Road Construction Safety Audit for Interstate Reconstruction

(Volume 2)

Christopher P. Bowler, E.I.T., M.S.
Eugene M. Wilson, P.E., Ph.D.

Department of Civil and Architectural Engineering
University of Wyoming
Laramie, WY 82071

October 1998

ACKNOWLEDGEMENT

This research was sponsored by the U.S. Department of Transportation's University Transportation Centers Program, the Wyoming Department of Transportation and the University of Wyoming. The authors greatly appreciate this support.

DISCLAIMER

ABSTRACT

Traffic control alternatives associated with reconstruction projects on a rural interstate have been investigated in this research. Slab replacement projects, milling/resurfacing projects, and traffic controls in the vicinity of interstate ramps were analyzed. The recommendations obtained from a national focus group assisted in development of the Road Construction Safety Audit [RCSA] process. The RCSA process evaluates the traffic control plan [TCP], traffic control devices and strategies before an interstate work zone is established on the roadway. This process consists of six steps and a series of checklists used in the planning stage of a TCP to contrast interstate work zone traffic control alternatives while considering issues of the roadway and project. Checklists for slab replacement projects, milling/resurfacing projects and traffic control in the vicinity of interstate ramps were developed as part of this research. The key to the RCSA process and checklists is to ensure that major safety considerations of the project have not been overlooked, and alternative devices and/or strategies have been considered.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

INTRODUCTION

Work zone traffic control is used when an existing facility is to be maintained or reconstructed and the right-of-way is to be shared by workers and motorists. Four-lane divided interstate reconstruction projects are occurring throughout the interstate system. Associated with these projects is a need for temporary traffic control. Temporary traffic control takes on many shapes and forms, and many guidelines and layouts are available. Guidelines, such as the Manual on Uniform Traffic Control Devices [MUTCD], are used to layout work zones and redirect traffic in conjunction with the project's characteristics. However, a formal process to contrast work zone traffic control alternatives presently does not exist. In this project, a Road Construction Safety Audit [RCSA] was designed to consider interstate work zone traffic control alternatives for various roadway geometric factors and the type of reconstruction project.

Today's U.S. road construction has shifted from construction of new facilities to the reconstruction of existing facilities. The facilities are being rebuilt for many reasons, including safety improvements, resurfacing, capacity improvements, and repair of deteriorating pavement structures. Nationally this shift is illustrated by noting that between 1983 and 1985, the number of miles of highways and bridges resurfaced, restored, rehabilitated, or reconstructed was more than 15 times the number of newly constructed miles. With this shift in road construction projects, increasing conflicts between the driver and construction workers, and equipment is inevitable.

Conflicts between the motorist and work zone in road reconstruction projects often result in crashes. Crashes associated with work zones range from property damage only to fatalities. National statistics indicate that crashes and fatalities in work zones continue to increase. According to the American Traffic Safety Services Association, in 1991 there were 680 fatalities in highway work zones. Iin 1995 this number increased to 771. An increased focus on work zone safety is needed.

The objectives of this research project were to:

- evaluate the traffic control alternatives illustrated in the MUTCD manual and the alternatives used by the Departments of Transportation [DOTs] in the western United States.
- develop a safety audit checklist for selected rural interstate reconstruction projects.

LITERATURE REVIEW

After years of using the interstate system, the motorist becomes accustomed to the geometrics, signs, markings, and other elements of the roadway. In a work zone, some or all of the elements are absent and the roadway is often shared with equipment and workers.

Work zone traffic control protects the motorists and workers from work zone hazards while guiding the motorists through unfamiliar areas. Through the use of traffic control devices and a traffic control plan, a safe work zone is established. To ensure safety of the motorist and worker, eight fundamental principles are used as the guiding philosophy during the life of the work zone traffic control system. These principles (Part VI of the MUTCD) follow:

1. Make traffic safety an integral and high priority element of every project.
2. Avoid inhibiting traffic as much as possible.
3. Guide motorists in a clear and positive way.
4. Perform routine inspection of traffic control elements.
5. Give constant attention to roadside safety.
6. Provide proper training for the individuals in charge.
7. Acquire the proper authority when implementing regulatory devices.
8. Maintain a good public image.

Focus groups were established for this research project to determine practices used in different states and also to research alternative suggestions made by practicing DOT professionals. Twenty engineers employed by the Wyoming Department of Transportation (referred to as WYDOT) and a

member from the other 23 state departments of transportation (referred to as DOTs) west of the Mississippi River were asked to participate in this research.

A written survey method was used to collect input from the two focus groups. The surveys used a modified Delphi technique. The Delphi survey technique is the combination of a polling procedure and an inquiry survey. The general methodology involves a questionnaire in which the respondent is asked for input or answers to questions based on their own judgment and professional knowledge. Separate surveys were designed and analyzed for a slab replacement project, a milling/resurfacing project, and work in the vicinity of exit and entrance ramps.

ANALYSIS AND RESULTS

Delphi surveys on traffic control preferences were obtained for a slab replacement project, interstate ramp traffic control, and a milling/resurfacing project. Results from the surveys and concurrent traffic studies were used to develop prototype checklists for each type of work zone area. Principle findings for each area are summarized in the next subsections.

Traffic Control for Slab Replacements on a Rural Interstate

The first Delphi survey examined work zone traffic control associated with slab replacements on rural interstates. Thirty of 47 surveys were returned, including 10 of 24 from WYDOT and twenty from DOTs outside of Wyoming.

The survey examined issues of traffic control and compared Wyoming responses between the two groups. Findings from the survey follow.

1. Both groups favored a single lane closure (SLC) strategy instead of a two-lane, two-way operation (TLTWO) strategy for a slab replacement project.
2. A drum was the channeling device preferred by the two groups in the transition area, buffer space, work space, and termination area when controlled by a SLC strategy.

3. The drum was the channeling device recommended most frequently by the two groups in the merging area, and the single lane closure area of a work zone controlled by a TLTWO strategy.
4. Roadway and project characteristics affected the type(s) of channeling devices recommended by both groups. Terrain, roadway, and geometric characteristics were primary factors in changing the recommended channeling devices.
5. State DOTs other than WYDOT favored the use of a positive barrier system for separating the opposing traffic lanes on a TLTWO strategy, while members from WYDOT recommended use of a drum for separating the opposing traffic lanes on a TLTWO strategy. It should be noted that the types of channeling devices actually used varied widely from positive barriers to tubular markers or short wands on projects with TLTWO strategies as long as 17 miles.
6. Finally, both groups generally recommended speed reductions in the work zones.

Ramp Traffic Control on a Rural Interstate Reconstruction Project

The second Delphi survey was conducted for traffic control in the vicinity of entrance and exit ramps located in a work zone on a rural interstate. A total of 28 surveys were returned, including 11 from WYDOT and 17 from DOTs outside of Wyoming. The important findings associated with ramp traffic control follow.

1. Using a STOP sign on an entrance ramp was influenced by the characteristics of the traffic volumes, sight distance, and the ramp geometry.
2. A STOP line was suggested when a STOP sign is employed on an entrance ramp.
3. The drum was the most used channeling device to guide traffic from an entrance ramp to the mainline.

4. Driver observance studies conducted at four different entrance ramps in construction areas in Wyoming indicated that only 10 percent of the motorists complied with a STOP sign at the end of the entrance ramp.
5. The drum was the most used channeling device for directing traffic onto an exit ramp.
6. WYDOT recommended additional exit signs for warning motorists of a temporary exit ramp in the work zone. The DOTs' group suggested that reducing the spacing of channeling devices in the vicinity of an exit ramp was a suitable method for warning motorists of an exit ramp.

Traffic Control for a Milling/Resurfacing Project on a Rural Interstate

Twenty-six surveys were returned, including 11 from WYDOT and 15 from the DOTs, which were used to study milling and resurfacing projects. Important findings included the following:

1. Both groups favored a SLC strategy instead of a TLTWO strategy for a milling/resurfacing project.
2. Widths of the travelway influenced the types of channeling devices recommended for a milling/resurfacing project. Group members suggested the use of a tubular marker or a smaller device when width of the travel lane was too narrow for a drum.
3. Members from the two groups strongly recommended placing the channeling device at the edge of the unmilled lane on a milling/resurfacing project and not in, or alternating in and out of, the milled area.
4. A positive barrier system was recommended by WYDOT when the drop off depth was at least 6.30 inches (STDEV = 3.74 inches). Members from the other DOTs recommended use of a positive barrier system when the minimum drop off depth was at least 2.95 inches (STDEV = 1.91 inches).

5. A full-time traffic control device maintainer often was recommended for a milling/resurfacing project.

6.

ROAD CONSTRUCTION SAFETY AUDITS

Other objectives associated with this project were to develop a Road Construction Safety Audit [RCSA] process and a series of checklists for these interstate reconstruction projects and the entrance and exit ramps traffic control.

The RCSA evaluates the traffic control plan, devices and strategy before the interstate work zone is established. This checklist also has utility in considering alternative work zone traffic control issues. There are two stages where the RCSA process and the checklists primarily are beneficial for interstate construction projects. These are the planning stage (i.e. during the design of the traffic control plan [TCP]) and the pre-opening stage (i.e. after the TCP has been completed). The RCSA process and checklists were developed for transportation professionals that have knowledge and experience in interstate work zone design.

The RCSA checklists developed were based on the various and often different recommendations from the three Delphi surveys. The checklists ensure that major safety considerations have not been overlooked. Specific values for speed limits, milling drop off depths, and types of devices have been considered with the RCSA. However, state practices, tort liability, and preference also are factors to consider in modifying the different RCSA values or devices indicated. For this reason, a second set of the RCSA checklists was developed without specific values or specific types of devices. This allows for agencies using checklists, to input their device preferences, speed limits and drop off heights. An independent auditor or a team of auditors using the RCSA is recommended. The auditor(s)' knowledge in road safety engineering, traffic engineering, construction safety, and work zone design is essential.

The process recommended for an RCSA consists of six steps (modified from Road Safety Audits, Austroads 1994).

1. Select auditor(s).
2. Provide information about the project and the facility.
3. Obtaining the TCP for the project or plan the TCP using the RCSA checklists.
4. Evaluate the project using the corresponding CHECKLISTS to assist evaluation.
5. Submit comments indicating suggestions.
6. Incorporate RCSA checklists during routine inspections of the Work Zone to check safety associated with the TCP implemented.

Completing the RCSAs during the planning stage of a project will enable auditors to point out problems and/or recommend suggestions and to consider alternatives before the work zone is operational. The last step will help to assure that the implemented TCP does not overlook important safety issues.

CONCLUSIONS

This section presents conclusions associated with work zone traffic control practice obtained from analysis of the survey results. For ease of presentation, they are listed by type of project.

Slab Replacement Project

1. The SLC strategy is most often recommended for a slab replacement project on a rural interstate.
2. Closing one entire traffic lane at a time and repairing all the slabs in that lane is the preferred lane closure option for slab replacement projects control by a SLC strategy.
3. The DOTs' group recommended a concrete barrier system for separating two opposing traffic lanes on a project controlled by a TLTWO strategy.
4. Lowering speed limits in a work zone for the SLC and TLTWO strategies is recommended.

Ramp Traffic Control

1. Location for a STOP sign on an entrance ramp in the work zone area (on the ramp or at the ramp entrance) was not consistent.
2. Striping the stop line was recommended when a STOP sign is used.
3. Either STOP or YIELD control was recommended at the end of an entrance ramp when the acceleration lane is not present due to the work activity on the mainline.
4. When there is no deceleration lane and only one lane is open on the mainline, decreased device spacing or an alternative type of channeling device was recommended in the vicinity of an exit ramp.

Traffic Control for a Milling/Resurfacing

1. SLC strategy was most often recommended for a milling/resurfacing project on a rural interstate.
2. There was no consistent traffic control recommended for milling/resurfacing projects.
3. Channeling devices generally were not used when an edge drop off of 1.5 inches or less exists on a milling/resurfacing project.
4. Cones, tubes, and drums were recommended for drop off depths up to 3.5 inches.
5. Placing channeling devices at the edge of an unmilled lane, and not in the milled lane, was recommended where the milled lane is closed to traffic.
6. Use cones as the primary channeling device for daytime operations only. For projects with an exposed milled lane left overnight, use drums or tubular markers.
7. A full-time traffic control device maintainer was recommended on a milling/resurfacing project when traffic control devices are left overnight.

Road Construction Safety Audit [RCSA] Checklists

1. Using the RCSA procedure on an interstate reconstruction project will help focus on traffic control alternatives and devices. Audit issues were based on safety and a consensus recommendation of the states surveyed.
2. Formatting the RCSA checklists with agency policies to help achieve consistency within interstate work zones is recommended.
3. Adapting a consistent national RCSA process is needed.

RECOMMENDATIONS

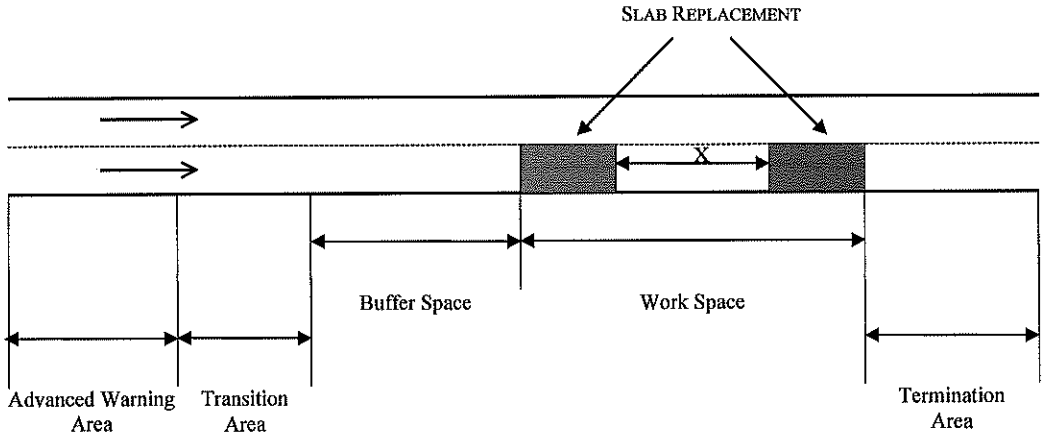
Presented in this section are recommendations for additional research concerning work zone traffic control on a rural interstate.

1. Further research is needed to determine the effect of traffic volumes on implementation of traffic control strategies and devices. Actual application of the RCSA checklists, refinement of RCSA checklists, and documentation of their safety benefits is needed.
2. Similar surveys on other reconstruction projects such as bridge deck repair and roadway realignment are needed to develop additional checklists.
3. Additional research on ramp traffic control in work zones is needed, including traffic control studies on driver compliance with YIELD signs on interstate entrance ramps, traffic studies on driver observance of STOP signs, the affect of adding portable rumble strips, and determining optimal sign location on an interstate entrance ramp.
4. A national documentation procedure for work zone crashes is needed to determine where crashes are occurring in the work zone.

APPENDIX A

"TRAFFIC CONTROL DESIGN FOR SLAB REPLACEMENTS ON A RURAL INTERSTATE"
Delphi Survey Questionnaire No. 1
and
Summary Results

TRAFFIC CONTROL DESIGN FOR SLAB REPLACEMENTS
ON A RURAL INTERSTATE



Project Description: The project to be completed consists of an 8 mile stretch of a four lane divided rural highway with 12 ft travel lanes, and variable shoulder widths. Numerous concrete slab replacements at random spacing are required in both of the travel lanes and on both sides of the highway.

Directions: Based on the sketch above and your knowledge, please answer all of the questions listed below and return the survey to the Wyoming T^2 center at your earliest convince. Also please list any COMMENTS about the survey on the bottom of page 6.

TRAFFIC CONTROL STRATEGIES

1. Based solely on the sketch and project description above, what traffic control strategy would you implement?
   - A. ____TLTWO [Two-Lane, Two-Way Operation]
   - B. ____SLC [Single Lane Closure]
   - C.____Others (please list)

2. Please indicate which of these characteristics direct you towards choosing a specific Traffic Control Strategy. Do this by indicating: **1** for the TLTWO Strategy; **2** for the SLC Strategy; **3** for both TLTWO and SLC; and **4** for neither TLTWO or SLC.

VOLUME
_____Low Volume
_____High Volume

GEOMETRICS
_____Straight
_____Curves
_____Up-Grade
_____Down-Grade
_____Wide Shoulders (> 6 ft)
_____Narrow Shoulders (< 6 ft)
_____Interchanges Located within the Work Zone
_____Ramps Located within the Work Zone

PROJECT CHARACTERISTICS

Project Duration
_____(< 3 months)
_____(> 3 months)

Length of Roadway under Construction
_____(< 4 miles)
_____(> 4 miles)

Travelway Width through Work Zone
_____(> 12 ft.)
_____(< 12 ft.)

Slab Replacement Depth
_____(< 4")
_____(> 4")

SINGLE LANE CLOSURE
[SLC]

3. If you elected answer B [SLC] in Question 1, please indicate which lane closure plan you would use.

_____Close one entire traffic lane at a time and repair all of the slabs in that lane.
_____Stagger the one lane closures in both traffic lanes and repair all of the slabs within that section.

4. At what distance (x), would you consider the slab replacements separate work spaces?
   _____ (ft. or miles)

5. What do you think the posted speed limit should be for the following work zone areas in a Single Lane Closure Strategy?

