

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

DEVELOPMENT OF AN INTERNALLY  
ILLUMINATED SCHOOL SPEED LIMIT SIGN

TSD-TR-127-70

By

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Traffic Research Section  
Traffic & Safety Division

March 1970

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## ABSTRACT

To evaluate effectiveness of the Internally Illuminated School Speed Limit Sign, speed studies were taken comparing its operation against the Department's standard 36 inch by 36 inch (W9-1-36) non-reflective school sign, with and without flashers.

Based on the results, the Internally Illuminated Speed Sign was judged superior in reducing vehicle speed over the standard 36 inch by 36 inch (W9-1-36) school signs, when school children are present. This can be expected due to the physical characteristics of the Internally Illuminated Sign.

In general, the presence of school children, within the physical area of the school, reduced vehicle speeds significantly as compared to the use of each of the three type signs.

The proper use of the Internally Illuminated School Speed Limit Sign reduces school childrens' exposure to traffic hazards and is recommended for future use.

## INTRODUCTION

Michigan does not use a standard legal speed limit for all school zones. The realization that a reduced speed is necessary when children are present along a trunkline, during school hours, has required the establishment of school speed limits to fit the individual zone.

Establishing a school speed control zone by legislative act is unsatisfactory since the average motorist, while willing to conform to the posted speed limit during school crossing hours, is not willing to drive at such speed when he feels the crossing is not being used.

A Traffic Control Device is required to display a message to the motorist only when children are present. Such a device should alert the motorist at a point sufficiently in advance of the school, and it should display a speed legend which disappears when the sign is inoperative.

The Michigan Department of State Highways has recently been granted a patent on an internally illuminated, disappearing legend School Speed Limit Sign. The sign was developed and a patent applied for by the Department to enable all sign producers to bid on and manufacture the sign.

## SIGN DESIGN AND OPERATION

The overall dimensions of the sign are approximately four feet by six feet displaying a non-reflective black-on-white "School Speed Limit" message which is visible at all times.

The changeable speed message is a disappearing type legend which is blanked out by the use of a louvered screen when the message is not illuminated. The matrix board displays a changeable speed message in 16 inch high numerals using 27 watt yellow incandescent lamps. This makes the sign very effective since the motorists cannot see the speed message until the sign is activated. The entire matrix panel can be quickly removed for maintenance or changing speed message.

Two eight inch amber vehicular traffic signal heads are mounted horizontally on top of the sign and flash alternately, when the sign is activated, to attract the motorist's attention before he can read the speed message.

The sign is illuminated only during those hours when children are present near the school or crossing. The sign is usually controlled by a crossing guard or school official. Motorists become accustomed to children being present when the sign is illuminated and reduce speeds of their vehicles when they see the sign in operation.

It is of the utmost importance that the sign be activated only when the children are coming and going from school. This does not and should not include hours when school is in session. For maximum effectiveness, the motorists must realize that the sign operates only when the children are being exposed to traffic.

#### PREVIOUS STUDIES

Since the early 1950's, Michigan Traffic Engineers have realized the need for special devices to control speed limits at school crossings on state trunklines.

The first such sign was developed in 1955, field tested, and became an operative item (School Speed Limit Sign - 1955 by E. F. Gervais).

In 1960 it became apparent, with increasing traffic and new type components such as lamps, that the School Speed Limit Sign needed updating to meet present traffic and school crossing needs.

A new sign was developed, fabricated and installed at a trunkline school crossing. A group of 100 vehicle speed samples each were taken, comparing only the vehicle speeds with the sign on against the sign off. Results are shown in Table #1.

TABLE #1

Summary of Speed Studies taken at M-78 and Hitching  
Post Road (85th percentile speeds)

Date Speed Study Taken	Legal Speed	Station		School Speed Limit Sign Operation
		E.BD.	W.BD.	
Jan. 1964	50	51.8	52.5	Illuminated Sign OFF
	35	44.5	43.3	Illuminated Sign ON
April 1964	50	50.2	51.1	Illuminated Sign OFF
	35	43.0	45.8	Illuminated Sign ON

January Test - Prototype MDSH Illuminated School Speed  
Limit Sign - Flashers mounted vertically.

April Test - Final design MDSH Illuminated School Speed  
Limit Sign - Flashers mounted horizontally  
at top of sign.

Following is a summary of a statistical test on the 85th  
percentile speeds:

The reduction in vehicle speeds experienced by using the  
blankout sign was highly significant over speeds recorded  
with the sign off. The presence of children was not con-  
sidered.

There was no significant difference when comparing the  
January speeds vs. April speeds. Therefore, the sign design,  
using horizontal mounted flashers at top of sign, was chosen  
as the Department Standard since this design could be patented.

## RESEARCH PROCEDURE

A comprehensive study was undertaken at locations in three Michigan cities, Grand Rapids, Escanaba, and Gladstone, to collect and analyze vehicle speeds under the following conditions:

1. Using the standard 36 inch x 36 inch school sign.
2. Using the standard 36 inch x 36 inch school sign with flashers.
3. Using the newly developed blankout sign.

