EVALUATION OF CHEVRON PATTERNS FOR USE ON TRAFFIC CONTROL DEVICES IN STREET AND HIGHWAY WORK ZONES

by

Benjamin H. Cottrell, Jr.
Highway Research Scientist

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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ABSTRACT

The chevron pattern consists of alternate orange and white stripes that form an arrow pointing in the direction in which traffic is being diverted. The objectives of this research were (1) to select the most effective design for the chevron pattern, and (2) to evaluate the effectiveness of selected chevron designs under road conditions as compared to presently used designs.

The most effective chevron pattern was selected by a subjective rating of groups of patterns used on channelizing devices. In general, the selected chevron designs were preferred over the presently used patterns. A black stripe separating the orange and white stripes proved effective in reducing haloation.

The measure of performance used in the field tests was the position of lane changing relative to the transition taper. It was found that driver response was not strongly dependent on the channelizing device employed in the taper. The subjective evaluation revealed the chevron patterns to be preferred over the presently used patterns because of their clear directional message.

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INTRODUCTION AND PROBLEM

A total system of traffic control devices is installed to assure smooth, safe vehicular movement in the vicinity of street and highway work zones. Barricades and channelizing devices, essential elements in the total system, are employed "to warn and alert drivers of hazards created by construction or maintenance activities in or near the traveled way, and to guide and direct drivers safely past the hazards."[1]

The marking on the standard barricade rail consists of alternate orange and white stripes of equal width. The stripes slope downward at an angle of 45° in the direction the traffic is to pass. This directional information does not provide guidance since many drivers do not understand the message the design is meant to impart. Moreover, field crews often are confused as to which diagonal sign (slope right vs. slope left) should be installed. In general, the pattern of stripes on the standard barricade rail promotes confusion in directional guidance.

The Virginia Department of Highways and Transportation recommends extensive use of orange cones for channelization on daytime only work. Since cones are not reflectorized, simulated drum panels, vertical panels with orange and white horizontal stripes of reflective material, are used at sites where the work is extended into the evening. These vertical panels have replaced drums because drums are scarce in Virginia.

Recent research efforts have investigated the application of the chevron pattern to barricades and channelizing devices. The chevron pattern consists of alternate orange and white stripes that form an arrow pointing in the direction in

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which traffic is being diverted. Studies have documented the effectiveness of signs bearing the chevron pattern in providing positive guidance information,(2,3) but the optimal design for this sign has not been determined.

The chevron pattern has significant potential as a standard design on barricades and channelizing devices.

OBJECTIVES AND SCOPE

The objectives of this research were (1) to select the most effective design of the chevron pattern, and (2) to evaluate the effectiveness of selected chevron designs under road conditions. A traffic sign's performance measures its ability to command attention and convey a clear, meaningful message to the driver. The evaluation compared the performance of traffic control devices bearing the chevron design to that of the barricades and channelizing devices bearing the presently used stripings.

The scope of the research was limited to the use of barricades and channelizing devices to provide directional guidance. This restriction was important because there are a variety of situations in which barricades and channelizing devices are applicable but directional guidance is not warranted.

To achieve the two objectives, the study comprised four major tasks as listed below.

A. Review of the literature covering completed and ongoing research on traffic control devices used in work zones.

B. Selection of chevron designs by subjective evaluation for examination in field tests.

C. Field tests on selected chevron patterns and the presently used patterns to obtain data on the average driver's response to these devices.

D. Comparative evaluation using the results of the field testing.

LITERATURE REVIEW

A search of the available literature was conducted through the facilities of the Transportation Research Information Service. Reports selected from the abstracts received through the literature search were obtained. Additional reports were identified by transportation professionals and through a less formal literature search. Information derived from the literature review is documented throughout the report.

CHEVRON DESIGN SELECTION

One of the objectives was to select the most effective design for the chevron pattern. The approach used to perform this task and the results are presented in this section.

Previous Experience with Chevron Designs

The concept of chevron patterns is not new. Standard chevron barricades are in use in France, Canada, and the state of Utah. These devices are usually large and are used to supplement a taper or to close a roadway.

The effectiveness of the chevron pattern has been addressed in research efforts by the California Department of Transportation[2] and BioTechnology, Inc.,[3] and conclusions drawn from reports on those efforts influenced the selection of the chevron patterns in the present study.

Chevron Pattern Design

Several parameters must be specified in order to define alternative chevron designs, including the length and width of the sign face, the ratio of orange stripes to white stripes, and the width of the stripes. Other considerations are the placement of thin black stripes between the white and orange stripes and the use of borders (black or orange). Encapsulated lens sheeting is used on all channelizing devices except cones.

The target value of the sign depends on the size of the sign face and width of the stripes. Both chevron research efforts cited above concluded that the diagonal pattern was recognizable at a greater distance than the chevron pattern of

2066 similar size and stripe width. The reason for this appears to be haloation, a phenomenon by which the reflection of the white stripe dominates and distorts the orange. Haloation causes the point of the chevrons to appear less distinct. Increasing the ratio of orange to white and placing thin black stripes between the white and orange stripes are measures for eliminating haloation. The objective of borders is to outline the sign.

In the comparison of the striping patterns, the size of the signs was varied little. On the other hand, since overcoming haloation is important, the stripe ratio was varied quite widely and the black stripe was employed.

Chevron Design Demonstration

Groups of chevron designs were subjectively rated by observers in vehicles at two points — the point of detection and the point of legibility. At the point of detection, 500 ft. (154 m) from the devices, the patterns are visible but the message the pattern imparts is unclear. The message is clear at the point of legibility (300 ft. [93 m] from the devices). These two points are important and are discussed in subsequent sections. The demonstrations were conducted under both day and night conditions. At night, the groups of designs were observed under both high and low beam headlights.

The various groups are displayed in Figure 1 and photographs of the groups are given in Appendix A. Table 1 identifies each group in Figure 1 with a specific channelizing devices.

Table 1

Sign Groups and Device Types

GROUP		DEVICE
1,2,3	-	Type II barricades[a]
4,4A	-	Type I barricades
5,6,7	-	Vertical panels

[a]Only one rail displayed.

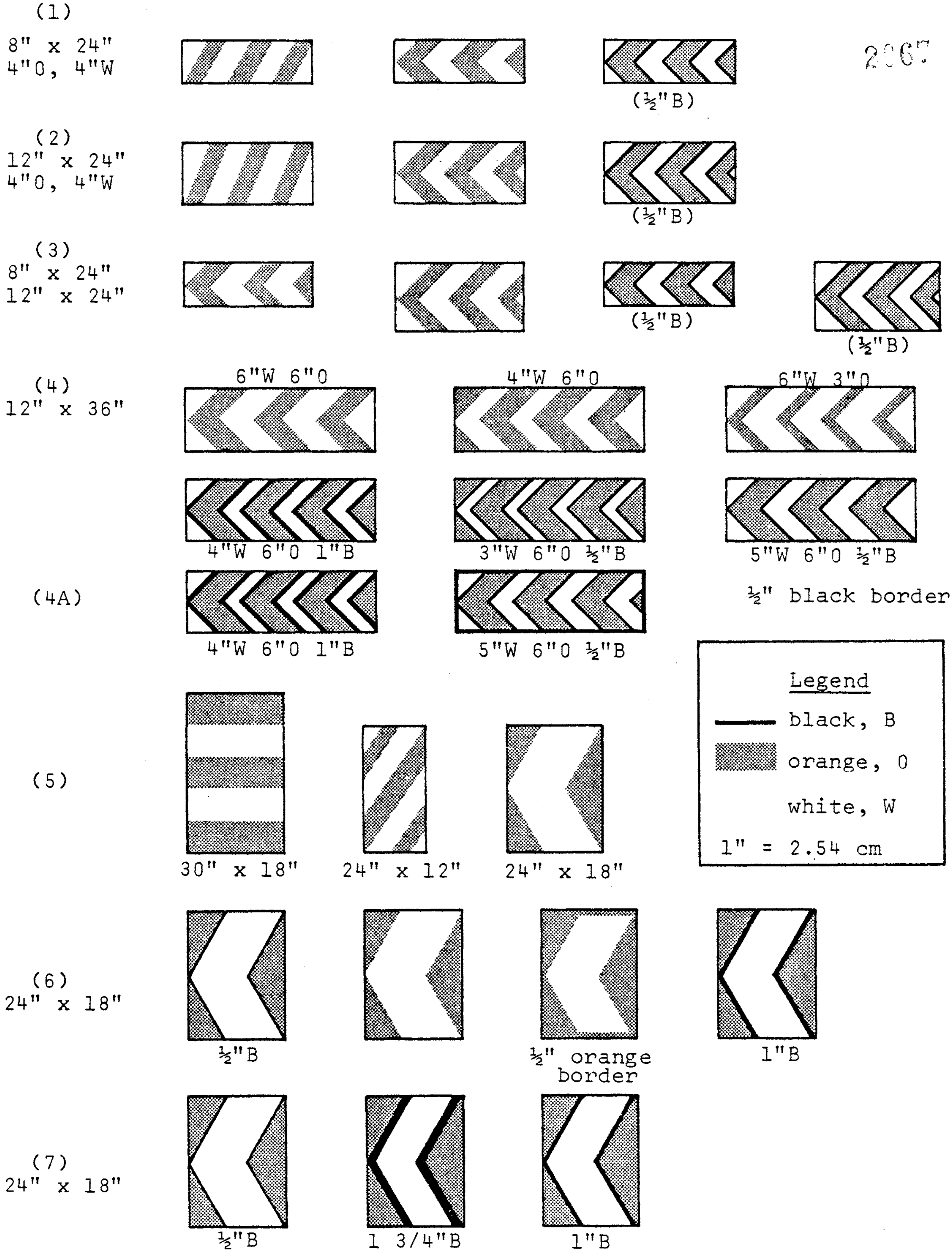

Figure 1. Chevron pattern groups.

Rating Procedure

The observers rated the pattern groups at the two points in terms of the parameters given in Table 2. The rating form is shown in Figure 2.

Table 2

Parameters for Rating Sign Groups

At Point of Detection		At Point of Legibility	
Ability to command attention	(a)	Ability to convey clear, distinct messages	(d)
Ability to warn and alert	(b)	Ability to guide and direct	(e)
Overall appearance	(c)	Overall appearance	(f)

The rating scale was varied depending on the number of patterns in a group. The parameters were summed to obtain one measure at each point for each pattern by an observer (i); in symbols, $x_i = (a+b+c)_i$; $y_i = (d+e+f)_i$. These measures were summed for all the observers' ratings of each pattern at each point; in symbols, $X = \sum_{\text{all } i} x_i$; $Y = \sum_{\text{all } i} y_i$. These two cumulative measures were compared with those for the other patterns in the group. The mean and standard deviation were calculated and the Wilcoxon Ranked Sign Test was used to statistically rank the patterns with a 0.05 level of significance for a two-tailed test. The 0.05 level of significance was selected since it is customary to consider a test significant if the null hypothesis is rejected at this level.

For the ratings, three demonstrations were conducted with minor differences in the sign groups in the first demonstration as compared to those in the last two. The results of the first demonstration prompted the omission of group 4A in which one pattern was obviously superior and the addition of group 7 to identify the threshold width for the effectiveness of the black stripe. The dates of the demonstrations and the participants are listed in Table 3.

Your Title ______________________

Rating Scale: 1 — Inadequate; 2 — Fair; 3 — Adequate

The signs are identified from left to right by following the order of the alphabet.

Example: ▭ A ▭ B ▭ C

Observe all of the patterns before rating them.

Group No. _____

Rate the Following Patterns with Respect To Their:

	Point of Detection				Point of Legibility			
Sign Description	Ability to Command Attention	Ability to Warn and Alert	Overall Appearance		Ability to Convey Clear, Distinct Message	Ability to Guide and Direct	Overall Appearance	
A								
B								
C								

Comments:

Figure 2. Chevron rating form.

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Table 3.

Demonstration Schedule

Date	Group	Participants
April 4-5, 1979	A	Traffic Research Advisory Committee members and district traffic engineers
April 19-20, 1979	B	Student assistants at the Research Council
May 2-3, 1979	C	Staff members at the Research Council

The average numbers of observers in the groups were 14 for A, 10 for B, and 8 for C. The visual acuity of the participants was assumed to be representative of that of the general population. The majority of persons in groups B and C were not involved in traffic oriented research.

In cases where it was not possible to conclude which pattern was preferred, the results for Groups B and C were combined to increase the data available for the Wilcoxon Ranked Sign Test. This combination is reasonable because the grouping arrangements, location, and weather conditions were similar.

This procedure was followed on the pattern groups for both day and night observations. Where there were inconsistencies between day and night observations or between demonstration groups, a subjective decision was made to select one of the patterns.

The results of the ratings are given in Table 4. The day and night rankings are displayed for each pattern group along with the sign selected.