	SLC
_____	(mph) Transition Area
_____	(mph) Buffer Space
_____	(mph) Work Space

6. Do you think that the drop offs at the edge of the travel lane should be filled in at night?

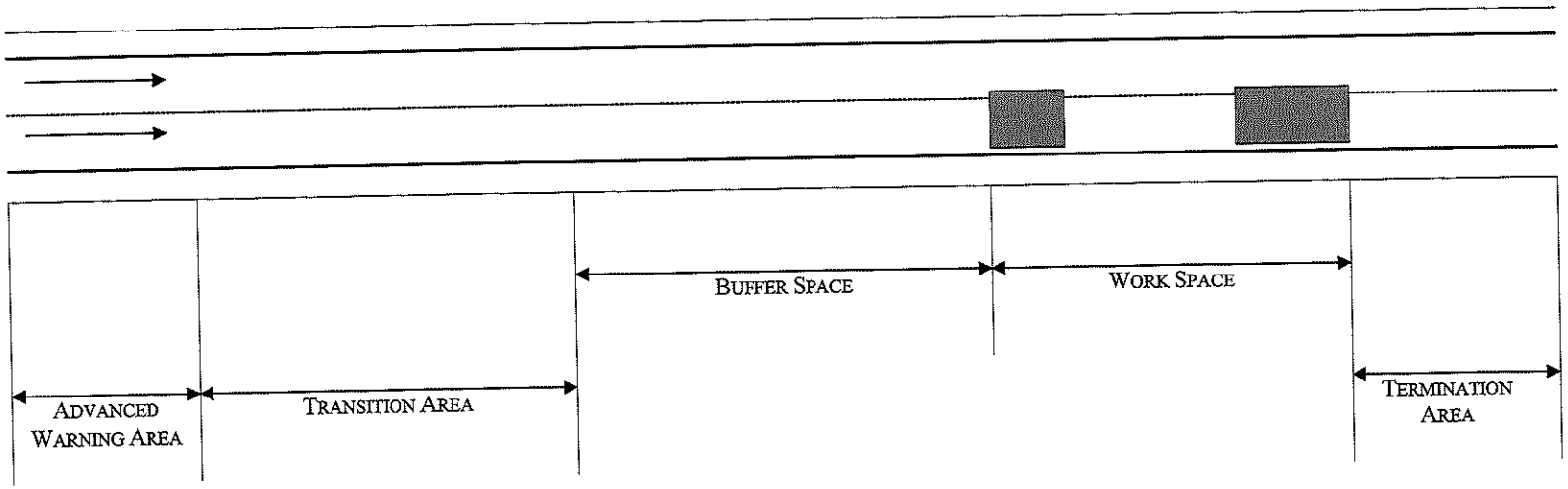
   _____ YES
   _____ NO

7. When choosing a channeling device for a SLC Strategy, what characteristics of the work area influence your choice? (Complete this question by: 1. Checking off the characteristics that have influence, and 2. Then ranking the characteristics that have been checked off, with # 1 having the strongest influence)

Influence	*Characteristics*	*Ranking*
_____	Drop Off Height	_____
_____	Travelway Width	_____
_____	Shoulder Width	_____
_____	Posted Speed Limit	_____
_____	Traffic Volume	_____
_____	Location of Workers	_____
_____	Horizontal Curvature of the Roadway	_____
_____	Grade of the Roadway	_____

8. In the project illustration below, please layout a Single Lane Closure Strategy using the devices listed in TABLE 1, PAGE 6. (Complete this question by: 1. Sketching out lines that represent **your** desired Traffic Control Device(s) and patterns, and 2. Labeling the lines with a device(s) number followed by the category letter provided in TABLE 1.)

CONCRETE SLAB REPLACEMENT
ON A RURAL INTERSTATE



TWO-WAY, TWO-LANE OPERATION
[TWTLO]

9. What do you think the posted speed limit should be for the following work zone areas in a Two-Lane, Two-Way Operation Strategy?

TLTWO

_____(mph) Merging Area
_____(mph) Median Crossover
_____(mph) Two-Way, Two-Lane Operation

10. When choosing a channeling device for a TLTWO Strategy, what characteristics of the work area influence your choice? (Complete this question by: 1. Checking off the characteristics that have influence, and 2. Then ranking the characteristics that have been checked off, with #1 having the strongest influence)

Influence	*Characteristics*	*Ranking*
_____	Travelway Width	_____
_____	Shoulder Width	_____
_____	Posted Speed Limit	_____
_____	Grade of the Roadway	_____
_____	Opposing Traffic Volumes	_____
_____	Percentage of Trucks	_____
_____	Potential Problems with Channeling Devices which are being hit	_____

11. In the project illustration below, please layout a Two-Lane, Two-Way Operation Strategy using the devices listed in TABLE 1, PAGE 6. (Complete this question by: 1. Sketching out lines that represent **your** desired Traffic Control Device(s) and patterns, and 2. Labeling the lines with a device(s) number followed by the category letter provided in TABLE 1.)

CONCRETE SLAB REPLACEMENT
ON A RURAL INTERSTATE

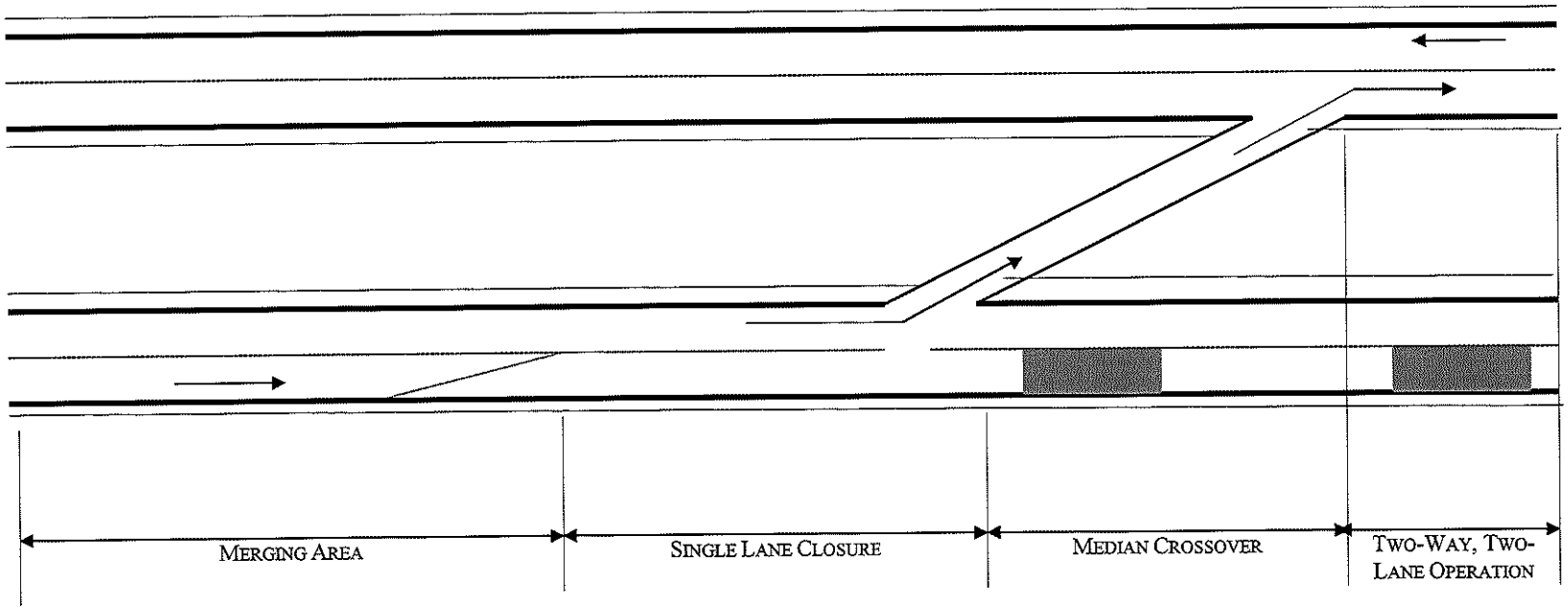


TABLE 1

DEVICE CATEGORIES	ALTERNATIVE TRAFFIC CONTROL DEVICES	
A. Channeling Devices	1. Cones 2. Tubular Markers 3. Vertical Panels 4. Drums 5. Barricades	6. Portable Barriers 7. Temporary Raised Islands 8. Concrete Barriers 9. Other
B. Markings [Pavement]	1. Paint 2. Reflective Tape 3. Raised PVT Markers	4. Delineators 5. Other
C. Lighting Devices	1. Floodlights 2. Warning Lights Type A Type B Type C	3. Hazard Identification Beacons (Flashing Electric Lights) 4. Other
D. Motorist Warning Devices	1. Warning Signs 2. Portable Changeable Message Signs	3. Arrow Display (flashing) 4. Flaggers 5. Other
E.		
F. Motorist Speed Control Devices	1. Slower Speed Limit Signs 2. Pilot Car(s) 3. Highway Patrol Cars	4. Highway Patrol Officers 5. Other
G. Other Devices	1. Impact Attenuators a. Roadside b. Truck-Mounted 2. Portable Barriers 3.Temporary Traffic Signals	4. Rumble Strips 5. Screens 6. Opposing Traffic Lane Divider 7. Other

COMMENTS

NAME
ORGANIZATION
Phone # _____ Fax # _____

NOTES:

1. Survey Respondents' comments are typed in **ALL CAPS**.
2. The focus group consists of two groups, the first included Wyoming Department of Transportation engineers (know as WYDOT) and the second group was made up of engineers from DOTs outside of Wyoming (known as DOTs).
3. Thirty surveys were returned including, then from WYDOT and twenty from the DOTs group.

QUESTION #1

Based solely on the sketch and project description above, what traffic control strategy would you implement?

QUESTION #1 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	TLTWO	*SLC*	1.248
WYDOT	**4**	7	
Proportions	0.364	0.636	P-VALUE
DOTs	**3**	**14**	0.264
Proportions	0.177	0.823	
90% Wald C.I. = 0.187 +/- 0.370			

Comments:

DOTs COMMENTS

- "FOR ANSWERING MOST QUESTIONS, ONE MUST KNOW THE LOCATION OF SLAB REPLACEMENTS.
- HOW ABOUT WORKER SAFETY ISSUES.
- TLTWO-BECAUSE REPLACEMENTS ARE NUMEROUS & IN BOTH SIDES."

QUESTION #2

*Please indicate which of these characteristics direct you towards choosing a specific Traffic Control Strategy. Do this by indicating: **1** for the TLTWO Strategy; **2** for the SLC Strategy; **3** for both TLTWO and SLC; and **4** for neither TLTWO or SLC.*

NOTE: Responses of 3 (both TLTWO & SLC); 4 (neither TLTWO or SLC) and NR (no responses) were grouped together to form a single grouping. Thus, three groups data were evaluated for this question instead of the designed four groups.

QUESTION #2 RESULTS:

PERCENTAGES OF RESPONSES						
TRAFFIC CONTROL STRATEGY	TLTWO		SLC		BOTH; NEITHER & NO RESPONSE	
AGENCIES	WYDOT	DOTs	WYDOT	DOTs	WYDOT	DOTs
VOLUME						
Low Volume	20%	0%	50%	33%	30%	67%
High Volume	20%	11%	50%	17%	30%	67%
GEOMETRICS						
Straight	0%	0%	40%	17%	60%	83%
Curves	10%	11%	30%	17%	60%	72%
Up-Grade	10%	0%	30%	17%	60%	83%
Down-Grade	10%	6%	30%	17%	60%	78%
Wide Shoulders	20%	11%	40%	33%	40%	56%
Narrow Shoulders	10%	11%	50%	17%	40%	72%
Interchanges w/in W.Z.	0%	0%	70%	44%	30%	56%
Ramps w/in W.Z.	0%	0%	70%	44%	30%	56%
PROJECT DURATION						
(< 3 months)	20%	6%	60%	50%	20%	44%
(> 3 months)	30%	22%	40%	6%	30%	67%
LENGTH OF CONSTRUCTION						
(< 4 miles)	10%	6%	70%	22%	20%	72%
(> 4 miles)	40%	0%	40%	11%	20%	83%
LANE WIDTH IN W.Z.						
(> 12 ft.)	0%	11%	70%	17%	30%	72%
(< 12 ft.)	40%	11%	30%	17%	10%	72%
SLAB REPLACEMENT DEPTH						
(< 4")	0%	6%	80%	33%	20%	61%
(> 4")	30%	11%	40%	11%	10%	78%

Comments:

WYDOT COMMENTS

◊ "WORK IN BOTH LANES.
◊ HAZZARD TO WORKERS.
◊ HAZZARD TO MOTORISTS.
◊ SHORTER PROJECT DURATION IN TLTWO.
◊ MEDIAN WIDTH SOMETIMES A CONSIDERATION."

DOTs COMMENTS

◊ "THE TWO MAIN FACTORS FOR WZTC ARE TRAFFIC SPEED & THE NUMBER OF LANES.
◊ COST OF CONSTRUCTION OF BYPASS AND PORTABLE CONCRETE WALL FOR TLTWO INCLUDING TIME TO DO THE WORK.
◊ LENGTH OF SLAB REPLACEMENT AREAS - ASSUMED THAT THEY WERE 750'."

QUESTION #3

If you elected answer B [SLC] in Question 1, please indicate which lane closure plan you would use.

QUESTION #3 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Close one entire lane	*Stagger lane closures*	*0.014*
WYDOT	**7**	**1**	
Proportions	0.875	0.125	P-VALUE
DOTs	**12**	**2**	0.907
Proportions	0.857	0.143	
90% Wald C.I. = 0.018 +/- 0.359			

Comments:

DOTs COMMENTS

◊ *ONE RESPONDER CHECKED OFF BOTH OPTIONS.

◊ "LET CONTRACTOR SCALE OF ECONOMICS CONTROL."

QUESTION #4

At what distance (x), would you consider the slab replacements separate work spaces?

QUESTION #4 RESULTS:

AGENCY	WYDOT	DOTs	
UNITS	MILES	MILES	
Mean (μ)	0.982	1.778	
Standard Deviation	0.582	0.984	
TWO SAMPLE T-TEST ($\alpha = 0.10$) H_0: $\mu_{WYDOT} = \mu_{DOTs}$ vs. H_1: $\mu_{WYDOT} \neq \mu_{DOTs}$			
T statistic	T value	p	DF
-2.43	1.73	0.024	20
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-1.36, -0.23)			

QUESTION #5

What do you think the posted speed limit should be for the following work zone areas in a Single Lane Closure Strategy?

QUESTION #5 RESULTS:

AGENCY	WYDOT		DOTs	
-	MEAN (μ)	STDEV	MEAN (μ)	STDEV
UNITS	MPH	MPH	MPH	MPH
Transition Area	59	5.8	57	7.8
Buffer Space	56	5.2	55	9.2
Work Space	53	7	52	10.6
TWO SAMPLE T-TEST ($\alpha = 0.10$) TRANSITION AREA				
H_o: $\mu_{WYDOT} = \mu_{DOTs}$ vs. H_1: $\mu_{WYDOT} \neq \mu_{DOTs}$				
T statistic	T value	p	DF	
0.54	1.734	0.60	18	
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-3.5, 6.8)				
BUFFER SPACE				
0.40	1.729	0.69	19	
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-4.1, 6.6)				
WORK SPACE				
0.39	1.729	0.70	19	
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-4.9, 7.9)				

Comments:
DOTs COMMENTS
◊ "ONLY WHEN WORKERS ARE PRESENT."

QUESTION #6

Do you think that the drop offs at the edge of the travel lane should be filled at night?

QUESTION # 6 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	0.187
WYDOT	**5**	**3**	
Proportions	0.625	0.375	P-VALUE
DOTs	**10**	**4**	0.665
Proportions	0.714	0.286	
90% Wald C.I. = -0.089 +/- 0.463			

Comments:
WYDOT RESPONSES
4:1TAPER OR NOT ALLLOWED OVER NIGHT."
DOTs COMMENTS
◊ "IF OVER 3" FILL IN OR PROTECT WITH BARRIER.
◊ IDEALLY - NOT PRACTICAL - YES, FILL IN."

QUESTION #7

When choosing a channeling device for a SLC Strategy, what characteristics of the work area influence your choice?

QUESTION #7 RESULTS:

AGENCY	WYDOT		DOTs	
CHARACTERISTICS	INFLUENCE %	MEDIAN RANK	INFLUENCE %	MEDIAN RANK
Drop off Height	85.7%	1	73.3%	3.0
Travelway Width	85.7%	2.5	86.7%	2.0
Shoulder Width	57.1%	5	60.0%	4.0
Posted Speed Limit	42.9%	Not influential	66.7%	4.0
Traffic Volume	85.7%	3.5	66.7%	6.0
Location of Workers	100.0%	2	86.7%	4.0
Horizontal. Curvature	25.0%	Not influential	40.0%	Not influential
Grade of Roadway	0.0%	Not influential	33.3%	Not influential

NOTE: 1. Influence % = number of times the characteristic was checked off, divided by total responses.

2. Not Influential = Median Rank equal to 10 (A value of 10 was applied all of the characteristics that were not ranked).

Comments:

DOTs COMMENTS

◊ " I THINK YOU SHOULD ADD DURATION THERE IS A DIFFERENCE FOR DAYTIME ONLY VS. NIGHTIME."

QUESTION #8

In the project illustration below, please layout a SLC Strategy using the devices listed in Table 1 PG 6.