Each type sign was tested alone for its effects on reducing vehicle speeds. Each type sign was also tested with children present to evaluate effects presence of children have on reducing vehicle speeds.

Sign types were also compared under the above conditions.

Vehicle speeds were collected at selected points within the study areas by the standard 100 vehicle random sample method using a radar speed detector.

Speeds were recorded under similar weather condition, testing each type sign and the effects of children being present upon traffic speeds. Speeds were also sampled with children not present and signs activated. However, children were never exposed to traffic with the sign turned off.



## OBJECTIVES

The objectives are to show benefits of internally illuminated disappearing legend sign over other type signs studied by reduced speeds, and to test if presence of children had a greater effect on reducing speeds than the use of the signs.

DATA COLLECTION

GRAND RAPIDS

Set #1 (9-23-64)  
36 inch x 36 inch  
Non Reflective  
"School" Sign #W9-1-36



Set #2 (10-25-65)  
Internally Illuminated  
School Speed Limit Sign  
(See Picture #1)

Set #3 (1-20-66)  
Internally Illuminated  
School Speed Limit Sign  
(See Picture #1)

Location As Listed On Drawing

Ae - 400 feet in advance of school

Be, Bw - At school crossing

Cw - 800 feet in advance of school

Sign Conditions

A - Children Present

B - Children in Class

C - Sign on (in Set #1, Sign Always Considered On)

D - Sign Off

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GRAND RAPIDS

LOCATION	CONDITION	POSTED			SET #3	VARIABLE SPEED LIMITS FOR SETS #2 & #3
		SPEED	LIMIT	SET #1		
Ae	A-C			43.9	34.3	33.9
	B-C	35		43.5	----	34.8
	B-D			----	44.2	43.2
Be	A-C			41.8	34.4	32.8
	B-C	35		43.2	38.3	31.9
	B-D			----	42.7	36.6
Bw	A-C			38.8	39.8	33.3
	B-C	35		----	38.1	37.7
	B-D			----	39.7	39.7
Cw	A-C			33.5	33.6	27.5
	B-C	35		35.9	----	29.7
	B-D			----	37.4	30.7

Each speed is the 85th percentile computed  
from a 100 vehicle sample.

29 x 100 = 2900 Vehicle Sample.

ESCANABA

Set #1 (10-21-64)  
36 inch x 36 inch  
Non Reflective  
"School" Sign #W9-1-36



Set #2 (11-11-64)  
36 inch x 36 inch  
Non Reflective  
"School" Sign #W9-1-36  
With Flashers



Set #3 (9-28-65)  
Internally Illuminated  
School Speed Limit Sign  
(See Picture #1)

Location As Listed on Drawing

- An - 1300 feet in advance of school
- As - 800 feet in advance of school
- Bn - 450 feet in advance of school
- Bs - School Crossing
- Cn - School Crossing
- Cs - 200 feet in advance of school
- Dn - 250 feet in advance of school
- Ds - 250 feet beyond school

Sign Conditions

- A - Children Present
- B - Children in Class
- C - Sign on (in Set #1, Sign Always Considered On)
- D - Sign Off

ESCANABA

LOCATION	CONDITION	POSTED			VARIABLE SPEED LIMITS FOR SETS #2 & #3
		SPEED LIMIT	SET #1	SET#2	
An	A-C	45	42.7	46.8	41.8
	B-C		48.1	48.5	42.0
	B-D		----	----	45.3
As	A-C	35	44.8	42.8	33.8
	B-C		44.6	49.3	38.7
	B-D		----	----	----
Bn	A-C	45	44.6	46.0	39.7
	B-C		42.8	48.3	42.5
	B-D		----	----	45.0
Bs	A-C	35	39.3	39.6	36.7
	B-C		40.3	46.0	37.4
	B-D		----	----	39.3
Cn	A-C	35	41.3	39.8	39.1
	B-C		43.6	46.4	42.5
	B-D		----	----	44.8
Cs	A-C	35	39.0	43.1	39.3
	B-C		44.5	46.7	37.9
	B-D		----	----	44.8
Dn	A-C	35	39.4	46.2	37.3
	B-C		41.4	46.7	37.5
	B-D		----	----	47.2
Ds	A-C	35	39.6	44.8	39.3
	B-C		42.5	44.1	38.1
	B-D		----	----	44.6

Each speed is the 85th percentile speed computed from a 100 vehicle sample.