From the results of the ratings of the pattern groups, the following conclusions and recommendations were developed.

- In general, the observers were not aware of the directional message imparted by the diagonal pattern.

- Despite some variations in the weather, the ratings were consistent.

Table 4

Chevron Design Selection Results
(Refer to Figure 1 for a sketch of the chevron patterns)

Note: The designs are listed in order of decreasing preference

Group #	Day	Night	Overall
1	a chevron striped	a chevron striped	chevron striped
	b chevron	a chevron	
	b diagonal	c diagonal	
2	a chevron striped	a chevron striped	chevron striped
	a chevron	b chevron	
	c diagonal	c diagonal	
3	a 12" chevron striped	a 12" chevron striped	12" chevron striped
	a 12" chevron non-striped	a 12" chevron non-striped	
	c 8" chevron striped	c 8" chevron striped	
	d 8" chevron	d 8" chevron	
4	a 4"W, 6"O, 1"B	a 4"W, 6"O, 1"B	4"W, 6"O, 1"B
	a 6"W, 6"O	b 3"W, 6"O, 1/2"B	
	a 5"W, 6"O, 1/2"B	b 5"W, 6"O, 1/2"B	
	d 4"W, 6"O	b 4"W, 6"O	
	d 3"W, 6"O, 1/2"B	e 6"W, 6"O	
	f 6"W, 3"O	f 6"W, 3"O	
4A	a 4"W, 6"O, 1"B	a 4"W, 6"O, 1"B	4"W, 6"O, 1"B
	b 5"W, 6"O, 1/2"B with border	b 5"W, 6"O, 1/2"B with border	
5	a drum	a drum	drum; chevron
	a chevron	a chevron	
	c diagonal	c diagonal	
6	a 1"B	a 1"B	1"B striped chevron
	b 1/2"B	b 1/2"B	
	c standard	c standard	
	d orange border	d orange border	
7	a 1"B	a 1"B	1"B striped chevron
	a 1 3/4"B	a 1 3/4"B	
	c 1/2"B	c 1/2"B	

Legend

alphabet indicates rank

1" = 2.54 cm

- For the 24 in. (61 cm) long barricade rails, there was little difference between the three patterns at the point of detection, but both of the chevron patterns were preferred over the diagonal pattern at the point of legibility. Note that the diagonal pattern was rated slightly higher at detection. Even with the 1/2 in. (1.3 cm) black stripe, the chevron point is distorted. The 12 in. (30.5 cm) wide rails were preferred over the 8 in. (20.3 cm) wide rails (group 3).

- The use of black borders on barricade rails (group 4a) was not favored and is not recommended.

- Nonsymmetric patterns (more orange than white) were preferred for night use for 12 in. X 36 in. (30.5 cm X 91.4 cm) barricade rails (group 4). Due to haloation, the nonsymmetric patterns would be expected to be more suitable for night use. The pattern with 4 in. (10.2 cm) white, 6 in. (15.2 cm) orange, and 1 in. (2.54 cm) black stripes was highly rated both day and night.

- The black stripe separating the orange and white stripes was effective in improving the effectiveness of the patterns (groups 4, 7)

- The 30 in. X 18 in. (76.2 cm X 45.7 cm) and 24 in. X 18 in. (16.0 cm X 45.7 cm) drum panels were equally rated at detection, but the chevron was preferred at legibility (group 5). For vertical panels, black stripes larger than 1 in. (2.5 cm) (that is 1-3/4 in. [4.4 cm]) were equal to the 1 in. (2.54 cm) stripe in the ratings (group 7). A 1 in. (2.54 cm) black stripe is recommended.

- In general, the selected chevron designs were either preferred over the presently used designs or rated equal to them.

Some observers noted that visual distractions in the background, group layout (spacing of patterns), and stationary observation as opposed to moving observation adversely influenced the demonstration. The first two situations were imposed by limitations on the availability of appropriate sites. However, it is realistic to assume that the channelizing devices will be used in several different environments where visual distractions (such as construction and maintenance equipment) may exist, and only one observer commented on the group layout. In regard to the mode of observation, it was reasoned that ratings by moving observers would increase the number of variables involved, and thus introduce complications.

Through the subjective ratings and statistical analysis, combined with some judgement, the following patterns were selected for field testing.

Type I barricades	- 12 in. X 36 in. (30.5 cm X 91.4 cm) chevron with 4 in. (10.2 cm) white, 6 in. (15.2 cm) orange, and 1 in. (2.54 cm) black stripes.
Type II barricades	- 12 in. X 24 in. (30.5 cm X 61.0 cm) chevron with 4 in. (10.2 cm) white, 4 in. (10.2 cm) orange, and 1/2 in. (1.3 cm) black stripes.
Vertical panels	- 24 in. X 18 in. (61.0 cm X 45.7 cm) chevron panel with a 1 in. (2.54 cm) black stripe.

FIELD TESTS

In evaluating the effectiveness of chevron designs, input from the motorist is desired. The objective of the field tests was to obtain data on the motorists' response to a given channelizing device in a taper arrangement. Preliminary work, such as the development of a test procedure and the conduct of pilot testing, and the field tests are discussed below.

Test Procedure

Since the scope of the research was limited to situations in which directional guidance is necessary, a single-lane closure arrangement was selected. The measure of effectiveness deemed most appropriate was the position of the motorists' lane change. To minimize the number of lane changes occurring, a four-lane divided highway was specified. A right-lane closure was desired because most motorists drive in the right lane and for them a lane change in the work zone would, therefore, be necessitated.

A zonal system was devised to facilitate the collection of data on a driver's lane change as a response to a specific channelizing device. The basic premise for using lane changing as the measure of effectiveness is that the earlier a driver changes lanes, the more effective the channelizing device is in providing guidance. The zone system is displayed in Figure 3. Two zones, each 350 ft. (107.7 m) long, were set up prior to the transition taper zone. The zone length is based on the estimated time required to change lanes, which is 4 to 5 seconds.[4]

Zone 1 included the point of detection (500 ft. [154 m]) and zone 2 the point of legibility (300 ft. [93 m]). The point of legibility is critical since this is the point at which the message conveyed by the pattern becomes clear. It is important to note that the legibility distance (300 ft. [93 m]) does not provide the estimated distance for negotiating a lane change (350 ft. [107.7 m]).

Four zones were used in the data collection, with a zone being prior to zone 1. Lane changes occurring prior to zone 1 were mostly due to supplemental devices, such as the flashing arrow panel and warning signs, rather than to the pattern on the channelizing device. For this reason, only 3 zones were considered in the data analysis.

Traffic counters were placed at the boundaries of the zones with the rubber tubes extending across the right lane of traffic. By determining the difference in the volume count on the traffic recorders bounding a zone, the number of vehicles changing lanes in that zone was obtained. Note that zone 3 was the critical zone because forced mergers occurred there.

The transition taper is the single most important element within the system of traffic control devices in work zones where a reduction in pavement width is desired.[1] Much care was used in arranging the taper in accordance with MUTCD and Virginia Department of Highways and Transportation guidelines.

Four field tests were conducted to compare the presently used and proposed barricades and channelizing devices. The features of these tests are summarized in Table 5 and the devices are displayed in Figure 4.

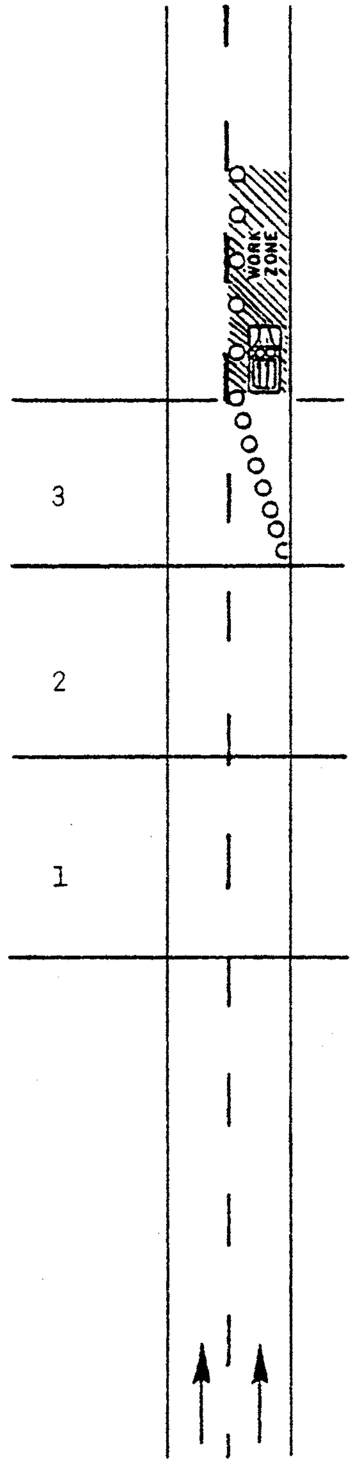

Figure 3. Zone system at the test site.

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Table 5

Design of Field Tests

Test No.	Type of Device: Presently Used	Type of Device: Proposed	Time of Day
1	Cone	Chevron Type I barricade	Day
2	Type II barricade	Chevron Type II barricade	Day & night
3	Horizontal stripe vertical panel	Chevron vertical panel	Day & night
4	Diagonal stripe vertical panel	Chevron vertical panel	Day & night

Data were collected at each site for an average of 21 hours for each channelizing device except the cone, for which data were collected for 8 hours in the daytime only.

Method of Analysis

The distribution of lane changes by zones was determined for each channelizing device, and the percentages of lane changes by zones were obtained based on the total of all lane changes occurring in the zone system. Then, the percentages for the presently used and proposed barricades and channelizing devices in each test were compared.

In an effort to establish a single parameter for the comparison in a test and to relate the zone of lane change to its position relative to the work area, zonal lane changes were weighted. The amount of weighting depended on the distance from the zone to the work area behind the taper. The percentage of lane changes within a zone and the weighted factors were multiplied and summed. Thus,

$$\text{weighted lane changes} = 3 \times \text{zone } 1 + 2 \times \text{zone } 2 + 1 \times \text{zone } 3$$

where zone i = percentage of lane changes in i.

Therefore, the more effective channelizing device is indicated by the higher weighted lane changes. These measures were calculated for day, night, and total (day and night) time periods.

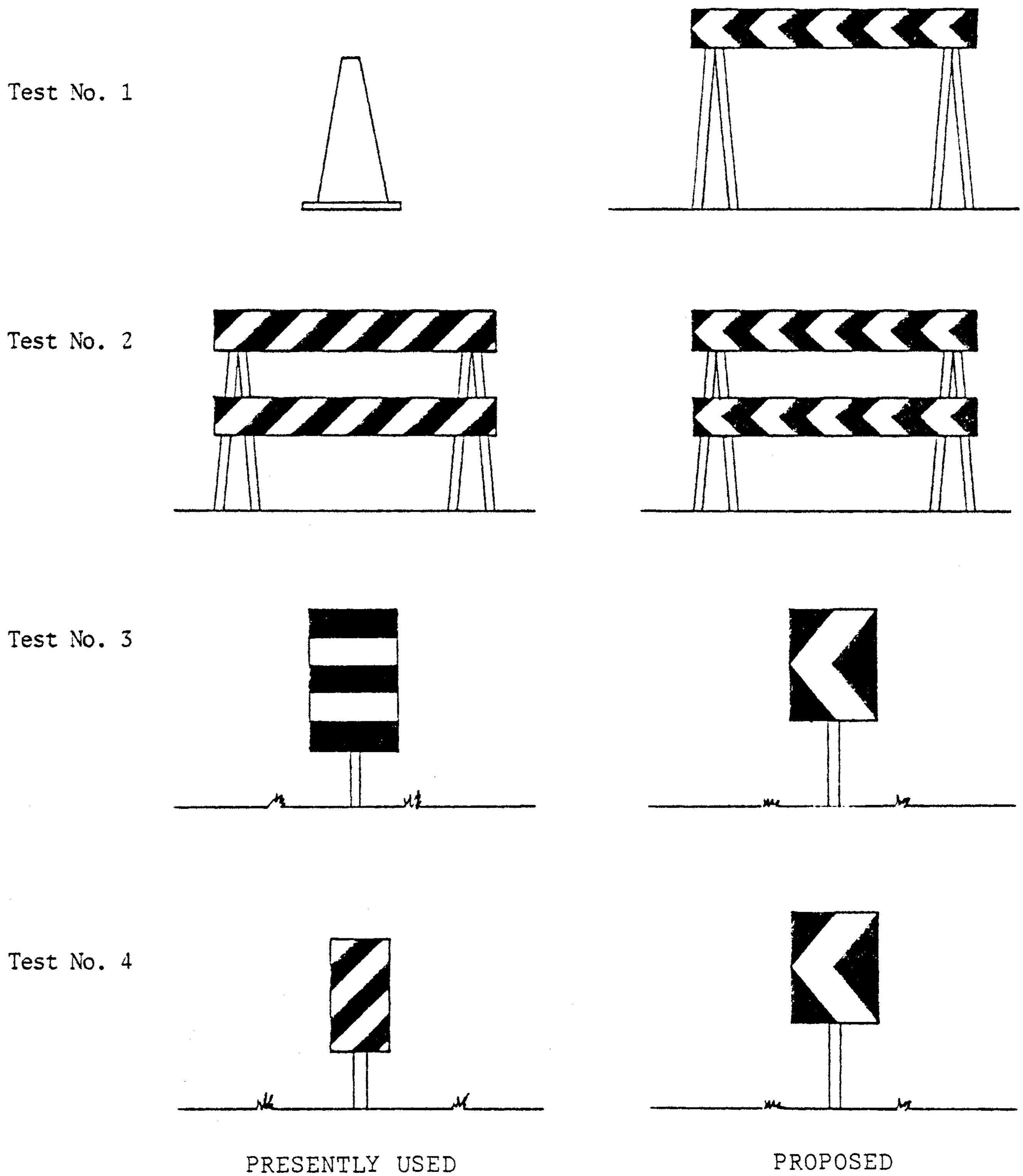

Figure 4. Presently used and proposed devices rated in field tests.