QUESTION #8 RESULTS:

DOTs

RESPONDER #	7	10	11	**12**	13	14	16	17	**18**	**20**
ADVANCED WARNING	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	**Devices**	**Devices**
	C-2b	D-1	D-1	**D-1**	D-1	D-1		D-1	**D-1**	**D-1**
	D-1			**F-1**		C-2c		D-5		**D-3**
	E-1							F-1		**F-1**
	F-1									
TRANSITION AREA	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	**Devices**	**Devices**
	A-1	A-4	A-4	**A-4**	A-4	A-6*	A-1	A-4	**A-4**	**A-4**
	B-2	D-3	C-3	**D-3**	B-1	C-2c	A-3	C-2	**D-1**	**D-1**
	D-3		D-3		D-3	G-1		D-3	**D-3**	
					F-1			A-2		
BUFFER SPACE	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	**Devices**	**Devices**
	A-4	A-4	A-4	**A-2**	A-3	A-6*	A-4	A-2	**A-4**	**A-4**
	A-6	G-1b	A-5	**D-1**		C-2c	A-8	A-4	**G-1a**	**D-3**
	B-2		F-1							
			G-1b							
WORK SPACE	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	**Devices**	**Devices**
	A-4	A-4	A-4	**A-2**	A-3	A-6*	A-8	A-2	**A-4**	**A-4**
	A-6			**A-6**		C-2c		A-4		
	B-2									
TERMINATION AREA	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	**Devices**	**Devices**
	A-4	A-4	A-4	**A-2**		A-2	A-1	A-2	**A-4**	**A-4**
	B-2			**A-6**		C-2		A-4		**D-1**
	D-1					D-1		D-1		

DOTs

RESPONDER #	21	23	**24**	**26**	27	**30**	31		
ADVANCED WARNING AREA	Devices	Devices	**Devices**	**Devices**	Devices	**Devices**	Devices		
	D-1	D-1	**D-1**	**D-1**	D-1	**D-1**	D-1		
	F-1	D-3	**D-3**				D-3		
		F-1	**F-1**				C-2a		
TRANSITION AREA	Devices	Devices	**Devices**	**Devices**	Devices	**Devices**	Devices		
	A-8	A-4	**A-4**	**A-3**	A-1	**A-4**	A-4		
	D-3	F-1	**D-1**	**A-4**	A-4	**B-2**	C-2c		
			D-3	**C-2c**	D-3	**D-1**			
				D-1		**D-3**			
						F-1			
BUFFER SPACE	Devices	Devices	**Devices**	**Devices**	Devices	**Devices**	Devices		
	A-8	A-4	**A-4**	**A-4**	A-1	**A-4**	A-4		
		F-1		**A-5(3)**	G-1b	**A-5**	C-2c		
				A-3		**D-1**			
				C-2a					
				C-2c					
WORK SPACE	Devices	Devices	**Devices**	**Devices**	Devices	**Devices**	Devices		
	A-8	A-4	**A-4**	**A-4**	A-1	**A-4**	A-4		
		F-1		**A-5(2)**	G-1b		C-2c		
				A-3					
TERMINATION AREA	Devices	Devices	**Devices**	**Devices**	Devices	**Devices**	Devices		
	A-8	A-4	**A-4**	**A-3**	A-1	**A-4**	A-4		
				A-4			C-2c		
				C-2c					

NOTES: 1. A-6* - Water filled barriers.

2. Devices in **BOLD** were obtained from plans sent to WT^2 Center.

QUESTION #8 RESULTS CONTINUED:

WYOMING DEPARTMENT OF TRANSPORTATION

RESPONDER #	2	3	4	5	8	**19**	**28**	**29**
ADVANCED WARNING AREA	Devices	Devices	Devices	Devices	Devices	**Devices**	**Devices**	**Devices**
	D-1	D-1	D-1	D-1	D-1	**A-4**	**A-4**	**A-4**
		F-5	K-1	F-1	F-1	**D-1**	**D-1**	**D-1**
						D-3	**D-3**	**D-3**
TRANSITION AREA	Devices	Devices	Devices	Devices	Devices	**Devices**	**Devices**	**Devices**
	A-4	A-4	A-4	A-4	A-4	**A-4**	**A-4**	**A-4**
	F-1	D-3	D-3	D-3	D-3	**A-8**	**A-8**	**A-8**
						F-1	**F-1**	**F-1**
						F-3	**F-3**	**F-3**
BUFFER SPACE	Devices	Devices	Devices	Devices	Devices	**Devices**	**Devices**	**Devices**
	A-4	A-3	A-4	A-4	A-4	**A-8**	**A-8**	**A-8**
	A-5	A-5	A-5	A-5	G-2			
	F-1	F-1	F-1					
WORK SPACE	Devices	Devices	Devices	Devices	Devices	**Devices**	**Devices**	**Devices**
	A-4	A-3	A-4	A-4	A-4	**A-8**	**A-8**	**A-8**
	A-5	A-5	A-5	A-8(1)				
				D-1				
				D-4				
TERMINATION AREA	Devices	Devices	Devices	Devices	Devices	**Devices**	**Devices**	**Devices**
	A-2	A-3	A-4	A-4	A-4	**A-8**	**A-8**	**A-8**
	A-4	F-5a						
	F-1							

NOTES: 1. Use Concrete Barriers if drop off is over 8".

2. Devices in **BOLD** were obtained from plans sent to WT^2 Center

QUESTION #9

What do you think the posted speed limit should be for the following work zone areas in a Two-Lane, Two-Way Operation Strategy?

QUESTION #9 RESULTS:

AGENCY	WYDOT		DOTs	
WORK ZONE AREAS	AVERAGES	STDEV	AVERAGES	STDEV
UNITS	MPH	MPH	MPH	MPH
Merging Area	60	4.1	57	11.1
Median X-Over	53	8.9	54	11.2
TLTWO	60	4.1	59	9.1
TWO SAMPLE T-TEST ($\alpha = 0.10$) MERGING AREA				
H_o: $\mu_{WYDOT} = \mu_{DOTs}$ VS. H_1: $\mu_{WYDOT} \neq \mu_{DOTs}$				
T statistic	T value	p	DF	
0.92	1.730	0.37	20	
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-2.5, 8.1)				
MEDIAN CROSSOVER				
-0.35	1.717	0.73	22	
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-8.2, 5.4)				
TLTWO				
0.24	1.717	0.81	22	
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-3.9, 5.1)				

Comments:

DOTs COMMENTS

◊ "REQUIRES ENGINEERING JUDGEMENT PER PROJECT LOCATION.

◊ 40 MPH - ONLY WHEN WORKERS ARE PRESENT."

QUESTION #10

When choosing a channeling device for a TLTWO Strategy, what characteristics of the work area influence your choice?

QUESTION #10 RESULTS:

AGENCY	WYDOT		DOTs	
CHARACTERISTICS	INFLUENCE %	MEDIAN RANK	INFLUENCE %	MEDIAN RANK
Travelway Width	60.0%	2.0	100.0%	1.0
Shoulder Width	40.0%	Not influential	62.5%	4.5
Posted Speed Limit	30.0%	Not influential	56.3%	5.5
Grade of Roadway	30.0%	Not influential	25.0%	Not influential
Opposing Traffic Volume	60.0%	1.0	75.0%	2.5
Percentage of Trucks	50.0%	3.5	43.5%	Not influential
Devices Being Hit	70.0%	2.5	62.5%	3.0

NOTE: See Question #7 for a definition of Median Rank & Influence %.

Comments:

WYDOT RESPONSES

◊ "CURVATURE, URBAN VS RURAL."

DOTs COMMENTS

◊ "WORKER/DRIVER SAFETY.

◊ STOP PEOPLE FROM PASSING IN THIS AREA.

◊ ALL OF THE ABOVE -#1 I AM MOST CONCERNED WITH PROVIDING A VISUAL BARRIER THAT IS FORGIVING. THAT IS, A BARRIER THAT WILL NOT REDIRECT THE VEHICLE OR CAUSE IT GO INTO THE OTHER LANE."

QUESTION #11

In the project illustration below, please layout a TLTWO Strategy using the devices listed in Table 1 PG 6.

QUESTION #11 RESULTS:

DOTs

RESPONDER #	7	10	11	**12**	13	14	15	16	17	**18**
MERGING AREA	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	Devices	**Devices**
	A-4	A-4	A-4	**A-4**	A-4	A-6*	A-4		A-4	**A-4**
	B-2	D-3	C-3	**D-1**	B-1	C-2c	D-1		C-2a	**D-1**
	D-1		D-3	**D-3**	D-1	D-1	D-3		D-1	**D-3**
	D-3			**F-1**	D-3	D-3	F-1		D-3	
	E-1				F-1	G-1			D-5	
	F-1								F-1	
SINGLE LANE CLOSURE	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	Devices	**Devices**
	A-4	A-4	A-4	**A-4**	A-5	A-6*	A-4		A-4	**A-4**
	B-2	A-5	A-5	**D-1**	C-1	C-2c	A-5		A-5	**D-1**
			F-1				D-1		C-2a	
MEDIAN CROSSOVER	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	Devices	**Devices**
	A-4	A-4	A-5	**A-5**	C-1	A-5(3)	A-4	A-3	A-4	**A-4**
	A-5			**D-1**		C-2c	A-9**	A-6	A-5	**A-6**
	B-2					D-1			B-1	**D-1**
	D-1								C-2	
									D-1	
TLTWO	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	Devices	**Devices**
	A-2	A-4	A-6	**A-8**	A-2	A-6*	A-3	A-3	A-2	**A-4**
	A-3			**G-1a**	B-1	C-2c	A-8	A-6	B-2	**D-1**
	A-6				B-3		B-1	A-8		
	B-2				D-1		G-1a			
	E-1									

QUESTION #11 RESULTS CONTINUED:

DOTs

RESPONDER #	**20**	21	23	**24**	**26**	27	**30**	**31**	
MERGING AREA	**Devices**	Devices	Devices	**Devices**	**Devices**	Devices	**Devices**	**Devices**	Devices
	A-4	A-3	A-4	**A-4**	**A-4**	A-2	**A-2**	**A-4**	
	D-1	A-4	B-3	**B-1**	**C-2c**	D-3	**D-3**	**D-1**	
	D-3	D-1	F-1	**D-1**	**D-1**	F-1	**F-1**	**D-3**	
	F-1	D-3		**D-3**	**D-3**				
		F-1			**F-1**				
SINGLE LANE CLOSURE	**Devices**	Devices	Devices	**Devices**	**Devices**	Devices	**Devices**	**Devices**	Devices
	A-4	A-3	A-4	**A-4**	**A-4**	A-2	**A-2**	**A-4**	
	D-1	A-4	B-3	**B-4**	**C-2c**	D-1	**D-1**	**D-1**	
MEDIAN CROSSOVER	**Devices**	Devices	Devices	**Devices**	**Devices**	Devices	**Devices**	**Devices**	Devices
	A-6	A-3	A-4	**B-1**	**A-4**	A-5	**A-5**	**A-4**	
	B-1	A-4		**D-1**	**A-5(3)**	B-4	**B-4**	**A-5**	
	D-1	A-6			**C-2c**	D-1	**D-1**	**C-1**	
		D-1						**D-1**	
TLTWO	**Devices**	Devices	Devices	**Devices**	**Devices**	Devices	**Devices**	**Devices**	Devices
	A-8	A-8	A-2	**A-2**	**a-5(3)**	A-2	**A-2**	**A-8**	
	D-1		B-3	**B-1**	**A-8**	D-1	**D-1**	**D-1**	
			F-1	**B-3**	**C-2c**	F-1	**F-1**	**F-1**	
					G-1a				

NOTES: 1. A-6* - Water filled barriers.
2. A-9** - Earth Berms
3. E-1 - Do Not Pass Sign
4. Devices in **BOLD** were obtained from plans sent to WT^2 Center

QUESTION #11 RESULTS CONTINUED:

WYOMING DEPARTMENT OF TRANSPORTATION

RESPONDER #	2	3	4	5	6	8	**19**	**28**	**29**
MERGING AREA	Devices	Devices	Devices	Devices	Devices	Devices	**Devices**	**Devices**	**Devices**
	A-4	D-1	A-4	A-4	A-1	A-4	**A-4**	**A-4**	**A-4**
	D-1	F-1	D-1	D-3	D-1	D-1	**D-1**	**D-1**	**D-1**
		F-5	D-3	F-1	D-2	D-3	**F-1**	**F-1**	**F-1**
			F-1		D-5	F-1			
					F-1				
SINGLE LANE CLOSURE	Devices	Devices	Devices	Devices	Devices	Devices	**Devices**	**Devices**	**Devices**
	A-4	A-4	A-4	A-4	A-1	A-4	**A-4**	**A-4**	**A-4**
	F-1	D-3	A-5	D-1	A-5	F-1	**B-1**	**B-1**	**B-1**
			D-1		B-1	G-2	**D-1**	**D-1**	**D-1**
			F-1		D-1		**G-2**		
MEDIAN CROSSOVER	Devices	Devices	Devices	Devices	Devices	Devices	**Devices**	**Devices**	**Devices**
	A-4		A-4	B-3	B-1	B-2	**A-4**	**A-4**	**A-4**
	A-5		A-5	B-4			**B-1**	**B-1**	**B-1**
	B-4		D-1				**D-1**	**D-1**	**D-1**
			B-3						
			B-4						
TLTWO	Devices	Devices	Devices	Devices	Devices	Devices	**Devices**	**Devices**	**Devices**
	A-3	A-4	A-2	A-4	A-2	D-3	**A-4**	**A-4**	**A-4**
	D-1		A-4	B-3	F-1		**B-1**	**B-1**	**B-1**
	F-1		D-1	D-1			**D-1**	**D-1**	**D-1**
			F-1						

NOTES: 1. Devices in **BOLD** were obtained from plans sent to WT^2 Center

APPENDIX B

"RAMP TRAFFIC CONTROL FOR A RURAL INTERSTATE RECONSTRUCTION PROJECT"
DELPHI SURVEY QUESTIONNAIRE NO. 2
AND
SUMMARY RESULTS

RAMP TRAFFIC CONTROL FOR A RURAL INTERSTATE RECONSTRUCTION PROJECT

Survey's Purpose: The purpose of this survey is to examine the traffic control alternatives for entrance/exit ramps located within a long-term reconstruction project on a rural interstate. The survey consists of two sections, the first section concentrates on entrance ramps while the second section focuses on exit ramps.

Directions: Please answer all of the questions listed below. The majority of the questions require only a checkmark for an answer, while other questions require you to layout a traffic control plan. Please send your responses in the provided business reply envelop or fax it to us at, (307) 766-6784. Also, please list any COMMENTS about the survey on the bottom of page 6.

ENTRANCE RAMP SECTION

Description: Questions 1-6 focus on three traffic control options (i.e. Stop, Yield or No Control) associated with temporary entrance ramps. Although you may feel that only one of these traffic control options is applicable for an entrance ramp, please answer the remainder of the questions.

1. Please indicate, by a checkmark, which of these characteristics of a long-term reconstruction project direct you towards employing a STOP Sign at the end of an entrance ramp.

CHARACTERISTICS OF TEMPORARY ENTRANCE RAMP CHARACTERISTICS	ROADWAY / PROJECT
_____Low Traffic Volume on Ramps	_____Single Lane Closure
_____High Traffic Volume on Ramps	_____Two-Lane, Two-Way Operations
_____No Acceleration Lane	_____Low Volume
_____Limited Sight Distance	_____High Volume
Other (please list)_____	

2. If a STOP Sign is employed on a temporary entrance ramp, where do you think the motorist should stop?

_____On the ramp (i.e. prior to the entrance of the main line)
_____At the entrance of the main line

3. When a STOP Sign is utilized on a temporary entrance ramp, do you feel that a temporary stop line should be placed at the location of the STOP Sign?

_____YES
_____NO

4. Please indicate, by a checkmark, which of these characteristics of a long-term reconstruction project direct you towards employing YIELD CONTROL at the end of an entrance ramp.

CHARACTERISTICS OF TEMPORARY ENTRANCE RAMP	ROADWAY / PROJECT CHARACTERISTICS
_____Low Traffic Volume on Ramps	_____Single Lane Closure
_____High Traffic Volume on Ramps	_____Two-Lane, Two-Way Operations
_____No Acceleration Lane	_____Low Volume
_____Limited Sight Distance	_____High Volume
Other (please list)_____	

5. If a YEILD Sign is employed on a temporary entrance ramp, where do you think the YIELD Sign should be placed?
_____On the ramp (i.e. prior to the entrance of the main line)
_____At the entrance of the main line

6. Please indicate, by a checkmark, which of these characteristics of a long-term reconstruction project direct you towards employing NO CONTROL at the end of an entrance ramp.

CHARACTERISTICS OF TEMPORARY ENTRANCE RAMP	ROADWAY / PROJECT CHARACTERISTICS
_____Low Traffic Volume on Ramps	_____Single Lane Closure
_____High Traffic Volume on Ramps	_____Two-Lane, Two-Way Operations
_____No Acceleration Lane	_____Low Volume
_____Limited Sight Distance	_____High Volume
Other (please list)_____	

7. Do you think that Warning Signs (such as SINGLE LANE AHEAD) should be placed on an entrance ramp (where the ramp is under Yield Control or No Control) to warn the ramp motorists that there is only one thru lane on the interstate due to two-way, two-lane traffic?
_____YES
_____NO

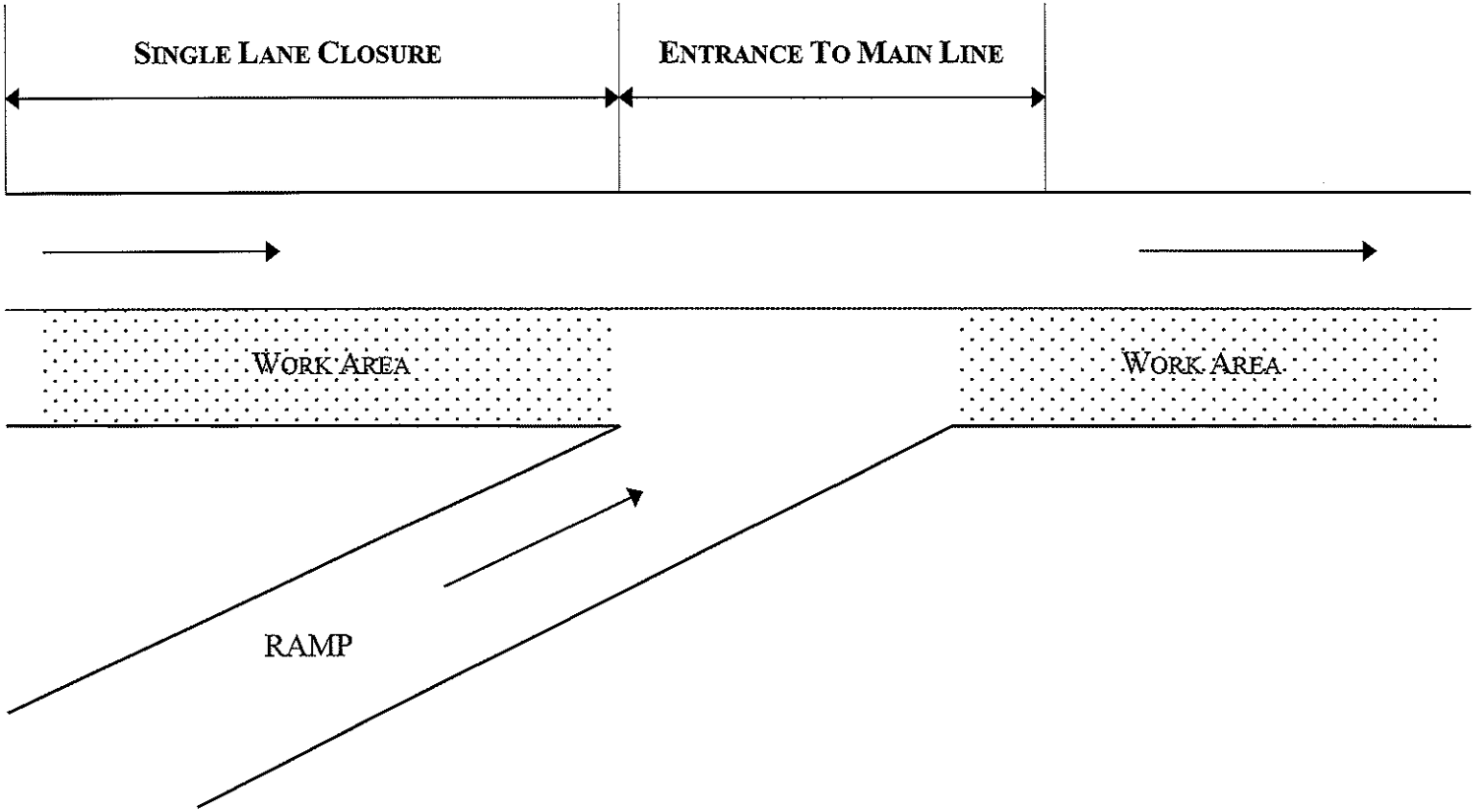
8. Do you think temporary lighting should be employed in the vicinity of entrance ramps?
_____YES
_____NO

9. Do you think that the spacing of the channeling devices should be reduced in the vicinity of an entrance ramp to alert motorists, on the main line, of merging traffic?
_____YES
_____NO

10. If you answered No to Question 9, please indicate what actions that you feel should be taken to alert the motorists, on the main line, of an entrance ramp.