7 x 8 - 56 x 100 - 5600 vehicle sample (total)

GLADSTONE

Set #1 (10-22-64)  
36 inch x 36 inch  
Non Reflective  
"School" Sign #W9-1-36



Set #2 (11-22-64)  
36 inch x 36 inch  
Non Reflective  
"School" Sign #W9-1-36  
With Flashers



Set #3 (9-26-65)  
Internally Illuminated  
School Speed Limit Sign  
(See Picture #1)

Location As Listed On Drawing

An - 700 feet in advance of school

As - 500 feet in advance of school

Bn - 300 feet in advance of school

Bs - 100 feet in advance of school

Sign Conditions

A - Children Present

B - Children in Class

C - Sign on (in Set #1, Sign Always Considered On)

D - Sign Off

GLADSTONE

LOCATION	CONDITION	POSTED			VARIABLE SPEED LIMIT FOR SETS #2 & #3
		SPEED LIMIT	SET #1	SET #2	
An	A-C		49.5	52.2	44.3
	B-C	65	50.0	57.1	44.3
	B-D		----	----	54.7
As	A-C		57.3	52.9	44.9
	B-C	65	56.1	53.3	45.0
	B-D		----	----	54.1
Bn	A-C		48.8	46.4	42.0
	B-C	65	52.2	55.0	44.7
	B-D		----	----	51.9
Bs	A-C		52.1	46.9	38.3
	B-C	65	53.0	50.8	44.6
	B-D		----	----	53.5

Each speed is the 85th percentile speed computed from a 100 vehicle sample.

7 x 4 = 28 x 100 = 2800 vehicle sample.

## DATA ANALYSIS

The test for significance was accomplished by the limiting distribution of the Wilcoxon Test.

One hundred observations were taken under each condition. The observations were grouped in 5 m.p.h. increments as is customary.

The Mann Whitney statistics was defined for comparisons of two conditions,  $X_i$   $Y_j$   $i, j = 1, \dots, 100$  as

$$Z_{ij} = \begin{cases} 1 & X_i < Y_j \\ \frac{1}{2} & X_i = Y_j \\ 0 & X_i > Y_j \end{cases}$$

for all pairs  $(X_i, Y_j)$

The mean  $Z_{ij}$  under this listing is 5000 for each comparison.

The variance was determined by the usual formula and corrected for ties by the factor  $.0209 \sum_{k=1}^e (t_k^3 - t_k)$  where  $e =$  number of non-zero 5 m.p.h. categories

$$t_k = X_k + Y_k \text{ where } X_k \text{ and } Y_k \text{ are the observations listed in the } k\text{th category}$$

$$W = \frac{\sum \sum Z_{ij} - 5000}{160.450 - .0209 \sum_{x=1}^e (t_k^3 - t_k)}$$



An observation was said to be significant if

$$2 < W < 3$$

and highly significant if

$$W > 3$$

Explanation of data contained in each column:

LOCATION

- Location listed on respective drawing where speed samples were taken.

STATISTICAL ANALYSIS

- First column is the "sum of the rank's." Second column is the asymptotic Standard Deviation of the ranks (under the Null Hypothesis-mean rank is 5000)

SPEED CHANGE IN MPH

- Represents a reduction in speeds between the two conditions (a negative number represents an increase in speed).

GRAND RAPIDS

Set #1 Children Present Vs. Children Not Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE MPH</u>	<u>SIGNIFICANCE</u>
AE	542	398	- .4	Not Significant
BE	1092	396	1.4	Significant
CW	- 611	388	-2.4	Not Significant

Av. of All Location 1.13

Using the standard W9-1-36 School Sign there was no speed reduction at the outer limits, but children present at the school caused a significant speed reduction over the sign alone.

GRAND RAPIDS

Set #1 Vs. Set #3 - Children Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE MPH</u>	<u>SIGNIFICANCE</u>
AE	8218	400	10.0	Highly Significant
BE	8516	400	9.0	Highly Significant
BW	6769	394	5.5	Highly Significant
CW	7931	377	4.3	Highly Significant
Av. BE & BW				7.35
Av. of All Locations				7.2

The Internally Illuminated School Speed Limit Sign provides a highly significant reduction in speeds, at all locations, over the standard W9-1-36 School Sign, with children present.