Pilot Test

A pilot test was conducted to examine the adequacy of the test procedure and method of analysis. In the pilot test, which was conducted on U. S. Route 460 East in Giles County, the channelizing devices compared were the Type III barricades with orange and white diagonal striped rails (12 in. X 48 in. [30.5 cm X 121.9 cm]) with an arrow sign (24 in. X 48 in. [61.0 cm X 121.9 cm] black with orange background) mounted on the top left corner of each barricade and oversized chevrons (36 in. X 48 in. [91.4 cm X 121.9 cm] with a 1-1/2 ft. [0.46 m] wide white arrow on an orange background). Each zone was 533 ft. (164 m) in length since these channelizing devices were larger than the devices to be tested later in the main study and therefore visible from a greater distance. The warning sign layout is in Appendix B and the channelizing devices are shown in Appendix C, Figure C-1.

The results of the pilot test are given in Table 6. From the weighted totals it appears that the Type III barricade is slightly more effective than the oversized chevron. The Type III barricade and arrow sign is significantly larger than the chevron panel. Also note that the chevron did not have a black stripe separating the orange and white (recall that this was quite effective in the chevron design selection).

On the basis of the pilot test, minor adjustments were made in the field test and analysis procedure.

Site Selection

Three sites, all on four-lane divided highways, were selected for testing. The first site was on U. S. Route 17 South in Essex County, approximately 2 miles (3.2 km) north of Tappahannock. The southbound traffic was channeled across the median to the inside northbound lane due to construction on the southbound Mt. Landing Creek Bridge. The average daily traffic volume was 6,695.

The second site was on Interstate Route 81 South in Shenandoah County between Edinburgh and Woodstock. A right-lane closure channeled traffic into the left lane and through the work area on the Narrow Passage Creek Bridge. The average daily traffic volume was 13,120. Since the bridge work was completed before the field tests were finished, a third site, located at the northern end of Shenandoah County on Interstate 81 South, was studied with a similar work zone arrangement and traffic volume.

The sign layouts for the three sites are illustrated in Appendix B.

Table 6

Pilot Test Results

Test Site: U.S. Route 460 East in Giles County
Date : July 18-20, 1979
Spacing : 40 feet (12.3m)

	Percent Lane Change by Zone									Weighted Lane Changes		
	1			2			3					
	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total
Type III diagonal with arrow sign	21.8	25.5	22.7	44.8	57.8	47.9	33.3	16.7	29.4	188.3	208.8	193.3
Chevron	22.2	25.4	23.0	40.2	47.6	42.0	37.6	27.0	35.1	184.6	198.4	188.1

Field Test Results

The field data collected in the three tests are shown in Tables 7-9.

U.S. Route 17 — Mt. Landing Creek

The test site on U.S. Route 17 — Mt. Landing Creek was selected in order to observe a work zone situation other than a typical right-lane closure. From Table 7, it is noted that a high percentage of lane changes for all the channelizing devices were forced. An early lane change is not encouraged at the median crossover setup because (1) the lane width is narrowed only to approximately 16 ft. (4.9 m), and (2) the driver can see channelizing devices extended across the entire roadway. The range of the total weighted lane changes is 120.6 to 126.7 with the Type I chevron barricade and cone as the endpoints, respectively. A 40-ft. (12.3 m) taper spacing was used.

U.S. Interstate 81 — Cedar Creek

The test site at Cedar Creek consisted of a right-lane closure due to bridge resurfacing. The cone (184.3) and the simulated drum panel (193.2) represent the low and high endpoints, respectively (Table 8). A linear taper with devices spaced 40 ft. (12.3 m) apart was used.

U.S. Interstate 81 — Narrow Passage

The test site at Narrow Passage used an 80-ft. (24.6 m) spacing of channelizing devices in the taper. The Type I chevron (187.8) was ranked highest and the cone (169.3) ranked lowest (Table 9). Note from test #1 that for day only the 40-ft. (12.3 m) and 80-ft (24.6 m) spacing of devices are equal for the Type I chevron. This result prompted the use of the 80-ft. (24.6 m) spacing at this test site. There were four incidents of vehicles colliding with channelizing devices in the taper. The devices involved were the simulated drum, chevron, and diagonal panels. All of the incidents occurred during the same week. In the previous week, there were no collisions with barricades with similar taper arrangements. The area of contact involved the middle of the taper. No reasons were identified for the collisions. However, the holding of the one-week county fair during that week may be related to the incidents.

All of the channelizing devices are ranked by total weighted lane changes for each site in Table 10.

Table 7

Field Test Results

Test Site: U.S. Route 17, Mt. Landing Creek
Time : August 6-17, 1979
Spacing : 40 ft. (12.3m)

	Percent of Lane Changes by Zone									Weighted Lane Changes		
	1			2			3					
	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total
Test #1												
Type I Chevron	5.9	4.3	5.6	9.5	9.2	9.4	84.6	86.5	85.0	121.3	117.8	120.6
Cone	7.0			13.5			78.7			126.7		
Test #2												
Type II Chevron[a]	-			-			-			-		
Type II Diagonal	6.7	3.9	6.2	11.7	9.6	11.3	81.6	86.5	82.5	125.1	117.4	123.7
Tests #3 & 4												
Chevron	7.6	1.9	6.4	11.7	8.7	11.0	80.7	89.4	82.6	126.9	112.5	123.8
Drum	5.6	6.2	5.7	12.9	10.3	12.5	81.5	83.5	81.8	124.1	122.7	123.9
Diagonal	7.1	3.1	6.4	11.8	10.7	11.6	81.1	86.2	82.0	126.0	116.9	124.4

[a]A traffic counter malfunction caused the data for the type II chevron to be incomplete.

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Table 8

Field Test Results

Test Site: U.S. Interstate 81, Cedar Creek
Time : October 22-31, 1979
Spacing : 40 ft. (12.3m)

	Percent Lane Changes by Zone									Weighted Lane Changes		
	1			2			3					
	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total
Test #1												
Type I chevron	32.6	30.3	31.4	27.9	24.9	26.3	39.5	44.9	42.2	193.1	185.6	189
Cone	27.6			29.1			43.3			184.3		
Test #2												
Type II chevron	29.9	29.7	29.8	27.4	25.1	26.2	42.7	45.2	44.0	187.2	184.5	185.8
Type II diagonal	29.1	29.2	29.1	29.3	26.5	28.0	41.6	44.3	42.8	187.5	184.9	186.1
Tests #3 & 4												
Chevron	29.2	28.6	29.0	30.4	22.0	26.5	40.4	49.4	44.5	188.8	179.2	184.5
Drum	33.3	30.5	31.8	31.2	28.1	29.6	35.5	41.4	38.6	197.8	189.1	193.2
Diagonal	30.5	27.7	29.1	30.8	26.5	28.6	38.6	45.8	42.4	190.2	181.9	186.9

Table 9

Field Test Results

Test Site: U.S. Interstate 81, Narrow Passage
Time : August 20-30, 1979
Spacing : 80 ft. (24.6m) (except for Type I chevron noted as 40 ft. [12.3 m])

	Percent of Lane Changes by Zones									Weighted Lane Changes		
	1			2			3					
	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total
Test #1												
Type I chevron[a]	27.4			35.0			37.6			189.8		
Type I chevron	27.5	27.6	27.6	34.4	30.3	32.6	38.0	42.1	39.8	189.3	185.5	187.8
Cone	18.2			32.9			48.9			169.3		
Test #2												
Type II chevron	18.2	25.0	20.5	35.3	33.6	34.7	46.5	41.4	44.8	171.7	183.6	175.7
Type II diagonal	19.2	22.0	20.2	33.7	30.7	32.7	47.1	47.3	47.2	172.1	174.7	173.2
Tests #3 & 4												
Chevron	25.0	23.8	24.6	39.1	30.5	36.3	35.9	45.6	39.1	189.1	178.0	185.5
Drum	19.8	22.2	20.5	34.6	29.4	33.1	45.7	48.4	46.5	174.3	173.8	174.2
Diagonal	25.3	22.4	24.3	36.9	27.2	33.6	37.8	50.5	42.1	187.5	172.1	182.2
New Jersey barrier	23.8	21.0	22.4	22.4	19.2	20.8	53.8	59.8	56.8	170.0	161.2	165.6

[a] 40-ft. (12.3m) spacing for 4 hours during the day

2000

2084

Table 10

Rank of Total Weighted Lane Changes

Rte. 17— Mt. Landing Creek	I-81— Cedar Creek	I-81— Narrow Passage
Cone (126.7)	Drum panel (193.2)	Type I chevron (187.8)
Diagonal panel (124.4)	Type I chevron (189.0)	Chevron panel (185.5)
Drum panel (123.9	Diagonal panel (186.9)	Diagonal panel (182.2)
Chevron panel (123.8)	Type II diagonal (186.1)	Type II chevron (175.7)
Type II diagonal (123.7)	Type II chevron (185.8)	Drum panel (174.2)
Type I chevron (120.6)	Chevron panel (184.5)	Type II diagonal (173.2)
Type II chevron (-)	Cone (184.3)	Cone (169.3)
		N J barrier (165.6)

Note: The weighted total for the cone includes day only data whereas those for all other channelizing devices incorporated both day and night data. For direct comparison for day only data, refer to Tables 7-9.

Comparisons of Field Test Results

In general, the day weighted lane changes were greater than the night weighted lane changes, probably because of the decreased visibility at night.

The results of the four tests are discussed below with reference to each field test site.

Test #1 — Type I Chevron Barricade vs. Cone

The Type I chevron barricade ranked over the cone in all cases except for the Route 17 — Mt. Landing Creek site. No explanation for this exception is evident in the data. Cones are more mobile than barricades, and this advantage is important.

Test #2 — Type II Barricades: Chevron vs. Diagonal

The Type II barricade chevron and diagonal patterns ranked about the same. The Type II chevron barricade performed better at night than the Type II diagonal pattern at the Narrow Passage site.

Test #3 — The Chevron Panel vs. the Simulated Drum Panel

The simulated drum panel ranked over the chevron at Cedar Creek, equal to the chevron at Mt. Landing Creek, and lower at Narrow Passage. The low ranking of the simulated drum panel at Narrow Passage was not expected, since it has the largest surface area of all the vertical panels.

Test #4 — The Chevron Panel vs. the Diagonal Panel

The chevron and diagonal vertical panels consistently ranked close enough to be considered equal. Under night conditions, the diagonal appeared mostly white and the chevron predominantly orange.

The channelizing devices favored for each of the four tests are shown in Table 11. Channelizing devices which are equal are also noted. Except for the results of test #3, the Cedar Creek and Narrow Passage test sites have similar results.

Table 11

Channelizing Device Designs Selected from the Field Test Results

Test #	Rt. 17— Mt. Landing Creek	I-81— Cedar Creek	I-81 — Narrow Passage
1	Cone	Type I chevron	Type I chevron
2	Not available	Type II chevron; Type II diagonal	Type II chevron; Type II diagonal
3	Drum panel; chevron panel	Drum panel	Chevron panel
4	Diagonal panel; chevron panel	Diagonal panel; chevron panel	Chevron panel; diagonal panel

Note: The listing of two channelizing devices indicates equal ratings.

Zone 2 and the Legibility Distance

In the chevron design selection, the legibility distance was defined as 300 ft. (93 m). Therefore, the message imparted by the pattern was not clear until the driver was in zone 2. For this reason, zone 2 was examined alone to determine if there was a difference in the percentage of lane changes in this zone for the channelizing devices in a given test. Table 12 shows the percentages of lane changes in zone 2 (based on the vehicles which entered zone 2 in the right lane) for Cedar Creek and Narrow Passage Creek.

