving elementary and kindergarten students. The plan consists of a simple map showing streets of the area served by the school, the school, existing traffic controls, established school routes, and crossings. Figure 1 shows a typical school route plan map.

The plan permits the orderly review of school area traffic control needs, the coordination of school pedestrian safety education and engineering activities, and is useful in developing uniformity in the use of school area traffic controls.

1. The criteria considered necessary in developing a good route plan are as follows:

    a. In general, the school route plan should be designed to provide maximum protection for the children at minimum cost to the taxpayer. School routes should be planned to take advantage of the protection afforded by existing traffic controls. Where feasible, school boundaries should be revised if a change therein would eliminate a hazardous crossing. Children occasionally

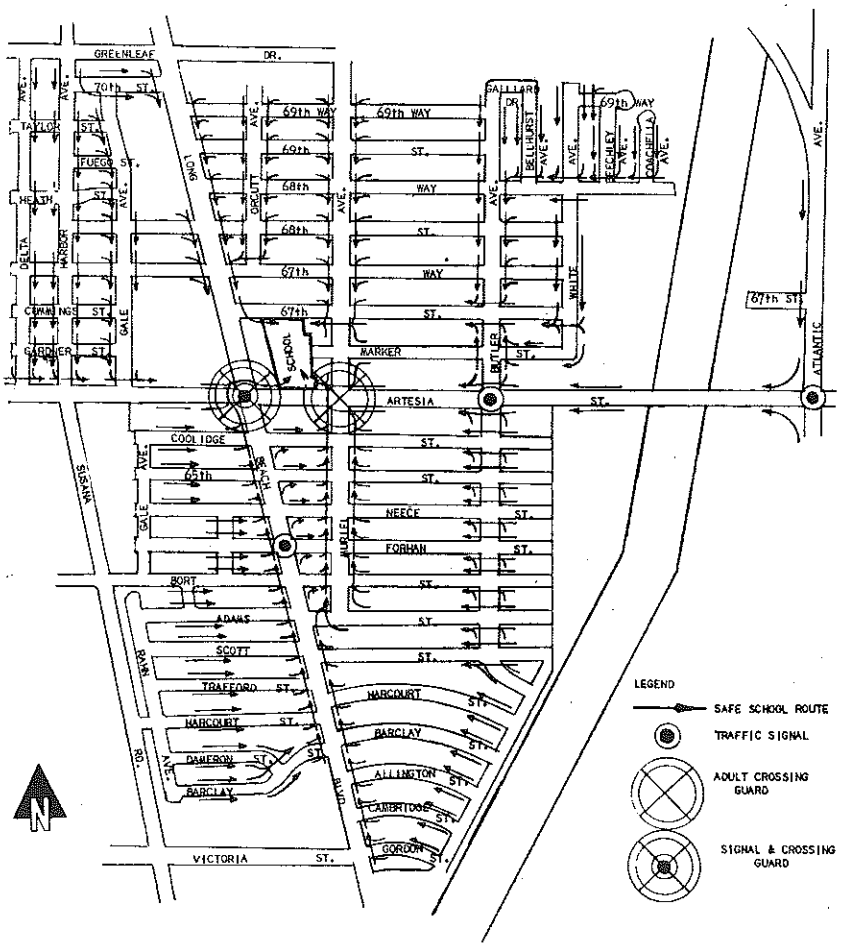


Figure 1. Typical school route plan map.

must be required to walk longer distances to avoid hazardous crossings and to make use of existing traffic controls. The following factors should be considered in a determination of the feasibility of requiring children to walk longer distances under such circumstances:

(1) The availability of adequate, safe sidewalks, or off-road sidewalk areas to and from the location with existing control.

(2) The number of children using the crossing.

(3) The age levels of the children using the crossing.

(4) The total extra walking distance.

b. The School Traffic Safety Committee should adopt policies on the application of these factors.

c. School children should be thoroughly instructed by the schools and parents on the purpose and proper use of the school route plan. Each child should be provided with a copy of the map showing the school route plan. This map should be taken home so that parents may check the route to be used by their child and instruct him on its use, even to the extent of walking over the route with the child. It is desirable to have parents sign and return to the schools a statement indicating that they have instructed the child on the use of the appropriate school route.

d. Frequent field checks should be made along school routes to determine whether they are being properly used. This activity could be adopted as an annual safety project for parent-teacher organizations. Volunteer mothers could occasionally walk the school routes for the purpose of recording and reporting such circumstances as unsafe activities of school children, failure to use the routes, improper driving practices of parents, the need for enforcement to deter speeding, need of maintenance work to reduce potential hazards (such as cutting weeds or trimming or eliminating trees that obscure vision, and the repainting of pavement markings). The School Traffic Safety Committee should take prompt action toward correcting conditions reported from such surveys.

e. The school route plan should be reviewed by the School Traffic Safety Committee each year to determine the possible need for revision. This evaluation should be conducted between school years so that any necessary revisions may be made before the school term begins. Such revisions may be necessary because of new schools, changes in school district boundaries, changes in highway or traffic patterns, opening of new residential areas, or installation of new controls.

f. Special precautions should be taken in those areas where unusual conditions, such as extreme fog, create a hazard for school children. School officials may decide to adopt a policy whereby children are excused from school during periods when an unusual condition creates potential hazards at street or highway crossings all along the school routes.

2. After the school route plan has been developed, the following safety activities should be pursued:

a. School principals, parents, teachers, the public information media, and the general public should be made familiar with the school traffic safety program. The School Traffic Safety Committee should organize meetings and presentations to inform all concerned persons as to the purpose and value of the school route plan, the theory

and methods behind the planning of the school routes, and the procedure to be used in processing complaints and requests. Such events should include an opportunity for the audience to ask questions and offer suggestions on the program.

b. School children should be thoroughly instructed in all aspects of school traffic safety. The school training and supervision program should develop in all children at the earliest possible age the ability to take care of themselves and to assume responsibility for their own safety at all pedestrian crossings. This program should include the instruction of children in safe walking and bicycle riding habits. Traffic authorities should assist in this program by calling attention to specific conditions and hazards that require special emphasis in the child's education program.

c. The child must be taught that he alone is responsible for his safety and that he must be careful and alert at all times. He must be convinced that a traffic sign, a traffic signal, school bus flashers, or even a crossing guard does not relieve him of that responsibility; and that all street crossings are to be considered dangerous, and that only through safe crossing habits and practices will he remain safe.

II. SCHOOL CROSSING CONTROL CRITERIA

A. General

During the development of the school route plan there may be circumstances which will require that a route cross a major highway or other potential traffic hazard. By applying a uniform procedure of study and analysis to each of the possibly hazardous crossings, it will be possible to make recommendations and assign priorities for the uniform application of traffic controls or other measures described later in this guide.

B. Analyzing the Need for School Crossing Protection

1. The recommended procedure for study is based on the following assumptions:

   a. Alternating gaps and blockades are formed in the vehicular traffic stream in a pattern peculiar to each location. This requires an analysis of hazards at each location.

   b. Pedestrians will wait a reasonable time for an adequate gap in traffic before crossing a street.

   c. There is no traffic control signal at the location under study. If a signal has been installed, particular attention should be given to Appendix C before proceeding with items 2 and 3 of the field studies listed below.

2. Once it has been determined which intersections require further study, the necessary field survey data should be obtained. (See Appendix A)

3. For safety, a pedestrian must wait for a gap in traffic that is of sufficient duration to permit him to cross the street without interference from vehicular traffic. When the delay (between the occurrence of adequate gaps) becomes excessive, children may become impatient and endanger themselves by attempting to cross the street during an inadequate gap. Compounded by the inability of most children to properly judge gap size and vehicle speed, the need for control at, and warning of, crossings is especially critical. This delay may be considered excessive when the number of adequate gaps in the traffic stream during the period the children are using a crossing is less than the number of minutes in that same time period. With this condition (when adequate gaps occur less frequently than an average of one per minute), and where a significant number of children cross, some form of traffic control is needed which will create the gaps in the traffic stream necessary to reduce the hazard.