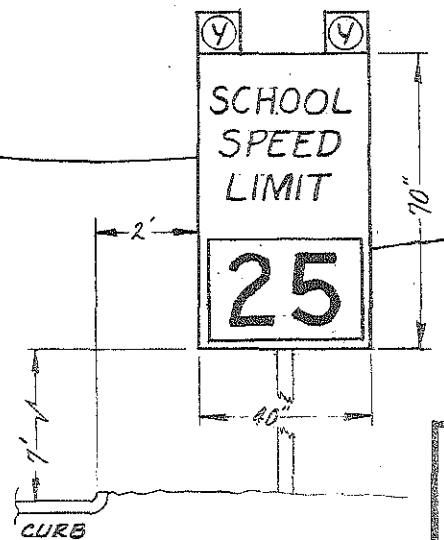
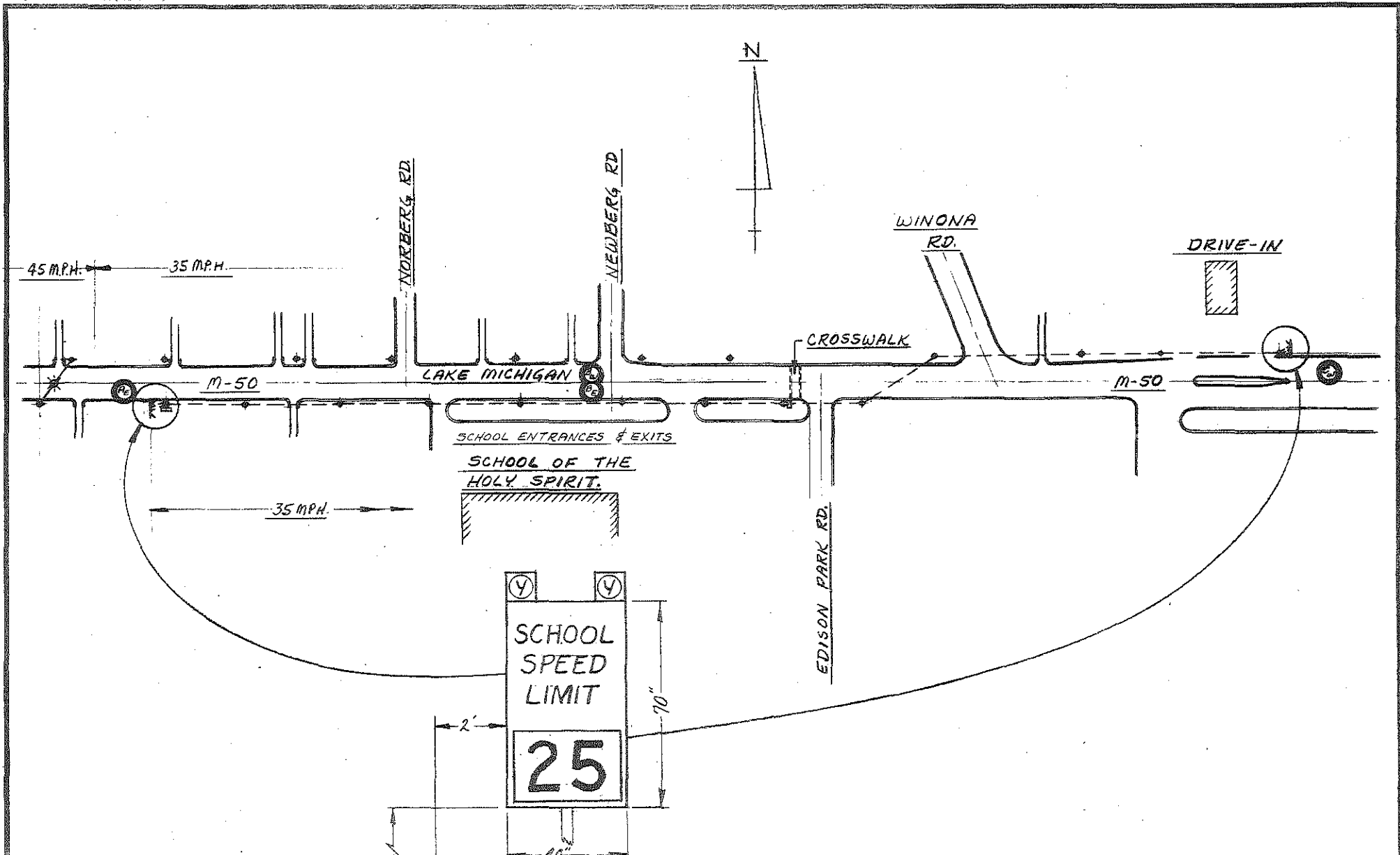
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GRAND RAPIDS

Set #3 - Children Present Vs. Children Not Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE</u> <u>MPH</u>	<u>SIGNIFICANCE</u>
AE	4388.5	392.8	.9	Not Significant
BE	5439.5	379	- .9	Not Significant
BW	3095	394.5	4.4	Highly Significant
CW	3858	343	2.2	Significant
		Av. BE & BW		1.7
		Av. of All Locations		1.6

Comparing the Internally Illuminated School Speed Limit Sign with children present vs. not present, shows no significant reduction in eastbound vehicle speed and a significant speed reduction with children present in the westbound direction. This suggests some unknown condition may have existed to effect vehicle speeds and/or errors in speed samples.



STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC DIVISION	AUTH. NO.	DRAWN W.C.G.	M-50 (LAKE MICHIGAN DR.) AT NEWBERG RD. CITY OF GRAND RAPIDS KENT CO.
	CDT. SEC.	DATE 1-31-68	
	REP.	SCALE 1" = 120'	
	SHEET OF	PLAN	

ESCANABA

Set #1 - Children Present Vs. Children Not Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE MPH</u>	<u>SIGNIFICANCE</u>
AN	6488	395	5.4	Highly Significant
AS	4411	395	-2	Not Significant
BN	4308.5	393	-1.8	Not Significant
BS	5217	394	1	Not Significant
CN	4400	399	2.3	Not Significant
CS	3507.5	398.5	5.5	Highly Significant
DN	3809	397	2	Significant
DS	4988.5	398	2.9	Not Significant
		Av. CN & CS	3.9	
		Av. of All	1.9	

In general, children present near the school crossing had no significant effect on reducing speed when compared to the W9-1-36 sign. However, at the outer limits of study area, children had significant effect in reducing speeds.