The chevron devices had a lower percentage of lane changes than the presently used devices at a 40-ft. (12.3 m) spacing, except in test #1. On the other hand, the chevron devices had a higher percentage of lane changes than the presently used devices at an 80-ft. (24.6 m) spacing. Therefore, it is concluded that the chevron devices are more effective at an increased spacing, based on the zone 2 results.

Table 12

Percentages of Lane Changes for Zone 2

	Percentage Lane Changes					
	Cedar Creek 40-ft. (12.3 m)			Narrow Passage Creek 80-ft. (24.6 m)		
	Day	Night	Total	Day	Night	Total
Test #1						
Type I chevron	41.3	35.7	38.4	47.5	41.8	45.1
Cone	40.2			40.3		
Test #2						
Type II chevron	35.1	36.2	35.6	43.1	44.8	43.7
Type II diagonal	45.5	36.9	41.3	41.7	39.4	40.9
Tests #3 & 4						
Chevron	42.9	30.8	37.4	52.2	40.1	48.1
Drum	46.8	40.4	43.4	43.1	37.8	41.6
Diagonal	44.3	36.6	40.3	49.4	35.0	44.4

Cross Test Comparisons

Additional results may be drawn by making comparisons between channelizing devices at different test sites. Because of the type of closure used on Route 17 — Mt. Landing Creek, it is not possible to compare this site with the other two.

Cedar Creek vs. Narrow Passage

The primary differences between the two sites on Interstate 81 are the road geometrics, taper alignment, and spacing of channelizing devices. The zone system at Cedar Creek (40-ft. [12.3 m] spacing) was set up on a curve and downgrade. The Narrow Passage Creek zone system was on a slight curve and slight upgrade (refer to Appendix B). Also, the taper alignment at Cedar Creek was linear and not dependent on the curving roadway as at Narrow Passage (80-ft. [24.6 m] spacing), where the taper alignment was parallel to the road alignment. A linear taper is more gradual in slope than a curved taper.

The total weighted lane changes for each channelizing device except the chevron panel and Type I barricade were greater at a 40-ft. (12.3 m) spacing than at an 80-ft. (24.6 m) spacing. The total weighted lane changes for the Type I chevron barricade and chevron panel did not vary much with respect to the change in spacing (refer to Tables 8 and 9). The positions of lane changes are more evenly distributed between zones at the 40-ft. (12.3 m) spacing than at the 80-ft. (24.6 m) spacing.

It seems that the chevron patterns would be more effective if the entire pattern were visible to the approaching motorists rather than if it was obscured by the preceding pattern. A 40-ft. (12.3 m) spacing presents the image of a wall with the taper devices running together (Figure 5). This is beneficial for nondirectional patterns. However, the directional patterns are more effective when spaced far enough apart to appear as separate devices. On the other hand, the nondirectional patterns do not convey a message when viewed separately.

Figure 5. Views of the 40-ft. (12.3 m) and 80-ft. (24.6 m) spacings for the Type I chevron barricade.

Type I Barricade vs. Type II Barricades

The Type I chevron barricade rated over the smaller Type II barricades. Barricade rails 2 ft. (0.62 m) long with 4-in. (10.2 cm) stripes are less effective than 3 ft. (0.92 m) long rails with wider stripes. In some cases, barricades less than 3 ft. (0.92 m) long are necessary due to limited lateral clearance. Moreover, 2-ft. (0.62 m) barricade rails are commonly used by contractors. The use of wider stripes on the smaller barricade rails, especially in reference to the chevron, would increase the effectiveness of the devices.

New Jersey Concrete Barrier

An additional test was incorporated into the study to compare the New Jersey concrete barrier with the channelizing devices for the Narrow Passage site. Based on reports addressing work zone safety,[5,6] bridge work and pavement reconstruction are associated with a greater increase in accident rates than are other construction activities. The typical work zone setup for these activities in Virginia employs a New Jersey concrete barrier and flashing arrow panel. Since the channelizing devices were being tested while serving as a supplement to the New Jersey barrier, a supplemental taper seemed like an obvious alternative.

The New Jersey barrier was rated equal to the cone for day only and lower than all other devices based on the weighted lane changes at Narrow Passage (Table 9). Steady-burn beacons and reflectors about 6 in. (15.2 cm) long were mounted on the New Jersey barrier, which had a slope of 16:1 for the 192-ft. (52.1 m) taper. From visual observations, all channelizing devices appeared more effective than the New Jersey barrier in influencing early shifts of the traffic. The New Jersey barrier was not visible from as great a distance as the channelizing devices. However, the flashing arrow board panel is probably the dominant channelizing element in the New Jersey barrier setup.

Subjective Evaluation

A brief and limited subjective evaluation was obtained from Virginia Department of Highways and Transportation personnel responsible for traffic control in the work areas tested. This evaluation was performed at Mt. Landing Creek and Narrow Passage. Two responses were obtained at each site. The evaluation form and results are shown in Appendix D. The respondents included a district traffic engineer, district safety officers, and an on-site inspector. Among comparisons for the 4 tests, the chevron pattern devices were preferred in all except that of the cone vs. the Type I barricade. The cone is preferred for daytime use because of its portability and effectiveness. The chevron patterns are selected for use where lateral movements are required. The channelizing device recommended among all the chevrons is the chevron panel. The single arrow chevron appears to excell in providing a clear picture of the required movement.

Cost Analysis

The costs of sheeting, labor, and paint for the channelizing devices are given in Table 13.

These cost estimates are based on a processing rate of 100/hour and do not include costs of the metal backing and heat pressure treatment.

Although the chevron pattern is more expensive than the presently used design except the simulated drum, a cost savings may be achieved by a reduction of inventory. Since chevrons may be used to guide traffic in either direction, an inventory of both left-and right-channelizing devices is not necessary. This savings is applicable only to the comparison of chevrons with diagonal patterns.

A direct cost comparison between chevrons and cones is not possible because all costs (including stands, metal backing, and heat pressure treatment) are not included.

Table 13

Cost Estimates

Test #1	36" orange cone	$7.00
	12" X 36" chevron with 1" stripe rail	6.26
Test #2	12" X 24" diagonal barricade rail	4.18
	12" X 24" chevron with 1/2" black stripe rail	4.28
Tests #3 & 4	18" X 30" simulated drum panel	7.78
	18" X 24" chevron panel with 1" black stripe	6.26
	12" X 24" diagonal panel	4.18

$0.33/linear inch for 24" orange high intensity sheeting

$0.42/linear inch for 30" orange high intensity sheeting

Source: Salem District Sign Shop, B. Cockram

1" = 2.54 cm

CONCLUSIONS

The conclusions drawn from this research indicate the relative effectiveness of various channelizing devices in providing directional guidance to motorists where lateral movements are required. Conclusions on related factors (such as taper spacing) identified in this research are discussed. The conclusions listed below have been drawn from results on the chevron sign selection and the field tests.

1. The black stripe separating the orange and white stripes improved the effectiveness of the chevron pattern

2. For barricade rails, the 12 in. (30.5 cm) wide rail was recommended over the 8 in. (20.3 cm) wide rail. The wider rail was clearer at equal distances. A nonsymmetric chevron pattern with more orange than white partially eliminated the haloation effect. Note that a black stripe was included with the nonsymmetric striping. Barricade rails 24 in. (61.0 cm) in length and with a stripe width of 4 in. (10.2 cm) received low ratings and were less visible than barricade rails with a greater stripe width.

3. Since the taper arrangement at Cedar Creek represents the standard 40-ft. (12.3 m) spacing, basic conclusions of the field test have been drawn from this site. The channelizing devices are listed below in decreasing order of the total weighted lane changes.

   Drum panel

   Type I chevron barricade

   Diagonal panel; chevron panel

   Type II chevron barricade; type II diagonal barricade

   Cone

   Channelizing devices large in surface area appear to be more effective than small ones. The drum panel and Type I chevron barricade were the most effective. The diagonal and chevron panels were equal and the Type II diagonal and chevron barricades were also equal.

4. The chevron panel was selected in the subjective evaluation as the recommended channelizing device among all seven reviewed. The single chevron arrow appeared to convey the clearest directional message.

5. For the chevron Type I barricade and the chevron panel, the 80-ft. (12.3 m) and 40-ft. (24.6 m) spacings yielded the same results. Therefore, the 80-ft. (24.6 m) spacing is preferred for those two patterns. The pattern on each channelizing device in the taper is more visible. Although the 80-ft. (24.6 m) spacing is rated lower than the 40-ft. (12.3 m) spacing for the other patterns, the 80-ft. (24.6 m) spacing performs satisfactorily. The question to be addressed is will the 80-ft. (24.6 m) spacing be an acceptable replacement for the 40-ft. (12.3 m) spacing? The number of channelizing devices required would be halved.

   A linear taper is recommended over a curved taper reflecting the road geometrics. Since these two variables, taper spacing and alignment, were changed simultaneously, it is not possible to indicate the degree of influence that each exerts with respect to channelizing. Note that the road geometrics also changed; therefore, these conclusions should be viewed with caution.

6. Since there are no distinct differences attributable to the difference in patterns used on a specific type of device (panel or barricade) in general, it may be concluded that the effectiveness of a channelizing device is not based primarily on the pattern used. Due to the short legibility (300-ft. [93 m]) and detection (500-ft. [154 m]) distances used, it is difficult to measure differences in driver's responses with respect to the patterns. The legibility distance for warning signs used in work zones is between 400 and 500 ft. (124 and 154 m) based on a legibility distance of 50 ft. per inch (38.7 m/cm) of letter height.(7) The legibility distance for guide signs is 600 to 800 ft. (185 m to 246 m).(12) The chevron alignment sign (black stripe with yellow background) should be visible (detectable) for at least 500 ft.(1) Therefore, the legibility distance would be much less. Because hazards exist at work areas protected by channelizing devices, there is a need for greater legibility distances. However, at the present, there are lower legibility distances at work zones than on normal roadway sections.

One study recommends a minimum visibility distance of 900 ft. (275 m) for channelizing devices at locations where the speed is 55 mph (96.5 km/h).[4] This distance permits the (a) detection and recognition, (b) decision and response, and (c) lane changing by the driver.

7. There is a need to supplement the New Jersey barrier with a taper of channelizing devices. Although the flashing arrow panel, the primary channelizing device used with the barrier, has proven to be effective[8], the severity of accidents involving a collision of a vehicle with the New Jersey barrier should warrant use of the supplemental taper. The field test results do support the warrant for using a supplemental taper. As an additional note, the supplemental taper of diagonal panels employed for regular use at Cedar Creek proved to be effective in reducing vehicle contact with the New Jersey barrier.

RECOMMENDATIONS

The results of this study do not support a recommendation for the adoption of the use of chevron patterns on all channelizing devices. Except for those relating to the Type I chevron barricade, the conclusions do not clearly and consistently favor the chevron patterns. In the chevron design selection, the chevron patterns were generally slightly favored or rated equal to the related presently used patterns. The responses of drivers as measured by the position of lane changing were similar for the two types of patterns. The chevron patterns, especially the chevron vertical panel, were preferred in the subjective evaluation for the clear directional message they convey. However, although directional information provided by channelizing devices is desirable, it does not appear necessary based on the reaction of drivers. That presently used patterns are not effective is evidenced by the considerable amount of research being conducted on work zone safety and driver information.

The recommendations of this study are discussed below.

1. The use of a supplemental taper of channelizing devices prior to the New Jersey concrete barrier is recommended. The supplemental taper provides advance warning to the lane transition and reduces the number of vehicular collisions with the New Jersey barrier.

2. The use of stripes wider than 4 in. (10.2 cm) on barricade rails less than 3 ft. (0.92 m) long is recommended pending further study comparing different stripe widths. In addition, a Type I diagonal barricade 3 ft. (0.92 m) long with 6 in. (15.2 cm) stripes should be tested in the field for direct comparisons with the Type I chevron.

3. This preliminary work indicates that the 80-ft. (24.6 m) spacing has the potential for effectively channelizing the traffic with less devices than used in the 40-ft. (12.4 m) spacing. The Type I chevron barricade and chevron panel are especially promising if an 80-ft. (24.6 m) spacing is acceptable. A double savings is achieved since half as many devices are used in the taper and a smaller inventory is possible with the reversible chevron patterns in place of the diagonal patterns. Field tests which compare different taper arrangements such as the spacing of devices (40 ft. [12.3 m] and 80 ft. [24.6 m]) and taper alignment should be conducted at the same site with one variable being altered at a time.

4. The legibility and detection distances of all channelizing devices employed in a taper deserve further consideration. There is a problem because the legibility distance is less than the estimated distance required to perform a lane change maneuver. Consequently, motorists are making maneuvers without discerning the directional message being imparted. Moreover, since the legibility and detection distances are dependent on the speed, locations with lower speed limits should be studied.