4. The need for some special form of protection can be determined by using procedures contained in Appendix B.

III. TRAFFIC CONTROL FOR SCHOOL AREAS

A. General

Up to this point, the analysis has merely separated those locations which need control from those which do not. That is, the analysis has identified those locations where gaps of adequate length for safe crossing do not exist in the traffic stream during the hours when the demand is greatest. The problem now is to select a measure which will create in the traffic stream the gaps necessary to alleviate or eliminate the hazard.

The decision to use a particular device at a particular location should be made on the basis of an engineering study of the location. Thus, while this guide provides standards for design and application of traffic control devices, it is not meant to be a substitute for professional judgment. It is intended that the provisions of this guide define the standards for traffic control devices, but these standards shall not be a legal requirement for their installation.

This part sets forth basic principles and prescribed standards to be followed in the design, application, installation, and maintenance of all traffic control devices and other controls required for the special pedestrian conditions of school areas. Such devices and controls include signs, signals, markings, adult guards, student patrols, and grade separated crossings.

1. Legal Authority

AS REQUIRED BY SECTION 615 OF THE MICHIGAN VEHICLE CODE, TRAFFIC CONTROL DEVICES FOR THE PURPOSE OF REGULATING, WARNING, OR GUIDING TRAFFIC SHALL BE PLACED ONLY BY THE AUTHORITY OF A PUBLIC BODY OR OFFICIAL HAVING JURISDICTION OVER THE ROAD. No traffic control device or its support shall bear any advertising or commercial message, or any other message that is not essential to traffic control and must conform with requirements set forth in the "Michigan Manual of Uniform Traffic Control Devices."

2. Meanings of "Shall," "Should," and "May"

In Sections of the Michigan Manual of Uniform Traffic Control Devices, dealing with the design and application of traffic control devices, the words "shall," "should," and "may" are used to describe specific conditions concerning these devices. To provide clarity of the meanings of these words, as used in this booklet, the following definitions are given:

a. SHALL - A mandatory condition. Where certain requirements in the design or application of the device are described with the "shall" stipulation, it is mandatory that these requirements be met.

b. SHOULD - An advisory condition. Where the word "should" is used, it is considered to be advisable usage, recommended but not mandatory.

c. MAY - A permissive condition. No requirement for design or application is intended.

3. The standards of the Michigan Manual of Uniform Traffic Control Devices outlined in this guide apply to all streets and highways in Michigan, regardless of type or level of governmental agency having jurisdiction.

4. All traffic control devices used in school areas shall conform to the applicable specifications of the Michigan Manual of Uniform Traffic Control Devices.

5. Maintenance of devices must be to high standards to assure that legibility is retained, that the device is visible, that it is functioning properly, and that it is removed if no longer needed.

6. Special care shall be taken to see that devices in use on a part-time basis are in operation only during the time periods they are required.

7. Regulatory traffic control devices for school areas should be removed, covered, or not operated when they are not needed for extended periods of time, such as during summer vacations.

B. Signs

1. Design of Signs

Uniformity in design includes shape, color, dimensions, symbols, wording, lettering, and illumination or reflectorization. The Michigan Department of State Highways and Transportation, upon request, will furnish detailed drawings of the standard signs illustrated in this guide.

2. Dimensions

The sign dimensions prescribed in this booklet shall be standard for application on public highways. An increase above these standard sizes is desirable where greater legibility or emphasis is needed.

3. Illumination and Reflectorization

Ordinarily, the signs used for school area traffic control need not be reflectorized or illuminated, but, if there is a considerable use of school facilities by children during hours of darkness, it may be desirable to give the signs in the vicinity of the school adequate nighttime visibility.

4. Position of Signs

   a. Signs should be placed in positions where they will convey their messages effectively without restricting lateral clearance or sight distances. Placement therefore should be accommodated to highway design and alignment and to roadside development.

   b. Signs should have the maximum practical lateral clearance from the edge of the traveled way for safety of vehicles that may leave the roadway and strike the sign supports. Normally, signs and/or supports should be positioned so that the edge of that part of the installation nearest the roadway is no closer than 2 feet from the edge of the shoulder. However, where no shoulder exists (or there is a shoulder of minimal width), a minimum distance of 6 feet from the edge of the roadway should be maintained.

   c. Where barrier curb exists and the lateral clearances indicated in the preceding paragraph are not practicable, a lesser clearance may be used; however, a minimum clearance of 2 feet between curb face and sign should be maintained.

   d. In urban areas, where sidewalk width is limited or existing poles are close to the curb, a sign clearance of 1 foot from the curb face is permissible.

   e. PORTABLE SIGNS OR OTHER CONTROL DEVICES, WHICH COULD BECOME PROJECTILES IF STRUCK BY A VEHICLE, SHALL NOT BE PLACED WITHIN THE ROADWAY AT ANY TIME.

5. Height of Signs

   a. Signs erected at the side of the road in rural districts shall be mounted at a height of at least 5 feet, measured from the bottom of the sign to the level of the roadway edge.

   b. In business, commercial, and residential districts where parking and/or pedestrian movement is likely to occur, or where there are other obstructions to view, the clearance to the bottom of the sign shall be at least 7 feet.

6. Erection of Signs

   Normally, signs should be mounted approximately at right angles to the direction of, and facing, the traffic that they are intended to serve.

7. School Advance Sign (S1-1)

   The School Advance sign is intended for use in advance of locations where school buildings or grounds are adjacent to the highway. It may also be used in advance of established school crossings not adjacent to a school ground.

S1-1
30" X 30" (urban areas)
36" X 36" (rural areas)

S2-1
30" X 30" (urban areas)
36" X 36" (rural areas)

Where used, the sign generally shall be erected not less than 150 feet nor more than 700 feet in advance of the school grounds or school crossing. The sign shall have a standard size of 36 inches by 36 inches when used in rural areas and a standard size of 30 inches by 30 inches when used in urban areas.

8. School Crossing Sign (S2-1)

   a. The School Crossing sign is intended for use at established crossings used by pupils going to and from school, except that the signs should be omitted at crossings where vehicular traffic is controlled by stop signs or signals. Only crossings adjacent to schools and those on established school pedestrian routes shall be signed.

      (1) When used, the sign shall be erected on the righthand side of the roadway at the crosswalk or at the minimum distance possible in advance of the crosswalk.

      (2) The sign shall have a standard size of 36 inches by 36 inches when used in rural areas and a standard size of 30 inches by 30 inches when used in urban areas.

   b. A School Advance sign shall be used in advance of the School Crossing sign.

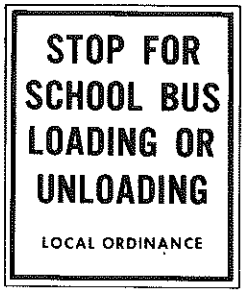
   c. School Crossing signs may be supplemented with hazard identification beacons when both of the following conditions are satisfied:

      (1) The 85th percentile speed (speed below which 85 percent of vehicles travel) is greater than 35 MPH.

      (2) There are a minimum of 50 crossings per day by school children.

9. Stop For School Bus Loading or Unloading Sign (S3-2)

This sign may be posted to instruct motorists to stop when approaching or overtaking a school bus which has stopped to receive or discharge passengers. The fifth line of the legend, consisting of the words "LOCAL ORDINANCE", shall be included only on those signs erected at the entrances to those communities where stopping for school buses is required by local ordinance.