ESCANABA

Set #2 - Children Present Vs. Children Not Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE MPH</u>	<u>SIGNIFICANCE</u>
AN	4032	398	1.7	Significant
AS	2453	398.5	6.5	Highly Significant
BN	3308	397	2.3	Highly Significant
BS	2513	397	6.4	Highly Significant
CN	3639	397.8	6.6	Highly Significant
CS	4483	400	3.6	Not Significant
DN	4977	398	.5	Not Significant
DS	4951	398.7	- .7	Not Significant
		Av. CN & CS	5.1	
		Av. of All	3.3	

Using the standard W9-1-36 School Sign, with flashers, speeds were significantly reduced when the children were present at the study zone limits and at the school crossing.

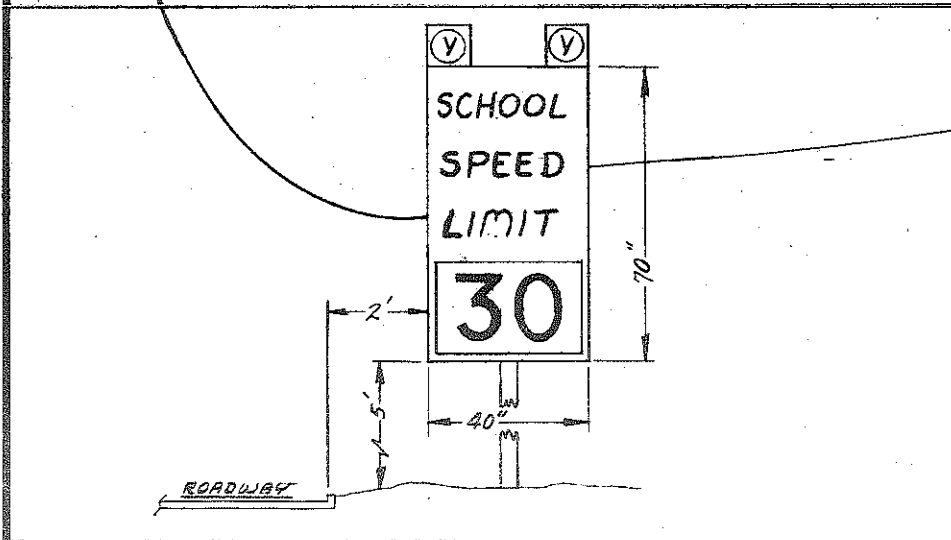
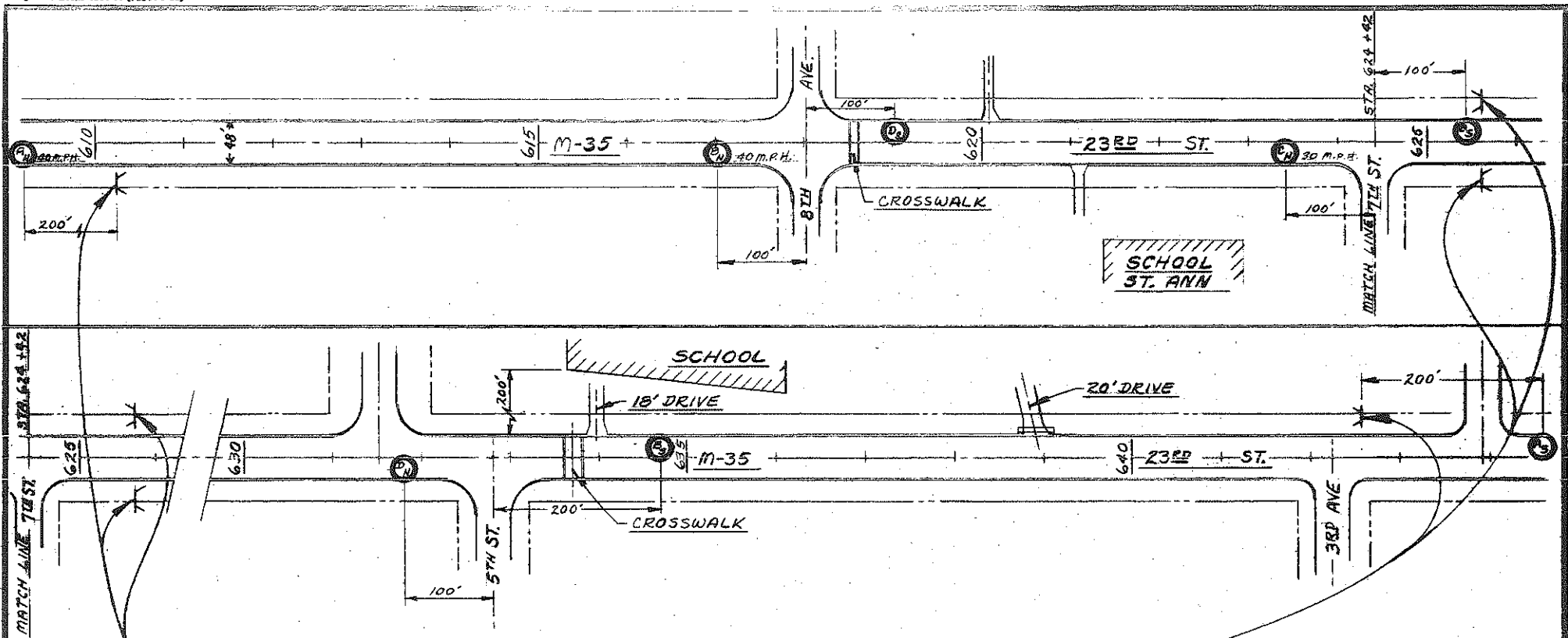
ESCANABA