5. This research focused on the observation of drivers' reactions. Future related research should consider drivers' perception, understanding, and preferences on an equal basis with drivers' reactions.

6. This research effort focused on one element of the total traffic control system in work zones. The impact of the other traffic control elements should be considered, because the drivers' reactions are influenced by the total system.

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REFERENCES CITED

1. Manual on Uniform Traffic Control Devices, Federal Highway Administration, U. S. Department of Transportation, 1978

2. McGee, H. W., Pain, R. F., and Knapp, B. G., Evaluation of Traffic Controls for Street and Highway Work Zones, BioTechnology, Inc. prepared for National Cooperative Highway Research Program, Transportation Research Board, Washington, D. C., 1979

3. Bailey, S. N., and Nail, R. E., "Evaluation of Barricade Patterns — Chevron versus Diagonal", State of California Department of Transportation, March 1977

4. McGee, H. W., and Knapp, B. G., "Visibility Requirements of Work Zone Traffic Control Devices", BioTechnology, Inc., prepared for FHWA, Washington, D. C., July 1978

5. Anderson, H. L., "Work Zone Safety" Transportation Research Record No. 693, Washington, D. C., 1978

6. Paulsen, R. J., Harwood, D. W., Graham, J. C., and Glenn, J. C., "Status of Traffic Safety in Highway Construction Zones" Transportation Research Record No. 693, Washington, D. C., 1978

7. Robertson, R. N., "Evaluation of High Intensity Sheeting for Overhead Highway Signs", Virginia Highway and Transportation Research Council, Charlottesville, Va., December 1974

8. Shepard, F. D., "Highway Signing for Safety", Virginia Highway Research Council, Charlottesville, Va., June 1971

2098

SELECTED REFERENCES

Cho, Sung C. Introductory Applied Statistics in Science, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1978

Post, T. E., Robertson, H. D., Price, H. E., Alexander, G. J., and Lunenfield, H. A User's Guide to Positive Guidance, Federal Highway Administration, Washington, D. C., June 1977

"Short Course in Construction and Maintenance Zone Safety Course — Notebook", prepared by the Virginia Highway and Transportation Research Council, Charlottesville, Va., December 1978

2100

APPENDIX A

PHOTOGRAPHS OF CHEVRON PATTERN GROUPS

2102

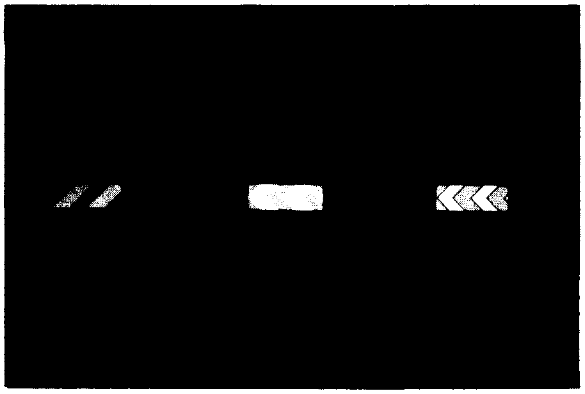


Figure A-1. Group #1.

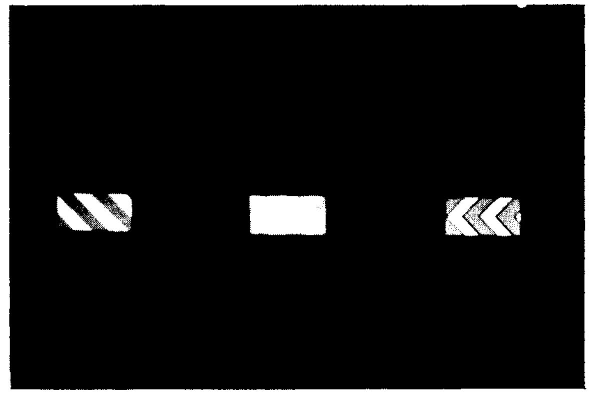


Figure A-2. Group #2.

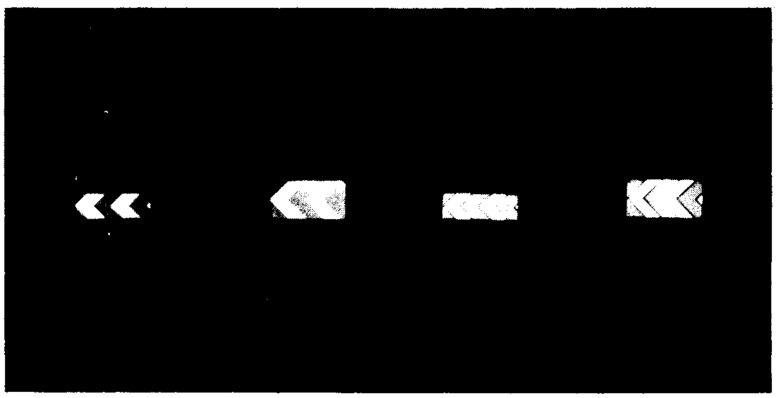


Figure A-3. Group #3.

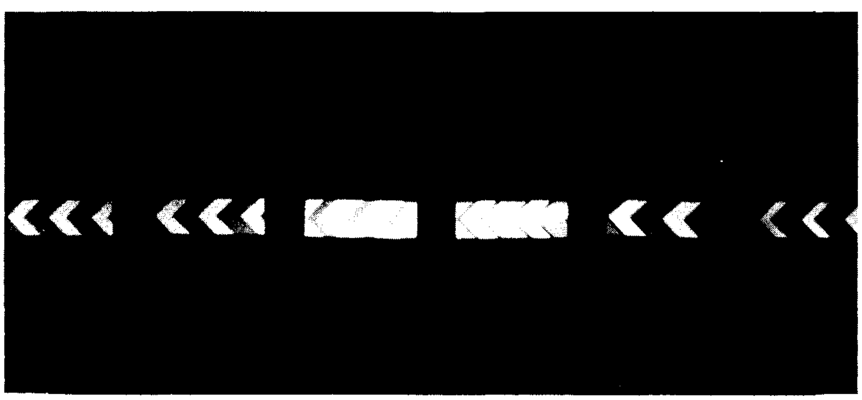
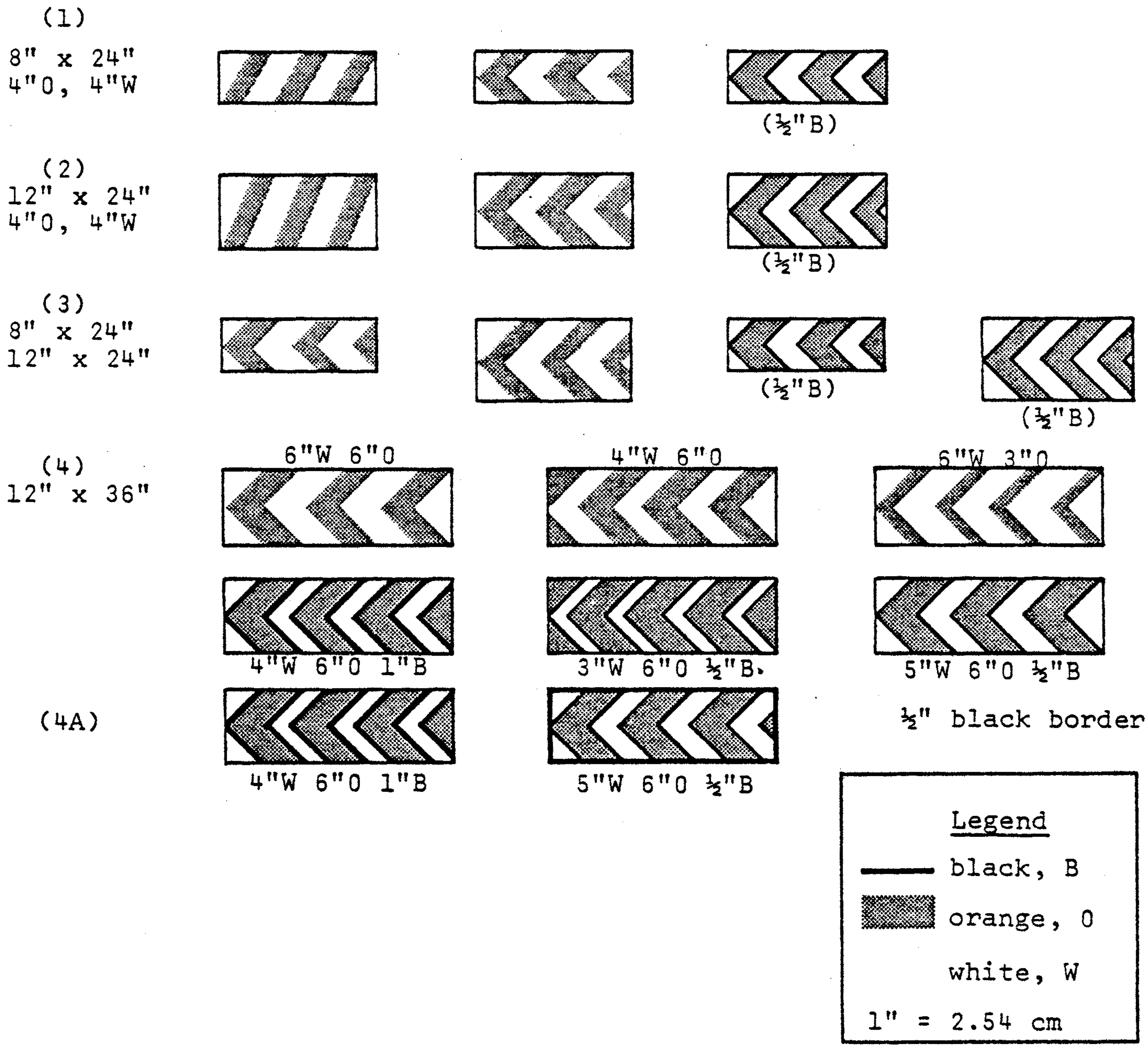


Figure A-4. Group #4.


(1)
8" x 24"
4"O, 4"W
(½"B)
(2)
12" x 24"
4"O, 4"W
(½"B)
(3)
8" x 24"
12" x 24"
(½"B)
(½"B)
(4)
12" x 36"
6"W 6"O
4"W 6"O
6"W 3"O
4"W 6"O 1"B
3"W 6"O ½"B.
5"W 6"O ½"B
(4A)
4"W 6"O 1"B
5"W 6"O ½"B
½" black border
Legend
black, B
orange, O
white, W
1" = 2.54 cm

2104

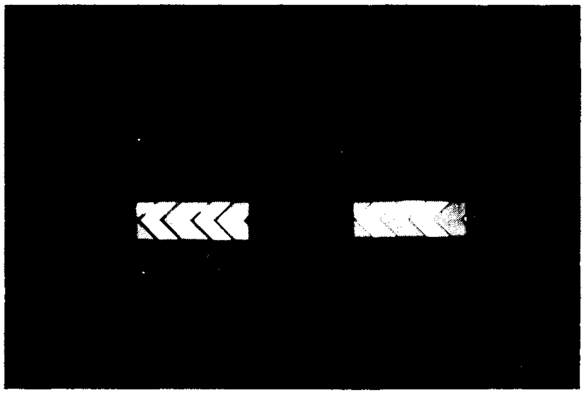


Figure A-5. Group #4A.

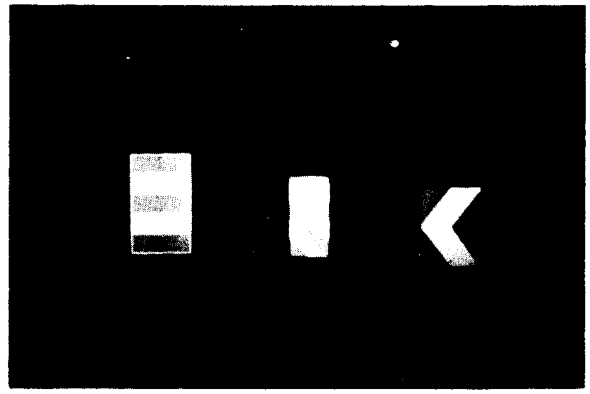


Figure A-6. Group #5.

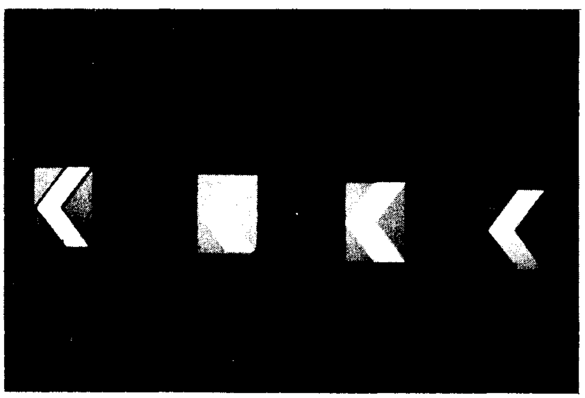


Figure A-7. Group #6.