11. In the project illustration below, please layout a traffic control plan for a passage from the Entrance Ramp to the main line using the devices listed in TABLE 1. (Complete this question by: 1. Sketching out lines that represent **your** desired Traffic Control Device(s) and patterns, and 2. Labeling the lines with a device(s) number followed by the category letter provided in TABLE 1, Page 6.)

WORK IN THE VICINITY OF AN ENTRANCE RAMP



EXIT RAMP SECTION

12. Do you use additional Signs to help locate a temporary exit ramp?

_____YES
_____NO

13. If you answered yes to Question 12, please list the messages and/or signs that you would use.

_____
_____
_____

14. Do you think temporary lighting should be employed in the vicinity of exit ramps?

_____YES
_____NO

15. Do you think that the spacing of the channeling devices should be reduced in the vicinity of an exit ramp to emphasize the opening of the ramp itself?

_____YES
_____NO

16. If you answered No to Question 15, please indicate what actions that you feel should be taken to alert the motorists, on the main line, of an exit ramp.

_____
_____
_____

17. In the project illustration below, please layout a traffic control plan for a passage from the main line to the Exit Ramp using the devices listed in TABLE 1. (Complete this question by: 1. Sketching out lines that represent **your** desired Traffic Control Device(s) and patterns, and 2. Labeling the lines with a device(s) number followed by the category letter provided in TABLE 1, Page 6.)

WORK IN THE VICINITY OF AN EXIT RAMP

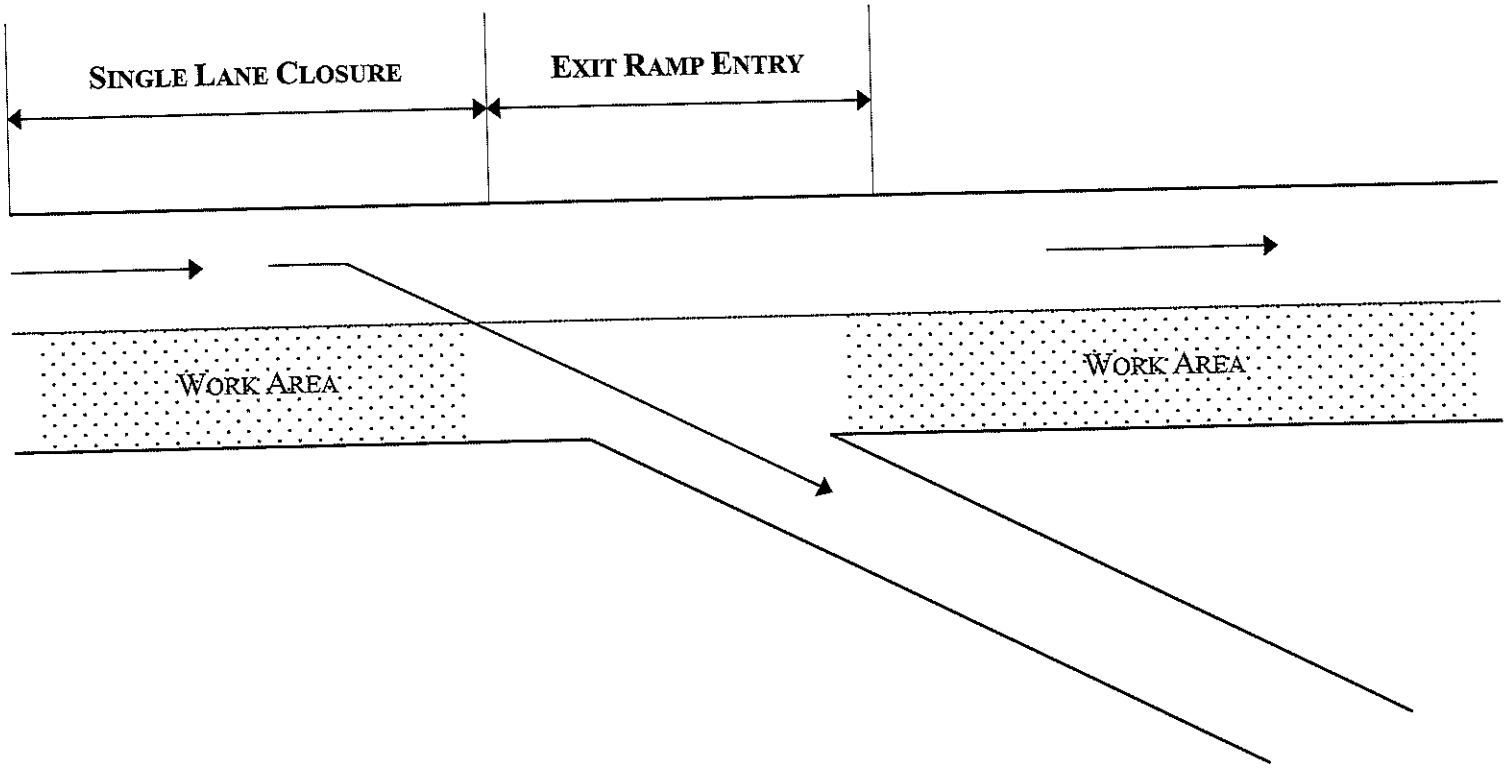


TABLE 1

DEVICE CATEGORIES	ALTERNATIVE TRAFFIC CONTROL DEVICES	
A. Channeling Devices	1. Cones 2. Tubular Markers 3. Vertical Panels 4. Drums 5. Barricades	6. Portable Barriers 7. Temporary Raised Islands 8. Concrete Barriers 9. Other
B. Markings [Pavement]	1. Paint 2. Reflective Tape 3. Raised PVT Markers	4. Delineators 5. Other
C. Lighting Devices	1. Floodlights 2. Warning Lights Type A Type B Type C	3. Hazard Identification Beacons (Flashing Electric Lights) 4. Other
D. Motorist Warning Devices	1. Warning Signs 2. Portable Changeable Message Signs	3. Arrow Display (flashing) 4. Flaggers 5. Other
E.	1. STOP Sign 2. STOP Bar	3. YIELD Sign
F. Motorist Speed Control Devices	1. Slower Speed Limit Signs 2. Pilot Car(s) 3. Highway Patrol Cars	4. Highway Patrol Officers 5. Other
G. Other Devices	1. Impact Attenuators a. Roadside b. Truck-Mounted 2. Portable Barriers 3.Temporary Traffic Signals	4. Rumble Strips 5. Screens 6. Opposing Traffic Lane Divider 7. Other

COMMENTS

NAME
ORGANIZATION
Phone # _____ Fax # _____

NOTES:

1. Survey Respondents' comments are typed in **ALL CAPS**.
2. The focus group consists of two groups, the first included Wyoming Department of Transportation engineers (know as WYDOT) and the second group was made up of engineers from DOTs outside of Wyoming (known as DOTs).
3. Twenty-eight surveys were returned, including eleven from WYDOT and seventeen from the DOTs group.

QUESTION #1

Please indicate, by a checkmark, which of these characteristics of a long-term reconstruction project direct you towards employing a STOP Sign at the end of and entrance ramp.

QUESTION #1 RESULTS:

CHARACTERISTICS FOR QUESTIONS #1, #4 & #6
ENTRANCE RAMP CHARACTERISTICS
1. Low Traffic Volume on Ramp
2. High Traffic Volume on Ramp
3. No Acceleration Lane
4. Limited Sight Distance
PROJECT CHARACTERISTICS
5. Single Lane Closure
6. Two-Lane, Two-Way Operation
7. Low Traffic Volume
8. High Traffic Volume

AGENCY	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	Total
WYDOT	3	4	8	9	4	4	2	6	40
Proportions	0.27	0.36	0.73	0.82	0.36	0.36	0.18	0.55	
DOTs	5	2	12	11	3	6	3	6	48
Proportions	0.29	0.12	0.71	0.65	0.18	0.35	0.18	0.35	
				Chi-square = 2.2004				DF = 7	

Comments:

DOTs COMMETS

◊ "CURVATURE, URBAN VS RURAL.

◊ "STOPPING AN ON RAMP TO AN INTERSTATE ROUTE CANNOT BE GENERALLY RECOMMENDED.

◊ THIS WOULD BE RARELY USED."

QUESTION #2

If a STOP Sign is employed on a temporary entrance ramp, where do you think the motorist should stop?

QUESTION #2 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	On the ramp	*At the entrance*	0.022
WYDOT	**5**	**5**	
Proportions	0.5	0.5	P-VALUE
DOTs	**9**	**8**	0.883
Proportions	0.530	0.471	
90% Wald C.I. = 0.029 +/- 0.422			

Comments:

DOTs COMMENTS

◊ "AT A POINT THAT PROVIDES SIGHT DISTANCE & ANGLE OF VIEW FOR DRIVER."

QUESTION #3

When a STOP Sign is utilized on a temporary entrance ramp, do you feel that a temporary stop line should be placed at the location?

QUESTION #3 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	2.40
WYDOT	**7**	**4**	
Proportions	0.636	0.364	P-VALUE
DOTs	**15**	**2**	0.121
Proportions	0.882	0.118	
90% Wald C.I. = -0.246 +/- 0.358			

Comments:

DOTs COMMENTS

◊ "CURVATURE, URBAN VS RURAL."

◊ "STOP LINE SHOULD BE PLACED TO MAXIMIZE SAFETY OF VEHICLE ON ENTRANCE RAMP."

QUESTION #4

Please indicate, by a checkmark, which of these characteristics of a long-term reconstruction project direct you towards employing a YIELD Sign at the end of an entrance ramp.

QUESTION #4 RESULTS:

AGENCY	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	Total
WYDOT	4	3	1	0	2	1	10	1	22
Proportions	0.36	0.27	0.09	0.0	0.18	0.09	0.91	0.09	
DOTs	6	3	8	4	7	6	9	2	45
Proportions	0.35	0.18	0.47	0.24	0.41	0.35	0.53	0.12	
				Chi-square = 9.8442				DF = 7	

Comments:

WYDOT COMMENS

◊ "GOOD SIGHT DISTANCE, STOP CONTROL WITH POOR COMPLIENCE.

◊ A YIELD SIGN IS PREFERRED OVER A STOP SIGN, IN MOST CASES."

DOTs COMMENTS

◊ "CURVATURE, URBAN VS RURAL.

◊ "THIS WOULD BE AN UNUSAL PRACTICE IN CALIFORNIA.

◊ LIMMITED LENGTH ACCELERATION LANE."

QUESTION #5

If a YIELD Sign is employed on a temporary exit ramp, where do think the YIELD Sign should be placed?

QUESTION #5 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	On the ramp	*At the entrance*	0.564
WYDOT	**5**	**5**	
Proportions	0.5	0.5	P-VALUE
DOTs	**6**	**11**	0.453
Proportions	0.353	0.647	
90% Wald C.I. = -0.147 +/- 0.417			

Comments:

WYDOT COMMENTS

◊ "AT A POINT THAT PROVIDES SIGHT DISTANCE AND ANGLE OF VIEW FOR DRIVER.

◊ INCLUDE "YIELD AHEAD" SIGN."

DOTs COMMENTS

◊ "IF HIGH SPEED - ON THE RAMP; IF LOW SPEED - AT THE ENTRANCE."

QUESTION #6

Please indicate, by a checkmark, which of these characteristics of a long-term reconstruction project direct you towards employing NO CONTROL at the end of an entrance ramp.

QUESTION #6 RESULTS:

AGENCY	*1*	*2*	-	-	*5*	*6*	*7*	*8*	Total
WYDOT	2	0	-	-	1	1	4	1	9
Proportions	0.18	0.0	-	-	0.09	0.09	0.36	0.09	
DOTs	4	1	-	-	2	0	4	1	12
Proportions	0.24	0.06	-	-	0.12	0.0	0.24	0.06	
				Chi-square = 2.625				DF = 5	

Comments:

WYDOT COMMENTS

◊ "I THINK NO CONTROL IS NOT AN OPTION.
◊ GOOD SIGHT DISTANCE, MERGING SPEED AT OR NEAR MAINLINE SPEED.
◊ IF THEY HAVE A DEAD LANE TO ENTER.
◊ I DON'T BELIEVE NO CONTROL SHOULD BE USED.
◊ I WOULD ALWAYS HAVE CONTROL.
◊ ALWAYS HAVE SOME TYPE OF CONTROL."

DOTs COMMENTS

◊ "ADEQUATE ACCELERATION LANE & TWO THROUGH LANES.
◊ ADEQUATE MERGING DISTANCE.
◊ WE GENERALLY USE CONTROL ON ALL RAMPS.
◊ I DON'T FEEL THIS IS AN OPTION.
◊ INSIDE SINGLE LANE CLOSURE; LOW VOLUME ROADWAY & LOW VOLUME RAMP.
◊ NO CONTROL IS NORMAL, STANDARD PRACTICE IN CALIFORNIA.
◊ ADEQUATE ACCEL LANE IS PROVIDED.
◊ THIS WOULD BE THE STANDARD INSTALATION."

QUESTION #7

Do you think that Warning Signs (such as SINGLE LANE AHEAD) should be placed on an entrance ramp (where the ramp is under Yield or No Control) to warn the ramp motorists that there is only one thru lane on the interstate due to two-way, two-lane traffic?

QUESTION #7 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	1.011
WYDOT	**6**	**5**	
Proportions	0.545	0.455	P-VALUE
DOTs	**6**	**11**	0.315
Proportions	0.353	0.647	
90% Wald C.I. = -0.193 +/- 0.400			

Comments:

WYDOT COMMENTS

◊ "PUT SINGLE LANE ON MAINLINE SOON AFTER RAMP ENTRANCE."

DOTs COMMENTS

◊ "RT OR LT LANE CLOSED AHEAD.

◊ USE MUTCD SIGN # W6-3 ON THE RAMP ALONG WITH MUTCD SIGN #W20-1.

◊ WOULD USE A DIRECTION SIGN ON THE MAINLINE."

QUESTION #8

Do you think temporary lighting should be employed in the vicinity of an entrance ramp?

QUESTION #8 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	1.534
WYDOT	**2**	**8**	
Proportions	0.2	0.8	P-Value
DOTs	**7**	**9**	0.216
Proportions	0.434	0.563	
90% Wald C.I. = -0.238 +/- 0.385			

Comments:

WYDOT COMMENTS

◊ "IF THE RAMP WOULD NORMALLY WARRENT LIGHTING.

◊ ESPECIALLY HIGH VOLMUE AREA.

◊ HIGH VOLUME ENTRANCE RAMP (YES); LOW VOLUME ENTRANCE RAMP (NO)."

DOTs COMMENTS

◊ "VOLUME WARRENTED - YES.

◊ DEPENDS ON SUCH THINGS AS NIGHT TIME TRAFFIC VOLUME.

◊ MAINTANING REFLECTIVE QUALITY OF CHANNELIZER.

◊ DEPENDS ON SUCH FACTORS AS EXISTING PERMANENT LIGHTING, ADJACENT LIGHTING."

QUESTION #9

Do you think that the spacing of channeling devices should be reduced in the vicinity of an entrance ramp to alert the motorist, on the mainline of merging traffic?

QUESTION #9 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	0.480
WYDOT	5	6	
Proportions	0.454	0.546	P-Value
DOTs	10	7	0.488
Proportions	0.588	0.412	
90% Wald C.I. = -0.134 +/- 0.404			

Comments:

WYDOT COMMENTS

- ◊ "TIGHT SPACING IS FOR DIRECTING RAMP TRAFFIC.
- ◊ CHANNELING DEVICES WILL OBSTRUCT VIEW OF RAMP TRAFFIC.
- ◊ CURRENT MAIN LINE SPACING IS ALREADY TIGHT.
- ◊ ALSO USE "ONEWAY" SIGNS."

QUESTION #10

If you answered No to Question 9, please indicate what actions that you feel should be taken to alert motorists, on the mainline, of an entrance ramp.