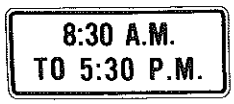


S3-2
30" X 36"
(4" and 1½" letters)

10. School Speed Limit Signs (S4-1, S4-3, S4-4)

a. The School Speed Limit sign shall be used to indicate the speed limit where a reduced speed zone for a school area has been established in accordance with law after an engineering and traffic investigation. The sign shall be either a fixed-message sign assembly or a variable display type sign.

(1) The fixed message sign assembly shall consist of a top panel SCHOOL (S4-3), a Speed Limit sign (R2-1), and a bottom panel (S4-1) indicating the specific period or periods of the day and/or days of the week when the special school speed limit applies. The bottom panel has a standard size of 24 inches by 10 inches, but it may be made larger, if needed, to accommodate the required legend.



S4-1
24" X 10"
(2½" letters and numerals)

S4-3
24" X 8"
(4" letters)

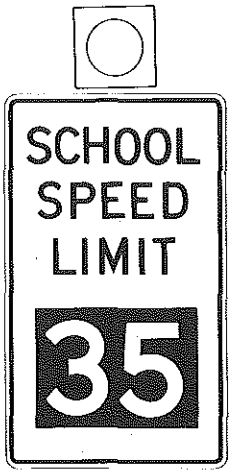
S4-4
24" X 10"
(2½" letters)

R2-1
24" x 30"
(4" letters)
(10" numerals)

(2) The numerical speed limit displayed on the sign shall be the limit established by law.

(3) Variable display signs may be used to indicate the special school speed limit. These signs may use blank-out messages or other methods to display the school speed limit only during the periods it applies. A Speed Limit Sign with Beacon may also be used, with a WHEN FLASHING sign (S4-4) to identify the periods the school speed limit is in force. The lens of a flashing beacon, when used with a SCHOOL SPEED LIMIT sign, may be positioned within the face of the sign.

(4) Because of special features, it may not always be practical to make variable display signs conform in all respects to the accepted standards. However, during the periods the school speed limit is in force, their basic shape, message, legend layout, and colors should conform to the standard for the fixed message sign, except that if the sign is internally illuminated, it may have a white legend on a black background.



Blank-Out Legend Speed Limit Sign with Beacon

Speed Limit Sign with Beacon

(5) Variable display signs with flashing beacons should be used for the more critical situations where greater emphasis of the special school speed limit is needed.

(6) Where practical, consideration should be given to including on the back of variable display signs a light or device to indicate the speed limit message is in operation or visible.

(7) At the end of an authorized and posted school speed zone, the speed limit for the following section of highway should be posted with a standard Speed Limit sign (R2-1).

(8) In general, SCHOOL SPEED LIMIT signs, with or without supplementary hazard identification beacons, should only be installed when all of the following conditions are satisfied:

(a) The existing posted speed limit is 35 or more miles per hour.

(b) There are a minimum of 50 crossings per day by school children.

(c) The 85th percentile speed does not exceed the posted speed limit by more than 7 MPH.

(9) If condition (c) is not satisifed, a review of the posted speed limit should be initiated. If the speed limit is deemed appropriate, increased enforcement should be encouraged.

(10) Generally, the SCHOOL SPEED LIMIT will not be more than 10 MPH less than the posted speed limit, with a minimum of 25 MPH.

11. Parking and Stopping Signs (R7 Series)

a. Experience shows that most accidents involving school children are caused by children crossing streets from between parked cars. Parked cars are a major obstruction to sight distance at crosswalks and intersections; therefore, it is very important that "no parking" zones be considered in school areas for child safety. As a minimum, the MICHIGAN VEHICLE CODE prohibits parking "within 20 feet of a crosswalk or if none, then within 15 feet of the intersection of property lines at an intersection of highways." Also, school bus loading zones and parking or stopping zones near entrances must be given careful attention. A publication titled "Traffic Safety Planning on School Sites," published by the Automobile Club of Michigan, contains recommended site plans for school areas. To improve both driver and pedestrian visibility, parking should be banned on all streets where such prohibition is necessary to maximize crossing safety. Loading zones should be off the street where possible.

b. Parking signs and other signs governing the stopping and standing of vehicles in school areas cover a very wide variety of regulations and only general specifications can be laid down here. Typical examples are as follows:

(1) No Parking 8:00 AM to 5:00 PM School Days Only
(2) No Stopping 8:00 AM to 5:00 PM School Days Only
(3) 5 Min. Loading 8:00 AM to 5:00 PM School Days Only

c. The legend on parking signs shall state whatever regulations apply, but the sign shall conform to the standards of shape, color, position, and use. Generally, parking signs should display as much of the following information as is appropriate from top to bottom of the sign in the order listed:

(1) Restriction or prohibition
(2) Time of day it is applicable, if not at all hours
(3) Days of week it is applicable, if not every day

d. Where parking is prohibited at all times, or at specified times, parking signs shall have red letters and border on a white background (parking prohibition signs); and where only limited time parking is permitted or where parking is permitted only in a particular manner, the sign shall have green letters and borders (parking restriction signs). Where parking is prohibited during certain hours and permitted under a time limit at other hours of the day, two parking signs should ordinarily be used with the prohibition above the restriction. As an alternative, both messages in different colors may be used on a single panel with the sign lengthened vertically if necessary.

e. For emphasis, the word "NO" or the numeral showing the time limit in hours or minutes may be in a reversed color arrangement in the upper left corner of the sign; i.e., in white on a rectangular area of red or green.

f. Normally, parking signs are placed perpendicular to the roadway. However, there may be times when it is advantageous to post them parallel with the roadway. In these cases, there should be a single headed arrow pointing in the direction the regulation is in effect if the sign is at the end of the zone. As an alternative to the arrow, if the signs are posted facing traffic at an angle of 90 degrees to the curb line, there may be included on the sign, or on a separate plate below the sign, such legend as HERE TO CORNER, HERE TO ALLEY, THIS SIDE OF SIGN, or BETWEEN SIGNS.

C. Pavement Markings

1. Functions and Limitations of Markings

a. Markings have definite and important functions to perform in a proper scheme of school area traffic control. In some cases, they are used to supplement the regulations or warnings of other devices, such as traffic signs. In other instances, they obtain results, solely on their own merits, that cannot be obtained by the use of any other device. In such cases, they serve as a very effective means of conveying certain regulations and warnings that could not otherwise be made clearly understandable.

b. Pavement markings have definite limitations. They may be obliterated by snow, may not be clearly visible when wet, and may not be very durable when subjected to heavy traffic. In spite of these limitations, they have the advantage, under favorable conditions, of conveying warnings or information to the driver without diverting his attention from the roadway.

2. Standardization

Each standard marking shall be used only to convey the meaning prescribed for it in this booklet.

3. Crosswalk Lines

Crosswalk lines shall be solid white lines marking both edges of the crosswalk. They shall be not less than 6 inches in width and should not be spaced less than 6 feet apart.

a. Under special circumstances (where no advance stop line is provided or where vehicular speeds exceed 35 MPH or where crosswalks are unexpected), it may be desirable to increase the width of the crosswalk line.

b. Crosswalk lines on both sides of the crosswalk should extend across the full width of pavement to discourage diagonal walking between crosswalks.

c. Crosswalks should be marked at all established routes to school where there is material conflict between vehicles and kindergarten or elementary students (while crossing) and where students could not otherwise recognize the proper place to cross.

d. For added visibility, the area of the crosswalk may be marked with white diagonal lines at a 45-degree angle or with white longitudinal lines at a 90-degree angle to the line of the crosswalk.

(1) These lines should be approximately 21 to 24 inches wide and spaced 12 to 24 inches apart.

(2) When diagonal or longitudinal lines are used to mark a crosswalk, the transverse crosswalk lines may be omitted.