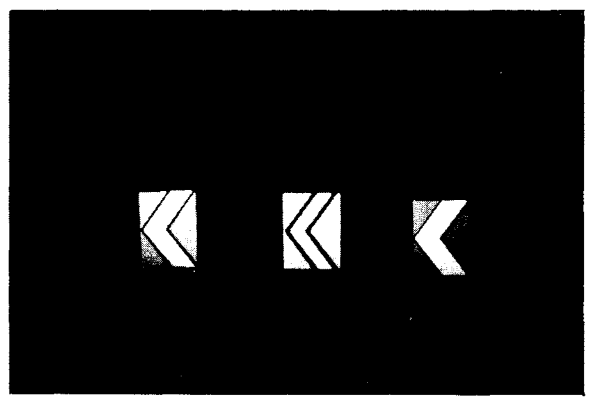


Figure A-8. Group #7.

2105

Legend

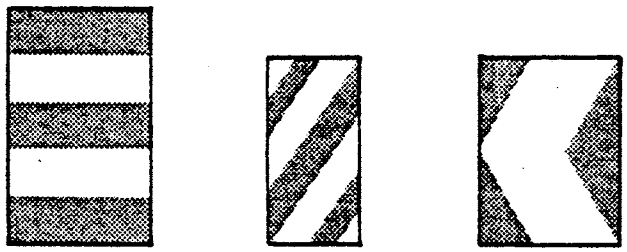
black, B

orange, O

white, W

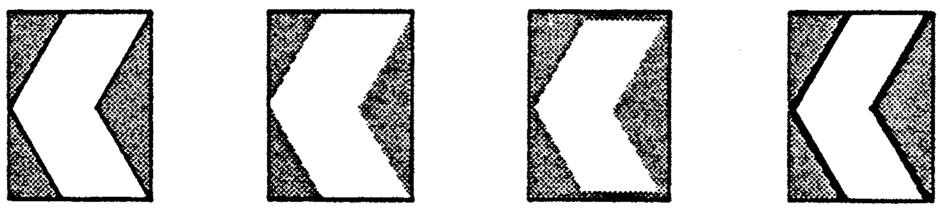
1" = 2.54 cm

(5)



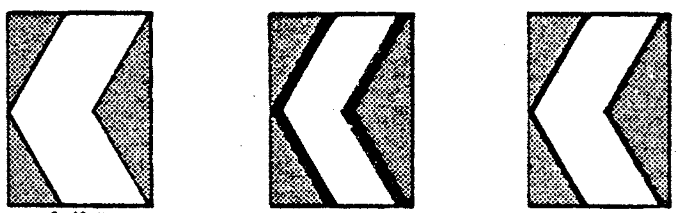
30" x 18"   24" x 12"   24" x 18"

(6)
24" x 18"



½"B   ½" orange border   1"B

(7)
24" x 18"



½"B   1 3/4"B   1"B

2106

APPENDIX B

TRAFFIC CONTROL SCHEMES FOR FIELD TESTS

2108

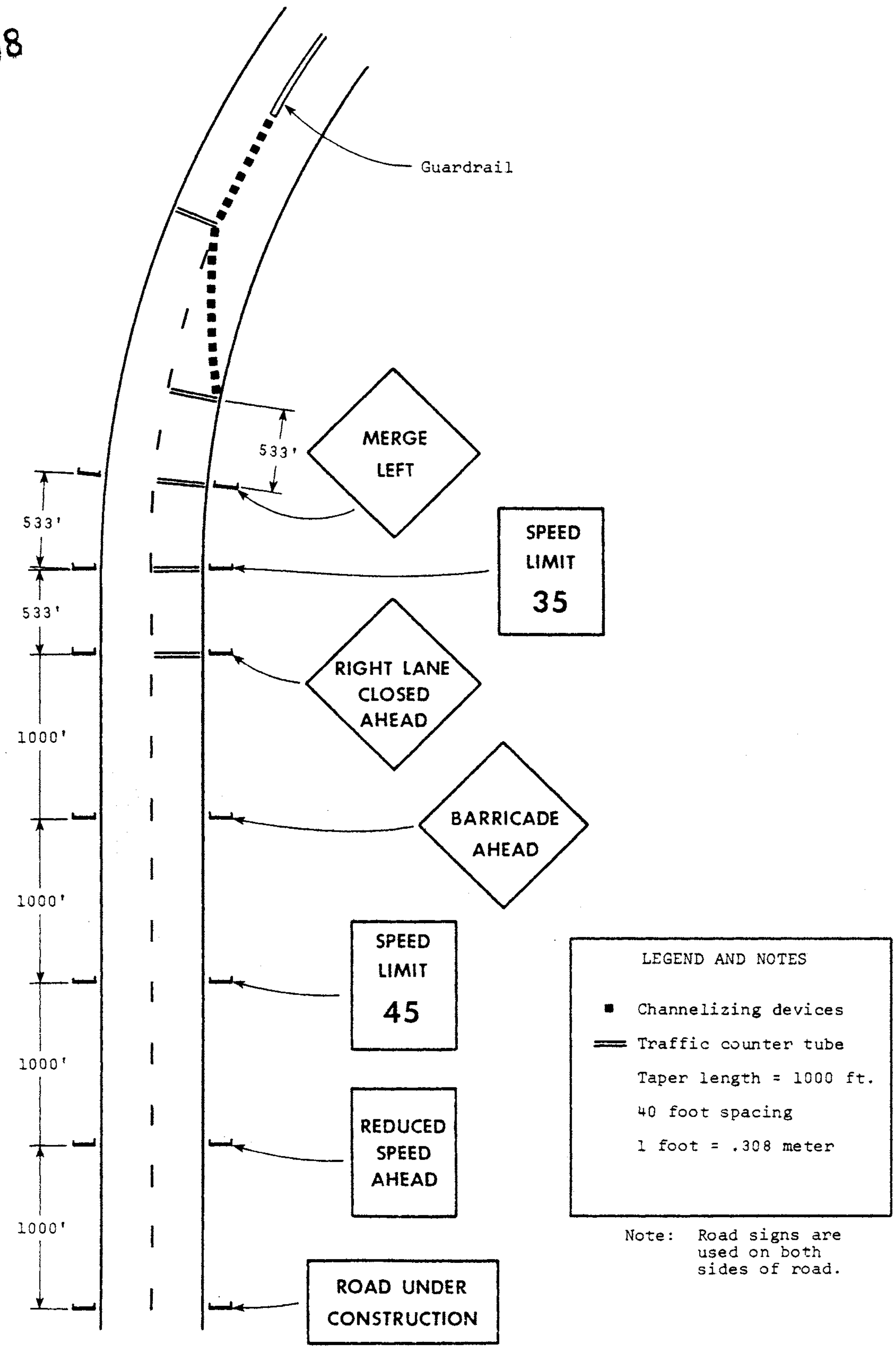


Figure B-1. Pilot test site - U. S. Rte. 460, Giles County.

2109

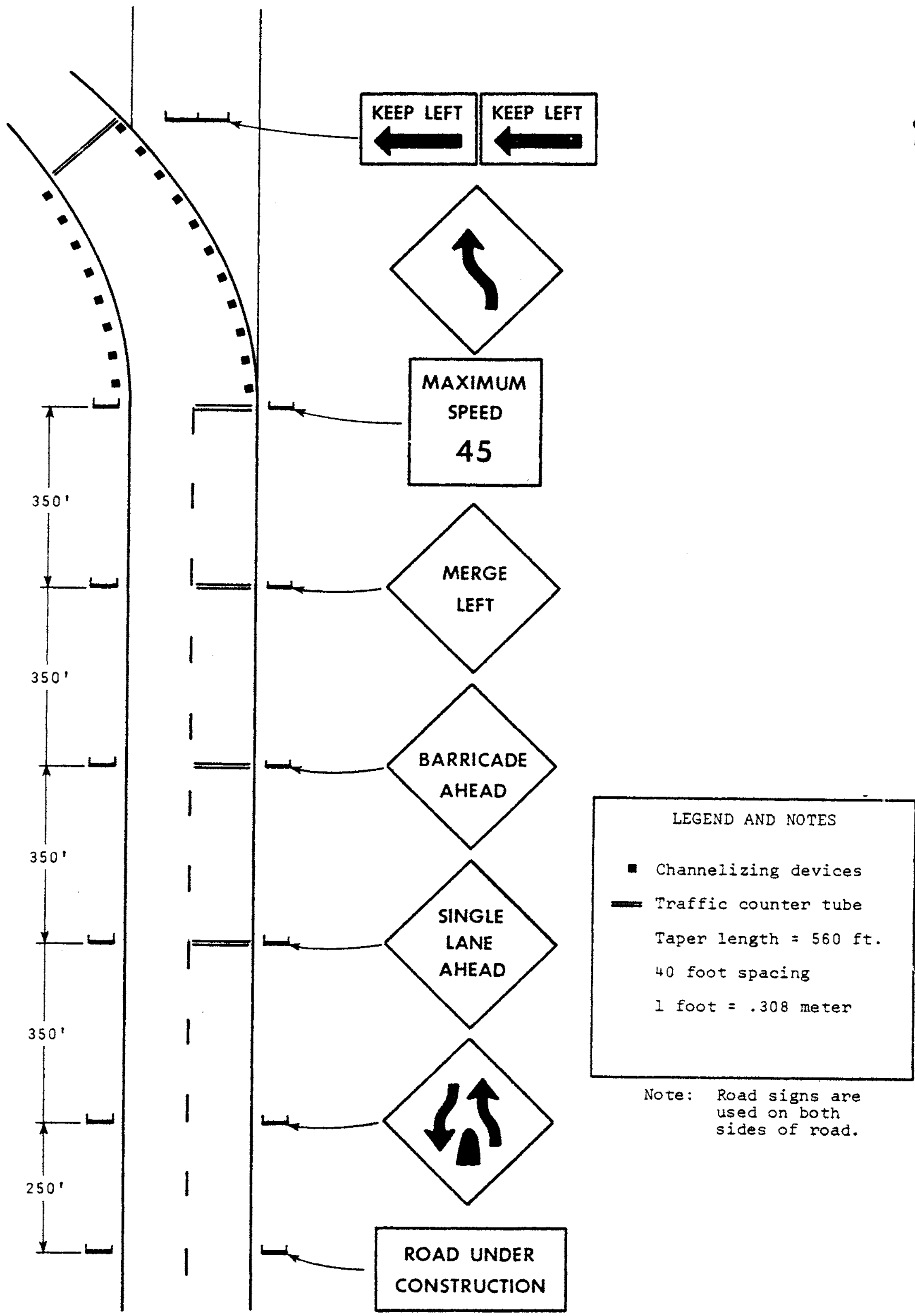


Figure B-2. U.S. Rte. 17 - Mt. Landing Creek site.

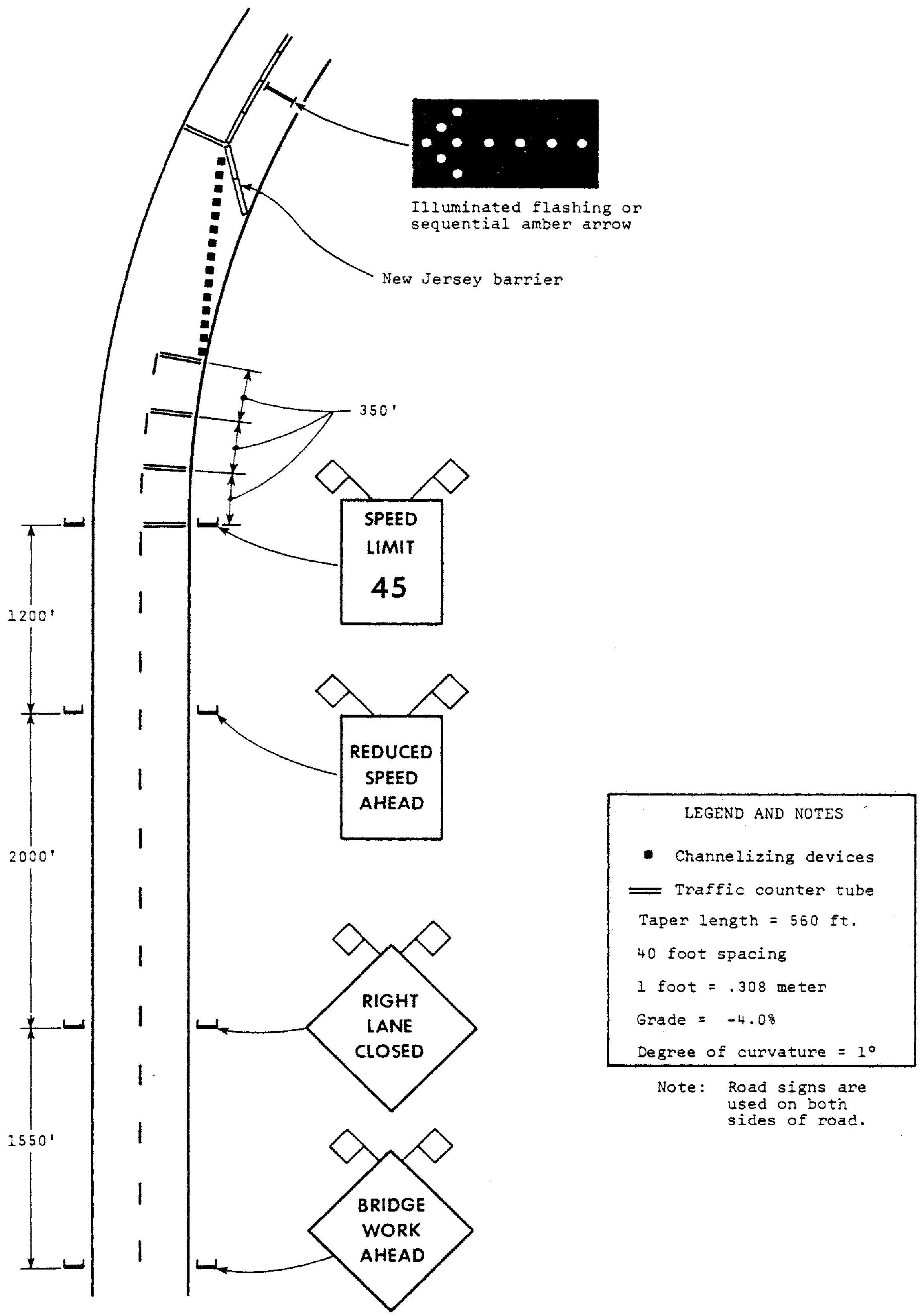


Figure B-3. U.S. Interstate I-81 South - Cedar Creek site.