Set #3 - Children Present Vs. Children Not Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE MPH</u>	<u>SIGNIFICANCE</u>
AN	5477.5	397.5	.2	Not Significant
AS	2622	390	4.9	Highly Significant
BN	4101.5	394	2.8	Significant
BS	5438	309	.7	Not Significant
CN	4474	396	3.4	Highly Significant
CS	5426.5	393.5	1.4	Significant
DN	4382	392	.2	Not Significant
DS	4613.5	397	-1.2	Not Significant
		Av. CN & CS		2.4
		Av. of All		1.5

Using the Internally Illuminated School Speed Limit, in four of the eight locations, speeds were significantly reduced by the presence of children, and generally within the physical area of the school.





STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS		APPROV. NO.	DRAWN <i>W.C.G.</i>
TRAFFIC DIVISION		CONT. SEC.	DATE 2-6-68
		REP.	SCALE 1" = 120'
		SHEET OF	PLAN
			<b>SCHOOL SIGN INSTALLATION</b> M-35 (23RD ST.) AT 5TH ST. CITY OF ESCANABA - DELTA COUNTY

GLADSTONE

Set #1 - Children Present Vs. Children Not Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE MPH</u>	<u>SIGNIFICANCE</u>
AN	4840	396	.5	Not Significant
AS	5000	398	-1.2	Not Significant
BN	4186	400	3.4	Highly Significant
BS	4320.5	390	.9	Significant
		Av. BS & BN		2.1
		Av. of All Location		.9

Using the standard W9-1-36 School Sign, there was no reduction at the outer limits, but children present at the school caused a significant speed reduction.

GLADSTONE

Set #2 - Children Present Vs. Children Not Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE MPH</u>	<u>SIGNIFICANCE</u>
AN	3782	402.5	4.9	Highly Significant
AS	4926	399.5	.4	Not Significant
BN	3746	400	8.6	Highly Significant
BS	7121	400	3.9	Highly Significant
		Av. BN & BS		6.25
		Av. of All Locations		4.45

In three of the four locations, children present, with the W9-1-36 sign with flashers, caused a highly significant reduction in vehicle speed compared to the W9-1-36 School Sign with flasher, by itself.

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GLADSTONE

Set #2 Vs. Set #3 - Children Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE</u> <u>MPH</u>	<u>SIGNIFICANCE</u>
AN	7529	401.5	7.9	Highly Significant
AS	7768	399	8.0	Highly Significant
BN	6519	400	4.4	Highly Significant
BS	7652	400	8.6	Highly Significant
		Av. BN & BS		6.5
		Av. of All Locations		7.2