QUESTION #10 RESULTS:

RESPONDER	ACTIONS TO ALERT MOTORISTS
	DOTs RESPONSES
4	Merge Sign
8	Merge Sign
11	Advance Warning Signs
14	Use W4-1(o) prior to merge point
15	Merge Sign, Too many channeling devices may confuse motorist
16	Merge Sign
24	Signing that warns traffic. Too many channeling devices may not convey a consistent message to all motorists or use BOTH, But not just Reduced Speed.
	WYDOT RESPONSES
2	Merge Sign
5	Merge Sign
7	Merge Sign
22	Ramp Sign for Merging Traffic
23	None, if Stop or Yield control is on the ramp
26	I would place an appropriate warning sign so the message is clear

QUESTION #11

In the project illustration below, please layout a traffic control plan for a passage from the Entrance Ramp to the mainline using the devices listed in Table 1.

QUESTION #11 RESULTS:

DOTs

Responder #	4	6	8	11	12	**13**	14	15	16
SINGLE LANE CLOSURE	Devices	Devices	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices
	A-4	A-4	A-1	A-8	A-4	**A-?**	A-4	A-4	A-2
	D-1	B-2	D-1	D-1		**D-1**	D-1	A-6	
		D-1						C-2	
RAMP	Devices	Devices	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices
	A-4	A-4	A-1	D-1	A-4	**D-1**	A-4	A-4	A-2
	D-1	B-2				**D-3**	B-2	A-6	B-2
		E-2						C-2	D-1
ENTRANCE TO MAIN LINE	Devices	Devices	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices
	A-4	A-4	A-1	A-8	A-4	**A-?**	A-4	A-4	A-2
		B-2	E-2	E-1		**D-1**	A-5	A-5	A-5
				E-1(a)		**E-2**	E-1	A-6	D-1
				G-1(a)			E-1(a)		G-6

QUESTION #11 RESULTS CONTINUED:

DOTs

Responder #	17	18	19	**20**	24	25	27	29
SINGLE LANE CLOSURE	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices
	A-1	A-4		**D-1**	A-4	A-2	A-3	A-8
		B-1			A-5	A-4	A-5	B-2
		B-2			D-1	D-1		B-3
						C-2(a)		D-1
								G-1(a)
RAMP	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices
	A-1	C-2		**A-?**	A-4	D-1	B-2	A-5
		D-1		**D-1**	B-2			B-2
								B-3
								D-1
ENTRANCE TO MAIN LINE	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices
	A-1	A-4	A-4	**A-?**	A-4	A-2	A-3	A-5
	A-5	A-5	B-2	**D-1**	A-5	A-4	A-5	A-8
	E-1	B-1	E-2		B-2	A-5	B-2	B-2
	E-1(a)	B-2			E-1	D-1	E-1	B-3
		E-2			E-1(a)	E-1	E-1(a)	E-1
								E-1(a)
								G-1(a)

NOTES: 1. Devices in **BOLD** were obtained from plans sent to WT^2 Center.

QUESTION #11 RESULTS CONTINUED:

WYOMING DEPARTMENT OF TRANSPORTATION

Responder #	1	2	**3**	5	7	9	10	22	**23**
SINGLE LANE CLOSURE	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	Devices	**Devices**
	A-4	A-2	**A-4**	A-1	A-4		A-6	A-3	**A-4**
		A-4	**D-1**	A-4	D-1		D-5	D-1	**D-1**
				A-5			D-6		
				F-1					
RAMP	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	Devices	**Devices**
	A-4	A-4	**A-4**	A-1	A-4	A-4	B-2	D-1	**A-4**
	E-1	D-1	**D-1**	A-4	D-1	D-1	B-3		**D-1**
							D-1		
ENTRANCE TO MAIN LINE	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	Devices	**Devices**
	A-4	A-4	**A-4**	A-1	A-4	A-4	A-6	A-4	**A-4**
	A-5	A-5	**A-5**	A-4		E-1	B-2	A-5	**A-5**
		D-1	**E-1**	A-5		E-1(a)	E-1	D-1	**E-1**
		E-1	**E-2**				E-1(a)	E-1	**E-2**
		E-1(a)	**E-1(a)**					E-2	**E-1(a)**

NOTES: 1. Devices in **BOLD** were obtained from plans sent to WT^2 Center.

QUESTION #11 RESULTS CONTINUED:

WYOMING DEPARTMENT OF TRANSPORTATION

Responder #	26	28							
SINGLE LANE CLOSURE	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices
	A-2								
	B-1								
RAMP	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices
	B-1	A-4							
	D-1	D-1							
ENTRANCE TO MAIN LINE	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices
	A-2	A-4							
	B-1	E-1							
	D-1	E-1(a)							
	E-2	E-2							
		G-2							

NOTES: 1. Devices in **BOLD** were obtained from plans sent to WT^2 Center.

QUESTION #12

Do you use additional Signs to help locate a temporary exit Ramp?

QUESTION #12 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	0.001
WYDOT	**9**	**2**	
Proportions	0.818	0.182	P-VALUE
DOTs	**14**	**3**	0.971
Proportions	0.824	0.176	
90% Wald C.I. = -0.005 +/- 0.330			

QUESTION #13

If you answered Yes to Question 12, please list the message and/or signs that you would use.

QUESTION #13 RESULTS:

WYDOT RESPONSES

RESPONDER	ACTIONS TO ALERT MOTORISTS
2	Exit 1000 ft; 500 ft; EXIT Advisory Speed, Exit Gone Sign
3	Three advance guide signs, Exit Advisory Speed, Exit Gone Sign
5	EXIT #() miles ahead
9	EXIT # Ahead---ft, Additional Exit Sign
10	Arrow and EXIT Sign
22	Exit Left & Right of Lane X ft; Exit sign in Gore
26	Advance Sign; EXIT (XX) ¼ Mile; EXIT Gore Sign
28	EXIT # 500 Feet; EXIT w/ Arrow

DOTs RESPONSES

4	Exit 1500 ft
6	May move permanent signs over
8	Relocate Exit Sign
12	Cover existing E5-1 & display a Temporary E5-1 (exit panel) at Temp. location
13	Addition Exit Sign placed on a roadway-changeable message sign
14	Black on Orange rectangular sign with exit information
16	"Portable" Exit
18	Black on Orange EXIT (with arrow) sign
19	Exit sign as shown in MUTCD Part 6
20	a Temp. guide sign describing EXIT # or intersection roadway
24	EXIT w/ Arrow and Ramp Ahead
25	Relocate Exit Sign with Exit Number
27	EXIT Number, EXIT Destination, Arrow

QUESTION #14

Do you think temporary lighting should be employed in the vicinity of exit ramps?

QUESTION #14 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	1.977
WYDOT	**2**	**8**	
Proportions	0.2	0.8	P-VALUE
DOTs	**8**	**9**	0.160
Proportions	0.471	0.529	
90% Wald C.I. = -0.271 +/- 0.380			

Comments:
WYDOT COMMENTS
◊ "IF THE RAMP NORMALLY WARRENTED LIGHTING.
◊ ESPECIALLY HIGH VOLUME ROADS.
◊ HIGH VOLUME EXIT (YES); LOW VOLUME EXIT (N0)."
DOTs COMMENTS
◊ "VOLUME WARRENTED - YES.
◊ DEPENDS ON SUCH THINGS AS NIGHT TIME TRAFFIC VOLUME."

QUESTION #15

Do you think that the spacing of channeling devices should be reduced in the vicinity of an exit ramp to emphasize the opening of the ramp itself?

QUESTION #15 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	3.161
WYDOT	**5**	**5**	
Proportions	0.5	0.5	P-VALUE
DOTs	**14**	**3**	0.075
Proportions	0.824	0.176	
90% Wald C.I. = -0.324 +/- 0.395			

Comments:
WYDOT COMMENTS
◊ "ON LARGE OPENINGS.
◊ TIGHT SPACING AS IS."

QUESTION #16

If you answered No to Question 15, please indicate what actions that you feel should be taken to alert the motorists, on the mainline of an exit ramp.

QUESTION #16 RESULTS:

WYDOT RESPONSE	
RESPONDER	ACTIONS TO ALERT MOTORISTS
2	An alternative channeling device should be used to provide contrast
5	A break in the channeling devices
10	Signing to indicate Exit in GORE
23	Advance Signing
26	Advance signs indicating the exit is coming up, similar to normal exit signs at interchanges should be used.
DOTs RESPONSES	
8	Relocate Exit Signs
17	Relocate the Exit Gore Sign to Temporary Gore Point

QUESTION #17

In the project illustration below, please layout a traffic control plan from the mainline to the exit ramp using the devices listed in Table 1.

QUESTION #17 RESULTS

DOTs

Responder #	4	6	8	11	12	**13**	14	15	16
SINGLE LANE CLOSURE	Devices	Devices	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices
	A-4	A-4	A-1	A-8	A-4	**A-?**	A-4	A-4	A-2
	D-1	B-2		D-1		**D-1**	D-1	A-6	D-1
						D-3	G-7	C-2	
EXIT RAMP ENTRY	Devices	Devices	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices
	A-4	A-4	A-1	A-8	A-4	**A-?**	A-4	A-4	A-2
	D-1	B-2	D-1	G-1(a)		**D-1**	A-5	A-5	A-5
							B-2	A-6	A-6
							G-7	C-2	D-1
Responder #	17	18	19	**20**	24	25	27	29	
SINGLE LANE CLOSURE	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	
	A-1	A-4		**A-?**	A-4	A-2	A-3	A-8	
		B-1		**D-1**	A-5	A-4	A-5	B-2	
		B-2		**G-1(b)**	B-2	D-1	B-2	B-3	
					D-1			D-1	
EXIT RAMP ENTRY	Devices	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	
	A-1	A-4	A-4	**A-?D-1**	A-4	A-2	A-3	A-1	
	A-5	A-5	D-1	**G-1(b)**	A-5	A-4	A-5	A-8	
	D-1	B-1	B-2		B-2	A-5	B-2	B-2	
		B-2				B-2	D-1	B-3	
		D-1				D-1		D-1	

NOTE: 1. Devices in **BOLD** were obtained from plans sent to WT^2 Center.

QUESTION #17 RESULTS CONTINUED:

WYOMING DEPARTMENT OF TRANSPORTATION

Responder #	1	2	**3**	5	7	9	10	22	**23**
SINGLE LANE CLOSURE	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	Devices	**Devices**
	A-4	A-2	**A-4**	A-4	A-4	A-4	A-6	A-3	**A-4**
		A-4	**D-1**	A-5	D-1	D-1	B-2	D-1	**D-1**
		D-1		D-5			D-5		
EXIT RAMP ENTRY	Devices	Devices	**Devices**	Devices	Devices	Devices	Devices	Devices	**Devices**
	A-4	A-2	**A-4**	A-4	A-4	A-4	A-6	A-3	**A-4**
	A-5	A-4	**D-1**	A-5		D-1	B-2	A-4	**D-1**
		A-5					D-1	A-5	
		D-1							
Responder #	26	28							
SINGLE LANE CLOSURE	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices
	A-2	A-4							
	B-1	D-1							
	D-5								
EXIT RAMP ENTRY	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices	Devices
	A-2	A-4							
	B-1	D-1							
	D-5	G-2							

NOTE: 1. Devices in **BOLD** were obtained from plans sent to WT^2 Center.

APPENDIX C

DRIVER OBSERVANCE OF STOP SIGNS
Field Study
on
Entrance Ramps on an I – 80 Reconstruction Project
near
Laramie, Wyoming

DRIVER COMPLIANCE WITH STOP SIGNS ON INTERSTATE ENTRANCE RAMPS

Driver compliance with STOP signs studies were recorded at four entrance ramps on during reconstruction on Interstate 80. The purpose of these studies was to determine the Drivers' compliance with STOP Signs on an interstate ramp located within a construction zone.

Four driver actions were recorded at the STOP Signs. These were: full stop, almost stopped, forced stop, and no stop.

> "A full stop is defined as a complete cessation of movement, however brief. Nearly Stopped is defined most commonly as < 3 mph. A forced stop occurs when the motorist is required to stop because of conflict with cross traffic or pedestrians and no stop is defined as > 3 mph. (24)"

A sample size (N) of 235 vehicle actions were used for the first two studies, and 110 vehicle actions were used as the sample size for each of the other four studies. These sample sizes were calculated using the formula:

$$N = \frac{pqK^2}{E^2}$$

Where,

N = minimum number of required observations

p = proportion of drivers or pedestrians that observe the traffic regulation

q = proportion of driver or pedestrians that do not observe the traffic regulation

K = constant corresponding to the desired confidence level

E = permitted error in the proportion estimate of compliance (24).

The second sample size was calculated using the average p (proportion of drivers or pedestrians that observe traffic regulations) of the first two studies. Also, P.C. Box "...suggests that samples of 100 are often adequate to indicate compliance with TCDs, except when violation are rare" (24).

Components	N_1	N_2
p	0.7	0.11
q	0.3	0.89
E	0.06	0.06
K	2.0	2.0
Sample Size	235	110

DRIVER OBSERVANCE OF STOP SIGNS

LOCATION: Curtis Street Entrance Ramp I-80 East Bound STUDY NO.: #1

TIME: 7:15 to 9:15 A.M. WEATHER: Sunny, Partly Cloudy

RECORDER: Chris Bowler Date: 9/11/97 ROAD CONDITIONS: Dry

STUDY TIME	NON-STOPPING			PRACTICALLY STOPPED			STOPPED BY TRAFFIC			VOLUNTARY FULL STOP			Total Vehicles
	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	
7:15 - 9:15 AM Totals	30	44	8	34	43	9	16	11	0	23	16	1	235
Percentages of Driver Compliance		Σ 82 % **34.9%**			Σ 86 % **36.6%**			Σ 27 % **11.5%**			Σ 40 % **17.0%**		235
Percentage of Trucks	Σ 44 % **38.6%**			Σ 43 % **37.7%**			Σ 11 % **9.6%**			Σ 16 % **14.0%**			114
Percentage of Cars	Σ 30 % **29.1%**			Σ 34 % **33.0%**			Σ 16 % **15.5%**			Σ 23 % **22.3%**			103
Percentage of RVs		Σ 8 % **44.4%**			Σ 9 % **50.0%**			Σ 0 % **0.0%**			Σ 1 % **5.6%**		18

NOTES:

1. 7:20 AM Talked w/ Highway Patrol Officer
2. Queues are forming on the entrance ramp
3. Lot of practically stopped vehicles due to oncoming traffic
4. Counted school buses as trucks
5. Geometrics of Ramp: acceleration lane, 12 - 16' wide lane; stop line
6. Lot of vehicles slowing down after the stop sign - sign too far back?
7. Flaggers on overpass - may have resulted in queues being formed on entrance ramp
8. Driver actions were recorded at the stop sign

DRIVER OBSERVANCE OF STOP SIGNS

LOCATION: Curtis Street Entrance Ramp I-80 West Bound STUDY NO.: #2

TIME: 1:30 to 4:00 P.M. WEATHER: Sunny, Partly Cloudy

RECORDER: Chris Bowler Date: 9/16/97 ROAD CONDITIONS: Dry

STUDY TIME	NON-STOPPING			PRACTICALLY STOPPED			STOPPED BY TRAFFIC			VOLUNTARY FULL STOP			Total
	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	Vehicles
1:30 - 4:00 PM Totals	61	64	3	26	42	3	9	13	2	6	6	0	235
Percentages of Driver Compliance		Σ 128 % **54.5%**			Σ 71 % **30.2%**			Σ 24 % **10.2%**			Σ 12 % **5.1%**		235
Percentage of Trucks	Σ 64 % **51.2%**			Σ 42 % **33.6%**			Σ 13 % **10.4%**			Σ 6 % **4.8%**			125
Percentage of Cars	Σ 61 % **59.8%**			Σ 26 % **25.5%**			Σ 9 % **8.8%**			Σ 6 % **5.9%**			102
Percentage of RVs		Σ 3 % **37.5%**			Σ 3 % **37.5%**			Σ 2 % **25.0%**			Σ 0 % **0.0%**		8

NOTES:

1. Flagger on Ramp due to truck hauling route on ramp
2. Queues are forming on the entrance ramp (2 t0 3 vehicles)
3. Lot of practically stopped vehicles due to oncoming traffic
4. Driver expectations are violated, drivers are yielding instead of stopping
5. STOP Sign is on a stand, not a post
6. A lot of motorists were opening their doors or windows to look for oncoming traffic
7. Geometrics of Ramp: Median X-Over, no acceleration lane, 12- 16' Wide lane, and no shoulder
8. Driver actions were recorded at the stop sign

DRIVER OBSERVANCE OF STOP SIGNS

LOCATION: Snowy Range Entrance Ramp I-80 West Bound STUDY NO.: #3

TIME: 4:45 to 7:45 P.M. WEATHER: Sunny, Partly Cloudy

RECORDER: Chris Bowler Date: 9/23/97 ROAD CONDITIONS: Damp

STUDY TIME	NON-STOPPING			PRACTICALLY STOPPED			STOPPED BY TRAFFIC			VOLUNTARY FULL STOP			Total
	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	Vehicles
4:45 - 7:45 PM Totals	33	11	1	22	9	3	17	4	1	7	1	1	110
Percentages of Driver Compliance		Σ 45 % **40.9%**			Σ 34 % **30.9%**			Σ 22 % **20.0%**			Σ 9 % **8.2%**		110
Percentage of Trucks	Σ 11 % **44.0%**			Σ 9 % **36.0%**			Σ 4 % **16.0%**			Σ 1 % **4.0%**			25
Percentage of Cars	Σ 33 % **41.8%**			Σ 22 % **27.8%**			Σ 17 % **21.5%**			Σ 7 % **8.9%**			79
Percentage of RVs		Σ 1 % **16.7%**			Σ 3 % **50.0%**			Σ 1 % **16.7%**			Σ 1 % **16.7%**		6

NOTES:

1. Section of the Ramp is Gravel
2. Lot of practically stopped vehicles due to oncoming traffic
3. Driver expectations are violated, drivers are yielding instead of stopping
4. STOP Sign is on a stand, not a post
5. Geometrics of Ramp: Median X-Over, no acceleration lane, 12- 16' Wide lane, No STOP LINE
6. Driver actions were recorded at the stop sign