(3) Care should be taken to ensure that crosswalks with diagonal or longitudinal lines used at some locations do not weaken or detract from other crosswalks where special emphasis markings are not used.

4. Stop Lines

Stop lines are solid white lines, normally 12 to 24 inches wide, extending across all approach lanes, and used (under both urban and rural conditions) to indicate the point at

which vehicles are required to stop in compliance with a stop sign, traffic signal, officer's direction, or other legal requirement. When used, the stop line should ordinarily be placed at least 4 feet in advance of and parallel to the nearest crosswalk line.

5. Curb Markings for Parking Restrictions

Since curb markings of yellow and white are used for delineation and visibility, parking regulations must be established through the installation of standard signs. However, when local authorities prescribe special colors for curb markings as supplemental to standard signs, they may be used.

6. Word and Symbol Markings

a. Word and symbol markings on the pavement may be used for the purpose of guiding, warning, or regulating traffic. They should be limited to not more than a total of three lines of words and/or symbols. They shall be white in color.

b. Word and symbol markings shall not be used for mandatory messages except in support of standard signs.

c. The letters and symbols should be greatly elongated in the direction of traffic movement because of the low angle at which they are viewed by approaching drivers. Large letters, symbols and numerals should be used, 8 feet or more in height, and if the message consists of more than one word, it should read "up"; i.e., the first word of the message should be nearest to the driver. Where approach speeds are low, somewhat smaller characters may be used. The space between lines should be at least four times the height of the characters for low speed roads but not more than ten times the height of the characters under any conditions. Recommended design of elongated letters for the word SCHOOL is shown in Figure 2.

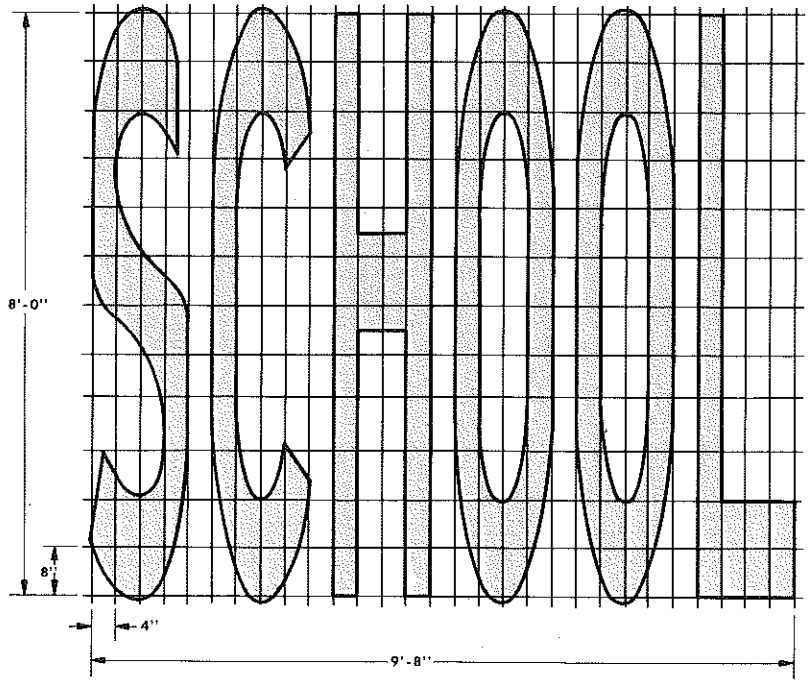


Figure 2. Single-lane pavement marking-detail of word "SCHOOL."

D. School Area Traffic Signals

1. Definition

School signals are standard traffic control signals erected at established school crossings on the basis of a need to create adequate gaps in the vehicular traffic stream for pedestrian crossings.

2. Advantages and Disadvantages

a. When properly designed, located, and operated under conditions that fully warrant their use, school signals may have the following advantages:

(1) Considering initial and operating costs, school signals, over a period of several years, represent an economy, as compared with the cost of providing police supervision or pedestrian bridges. However, adult supervision is recommended where school signals are located.

(2) Under conditions of favorable spacing, they can be coordinated with adjacent signals to provide for continuous or nearly continuous movement of vehicular traffic.

b. Properly designed and warranted signals also have some disadvantages, and the following should be considered when choosing a specific means of crossing control:

(1) In many cases, accident rates will increase following signalization.

(2) In most circumstances, the school signal control requires supplemental control by an adult guard or school safety patrol because signals tend to create a false sense of security, especially in school age children.

(3) School signal control has a much higher initial cost than police supervision or crossing guards. It should not be considered for locations where several years of use cannot be assured.

(4) If school signal control is to be installed, provision must be made for both periodic and emergency maintenance by capable, trained persons.

3. Standardization

Because of the great mobility of today's traffic and the ever increasing range of traffic circulation, it is of primary importance that there be national standardization of those features of traffic signals that affect public participation in traffic movement. This applies without exception to signals

at school crossings where instant recognition and understanding of controls is vital to both students and motorists. Deviations and innovations, however well-accepted by local people, are bound to lead to confusion and disobedience on the part of strangers.

Design, application, location, and operation lend themselves to a certain degree of standardization, and standards for such features are prescribed herein. A driver or pedestrian must first readily see signals and then react to their indications. Location and sequence of operation are basic requirements. Signals must be placed where a driver or pedestrian cannot miss seeing them. Standard signal messages can be recognized and heeded at a glance.

4. Warrants

a. A school signal may be warranted at an established school crossing when a traffic engineering study of pedestrian group size and available gaps in the vehicular traffic stream indicates that the number of adequate gaps in the traffic stream during the period the children are using the crossing is less than the number of minutes in that same time period. A minimum of 50 children should be utilizing the crossing before applying this warrant. A safe gap is defined as follows:

$$T = 3 + \frac{\text{width of street}}{4} + F$$

$$\text{where } F = \frac{(\text{Number of children per group} - 1) \times (2)}{5}$$

b. When traffic control signals are installed solely under this warrant:

(1) Pedestrian signal indications (WALK - DON'T WALK) shall be provided for each crosswalk established as a school crossing.

(2) At an intersection, the signal normally should be traffic-actuated. An actuated signal is a signal whose sequence and timing is determined by electronic detection of traffic or pedestrian demand on one or more approaches to the intersection. Intersection installations that can be fitted into coordinated systems may use pretimed control. At nonintersection crossings, the signal should be pedestrian-actuated, parking and other obstructions to view should be prohibited for at least 100 feet in advance of and 20 feet beyond the crosswalk, and the installation should include suitable standard signs and pavement markings. Special police supervision and/or enforcement should be provided for a new nonintersection location.

c. A School Advance sign and a School Crossing sign may be used at locations where signals are installed under this warrant.

5. Intersection and Nonintersection Installations

School signals may be installed at established school crossings at intersection and nonintersection locations where there are inadequate gaps in vehicular traffic to accommodate safe pedestrian crossings.

a. Intersection locations have the hazards of turning vehicles and generally require the provision of signal equipment for the control of vehicular traffic on two streets. However, they are less likely to present an element of surprise for drivers, and may perform the secondary function of improving vehicular access to an arterial street.

b. Nonintersection locations are free from the hazards of turning vehicles, require vehicle control equipment for one street only, and may offer added convenience to students. However, they can present an element of surprise for drivers who do not expect crossings and signal control between intersections. Therefore, special attention should be given to the signal head placement and the signs and markings used at nonintersection locations to be sure drivers are aware of this special application. Parking should not be allowed from 100 feet in advance of the crosswalk to 20 feet beyond.

6. Area of Control

a. A traffic control signal shall control traffic only at the intersection or midblock location where it is placed.

b. On a divided highway with a wide median (30 feet or greater), the crossing of each roadway must be signalized as a separate intersection.