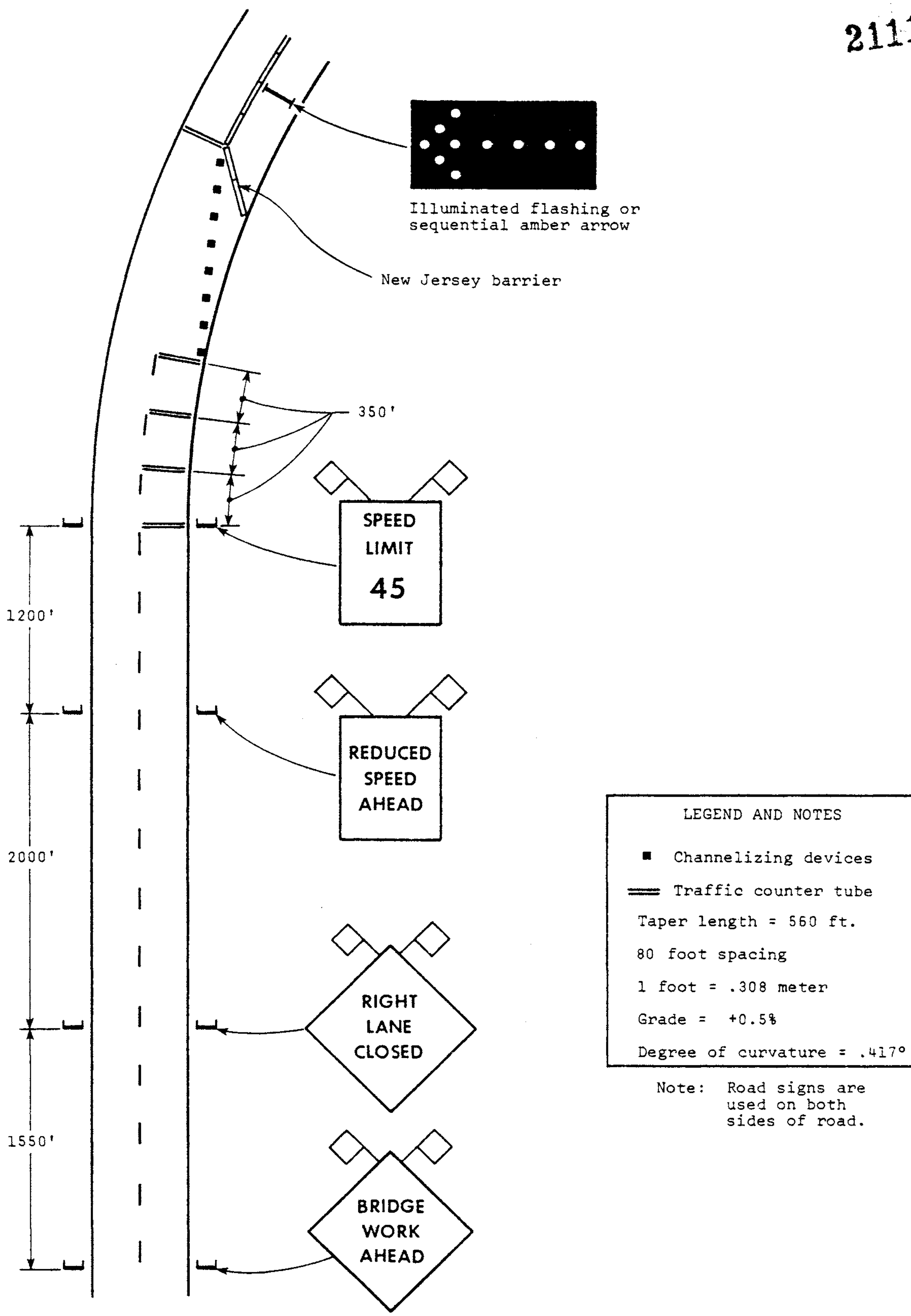


Figure B-4. U.S. Interstate I-81 South - Narrow Passage Creek site.

2112

APPENDIX C

FIELD TEST PHOTOGRAPHS

2114

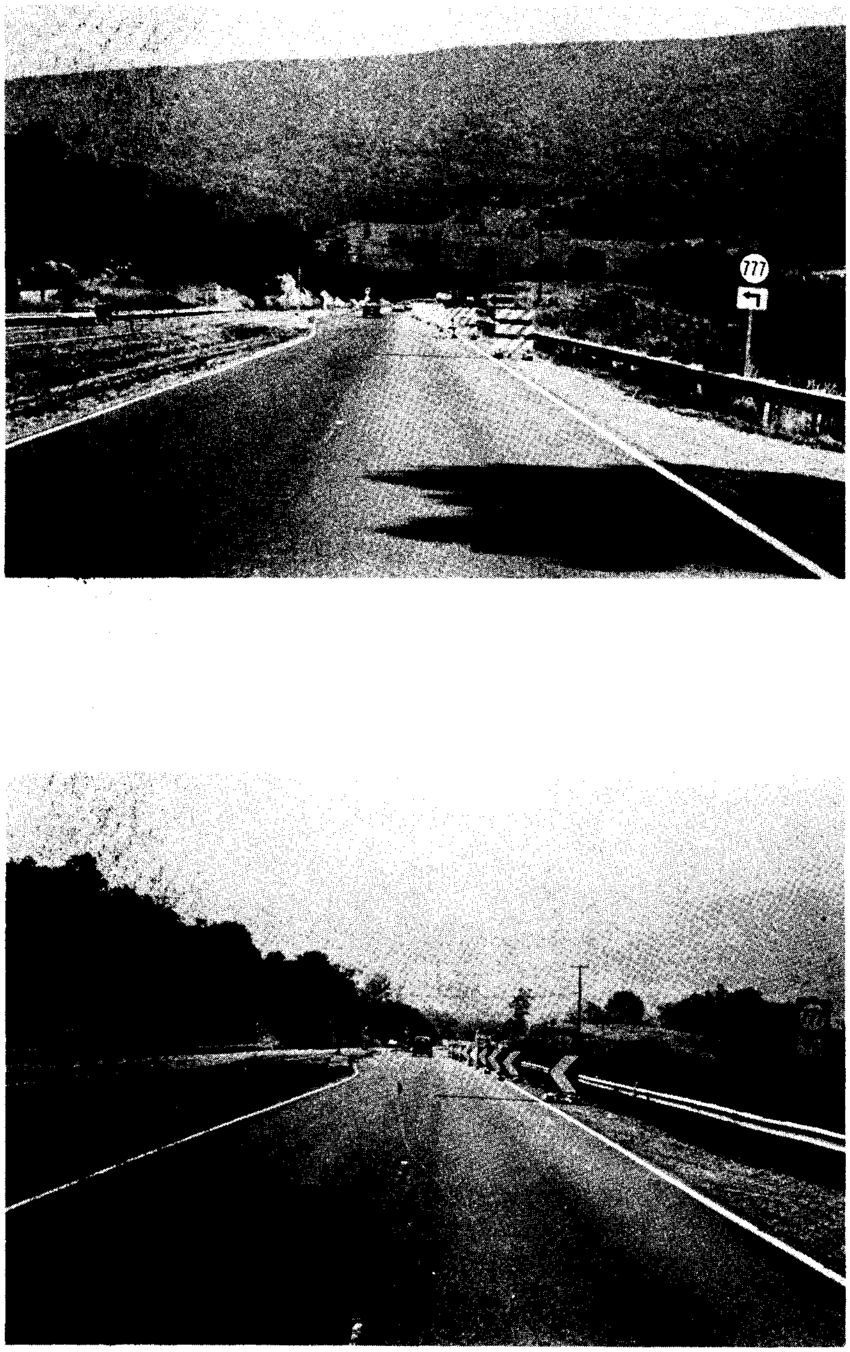


Figure C-1. Pilot test.
a) Type III diagonal barricade.
b) Oversized chevron vertical panel.

Figure C-2. Test #1.
a) Cone
b) Type I chevron barricade

Figure C-3. Test #2.
a) Type II diagonal barricade.
b) Type II chevron barricade.

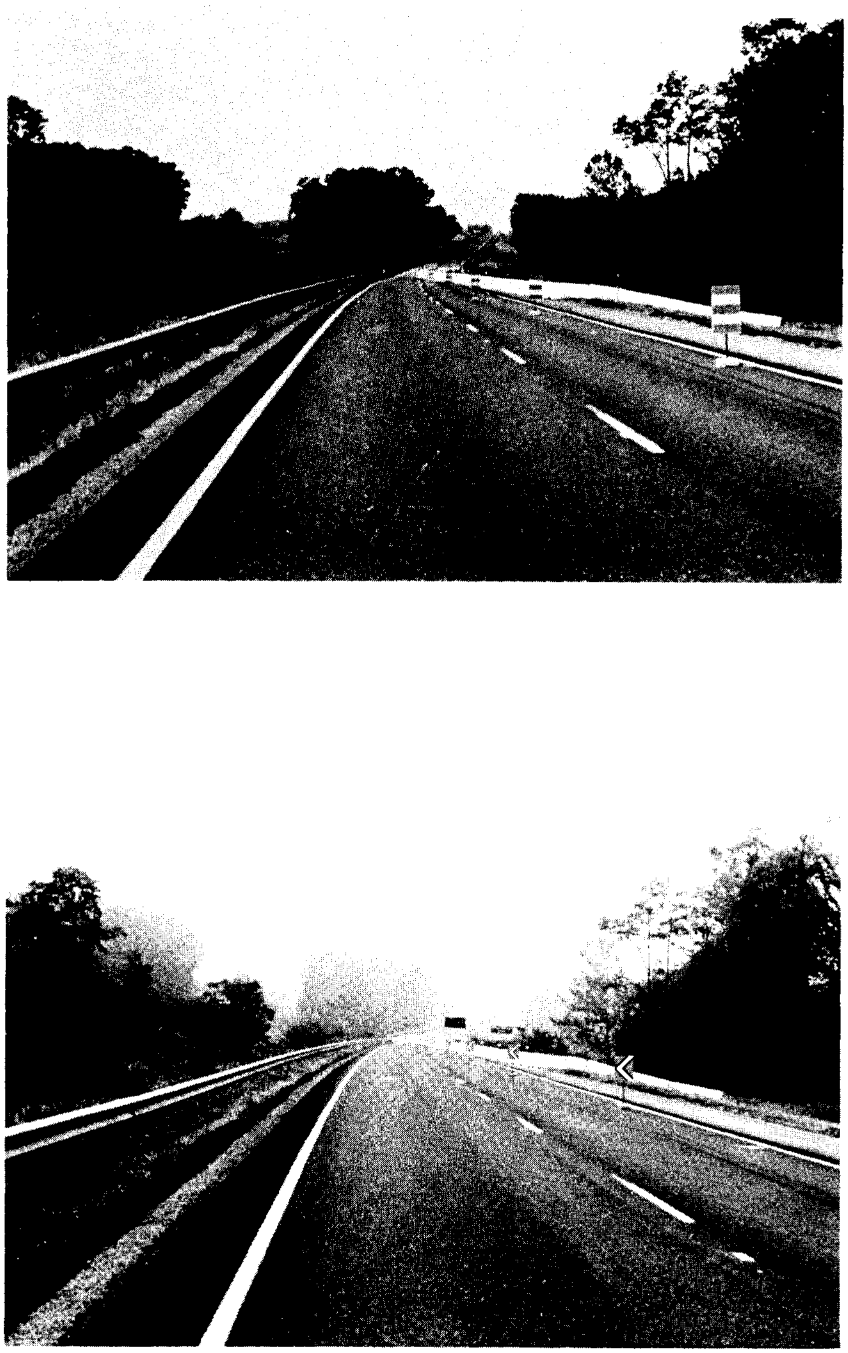


Figure C-4. Test #3.
a) Drum vertical panel.
b) Chevron vertical panel.