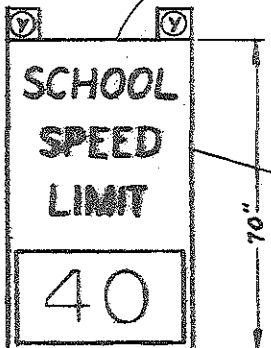
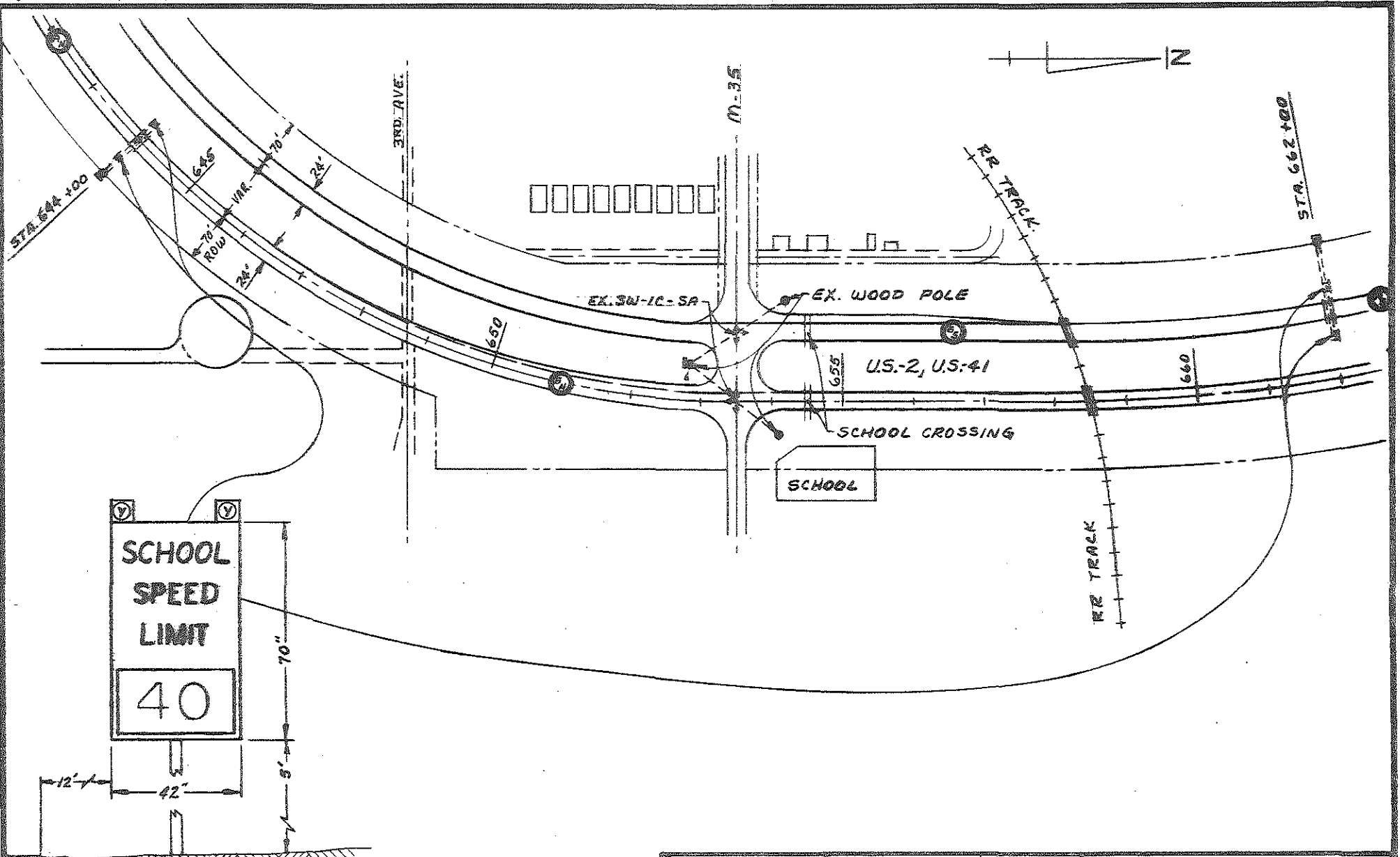
The Internally Illuminated School Speed Limit Sign shows a highly significant reduction in vehicle speeds, as compared to the W9-1-36 school sign with flashers, with children present.

GLADSTONE

Set #3 - Children Present Vs. Children Not Present

<u>LOCATION</u>	<u>STATISTICAL ANALYSIS</u>		<u>SPEED CHANGE MPH</u>	<u>SIGNIFICANCE</u>
AN	4598.5	396.5	0	Not Significant
AS	6777	394	.1	Not Significant
BN	3838	399	2.7	Significant
BS	2675	398.9	6.3	Highly Significant
		Av. BN & BS		4.5
		Av. of All Locations		2.25

Using the Internally Illuminated Sign, speeds were not significantly reduced at outer limits with children present, but at the school children present caused a significant speed reduction.



ROADWAY

MICHIGAN STATE HIGHWAY DEPARTMENT TRAFFIC DIVISION	AUTH. NO.	DRAWN	<b>SCHOOL SPEED LIMIT                  INSTALLATION</b> U.S.-2, U.S.-41 AT M-35 CITY OF GLOUCESTER DELTA CO.
	CONT. SEC.	DATE	
	REF.	SCALE	
	SHEET OF	PLAN	

## CONCLUSIONS AND RECOMMENDATIONS

At Grand Rapids and Gladstone, the presence of children significantly reduced speeds within the school crossing area when compared to the School Sign W9-1-36 and W9-1-36 with flashers only.

At Escanaba, children present at outer limits of the study zone significantly reduced speeds when compared to the W9-1-36 and W9-1-36 with flashers alone. This may be attributed to the physical conditions of the two schools closely located and the longer school zone.

The presence of children within the physical area of a school generally reduced vehicle speeds significantly over use of the illuminated sign alone. However, at outer area of school zones, the illuminated sign generally was more effective.