7. Design Requirements for School Signal Indications

The detailed standards and requirements governing the design of signal indications for all signals, including school signals, are given in Part IV of the Michigan Manual of Uniform Traffic Control Devices.

8. Speed Limit Sign Beacon

a. A Speed Limit Sign Beacon consists of two CIRCULAR YELLOW lens sections each having a visible diameter of not less than six inches, or alternately, one or more CIRCULAR YELLOW lenses, each having a visible diameter of not less than eight inches.

b. A Speed Limit Sign Beacon is intended for use with a fixed or variable Speed Limit sign. See sign section for criteria outlining use of the Speed Limit Sign Beacon.

c. The yellow lens color shall conform with the requirements of the Institute of Transportation Engineers Standard for Adjustable Face Vehicle Traffic Control Signal Heads, Revised 1970.

d. Where two lens sections are used, they shall be aligned vertically and alternately flashed.

e. Speed Limit Sign Beacons shall be flashed at a rate of not less than 50 nor more than 60 times per minute. The illuminated period of each flash shall not be less than one-half and not more than two-thirds of the total cycle.

f. When illuminated, the Speed Limit Sign Beacon shall be clearly visible to all drivers it faces for a distance of at least one-quarter of a mile, under normal atmospheric conditions, unless otherwise physically obstructed.

E. Crossing Supervision

1. Types of Crossing Supervision

a. Adult control of pedestrians and vehicles with adult guards.

Recommended practices for the organization, operation, and administration of an adult crossing guard program are given in Adult Guards for School Crossings[1] and Adult School Crossing Guards.[2]

1/ Adult Guards For School Crossings, Traffic Institute of Northwestern University, 1804 Hinman Avenue, Evanston, Illinois 60204.

2/ Adult School Crossing Guards, American Automobile Association, 8111 Gatehouse Road, Falls Church, Virginia 22042

b. Student control of pedestrians only with student patrols.

Recommended practices for the organization, administration and operation of a student patrol program are given in Policies and Practices for School Safety Patrols.[3]

3/ Policies and Practices for School Safety Patrols, American Automobile Association, 8111 Gatehouse Road, Falls Church, Virginia 22042

2. Adult Guards

Adult guards may be used to provide gaps in traffic at school crossings, where adequate gaps must be created.

An adult crossing guard should be considered as an appropriate supplemental technique at school crossings where it is deemed necessary to assist children across a street because of heavy vehicular turning movements or high vehicular speed.

3. Choice of Adult Guards

a. Adult guards shall be appointed by the local law enforcement agency.

b. The local law enforcement agency shall be responsible for the selection, training and supervision of adult guards.

c. High standards for selection of adult guards are essential. Adult guards must understand children and, in addition, should possess the following qualifications:

(1) Average intelligence
(2) Good physical condition, including sight and hearing
(3) Mental alertness
(4) Neat appearance
(5) Good character
(6) Dependable
(7) Sense of responsibility for safety of children
(8) Eighteen years or older

d. A person shall receive a minimum of 4 hours instruction before performing the duties of a school crossing guard. Two hours of additional instruction shall be given annually to a school crossing guard before the beginning of each school year by the local law enforcement agency or its designee.

4. Uniform of Adult Guards

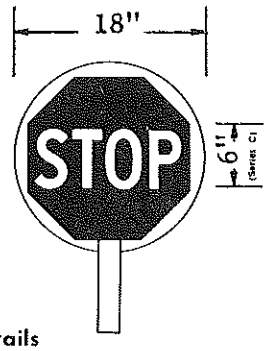
When on duty, a school crossing guard shall wear an outer vest of a color and style meeting the standards of the Michigan Manual of Uniform Traffic Control Devices. The school crossing guard shall also hold a stop sign which conforms to the Michigan Manual of Uniform Traffic Control Devices for hand-held signs (see Figure 3).

5. Operating Procedures for Adult Guards

Adult guards should not direct traffic in the usual police regulatory sense. In the control of traffic, they should pick opportune times to provide adequate safe gaps. At these times, their presence in the roadway serves as an easily recognized indication that pedestrians are about to use the crosswalk, and that all traffic must stop. To facilitate

stopping traffic, an adult guard must use a hand-held, double-faced STOP sign as illustrated in Figure 3. Drivers facing such hand-held STOP signs shall come to a stop and remain stopped while the adult guard allows the children to cross the roadway. Drivers may proceed when the adult guard signals them to do so.

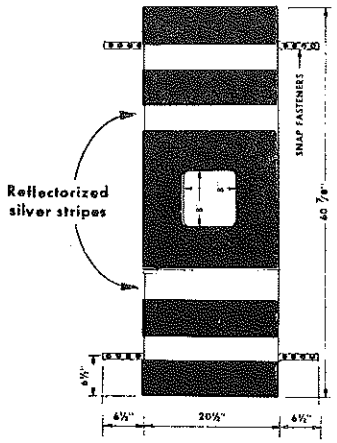
HAND-HELD STOP SIGN



Sign Details

1. All letters and spacing between letters shall be in accordance with standards prepared by the FHWA.
2. The legend shall be optically centered on the sign.
3. The sign shall be reflectorized when used during hours of darkness.

ADULT GUARD SAFETY VEST



Adult Guard Vest Details

1. The Adult Guard safety vest shall be orange in color and include silver reflectorized stripes as shown.

Figure 3. Design for hand-held stop sign and safety vest for adult school crossing guard

6. Student Patrols

   a. Student patrols may be used to direct and control children at crossings near schools where there are adequate gaps in traffic.

   b. Student patrols may be used to direct and control children at signalized intersections where turning movements are not a problem and to assist adult guards in the control of children at crossing locations used by large numbers of children.

   c. Student patrols shall not be responsible for directing vehicular traffic, and they shall not function as police officers or adult crossing guards.

   d. Student patrols should always be used to assist adult crossing guards.

7. Choice of Student Patrols

   a. Student patrols should be authorized by the local school board. School authorities should be responsible for organizing, instructing, and supervising patrols with the assistance of the local police.

   b. Student patrols should be carefully selected. They should be children from the 5th grade or higher, if possible. Leadership and reliability should be determining qualities for patrol membership.

   c. Parental approval should be obtained in writing before a child is used as a member of a student patrol.

8. Operating Procedures for Student Patrols

   Student patrols control children, not vehicles. They should stop children back of the curb or edge of the roadway and allow them to cross only when there is an adequate gap in traffic.

   Patrol members should reach their posts at least 30 minutes before the opening and five minutes before dismissal of classes and remain on duty until all students who are not stragglers have passed their post.

   Where school safety patrols are stationed, they should operate as follows:

   a. At crossings controlled by a crossing guard, the safety patrol will direct the crossing of the students in conformity with the signal of the crossing guard.

   b. At crossings controlled by traffic signals, patrol members shall hold the students off the roadway until the traffic stops and the signals allow them to cross. The patrol members shall allow only the immediate group to cross, and all latecomers must wait for the next "WALK" signal.

   c. At crossings with no signals, the patrol members shall:

      (1) Be posted to be clearly visible to approaching traffic; however, they shall stay out of the moving stream of traffic and, where there are parked cars obstructing their view, they should proceed to no further than the outer edge of the parked cars.

      (2) Patrol members shall not permit students to enter the roadway until it is safe for them to cross.

      (3) When it is safe for students to cross, the patrol members shall direct them to cross the roadway in a group.

d. At crossings with pedestrian-actuated traffic signals, the patrol member shall have the responsibility for operating the push button during his periods of duty.

F. Grade Separations

1. Grade-separated crossings may be used to physically separate the crossing of a heavy volume of school pedestrian traffic and a heavy flow of vehicular traffic.