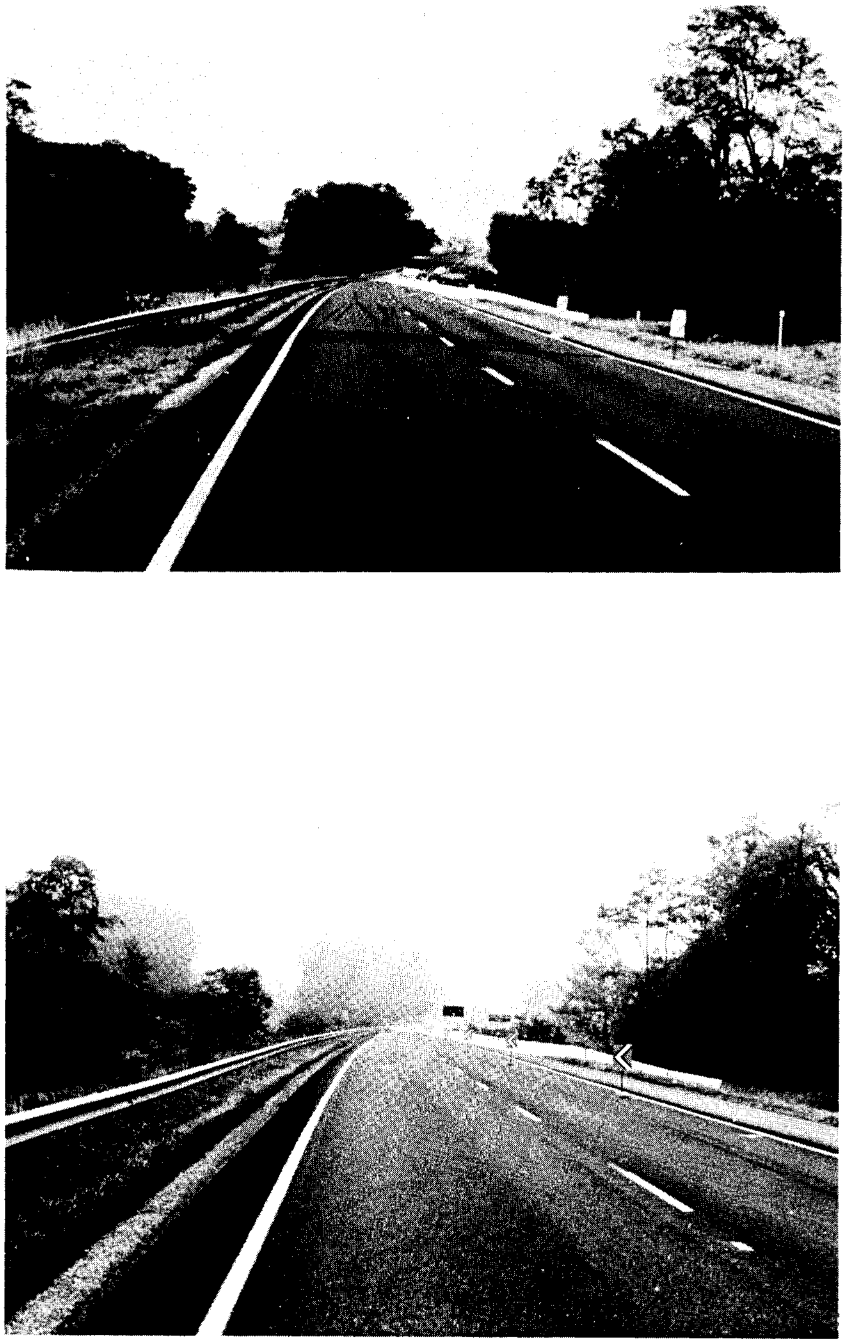


Figure C-5. Test #4.
a) Diagonal vertical panel.
b) Chevron vertical panel.

APPENDIX D

FIELD TEST SUBJECTIVE EVALUATION RESULTS

2120

EVALUATION OF CHEVRON PATTERNS FOR USE ON CHANNELIZING DEVICES

Instructions

This is a comparative evaluation between the present and chevron patterns for channelizing devices used to form tapers. The channelizing devices under consideration are displayed in Figure 1. An evaluation form is available for each test. Some general questions follow the comparative evaluation.

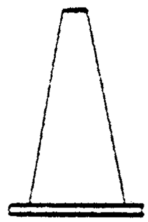
Due to the amount of time required at the test site to evaluate all of the channelizing devices, emphasis will be placed on observing the chevron patterns. However, observation of the present patterns is also desirable. If you are unable to observe the present pattern but you do observe the chevron pattern for a given test, complete the questions based on your familiarity with the present pattern. If you are unable to observe the chevron pattern, then ignore the questions for that test.

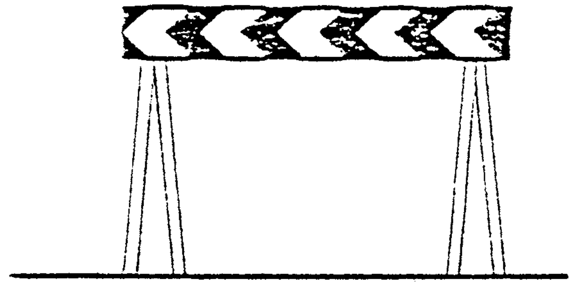
If additional space is necessary for answering questions, use the back of the page. You may wish to make a note of your observations rather than rely on your memory since a day or more may pass between the set up of the present and proposed patterns. Two blank pages at the end are available for this.

Please return to Ben Cottrell.

Name Summary of the responses.

2121





Cone		Chevron	
3 observed	1 not observed	3 observed	1 not observed
3 day	___ night	3 day	___ night

(check the appropriate spaces)

QUESTIONS

1. Which of these patterns do you prefer with respect to:

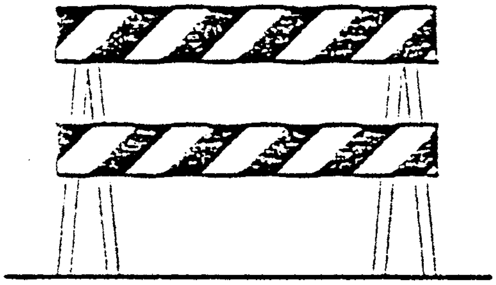
	Day Present	Day Chevron	Day Both	Night Present	Night Chevron	Night Both
effectiveness in guiding the motorist	1	2				
uniformity of design with other traffic control devices	1	1				
adequate decision sight distance		1	1			
protection of the motorists and workers		1	1			

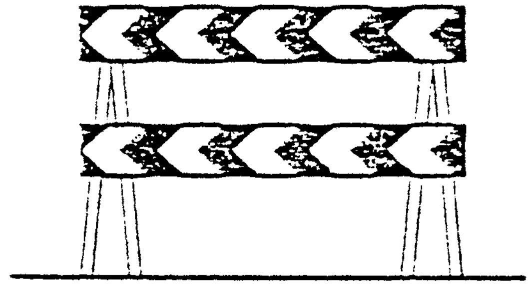
2. If the time of observation (day vs. night) changes your preferences, discuss the reason for this.

3. Overall, which pattern in this test do you prefer and why?

   1 - chevron
   1 - cone in daylight

2122





4 observed	___ not observed
3 day	1 night

3 observed	1 not observed
1 day	2 night

(check the appropriate spaces)

QUESTIONS

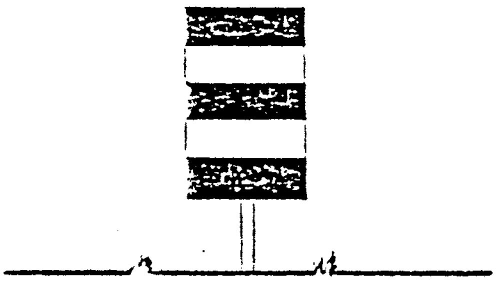
1. Which of these patterns do you prefer with respect to:

	Day			Night		
	Present	Chevron	Both	Present	Chevron	Bc
effectiveness in guiding the motorist		2	1		2	
uniformity of design with other traffic control devices			2		1	1
adequate decision sight distance		1	1		2	
protection of the motorists and workers			2		1	1

2. If the time of observation (day vs. night) changes your preferences, discuss the reason for this.

3. Overall, which pattern in this test do you prefer and why?

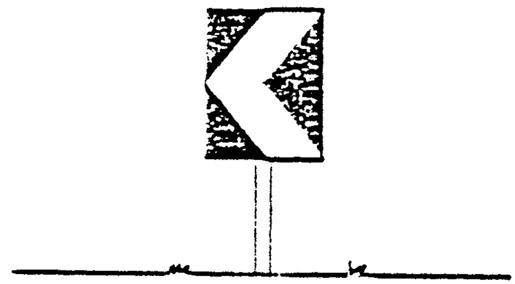
3 - chevron



4 observed ___ not observed

4 day 2 night

(check the appropriate spaces)



4 observed ___ not observed

3 day 3 night

QUESTIONS

1. Which of these patterns do you prefer with respect to:

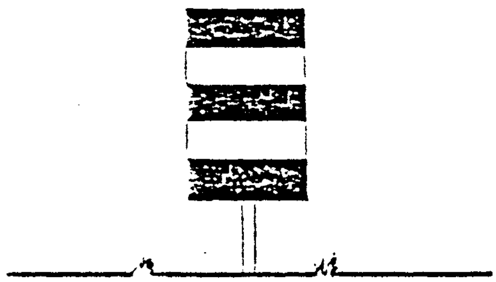
	Day			Night		
	Present	Chevron	Both	Present	Chevron	Both
effectiveness in guiding the motorist		3			3	
uniformity of design with other traffic control devices		1	1		1	1
adequate decision sight distance		2			2	
protection of the motorists and workers		2			2	

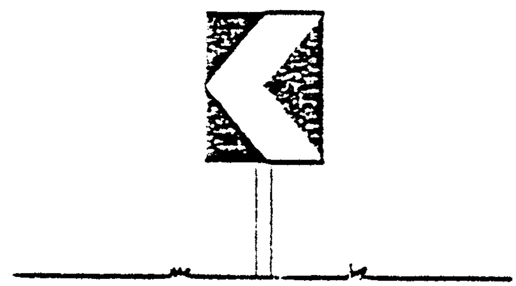
2. If the time of observation (day vs. night) changes your preferences, discuss the reason for this.

3. Overall, which pattern in this test do you prefer and why?

4 - chevron provides good direction message

2124





_4_ observed   ___ not observed

_4_ day   _2_ night

(check the appropriate spaces)

_4_ observed   ___ not observed

_3_ day   _2_ night

QUESTIONS

1. Which of these patterns do you prefer with respect to:

	Day Present	Day Chevron	Day Both	Night Present	Night Chevron	Night Bc
effectiveness in guiding the motorist		4			2	
uniformity of design with other traffic control devices		1	1			
adequate decision sight distance		2			1	
protection of the motorists and workers		1	1			

2. If the time of observation (day vs. night) changes your preferences, discuss the reason for this.

3. Overall, which pattern in this test do you prefer and why?

   4 - chevron provides a clear message

GENERAL QUESTIONS

1. There are two contrasting philosophies associated with safety at work sites:

   a) Channelizing devices are hazards and the objective is to minimize the hazards for the motorist. This encourages the use of small channelizing devices.

   b) Larger channelizing devices command respect and therefore they are avoided more than the smaller channelizing devices. In this case, larger devices are encouraged.

   Please comment on these philosophies based on your experiences.

   Channelizing devices are hazards but their use reduces the severity of accidents that may be incurred by accidents at the work site.

   The present size is sufficient. An increase in the spacing of devices would reduce the hazards and still perform effectively.

2. Which component of the total traffic control system at work sites is most influential (consider warning signs, arrow board panels, channelizing devices, delineators, etc.)? Why?

   4 - flashing arrow board panel

3. Of all the channelizing devices shown in Figure 1, which device would you recommend? Why?

   4 - The chevron panel for lateral shift situations because of its directional capabilities.

Thank you for your cooperation.