DRIVER OBSERVANCE OF STOP SIGNS

LOCATION: Curtis Street Entrance Ramp I-80 East Bound STUDY NO.: #4

TIME: 6:25 to 7:40 P.M. WEATHER: Sunny, Partly Cloudy

RECORDER: Chris Bowler Date: 9/25/97 ROAD CONDITIONS: Dry

STUDY TIME	NON-STOPPING			PRACTICALLY STOPPED			STOPPED BY TRAFFIC			VOLUNTARY FULL STOP			Total Vehicles
	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	
6:25 - 7:40 AM Totals	21	29	0	23	16	0	8	2	0	8	3	0	110
Percentages of Driver Compliance		Σ 50 % **45.5%**			Σ 39 % **35.5%**			Σ 10 % **9.1%**			Σ 11 % **10.0%**		110
Percentage of Trucks	Σ 29 % **58.0%**			Σ 16 % **32.0%**			Σ 2 % **4.0%**			Σ 3 % **6.0%**			50
Percentage of Cars	Σ 21 % **35.0%**			Σ 23 % **38.3%**			Σ 8 % **13.3%**			Σ 8 % **13.3%**			60
Percentage of RVs		Σ 0 % **0.0%**			Σ 0 % **0.0%**			Σ 0 % **0.0%**			Σ 0 % **0.0%**		18

NOTES:

1Most Visible Site, motorists were looking at the recorder
2. Queues are forming on the entrance ramp
3. Lot of practically stopped vehicles due to oncoming traffic
4. Conflicts between: non-stopping truck and traffic on interstate
5. Geometrics of Ramp: acceleration lane, 12 - 16' wide lane; stop line
6. Lot of vehicles slowing down after the stop sign - sign too far back?
7. Flaggers on overpass - may have resulted in queues being formed on entrance ramp
8. Driver actions were recorded at the stop sign

DRIVER OBSERVANCE OF STOP SIGNS

LOCATION: Snowy Range Entrance Ramp I-80 East Bound STUDY NO.: #5

TIME: 2:10 to 3:10 P.M. WEATHER: Sunny, Partly Cloudy

RECORDER: Chris Bowler Date: 10/7/97 ROAD CONDITIONS: Damp

STUDY TIME	NON-STOPPING			PRACTICALLY STOPPED			STOPPED BY TRAFFIC			VOLUNTARY FULL STOP			Total Vehicles
	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	
2:10 - 3:10 PM Totals	32	10	1	35	5	0	10	4	0	12	0	1	110
Percentages of Driver Compliance		Σ 43 % **39.1%**			Σ 40 % **36.4%**			Σ 14 % **12.7%**			Σ 13 % **11.8%**		110
Percentage of Trucks	Σ 10 % **52.6%**			Σ 5 % **26.3%**			Σ 4 % **21.1%**			Σ 0 % **0.0%**			19
Percentage of Cars	Σ 32 % **36.0%**			Σ 35 % **39.3%**			Σ 10 % **11.2%**			Σ 12 % **13.5%**			89
Percentage of RVs		Σ 1 % **50.0%**			Σ 0 % **0.0%**			Σ 0 % **0.0%**			Σ 1 % **50.0%**		2

NOTES:

1. Queues are forming on the ramp when EastBound Traffic is heavy
2. The majority of the motorists are yielding, not stopping
3. Geometrics of Ramp: Median X-Over, no acceleration lane, 12- 16' Wide lane, STOP LINE

DRIVER OBSERVANCE OF STOP SIGNS

LOCATION: Curtis Street Entrance Ramp I-80 West Bound STUDY NO.: #6

TIME: 3:20 to 4:50 P.M. WEATHER: Sunny, Partly Cloudy

RECORDER: Chris Bowler Date: 10/7/97 ROAD CONDITIONS: Dry

STUDY TIME	NON-STOPPING			PRACTICALLY STOPPED			STOPPED BY TRAFFIC			VOLUNTARY FULL STOP			Total
	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	Car	Truck	RV	Vehicles
3:20 - 4:50 PM Totals	22	37	0	12	16	0	7	11	0	3	2	0	110
Percentages of Driver Compliance		Σ 59 % **53.6%**			Σ 28 % **25.5%**			Σ 18 % **16.4%**			Σ 5 % **4.5%**		110
Percentage of Trucks	Σ 37 % **56.1%**			Σ 16 % **24.2%**			Σ 11 % **16.7%**			Σ 2 % **3.0%**			66
Percentage of Cars	Σ 22 % **50.0%**			Σ 12 % **27.3%**			Σ 7 % **15.9%**			Σ 3 % **6.8%**			44
Percentage of RVs		Σ 0 % **0.0%**			Σ 0 % **0.0%**			Σ 0 % **0.0%**			Σ 0 % **0.0%**		0

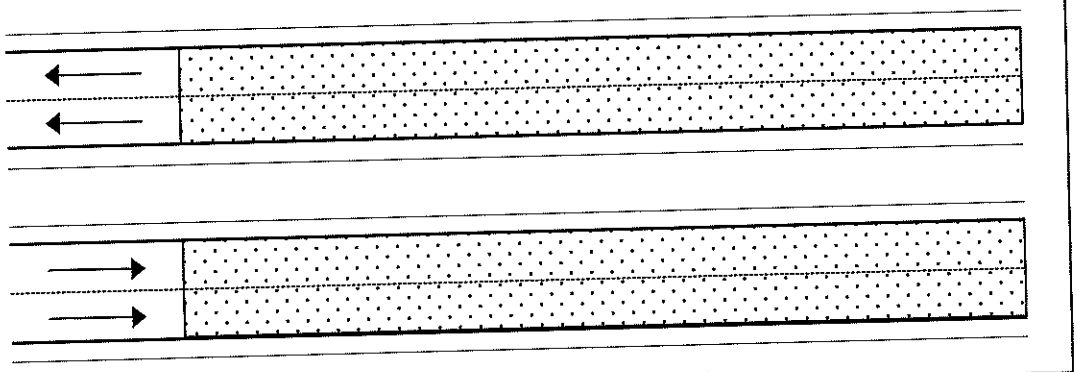
NOTES:

1. Flagger on Ramp due to truck hauling route on ramp
2. Queues are forming on the entrance ramp (2 t0 3 vehicles)
3. Lot of practically stopped vehicles due to oncoming traffic
4. Driver expectations are violated, drivers are yielding instead of stopping
5. STOP Sign is on a stand, not a post
6. A lot of motorists were opening their doors or windows to look for oncoming traffic
7. Geometrics of Ramp: Median X-Over, no acceleration lane, 12- 16' Wide lane, no shoulder
8. Driver actions were recorded at the stop sign.

APPENDIX D

"TRAFFIC CONTROL DESIGN FOR A MILLING/RESURFACING PROJECT ON A RURAL INTERSTATE"
DELPHI SURVEY QUESTIONNAIRE NO. 3
AND
SUMMARY RESULTS

TRAFFIC CONTROL DESIGN FOR A MILLING/RESURFACING PROJECT
ON A RURAL INTERSTATE



Project Description: The project to be completed consists of a 12 mile stretch of a four lane divided rural highway with 12 ft travel lanes, variable shoulder widths and a diamond interchange (located approximately 4.5 miles into the project). The asphalt surfacing of all four lanes are to be milled and resurfaced with asphalt concrete.

Directions: This survey consists of the three sections. Section A focuses on Traffic Control Strategies, Section B emphasizes the milling phase of the project and Section C focuses on the resurfacing phase. The majority of the questions require only a checkmark for an answer, while the other questions require a short list. Please send your responses in the provided business reply envelope or fax it to us at, (307) 766-6784 by March 6, 1998.

SECTION A: TRAFFIC CONTROL STRATEGIES

1. A. RURAL HIGHWAY WITH HIGH TRAFFIC VOLUMES
   Based solely on the sketch and project description above, which traffic strategy would you prefer to implement?
   _____TLTWO [Two-Lane, Two-Way Operations]
   _____SLC [Single Lane Closure]
   _____Others (please list)_____

   B. RURAL HIGHWAY WITH LOW TRAFFIC VOLUMES
   Based solely on the sketch and project description above, which traffic strategy would you prefer to implement?
   _____TLTWO [Two-Lane, Two-Way Operations]
   _____SLC [Single Lane Closure]
   _____Others (please list)_____

2. For the characteristics listed below, please indicate the cutoff value(s) for making a decision to use a SLC Strategy.

MILLING/RESURFACING PROJECT CHARACTERISTICS	IS A FACTOR		USE A SLC STRATEGY UP TO
	Yes	No	
A. Drop off depth - Exists overnight			(inches)
B. Drop off depth - Daytime only			(inches)
C. Length of Roadway under Construction			(miles)
D. Shoulder Width			(feet)
E. Travelway Width Through Work Zone			(feet)

3. Please indicate which agency is responsible for designing the traffic control plans for a milling/resurfacing project in your state.

_____State DOT
_____Contractor
_____Both the Contractor & the State DOT

SECTION B: MILLING OPERATIONS
SINGLE LANE CLOSURE

Description: Questions 4-8 focus on the milling phase of a milling/resurfacing project that is controlled by a Single Lane Closure Strategy. Although you may feel that a Two-Lane, Two-Way Operation is more appropriate for a milling/resurfacing project, please answer all of the questions.

4. A. Please indicate which order of operations that you would prefer to use for a milling/resurfacing project on a RURAL HIGHWAY WITH *HIGH TRAFFIC VOLUMES*

_____Mill the entire length of one lane in one direction, resurface that lane, then move to the other lane.
_____Mill all of the lanes, then resurface all of those lanes.
_____Other (please describe)_____

B. Please indicate which order of operations that you would prefer to use for a milling/resurfacing project on a RURAL HIGHWAY WITH *LOW TRAFFIC VOLUMES*

_____Mill the entire length of one lane in one direction, resurface that lane, then move to the other lane.
_____Mill all of the lanes, then resurface all of those lanes.
_____Other (please describe)_____

5. Please indicate which of the following characteristics influence your decision when choosing a channeling device for a milling/resurfacing project. (Complete this question by: 1. Checking off the characteristics that have influence, and 2. Then ranking the characteristics that have been checked off, with #1 having the strongest influence.)

Influence	*Characteristics*	*Ranking*
_____	----------Drop Off Height----------	_____
_____	--------Drop Off Exists Overnight--------	_____
_____	----------Shoulder Width----------	_____
_____	---------Length of Project (miles)---------	_____
_____	The Device's Past Field Performance	_____
_____	----------Motorist Safety----------	_____
_____	Worker Safety at the Milling/Resurfacing Site	_____
_____	Time between the Milling & Resurfacing Phase	_____
_____	Worker Exposure Associated with Installation/Maintenance & Removal of Devices	_____
	--------Other (please list & rank)--------	
_____	_____	_____
_____	_____	_____

6. Does the width of the travel lane influence which channeling device you would use?

_____Yes
_____No

7. If you answered Yes, to Question 6, please list the criteria you use to relate channeling devices to travel lane width.

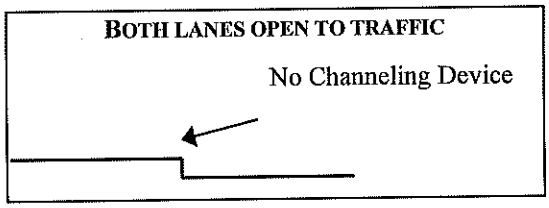
_____
_____
_____

8. Do you think that alternating or sequencing devices on a milling/resurfacing project is appropriate? (i.e. using a pattern such as; 1 barrel, 2 raised pavement markers, 1 tubular marker, etc. and repeating the sequence)

_____Yes (If Yes, please list the patterns and devices below)
_____No

SECTION C: POST MILLING OPERATIONS
SINGLE LANE CLOSURE

Description: Questions 9-13 focus the resurfacing phase of a milling/resurfacing project that is controlled by a Single Lane Closure Strategy. Although you may feel that a Two-Lane, Two-Way Operation is more appropriate for a milling/resurfacing project, please answer all of the questions.

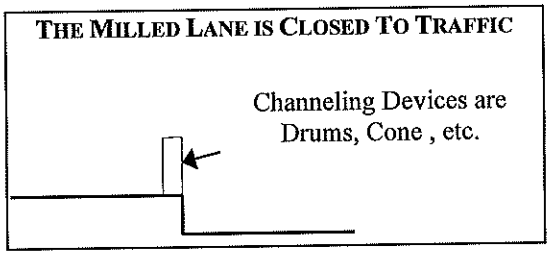


9. A. I feel that the maximum drop off depth for the situation above should be___ inches.

   B. Please list what traffic control devices that you would use to warn the motorist about the uneven travel lanes.

   _____

   _____



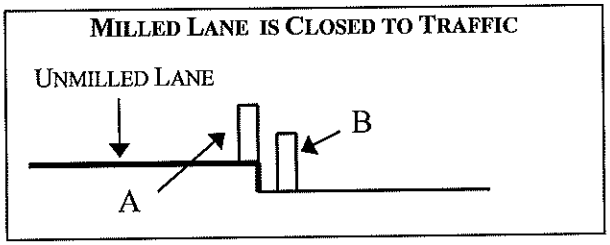
10. A. I feel that the maximum drop off depth for the situation above should be ___ inches

    B. In the Table below, please do the following:
       1. Indicate which channeling device(s) you would use for the situation described above.
       2. For the devices that you would use, please indicate the maximum drop off depth for that device and indicate if there is a difference with daytime and nighttime use.

CHANNELING DEVICES	USE THIS DEVICE		MAXIMUM DROP OFF DEPTH	DAYTIME USE ONLY		DAY & NIGHTTIME USE	
	Yes	No	(inches)	Yes	No	Yes	No
Cones							
Tubular Markers							
Vertical Panels							
Drums							
Barricades							
Other (please list)							

11. Please indicate where you think the channeling device should be placed.

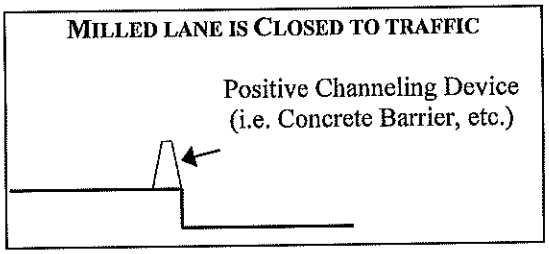
_____A. At the edge of the unmilled lane
_____B. In the milled lane
_____C. Staggered, both in the milled lane and on the edge of the unmilled lane.



If you answered B or C in Question 11, please indicate what is your device preference for placement in the milled lane.

_____

_____



12. I feel that the milled lane should be closed to traffic when the drop off depth is _____ inches.

13. A. Do you think that a full-time traffic control device maintainer should be generally used on a milling/resurfacing project?

_____YES
_____NO

B. For what length of project would you require a full-time traffic control device maintainer?

_____miles

COMMENTS

NAME
ORGANIZATION
Phone #_____ Fax # _____

NOTES:

1. Survey Respondents' comments are typed in **ALL CAPS**.
2. The focus group consists of two groups, the first included Wyoming Department of Transportation engineers (know as WYDOT) and the second group was made up of engineers from DOTs outside of Wyoming (known as DOTs).
3. Twenty-six surveys were returned, including eleven from WYDOT and fifteen from the DOTs group.

QUESTION #1. A. RURAL HIGHWAY WITH HIGH TRAFFIC VOLUMES

Based solely on the sketch and project description above, which traffic strategy would you prefer to implement?

QUESTION #1 A. RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	TLTWO	*SLC*	1.896
WYDOT	**4**	**7**	
Proportions	0.36	0.64	P-VALUE
DOTs	**2**	**13**	0.169
Proportions	0.13	0.87	
90% Wald C.I. = 0.230 +/- 0.370			

Comments:

DOTs COMMENTS

◊ "COMBINATION OF BOTH STRATEGIES DEPENDING ON DEPTH.

◊ NIGHT WORK ONLY AND HAVE ALL THAT WAS MILLED REPAVED BY PEAK TRAFFIC PERIOD THE NEXT DAY."

QUESTION #1. B. RURAL HIGHWAY WITH LOW TRAFFIC VOLUMES

Based solely on the sketch and project description above, which traffic strategy would you prefer to implement?

QUESTION #1 B. RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	TLTWO	*SLC*	Not valid
WYDOT	**1**	**10**	
Proportions	0.09	0.91	P-Value
DOTs	**1**	**14**	
Proportions	0.07	0.93	
90% Wald C.I. = 0.024 =/- 0.264			

Comments:

WYDOT COMMENTS

◊ "DO NOT LIKE POTENTIAL FOR HEAD-ON ACCIDENTS THAT EXIST WITH TLTWO."

DOTs COMMENTS

◊ "SLC WITH CLOSURE > 2 MILES."

QUESTION #2

For the characteristics below, please indicate the cutoff value(s) for making a decision to use a SLC Strategy.

QUESTION #2 RESULTS:

AGENCIES	WYDOT RESPONSE				DOTS RESPONSE			
MILLING/RESURFACING PROJECT CHARACTERISTICS	IS A FACTOR?		CUTOFF POINTS		IS A FACTOR?		CUTOFF POINTS	
	Yes	No	Mean (μ)	STDEV	Yes	No	Mean (μ)	STDEV
A. Drop off depth – Exists overnight (inches)	11	0	3.09	1.58	13	1	2.66	2.04
B. Drop off depth – Daytime only (inches)	9	2	3.78	2.05	8	6	1.79	0.39
C. Length of Roadway Under Construction (mi.)	6	5	5.0	1.55	5	9	2.50	1.73
D. Shoulder Width (feet)	5	6	4.0	3.10	5	8	4.80	2.28
E. Travelway Width through Work Zone (feet)	11	0	11.95	1.31	12	2	11.70	2.79

TWO SAMPLE T-TEST ($\alpha = 0.10$)

H_o: $\mu_{WYDOT} = \mu_{DOTs}$ vs. H_1: $\mu_{WYDOT} \neq \mu_{DOTs}$

A. Drop off depth – Exists overnight (inches)	*T statistic*	T value	p	DF
	0.55	1.734	0.59	18
	90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-0.92, 1.77)			
B. Drop off depth – Daytime only (inches)	*T statistic*	T value	P	DF
	2.85	1.860	0.021	8
	90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (0.69, 3.29)			
C. Length of Roadway Under Construction (mi.)	*T statistic*	T value	P	DF
	2.33	1.943	0.059	6
	90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (0.42, 4.58)			
D. Shoulder Width (feet)	*T statistic*	T value	P	DF
	-0.49	1.860	0.64	8
	90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-3.8, 2.2)			
E. Travelway Width through Work Zone (feet)	*T statistic*	T value	P	DF
	0.26	1.782	0.80	12
	90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-1.47, 1.98)			

Comments:
DOTs COMMENTS

◊ "MOST OF THE TIME WE MILL & INLAY DURINNG THE SAME TC EVENT & IF NEEDED USE 6:1 TAPERS AS AN INTERIAN ANSWER."