2. Grade-separated crossings may be either overpasses or underpasses. The design should follow the guidelines given in the published policies of the American Association of State Highway and Transportation Officials.[4] Experience has shown that overpasses are more satisfactory than underpasses since overpasses are easier to maintain and supervise.

4/ A Policy on Arterial Highways in Urban Areas, 1957, and A Policy on Geometric Design of Rural Highways, 1965; American Association of State Highways Officials, 341 National Press Building, Washington, D.C. 20004.

3. Grade-separated crossings should be considered only when the physical characteristics of the location make such a structure feasible. If use of the grade separation will be less convenient than the use of an at-grade crossing, barriers or supervision will be needed to assure a satisfactory level of use. The construction of a pedestrian grade separation should be considered when:

   a. The general conditions that require the school crossing are sufficiently permanent to justify such a structure (for example: a school route crossing a freeway). And there is no possibility that the replanning of school routes or school districts will eliminate the need for such a structure.

   b. A comparison between the cost of the structure and the cost of other controls indicates that the structure is justified from the standpoint of long-range economy.

   c. The physical characteristics of the location make such a structure feasible from an engineering standpoint.

   d. The initial cost of such an improvement does not reduce available funds to the point where other essential school crossing protection is neglected.

   e. Such a structure will serve other pedestrians besides school children.

4. When this particular type of measure is selected, the following steps should be taken by school and traffic authorities to assure proper use of the structures by school children, as well as by other pedestrians:

a. If bicycles cannot be taken to the other side, provide parking areas near the structure; however, new structures generally require barrier-free design; i.e., no stairs.

b. Install fence barriers to channelize the movements of children, thus preventing them from avoiding the structure through the use of other, more hazardous routes.

c. Provide for the maintenance of adequate sanitary conditions, particularly in underpasses.

d. Provide for adequate policing and illumination of the structure to avoid moral problems, particularly in underpasses.

e. Instruct the users in orderly conduct, particularly to prevent objects being thrown from overpasses with damage to vehicles or injury to persons passing beneath. In some instances, this may require enclosing the structure.

5. Since pedestrian grade separation structures form a permanent solution to the school crossing problem, it is suggested that their use be considered when justified by the foregoing criteria. However, the practical problems denoted must also be considered and provided for as part of the overall program. Failure to do so may create conditions which are, in themselves, more serious from a community point of view than the school crossing hazard that the structure was intended to eliminate.

G. Speed Limits

1. Speed zoning will not automatically reduce accident frequency or severity. Improper zoning may actually create a situation favorable to accidents by increasing the speed differential between vehicles and by causing pedestrians to rely on a posted limit which does not accurately reflect vehicular speeds.

2. Lowering a speed limit does not necessarily lower actual vehicle speeds. Speed zoning then is not a simple answer to hazard reduction. The speed limit selected must be based on a common sense evaluation of the hazard potential and must be reasonable to gain voluntary driver acceptance.

3. Proper speed zoning can:

a. Reduce vehicular speed differential
b. Provide basis for enforcement
c. Increase driver respect for speed zoning
d. Decrease accident potential

4. Speed zoning will not:

a. Automatically reduce vehicular speed
b. Automatically reduce accidents

5. Improper speed zoning may:

   a. Increase accident potential
   b. Increase vehicular speed differential
   c. Decrease driver respect for speed limits
   d. Mislead pedestrians as to true vehicular speed
   e. Leave actual speed virtually unchanged
   f. Make the majority of drivers "speeders"
   g. Create enforcement problems

6. The "Michigan Vehicle Code" describes the procedures necessary in establishing speed limits and should be followed at all times when speed zones are changed.

APPENDIX A

Field Survey Data

1. The number of rows of pedestrians walking five abreast at the crossing under study (N), or 1/5 the total number of pedestrians.

2. The width (in feet) of the pavement to be crossed by the group of pedestrians (W).

3. The actual pedestrian delay time (as a percentage of the total survey time) created by the traffic flow at the location under study (D).

4. Speed Limits (85th percentile, if possible, or speed limit).

Procedure for Making Field Studies

1. Determination of "N" - the number of rows

   It is assumed that five pedestrians will walk abreast when a group crosses a roadway. Therefore, if the group size is determined and divided by five, the required number of rows, "N", will be obtained. The 85th-percentile group size is used so as to include most situations.

   There is a natural tendency for pedestrians to group together before crossing a roadway as they wait for a break or gap in the traffic stream. Thus, an observer can count the number of pedestrians that gather in each of these groups at the crossing under study and record the size on a form such as suggested in Exhibit No. A-1. A simple computation will yield the 85th-percentile group and the value of "N" for the group size can be found in the second column. Note that "N" is taken as a whole number since even one pedestrian in excess of an even five will make an additional row, which will require extra clearance time.

   These pedestrian counts should be made on a normal school day during the heaviest hours of crossing activity in the morning or afternoon, preferably both.

2. Determination of "W" - the pavement width

   This is the curb-to-curb width as measured at the crossing under study. If the roadway is divided and the center island is wide enough for the maximum-sized group of pedestrians to stand on it in safety, the curb-to-curb width of only one roadway is used for "W". This information should be obtained at the same time that the pedestrian group size study is made by recording the information suggested at the top of Exhibit No. A-1.

PEDESTRIAN GROUP SIZE STUDY

Study date 5/10/62 Time: From 8 a.m. to 9 a.m. Location 4th and D

Crosswalk across D Street Curb-to-curb distance 40'

Divided roadway? Yes (No) Width of island None

Group size	Number of Rows (N)	Number of Groups Tally	Total	Cumulative	Computations
46 - 50	10				
41 - 45	9				
36 - 40	8	/	/	/	This figure includes "9" the cutoff for the 85th percentile group size. Therefore: N = 6
31 - 33	7	///	3	4	
26 - 30	6	⧸⧸⧸⧸ //	7	11	
21 - 25	5	⧸⧸⧸⧸ ⧸⧸⧸⧸ ///	13		
16 - 20	4	⧸⧸⧸⧸ ⧸⧸⧸⧸ ⧸⧸⧸⧸ ///	18		
11 - 15	3	⧸⧸⧸⧸ ⧸⧸⧸⧸ //	12		
6 - 10	2	⧸⧸⧸⧸	5		
5 or Less	1	/	/		
		Total Number of Groups	60	x 0.15 = 9	N = 6

Exhibit No. A-1

3. Determination of "D" - the actual pedestrian delay time

This information is developed in a second field survey based on the information obtained in the Pedestrian Group Size Study.

Before the field survey is made to determine pedestrian delay time at the location under study, it is necessary to find the minimum length (in seconds) of a gap in traffic which will permit an 85th-percentile group of pedestrians to cross a roadway of specified width. This minimum gap in traffic, known as the Adequate Gap Time (G), includes both the perception-reaction time and the time needed to walk across the roadway without coming into conflict with passing vehicles.

The Adequate Gap Time may be selected from the table in Exhibit No. A-2, or it may be computed using the following equation. In either case, the values for "W" and "N" are those determined in the Pedestrian Group Size Study.

Adequate Gap Time - G (in seconds) = $\frac{W}{3.5} + 3 + (N - 1)2$ where: W divided by 3.5 = Walking Time - the number of seconds required to walk across the roadway. This value is equal to the width of roadway (W) in feet, divided by the walking speed in feet per second (assumed to be 3.5 ft./sec.).

3 = Perception and Reaction Time - The number of seconds required for a child to look both ways, make a decision, and commence to walk across the street. This interval is assumed to be 3 seconds.

(N - 1)2 = Pedestrian Clearance Time - additional seconds of time required to clear large groups of children from the roadway. Children are assumed to cross the roadway in rows of five with two-second time intervals between each row. The clearance time interval is equal to (N - 1)2 where N is the number of rows, 1 represents the first row, and 2 is the time interval between rows.