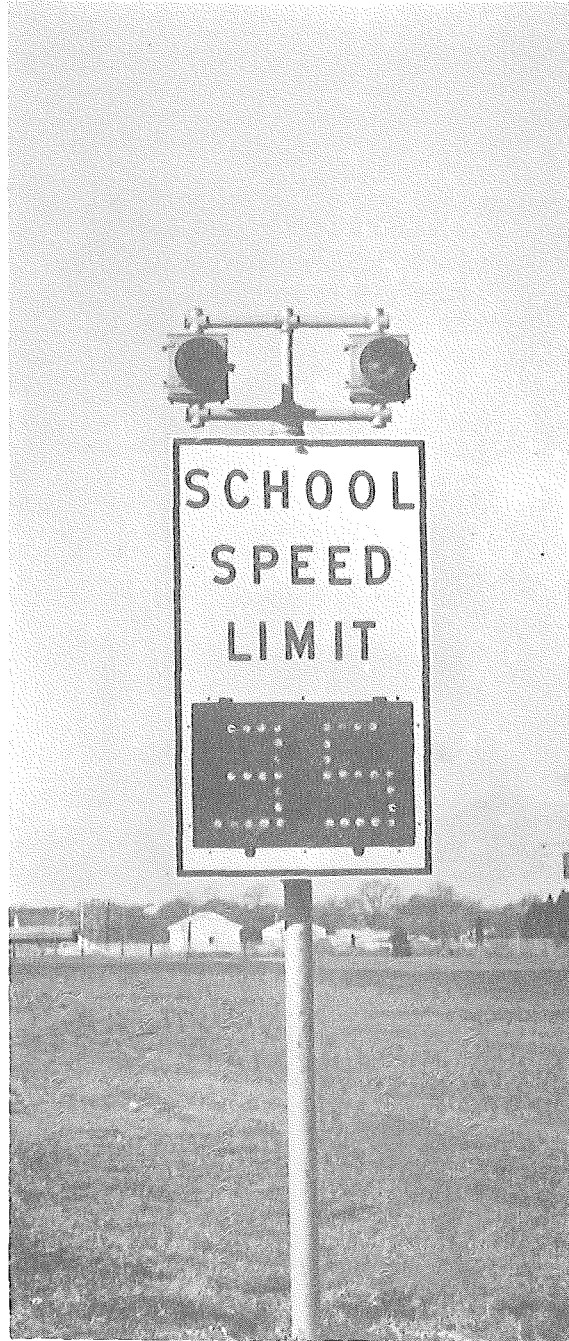
It should be noted that speeds taken with the signs in the "on" mode, and children in school, may have influenced the results since local drivers were familiar with school hours. The correct method to study true effects of children vs. sign alone would be to take vehicle speeds with children present, and without the school sign. However, this was not practical due to exposure of children to traffic.

Based on the results, the internally illuminated disappearing legend sign was judged superior in reducing vehicle speeds over the W9-1-36 and W9-1-36 with flashers, with children present.

A definite reduction in vehicle speed can be expected by the proper use of the illuminated sign. Positive results can only be expected when installations are operated on a strict schedule.

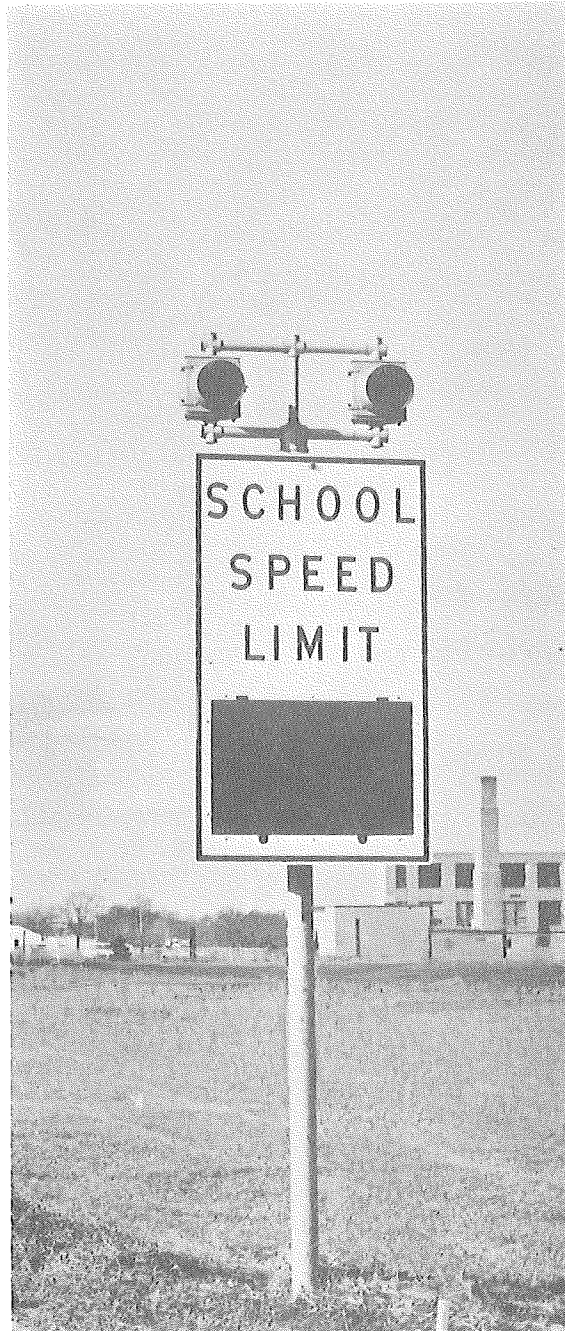
Although the extent of school crossing accidents involving children is small when compared to the total accident picture, any efforts in this area to reduce the child's exposure to traffic is worthwhile. The proper use of the internally illuminated school speed limit sign reduces school children's exposure to traffic hazards and should be encouraged for future installations.





Picture #1 - Internally Illuminated  
Sign in "on" mode

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Picture #2 - Internally Illuminated  
Sign in "off" mode