QUESTION #3

Please indicate which agency is responsible for designing the traffic control plans for a milling/resurfacing project in your state.

QUESTION #3 RESULTS:

AGENCY	OPTIONS			CHI-SQUARE
	State DOT	*Contractor*	*Both Contractor & State DOT*	Not valid
WYDOT	**6**		***5***	
Proportions	0.55		0.45	P-VALUE
DOTs	**10**	***2***	***3***	
Proportions	0.67	0.13	0.20	

Comments:
DOTs COMMENTS

◊ "ALL WOULD BE A FACTOR. THERE COULD BE ADDRESSED BY FIRST STRENGTHING OR RECONSTRUCTING THE SHOULDER TO CARRY TRAFFIC THEN ALLOWING TRAFFIC TO RUN THERE DURING SLC.
◊ THE DOT PROVIDES CONSTRACT PLANS W/ THE CONTRACT BUT ONE CONTRACTOR CAN SUBMIT DOTs TC PLANS FOR APPROVAL.
◊ CAN BE CHANGED BY CONTRACTOR WITH DOT APPROVAL."

QUESTION #4 A.

Please indicate which order of operations that you would prefer to use for a milling/resurfacing project on a RURAL HIGHWAY WITH HIGH TRAFFIC VOLUMES.

QUESTION #4 A. RESULTS:

AGENCY	OPTIONS			CHI-SQUARE
	Mill the entire length of one lane, resurface that lane, then move to the other lanes.	*Mill all of the lanes, then resurface all of the lanes*	*Other (please list)*	2.356
WYDOT *Proportions*	**3** 0.27	*5* 0.46	*3* 0.27	P-VALUE
DOTs *Proportion*	**8** 0.53	*3* 0.20	*4* 0.27	*0.308*

Comments:

WYDOT COMMENTS

◊ "DO IN 5 – 6 MILE SEGMENTS.
◊ MILL ONLY THAT AMOUNT WHICH CAN BE PLACED TO FULL DEPTH WITHIN 2 DAYS.
◊ MILL FULL WIDTH OF ROADWAY IN ONE DIRECTION BY END OF EACH DAY.
◊ DEPTH OF MILLING & DEPTH OF OVVERLAY MAY CHANGE THIS OPINION.
◊ CONCURRENT MILLING & OVERLAY OPERATION."

DOTs COMMENTS

◊ "MILL AND REPAVE MILLED AREA THE SAME DAY.
◊ AT NIGHT, MILL ONE LANE AND REPAVE PROR TO OPENING FOR PEAK TRAFFIC THE NEXT MORNING. MILL ONLY WHAT CAN BE REPAVED DURING THAT SHIFT.
◊ MILL ONE LANE FOR 4 MILES, RESURFACE AND THEN GO ON TO TE NEXT SECTION."

QUESTION # 4. B.

Please indicate which order of operations that you would prefer to use for a milling/resurfacing project on a RURAL HIGHWAY WITH LOW TRAFFIC VOLUMES.

QUESTION #4 B. RESULTS:

AGENCY	OPTIONS			CHI-SQUARE
	Mill the entire length of one lane, resurface that lane, then move to the other lanes.	*Mill all of the lanes, then resurface all of the lanes*	*Other (please list)*	2.955
WYDOT *Proportions*	**3** 0.27	*5* 0.46	*3* 0.27	P-VALUE
DOTs *Proportion*	**9** 0.60	*3* 0.20	*3* 0.20	0.228

Comments:

WYDOT COMMENTS

- ◊ "MILL ONLY ½ LENGTH OF PROJECT, AND NOT ALLOW FUTHER MILLING UNTIL PAVING KEEPS PACE. (ALL IN THE SAME LANE-NO CHANGING LANES).
- ◊ AS SOON AS MILLS GET FAR ENOUGH AHEAD THAT TOW OPERATIONS WITH THEIR TRAFFIC CONTROL DON'T INERFERE WITH EACH OTHER, BEGING PAVED.
- ◊ DEPTH OF MILLING & DEPTH OF OVVERLAY MAY CHANGE THIS OPINION.
- ◊ CONCURRENT MILLING & OVERLAY OPERATION."

DOTs COMMENTS

- ◊ "MILL AND REPAVE MILLED AREA THE SAME DAY.
- ◊ MILL AND REPAVE CONCURRENTLY IN ONE LANE, THEN DO THE OTHER LANES.
- ◊ MILL ONE LANE FOR 4 MILES, RESURFACE AND THEN GO ON TO TE NEXT SECTION.
- ◊ MILL ALL LANES SUCH THAT THERE ARE NO UNEVEN LANES AT THE END OF THE WORK DAY JUST A TRANSVERSE BUMP."

QUESTION #5

Please indicate which of the following characteristics influence your decision when choosing a channeling device for a milling/resurfacing project.

QUESTION #5 RESULTS:

AGENCY	WYDOT		DOTs	
CHARACTERISTICS	INFLUENCE %	MEDIAN RANK	INFLUENCE %	MEDIAN RANK
Drop off Height	100%	2	69.0%	4
Drop off exists overnight	100%	2	77.0%	4
Shoulder Width	27.0%	Not Influential	39.0%	Not Influential
Length of Project (miles)	36.0%	Not Influential	31.0%	Not Influential
Device's Past Field Performance	46.0%	Not Influential	46.0%	Not Influential
Motorist Safety	73.0%	2	85.0%	2
Worker Safety @ the Milling/Resurfacing Site	64.0%	7	85.0%	2
Time between Milling & Resurfacing Phase	64.0%	6	46.0%	Not Influential
Worker Exposure Associated w/ Installation/ Maintenance & Removal of Devices	46.0%	Not Influential	58.0%	5

NOTE: 1. Influence % = number of times the characteristic was checked off, divided by total responses.

2. Not Influential = Median Rank equal to 10 (A value of 10 was applied all of the characteristics that were not ranked).

Comments:

DOTs COMMENTS

- ◊ "REQUIRED BY STD. SPECS. FUNCTION.

◊ THIS IS IMPORTATANT BUT THE DEVICES IN USE HAVE PROVEN TO WORK EFFECTIVELY."

QUESTION #6

Does the width of the travel lane influence which channeling device you would use?

QUESTION #6 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	0.454
WYDOT	**8**	**3**	
Proportions	0.73	0.27	P-VALUE
DOTs	**9**	**6**	0.500
Proportions	0.6	0.4	
90% Wald C.I. = 0.127 +/- 0.395			

Comments:

QUESTION #7

If you answered Yes, to Question 6, please list the criteria you would use to relate channeling devices to travel lane width.

QUESTION #7 RESULTS:

WYDOT RESPONSES

RESPONDER	CRITERIA
2	The narrower the lane width, the use of flex sticks would be used in lieu of the drum
3	In areas that will be narrow it would be necessary to use as narrow of a device to decrease the controlling effect
4	An inside (passing lane) being used to carry traffic along with a narrow median shoulder might require use of tubular markers rather than drums
5	Separation between the travel lane and drop off shy distance for traffic control device
18	How the channeling device might tend to make the lane appear narrower i.e. wide devices, tall devices tent to reduce the usable lane width because of driver "shy" distance
21	In tight sections a wand rather than a barrel may be desirable to minimize further restriction of width
25	Drums make motorists feel constricted with a 12 ft lane. Lane widths narrower than 10.5' should not use drums.
DOTs RESPONSES	
6	Width between travel lane & work area > 3' – Drums w/ Lights Width < 3' – Vertical Panels w/ Lights Both may be supplemented w/ flexible pavement markers

8	On interstate highways the lane width cannot be less than 12' other highways cannot have a lane narrower than 10'
11	If a large channeling device will reduce the travel lane width, a smaller device would be preferred if it would perform satisfactory
13	We use tubular markers because they have a narrow profile and are easily installed and removed
15	If using portable concrete barriers, prepare to have at least 11' lane w/ 2' clear form edge lane to barrier
16	Encroachment on travelway Limited lane width
19	Available space for traffic control device
23	Use primarily drums unless a 10 ft lane width cannot be maintained. For lesser widths use vertical panels
24	Along side resurfacing may use 42" cones or vertical panels in place of plastic drums

QUESTION #8

Do you think that alternating or sequencing devices on a milling/resurfacing project is appropriate?

QUESTION #8 RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	0.112
WYDOT	**1**	**10**	
Proportions	0.09	0.91	P-VALUE
DOTs	**2**	**13**	0.738
Proportions	0.13	0.87	
90% Wald C.I. = -0.042 +/- 0.290			

Comments:

WYDOT COMMENTS

◊ "I WOULD USE ONE TYPE OF DIVICE.

◊ ALTERNATING SEEMS APPROPRIATE BUT DEPENDS ON SPACING – **TIGHT SPACING** – 1 BARREL – 2 RAISED PAVEMENT MARKERS OR 1 TUBULAR MARKER - 2 RAISED PAVEMENT MARKERS."

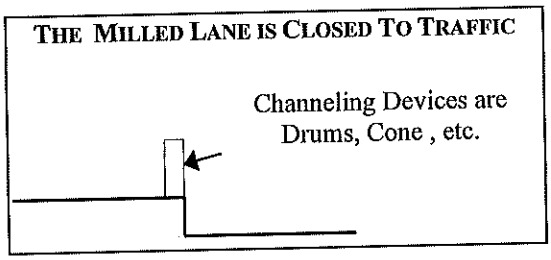
DOTs COMMENTS

◊ "MAY GIVE THE APPEARANCE OF A BREAK IN THE WALL OF DEVICES SEPARATING TRAFFIC FROM THE WORK AREA

◊ TUBES OR CONES SUPPLEMENTED W/ PAVEMENT MARKERS

◊ WE USE ALTERNATIVE DRUMS AND VERTICAL PANELS ON TAPERS WITH VERITCAL PANELS ON TANGENT SECTIONS"

QUESTION #9. A.



I feel that the maximum drop off depth for the situation above should be___inches.

QUESTION #9. A. RESULTS:

AGENCY	WYDOT	DOTs	
UNITS	INCHES	INCHES	
Mean (μ)	1.82	1.52	
Standard Deviation	1.17	0.85	
TWO SAMPLE T-TEST ($\alpha = 0.10$)			
$H_o = \mu_{WYDOT} = \mu_{DOTs}$ vs. $H_1 = \mu_{WYDOT} \neq \mu_{DOTs}$			
T statistic	T value	P	DF
0.72	1.740	0.48	17
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-0.42, 1.02)			

Comments:

WYDOT COMMENTS

◊ "UNLESS DAYLIGHT OPERATIOINS ONLY WHERE DEPTH COULD BE MORE."

QUESTION #9. B.

Please list what traffic control devices that you would use to warn the motorist about the uneven travel lanes.

QUESTION #9. B. RESULTS:

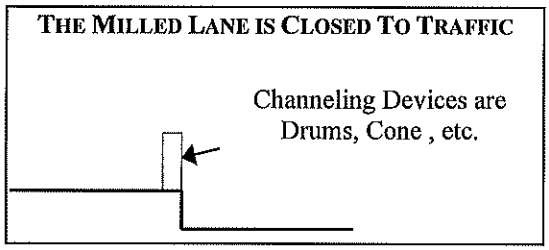
WYDOT RESPONSES

RESPONDER	TRAFFIC CONTROL DEVICES
1	Signs
2	Flex sticks
3	Signing
4	I would use the Uneven Pavement (symbol) sign spaced at ½ mile intervals with striping on center line near the joint
5	uneven lanes signing
17	Signs
18	Uneven pavement sign, drums
21	Drums,
22	Signs
25	Road Work Ahead, Uneven Pavement, and Do Not Pass signs

DOTs RESPONSES

6	Standard advance warning signs indicating "uneven surface" –symbol sign also motorcycle / grooved pavement signs
7	Warning Sign "UNEVEN LANES"
8	W21 – 801
10	W8 – 11
11	"UNEVEN LANES" signs every mile
14	Would not have drop off with both lanes open to traffic
15	Changeable message board
16	Uneven pavement warning sign
19	"UNEVEN LANES" signs
20	Sign advising drop off and cones on the edge of drop off and barricades in the closed lanes every 1000 ft
23	Warning Signs

QUESTION #10. A.



I feel that the maximum drop off depth for the situation above should be __inches.

QUESTION #10. A. RESULTS:

AGENCY	WYDOT	DOTs	
UNITS	INCHES	INCHES	
Mean (μ)	5.09	3.46	
Standard Deviation	1.64	1.81	
TWO SAMPLE T-TEST ($\alpha = 0.10$) $H_0 = \mu_{WYDOT} = \mu_{DOTs}$ vs. $H_1 = \mu_{WYDOT} \neq \mu_{DOTs}$			
T statistic	T value	p	DF
2.31	1.721	0.031	21
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (0.42, 2.84)			

Comments:

WYDOT COMMENTS

"UNLESS SAYLIGHT OPERATIONS ONLY WHERE DEPTH COULD BE GREATER."

DOTs COMMENTS

◊ "XX - WHAT CAN BE REPAVED THE SAME DAY.

◊ IF LEFT OVERNIGHT."

QUESTION #10. B.

In the Table below, please do the following:

1. Indicate which channeling device(s) you would use for the following situation described above. 2.For the devices that you would use, please indicate the maximum drop off depth for that device and indicate if there is a difference with daytime & nighttime use.

QUESTION # 10. B. RESULTS:

CHANNELING DEVICES	WYDOT RESPONSE						DOTS RESPONSE					
	IS A FACTOR		MAX. DROP OFF DEPTH		TIME OF DAY		IS A FACTOR		MAX. DROP OFF DEPTH		TIME OF DAY	
	Yes	No	Mean (μ)	STDEV	Day Use	Day & Night	Yes	No	Mean (μ)	STDEV	Day Use	Day & Night
Cones	6	5	4	2.35	6	2	10	4	3.0	1.52	8	1
Tubular Markers	11	0	4	1.77	5	9	7	7	3.1	1.57	4	3
Vertical Panels	5	6	4.75	2.22	2	4	6	8	3.2	1.79	1	5
Drums	11	0	6	1.89	2	10	9	5	2.5	1.23	2	7
Barricades	2	9	8	0	1	2	7	7	3.2	1.79		7
Concrete Barrier							1	0				1

TWO SAMPLE T-TEST ($\alpha = 0.10$)

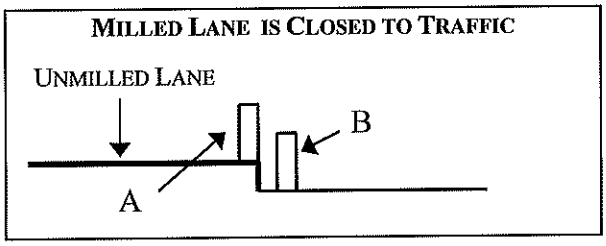
H_o: $\mu_{WYDOT} = \mu_{DOTs}$ vs. H_1: $\mu_{WYDOT} \neq \mu_{DOTs}$

	T statistic	T value	P	DF	90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$
Cones	0.85	1.943	0.43	6	(-1.3, 3.29)
Tubular Markers	0.75	1.771	0.46	13	(-0.86, 2.13)
Vertical Panels	1.13	2.015	0.31	5	(-1.2, 4.31)
Drums	3.82	1.761	0.0019	14	(1.69, 4.58)
Barricades					
Concrete Barrier					

Comments:

QUESTION #11

Please indicate where you think the channeling device should be placed.



QUESTION #11 RESULTS:

AGENCY	OPTIONS			CHI-SQUARE
	At the edge of the unmilled lane	*In the milled lane*	*In both the milled & unmilled lane*	Not valid
WYDOT	**9**	***1***	***1***	
Proportions	0.82	0.09	0.09	P-VALUE
DOTs	**12**	***3***		
Proportions	0.80	0.20	0.0	

Comments:

DOTs COMMENTS

◊ "IF SHOULDER IS USED FOR DRIVING SURFACE."

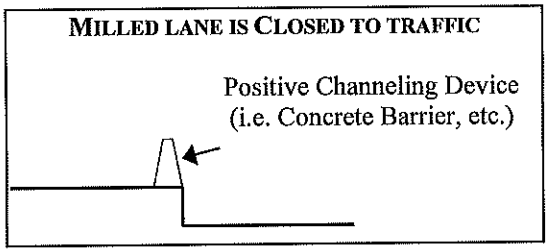
QUESTION 11. PART 2

If you answered B or C in Question 11, please indicate what is your device preference for placement in the milled lane.

QUESTION #11. PART 2 RESULTS:

RESPONDER	TRAFFIC CONTROL DEVICES
	WYDOT RESPONSES
1	Assuming you have 2 ft. min shoulder
5	Same device as unmilled lane for visible indication of drop off
25	2-4" (drop off depths) Drums, < or less than 2" – Tubular Markers
	DOTs RESPONSES
11	Drum
23	Drums-where space permits
24	Drum next to drop-off

QUESTION #12



I feel that the milled lane should be closed to traffic when the drop off depth is ___inches

QUESTION #12 RESULTS:

AGENCY	WYDOT	DOTs	
UNITS	INCHES	INCHES	
Mean (μ)	6.0	2.95	
Standard Deviation	3.74	1.91	
TWO SAMPLE T-TEST ($\alpha = 0.10$)			
$H_0 = \mu_{WYDOT} = \mu_{DOTs}$ vs. $H_1 = \mu_{WYDOT} \neq \mu_{DOTs}$			
T statistic	T value	P	DF
2.36	1.782	0.036	12
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (0.7, 5.36)			

Comments:

DOTs COMMENTS

◊ "2 INCHES IF NO 3:1 WEDGE.