TABLE OF ADEQUATE GAP TIMES
(in seconds)

Roadway Width - "W"	Number of Rows - "N"									
	1	2	3	4	5	6	7	8	9	10
16 - 19	8	10	12	14	16	18	20	22	24	26
20 - 22	9	11	13	15	17	19	21	23	25	27
23 - 26	10	12	14	16	18	20	22	24	26	28
27 - 29	11	13	15	17	19	21	23	25	27	29
30 - 33	12	14	16	18	20	22	24	26	28	30
34 - 36	13	15	17	19	21	23	25	27	29	31
37 - 40	14	16	18	20	22	24	26	28	30	32
41 - 43	15	17	19	21	23	25	27	29	31	33
44 - 47	16	18	20	22	24	26	28	30	32	34
48 - 50	17	19	21	23	25	27	29	31	33	35
51 - 54	18	20	22	24	26	28	30	32	34	36
55 - 57	19	21	23	25	27	29	31	33	35	37
58 - 61	20	22	24	26	28	30	32	34	36	38
65 - 68	22	24	26	28	30	32	34	36	38	40
75 - 80	25	27	29	31	33	35	37	39	41	43

Exhibit No. A-2

4. Pedestrian Delay Time Field Study. After the Adequate Gap Time has been selected, the field study to determine the actual delay time to pedestrians caused by passing traffic can be undertaken. This study actually measures the time intervals between passing vehicles. Those intervals or traffic gaps that are equal to or greater than the Adequate Gap Time are the periods during which children must cross the roadway. The intervals between these gaps are the delay periods, the sum of which is the Actual Pedestrian Delay.

Either of the following methods may be used to determine the gaps in the traffic stream. If the entire roadway must be crossed once the pedestrian leaves the curb, traffic flow in all lanes regardless of direction must be considered together.

a. The Graphic Recorder Method - A graphic recorder similar to the Esterline-Angus recorder is used. The pen on the recorder may be actuated by a radar speedmeter aimed at passing traffic or a manually-operated pushbutton arrangement. Passing vehicles are recorded on the moving tape of the recorder as a series of sharp peaks. Traffic gaps are measured in seconds of time from one peak to the next peak. The total time of all gaps (t) which is equal to or greater than the Adequate Gap Time (G), and the total time of survey are used in the analysis of the crossing.

Upon completion of the survey, the form suggested in Exhibit No. A-3 can be used to tally the results.

b. The Metronome Method - This method makes use of a mechanical or electrical metronome, which marks time by a ticking sound. Electrical metronomes, which usually can be constructed in the traffic signal workshop, require an inverter to adapt the power from the car battery. Traffic gaps are measured with the metronome by ear and sight. The instrument is set for one-second click intervals. The field observer counts the number of clicks between passing vehicles. In this way, the length of all gaps which are equal to or greater than the Adequate Gap Time (G) is measured and recorded; lesser gaps are discarded. The form suggested in Exhibit No. A-3 can be used as a field sheet for this purpose. The overall survey time is also recorded. The metronome method of survey is recommended because of its simplicity and its low cost in equipment and manpower.

PEDESTRIAN DELAY TIME STUDY

Study date 5/11/62 Location 4th and D Crosswalk across D Street

End of Survey (to nearest minute) 9:57 am | Number of Rows - "N" 6

Start of Survey (to nearest minute) 9:02 am | Roadway Width - "W" 40 ft.

Total Survey Time (minutes) 55 | Adequate Gap Time - "G" 24 secs.

Gap Size (Seconds)	Number of Gaps Tally	Number of Gaps Total	Multiply by Gap Size	Computations
8				
9				
10				
11				
12				
13				
14				
15	Discard gaps of less than 24 seconds from study.			
16				
17				
18				
19				
20				
21				
22				
23				
24	/	1	24	
25	////	4	100	
26	///	3	78	T = Total survey time x 60
27	//	2	54	
28	/	1	28	
29	///	3	87	T = 55 x 60
30	////	5	150	
31	//	2	62	
32	////	4	128	T = 3300 secs.
33		0	—	
34	///	3	102	
35	////	4	140	
36		0	—	
37	/	1	37	$D = \left(\frac{T - t}{T}\right) 100$
38				
39				$D = \left(\frac{3300 - 770}{3300}\right) 100$
40				
41				$D = 70$
42				
43				
"t" (total time of all gaps equal or greater than "G")			770 secs.	D = 70 %

Exhibit No. A-3

The survey should be conducted immediately before or after the period in which children are using the crosswalk, so that they will not affect the vehicular traffic pattern. At least two surveys should be made, in the morning and in the afternoon, of the heaviest traffic weekday. Additional surveys may be necessary to verify results.

5. Computation of Actual Pedestrian Delay. When the field survey is completed, the total time of all gaps in which pedestrians could cross is found by adding the length, in seconds, of each gap which was equal to or greater than the Adequate Gap Time (G). This figure is known as "t" and is subtracted from the total survey time is seconds (T). The following equation is then used to determine the percentage of actual pedestrian delay:

$$\text{Actual Pedestrian Delay - D (in \%)} = \frac{(T-t)}{T}100$$

APPENDIX B

Determination of the Need for Traffic Control at School Crossings

The need for some special form of protection can be determined by using Exhibit B-1. By plotting the percent pedestrian delay (D) on the horizontal axis and the width of street (W) on the vertical axis, a point will be found in relation to the appropriate pedestrian group line (N).

a. If the point is to the left of the line for the pedestrian group size being considered, no special form of traffic control is needed. However, certain signs, markings, parking restrictions, and special speed zones may be appropriate, as described later. (Point "A" on Exhibit B-1 is an illustration of this situation).

b. On the other hand, if the point is to the right of the line for the pedestrian group size (as indicated by point "B" on Exhibit B-1) some special form of control, such as described later, will be needed.

Note that this analysis does not identify the measure which will alleviate the hazard. It does, however, separate those locations for which special controls should be provided from those locations which need little or no treatment, based on a factual study of actual conditions. Furthermore, an indication of priority can be obtained by noting how far to the right a point is in relation to its group size (N number). For example, let points "P" and "Q" represent two locations where the following field conditions exist:

P	Q
N = 6	N = 1
W = 40'	W = 55'
D = 70%	D = 70%

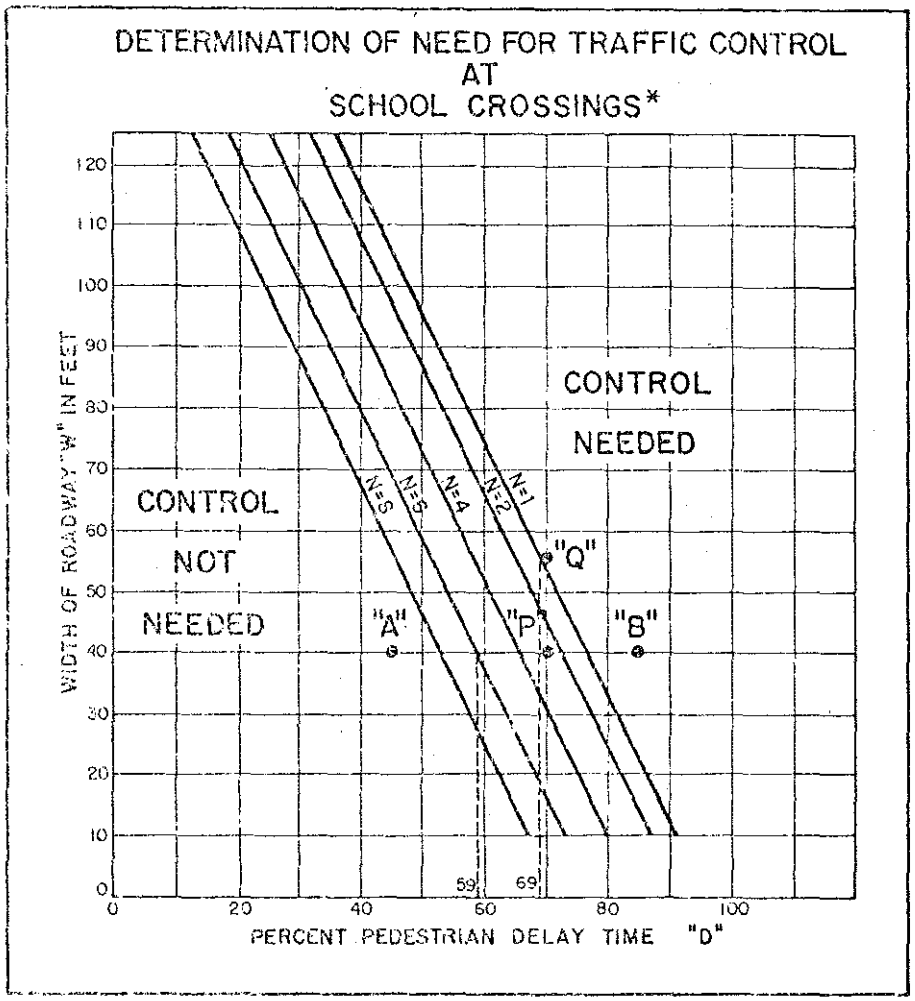


Exhibit B-1

The borderline between control needed and not needed occurs at D = 59% (N = 6) for location "P," a difference of 11 from the situation as measured in the field. For location "Q" the corresponding difference is 1. Therefore, this would indicate that conditions at "P" are more serious and should be corrected first.

APPENDIX C

Analysis of School Crossings at Signalized Intersections

In the body of this booklet, the analysis has assumed that traffic control signals have not been installed at the location under study. However, certain school crossings may be located at complicated and congested signalized intersections where heavy turning movements create confusion and hazard, particularly for small children. Special controls of the type discussed earlier may be necessary to assist children at these locations.

Hazard is created as right- and left-turning vehicles (moving on the same green signal interval as the children) traverse the pedestrian crosswalk being used by the children. This hazard is determined by measuring those gaps which are equal to or greater than the Adequate Gap Time (G) in the traffic turning across the crosswalk. In this instance, the width of roadway (W) is equal to one-half of the roadway, since the children are "protected" on the other half by vehicles waiting for the green light on the cross street. Except for one further consideration, the need for additional traffic control is calculated in the same manner and with the same equations used previously.

The additional item of information which must be considered is the cycle length of the traffic control signals. The cycle length is the factor "C" in the following equation for the family of lines which appear on the graph in Exhibit B-1.

$$D_a = \frac{(C - G)100}{C}$$

Where D_a = Allowable Pedestrian Delay Time (in percent)

C = Cycle Length

G = Adequate Gap Time

Since $G = \frac{W}{3.5} + 3 + (N - 1)2$,

the equation can be written as:

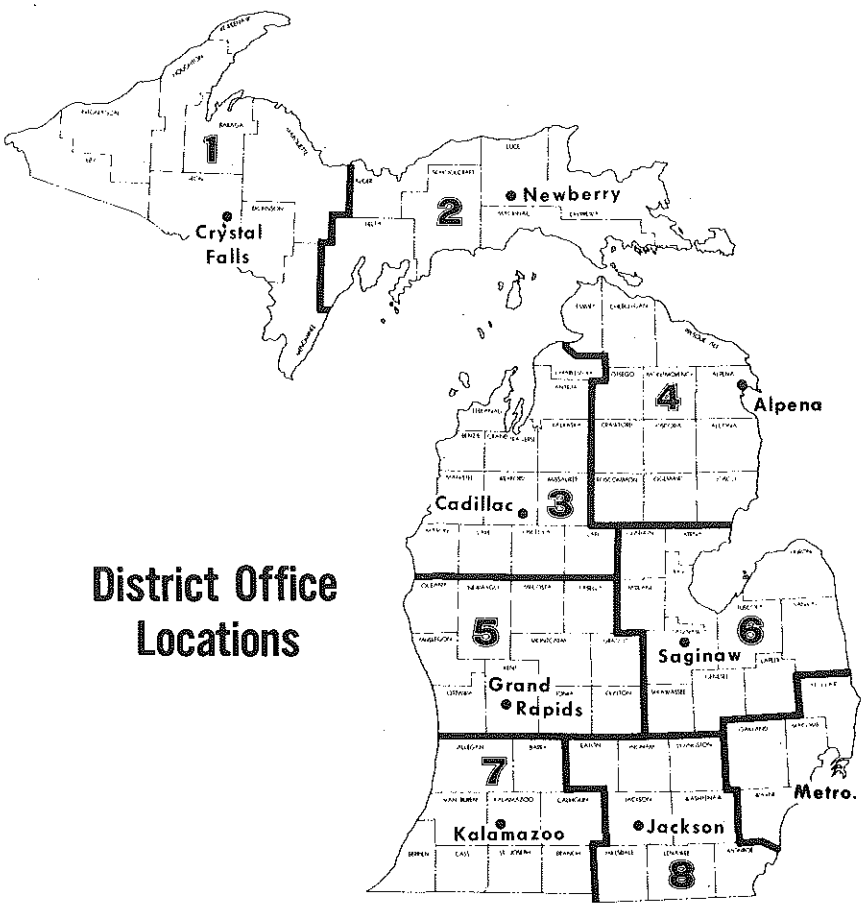
$$D_a = 1 - \frac{\frac{W}{3.5} + 3 + (N - 1)2}{C} \quad 100$$

"D_a," which by definition is the maximum delay time that is acceptable to a pedestrian, is equivalent to the green and yellow vehicle signal interval of a hypothetical traffic signal. The Adequate Gap Time (G) is used as the green and yellow signal interval of the pedestrian phase. The Allowable Delay Time is found by subtracting the Adequate Gap Time from the signal cycle (C).

In developing the graph in Exhibit B-1, "C" was assumed to be 60 seconds. At a signalized intersection, if "C" does not equal 60, it will be necessary to calculate "D_a" using the above equation.

To determine whether or not a special form of protection or control is needed, the calculated "D_a" is compared with "D", the actual percentage of pedestrian delay, as found by field studies. If "D" is less than "D_a" no special steps need be taken. Conversely, if "D" is greater than "D_a", one or more of the control or warning measures set forth may be appropriate.

Note that in cases where "D" is greater than "D_a" the difference can be used to set priorities for undertaking installation of controls among several locations.



District Office Locations

Addresses - District Traffic Engineers

District 1	Earl L. Martin 336 Superior Avenue Crystal Falls (49920) (906) 875-6651
District 2	Paul A. Michelin 405 Newberry Avenue Newberry (49868) (906) 293-5168
District 3	Bruce A. Conradson 100 East Chapin Street Cadillac (49601) (616) 775-3487
District 4	Fred I. Eggan 3022 South US-23 Alpena (49707) (517) 356-2231
District 5	Michael L. Jones 1420 Front Street, N.W. Grand Rapids (49504) (616) 451-3091
District 6	David Van Hine P. O. Box 990 55 Morley Drive Saginaw (48606) (517) 754-7443
District 7	Edwin H. Miller 7545 South Westnedge (Box 6) Portage (49081) (616) 327-3054
District 8	Larry V. Suboski Two North Plaza Jackson (49202) (517) 784-7172
Metro District (including Wayne, Oakland, Macomb, and St. Clair Counties)	Paul J. Riley P. O. Box 1226 18101 Nine Mile Road Southfield (48075) (313) 569-3993