◊ ANY DROP OFF SHOULD REQUIRE A LANE CLOSURE."

QUESTION #13. A.

Do you think that a full time traffic control device maintainer should be generally used on a milling/resurfacing project?

QUESTION #13. A. RESULTS:

AGENCY	OPTIONS		CHI-SQUARE
	Yes	*No*	3.082
WYDOT	**10**	**1**	
Proportions	0.91	0.09	P-VALUE
DOTs	**9**	**6**	0.079
Proportions	0.6	0.4	
90% Wald C.I. = 0.309 +/- 0.341			

Comments:

WYDOT COMMENTS

◊ "GENERALLY YES BUT MAY NOT BE NECESSARY ON LOW VOLUME ROADWAYS.

◊ NOT IF CAN OPEN TO TRAFFIC AT NIGHT."

DOTs COMMENTS

◊ "OREGON DOES NOT ALLOW OVER 2" ABRUPT EDGE TO REAMIN OPEN. LOW RISK."

QUESTION #13. B.

For what length of project would you require a full-time traffic control device maintainer?

QUESTION #13. B. RESULTS:

AGENCY	WYDOT	DOTs	
UNITS	MILES	MILES	
Mean (μ)	2.86	4.8	
Standard Deviation	2.12	3.27	
TWO SAMPLE T-TEST ($\alpha = 0.10$) $H_o = \mu_{WYDOT} = \mu_{DOTs}$ vs. $H_1 = \mu_{WYDOT} \neq \mu_{DOTs}$			
T statistic	T value	P	DF
-0.69	1.895	0.51	7
90 % C.I. for $\hat{u}_{WYDOT} - \hat{u}_{DOTs}$: (-4.26, 2.0)			

Comments:

WYDOT COMMENTS

◊ "DEPENDS MORE ON MANITENANCE CHARACTERISTICS OT TRAFFIC CONTROL DEVICES THAN ON PROJECT LENGTH.

◊ LENGTH WOULD NOT NECESSARILY BE A FACTOR – WOULD PRIMARILY LOOK AT TRAFFIC VOLUMES & WHETHER DAYTIME OR 24 HOUR CLOSURE.

◊ IF IN TWO-LANE, TWO-WAY OPERATIONS NEED MAINTAINER, REGARDLESS OF LENGTH."

DOTs COMMENTS

◊ " ALL PROJECTS.

◊ THERE SHOULD BE SOMEONE THERE AT ALL TIMES DURING WORK HOURS, THEN CHECKED PERIODICALLY.

◊ SINGLE LANE OPERATIONS WITH DROPOFFS >1" NEED TO BE TREATED W/ A 6:1 TEMPORARY TAPER WHEN CONCRETE WALL BARRIER IS NOT USED.

◊ ALL."

APPENDIX E

"RCSA CHECKLISTS FOR INTERSTATE WORK ZONES"

RCSA CHECKLIST - Slab Replacements (SR) Project on a Rural Interstate

PART A: GENERAL INFORMATION

PROJECT:_____ AUDITOR:_____

DATE: _____ EMERGENCY CONTACT:_____

PART B: CHARACTERISTICS OF THE PROJECT & ROADWAY

Length of project:_____(miles): Duration of Project: _____(days)

Number of Slab Replacements:_____ Depth of Slab Replacements:_____(inches)

Width of Slab Replacements: _____(feet)

Lanes where the Slab Replacements are located:_____Left _____Right _____Both

Maximum Distance between Slab Replacements: _____(feet)

Travel lanes width:_____(feet) Shoulder widths (Left & Right)_____ _____(feet)

ROAD CONSTRUCTION SAFETY AUDIT CHECKLISTS FOR A SLAB REPLACEMENT PROJECT ON A RURAL INTERSTATE

ENGINEERING PRELIMINARY CHECKLIST			
FOCUS AREA	ISSUES TO BE CONSIDERED	CHECK	COMMENTS
1. PAST PROJECTS	Check past slab replacement projects and determine what problems (i.e. traffic delays, worker injuries) occurred throughout the duration of the project.		
	Evaluate the problems and develop solutions to correct the problems.		
	Check to see if the agency's standards plans may be used for the slab replacement project.		
2. LOCATION	Use the solutions that were obtained from past projects on the existing project's Traffic Control Plan [TCP].		
	Check that the eight Fundamental Principles of work zone traffic control have been applied to the TCP.		
	Check the crash history of the project location and apply special consideration to the area(s) with crash history.		
	Check for areas on the roadway that may interfere with the function of the work zone (i.e. crest curves or compound horizontal curves).		
3. SLAB REPLACEMENT PROJECT	Go to CHECKLIST – SR		

CHECKLIST – SR			
FOCUS AREA	ISSUES TO BE CONSIDERED	CHECK	COMMENTS
1. SITE	Check that the time allowance between the removal and replacement of the slabs has been defined within the project's contract.		
	Check that the traffic control plan follows the current regulations.		
	Check to see if there are any entrance or exit ramps located in the work zone.		
	If entrance or exit ramps exist, go to CHECKLIST – ER		
	Check the need for access routes for equipment and workers.		
	Check that all parking and storage areas will not invade the travelway.		
	Check that the speed reduction(s) leading into and within the work zone is lowered in 10 mph increments		
	Check that the speed limit in the work zone does not alter the normal traffic flows.		
	Encompass traffic volumes, geometrics, project characteristics and the topography of the roadway when determining the speed limit for a project.		
2. TRAFFIC CONTROL STRATEGIES	Check which traffic control strategy will be used on the project. SLC (Proceed) TLTWO (Go to CHECKLIST – TLTWO)		
SINGLE LANE CLOSURE [SLC]			
3. TRANSITION AREA	Check that the taper and the signing in the transition area are placed correctly on the traffic control plan.		
	Check that _____is used in the taper to alert the motorists of the lane closure.		
	Check that _____or another type of channeling device are used.		
	Check that the entire length of one lane is closed at one time and that the work is completed in that lane before the other lane is closed and repaired.		
	Check that changeable message boards or warning signs are used to alert the motorists of the work activity ahead.		
4. WORK AREA	Check that adequate buffer spaces and/or truck attenuators are provided for the safety of the workers.		
	Check to see if the travelway width will be at least ____ feet wide through the work area.		

CHECKLIST – SR – PG 2			
FOCUS AREA	ISSUES TO BE CONSIDERED	CHECK	COMMENTS
4. WORK AREA CONTINUED	Check the need for filling in the drop off at the end of the work day		
	Check that the travel way width is wide enough for the proposed channeling devices.		
	Check that _____ or another type of channeling device are used.*		
	Check the need for a positive barrier system when the drop off is greater than _____inches and it exists overnight.		
5. TRAFFIC CONTROL DEVICES	Check that backup devices will be available in the event that one is lost.		
	Check that all channeling devices and pavement markings meet current standards.		
	Check that the channeling device spacing is reduced on horizontal curves.		
	Check the need for an alternative channeling device to highlight changes in the geometrics of the roadway.		
	Check that the warning signs are spaced correctly and mounted at the correct location.		
	Check the need for lighting the project with floodlights or other means.		
	Check that all traffic control devices will possess retroreflective strips.		
	Check that the channeling devices prescribed correlate with the drop off and lane width requirements for that device.		
	Check that the devices demand the motorists' attention.		
	Check that the devices will be easily seen.		
	Check that warning lights will be readily available for areas where adverse weather conditions may occur.		
6. MAINTENANCE	Check the need for a full-time traffic control device maintainer.		
	Check that an inspection schedule and system is prescribed for the entire duration of the project.		
	Check that an emergency contact is readily available 24 hours a day.		

RCSA CHECKLIST – Milling/Resurfacing (MR) Project on a Rural Interstate

PART A: GENERAL INFORMATION

PROJECT:_____ AUDITOR:_____

DATE: _____ EMERGENCY CONTACT:_____

PART B: CHARACTERISTICS OF THE PROJECT

Length of project:_____(miles): Duration of Project: _____(days)

Depth of Milling:_____(inches)

Lanes where the milling/resurfacing is proposed:_____Left _____Right _____Both

Travel lanes width:_____(feet) Shoulder widths (Left & Right)_____ _____(feet)

ROAD CONSTRUCTION SAFETY AUDIT CHECKLISTS FOR A MILLING/RESURFACING PROJECT ON A RURAL INTERSTATE

ENGINEERING PRELIMINARY CHECKLIST			
FOCUS AREA	ISSUES TO BE CONSIDERED	CHECK	COMMENTS
1. PAST PROJECTS	Check past slab replacement projects and determine what problems (i.e. traffic delays, worker injuries) occurred throughout the duration of the project.		
	Evaluate the problems and develop solutions to correct the problems.		
	Check to see if the agency's standards plans may be used for the milling/resurfacing project.		
2. LOCATION	Use the solutions that were obtained from past projects on the existing project's Traffic Control Plan [TCP].		
	Check that the eight Fundamental Principles of work zone traffic control have been applied to the TCP.		
	Check the crash history of the project location and apply special consideration to the area(s) with crash history.		
	Check for areas on the roadway that may interfere with the function of the work zone (i.e. crest curves or compound horizontal curves).		
3. MILLING/ RESURFACING PROJECT	Go to CHECKLIST – MR		

RCSA CHECKLIST – MR			
Focus Area	ISSUES TO BE CONSIDERED	CHECK	COMMENTS
1. SITE	Check that the traffic control plan meets the current regulations.		
	Check to see if there are any entrance or exit ramps located in the work zone.		
	If entrance or exit ramps exist, go to CHECKLIST – ER		
	Check the need for access routes for equipment and workers		
	Check that all parking and storage areas do not affect the traffic flow.		
	Check that the speed reduction(s) leading into and within the work zone is lowered in _____ mph increments		
	Check that the speed limit in the work zone does not alter the normal traffic flows.		
	Encompass traffic volumes, geometrics, project characteristics and the topography of the roadway when determining the speed limit for a project.		
2. STRATEGIES	Check which traffic control strategy the project will be using to control the traffic. SLC (Proceed) TLTWO (Go to CHECKLIST - TLTWO)		
SINGLE LANE CLOSURE [SLC]			
3. TRANSITION AREA	Check that the taper and the signing in the transition area are placed correctly on the traffic control plan.		
	Check that an arrow panel is used in the taper to alert the motorists of the lane closure.		
	Check that _____or another type of channeling device are used.		
	Check that changeable message boards or Warning signs are used to alert the motorists of the work activity ahead.		
4. WORK AREA	Check that the entire length of one lane is closed at one time and that the work is completed in that lane before the other lane is closed and repaired.		
	Check to see if the travelway width will be at least ____ feet wide in the work area.		
	Check that the travel way width is wide enough for the proposed channeling devices.		
	Check that _____ or another type of channeling device are used.		
	Check the need for filling in the drop off at the end of the work day.		

RCSA CHECKLIST – MR – PG 2			
Focus Area	Issues to be Considered	Check	Comments
4. Work Area Continued	Check the need for a positive barrier system when the drop off is greater than _____inches and it exists overnight.		
	Check that the milled lane is open to traffic and there are no channeling devices when the drop off depth is less than _____inches.		
	Check that the milled lane is closed to traffic and channeling devices are used to a maximum drop off depth of ____ inches.		
5. Traffic Control Devices	Check that backup devices will be available in the event that one is lost.		
	Check that all channeling devices and pavement markings meet current standards.		
	Check that the devices demand the motorists' attention.		
	Check that the devices will be easily seen.		
	Check that all traffic control devices will possess retroreflective strips.		
	Check that the warning signs are spaced correctly and mounted at the correct location.		
	Check that the channeling device spacing is reduced on horizontal curves.		
	Check the need for an alternative channeling device to highlight changes in the geometrics of the roadway.		
	Check the need for lighting the project with floodlights or other means.		
	Check that warning lights will be readily available for areas where adverse weather conditions may occur.		
6. Maintenance	Check the need for a full-time traffic control device maintainer.		
	Check that an inspection schedule and system is prescribed for the entire duration of the project.		
	Check that an emergency contact is readily available 24 hours a day.		

RCSA – Two-Lane, Two-Way Operations (TLTWO) on a Rural Interstate

RCSA CHECKLIST – TLTWO			
FOCUS AREA	ISSUES TO BE CONSIDERED	CHECK	COMMENTS
1. SINGLE LANE CLOSURE	Check that the lane closures in both directions are properly signed and the channeling devices are correctly in place on the traffic control plan.		
	Check to see if the travelway width will be at least _____ feet wide.		
2. MEDIAN CROSSOVER	Check that the proposed posted speed limit in the median crossover is not greater than design speed limit		
	Check that drums or an alternative channeling device are used to guide the motorists into and out of the median crossover		
	Check that raised pavement markers or _____is used in conjunction with the _____or another type of channeling device.		
	Check that barricades or other devices are used to keep motorists from proceeding on the closed roadway.		
	Check that channeling devices and pavement markings define the path on and off the median crossover.		
3. TLTWO	Check the need for a positive barrier system to separate the two opposing traffic volumes		
	Check that drums or an alternative channeling device are used if a positive barrier system is not required.		
	Check for signing that instructs the motorists not to pass.		
	Check that the existing pavement markings are to be removed.		
4. Traffic Control Devices	Go to CHECKLIST – SR or MR, Focus Area # 5		
5. Maintenance	Go to CHECKLIST – SR or MR, Focus Area # 6		

RCSA CHECKLIST –Entrance & Exit Ramps (ER) on a Rural Interstate

RCSA CHECKLIST - ER			
	ISSUES TO BE CONSIDERED	CHECK	COMMENTS
1. ENTRANCE RAMP	What type of control is prescribed for the ramp traffic? STOP Control (Go to #2) Yield Control (Go to #3) No Control (Proceed to #4))		
2. STOP CONTROL	Check the traffic volumes of the mainline and determine if sufficient gaps in the traffic will be available for the ramp traffic.		
	Check that the STOP sign is placed where the motorist will have an unobstructed view of the mainline traffic.		
	Check that a STOP bar is utilized in conjunction with a STOP sign.		
	Go to #4		
3. YIELD CONTROL	Check that the YIELD sign in positioned at or near the entrance of the mainline.		
	Go to #4		
4. ENTRANCE RAMPS	Check that barricades or other devices are positioned at the entrance of the mainline so the motorists will not proceed into the closed section of the roadway.		
	Check the need for warning signs on the entrance ramp to warn the motorist of the construction and/or the TLTWO on the mainline.		
	Check that the channeling device spacing is reduced in the vicinity of the entrance ramp or a different device is used to alert the motorists of merging traffic.		
EXIT RAMPS			
5. EXIT RAMPS			
	Check that barricades or other devices are positioned on the mainline so the motorists will not proceed into the closed section of the roadway.		
	Check the need for addition exit signs on the mainline where the existing exit sign is covered or removed.		
	Check that the channeling device spacing is reduced in the vicinity of the entrance ramp or a different device used to alert the motorists to merging traffic.		

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Road Construction Safety Audit for Interstate Reconstruction		5. Report Date October 1998 6. Performing Organization Code
7. Author(s) Christopher P. Bowler and Eugene M. Wilson Univ. of Wyoming		8. Performing Organization Report No. MPC 98-98 Vol. 2
9. Performing Organization Name and Address Mountain-Plains Consortium North Dakota State University Fargo, ND 58105		10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Research and Special Programs Administration 400 7th Street SW Washington, DC 20590-0001		13. Type of Report and Period Covered Project Technical Report 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Traffic control alternatives associated with reconstruction projects on a rural interstate have been investigated in this research. Slab replacement projects, milling/resurfacing projects, and traffic controls in the vicinity of interstate ramps were analyzed. The recommendations obtained from a national focus group assisted in the development of the Road Construction Safety Audit (RCSA) process. The purpose of the RCSA process is to evaluate the traffic control plan (TCP), traffic control devices and strategies before the interstate work zone is established on the roadway. This process consists of six steps and a series of checklists which are used during the planning stage of a TCP to contrast interstate work zone traffic control alternatives while considering issues of the roadway and the project. Checklists for slab replacement projects, milling/resurfacing projects and traffic control in the vicinty of interstate ramps were developed as part of this research. The key to the RCSA process and the checklists is to ensure that the major safety considerations of the project have not been overlooked, and laternative devices and/or strategies have been considered.

17. Key Words	18. Distribution Statement		
traffic, interstate, construction, roads, safety			
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages 80	22. Price

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 1998	project technical

4. TITLE AND SUBTITLE

Road Construction Safety Audit for Interstate Reconstruction

5. FUNDING NUMBERS

6. AUTHOR(S)

Christopher P. Bowler and Eugene M. Wilson
University of Wyoming

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Mountain-Plains Consortium
North Dakota State University
Fargo, ND 58105

8. PERFORMING ORGANIZATION REPORT NUMBER

MPC 98-98 Vol. 2

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Department of Transportation
Research and Special Programs Administration
400 7th Street SW
Washington, DC 20590-0001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Traffic control alternatives associated with reconstruction projects on a rural interstate have been investigated in this research. Slab replacement projects, milling/resurfacing projects, and traffic controls in the vicinity of interstate ramps were analyzed. The recommendations obtained from a national focus group assisted in the development of the Road Construction Safety Audit (RCSA) process. The purpose of the RCSA process is to evaluate the traffic control plan (TCP), traffic control devices and strategies before the interestate work zone is established on the roadway. This process consists of six steps and a series of checklists which are used during the planning stage of a TCP to contrast interstate work zone traffic control alternatives while considering issues of the roadway and the project. Checklists for slab replacement projects, milling/ resurfacing projects and traffic control in the vicinity of interstate ramps were developed as part of this research. The key to the RCSA process and the checklists is to ensure that the major safety considerations of the project have not been overlooked, and alternative devices and/or strategies have been considered

14. SUBJECT TERMS	15. NUMBER OF PAGES
traffic, interstate, construction, roads, safety	80
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
			UL