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16. Abstract

This report provides the results of focus group studies and human factors laboratory studies to investigate issues related to America's Missing: Broadcast Emergency Response (AMBER) alerts, disaster response and evacuation (flooding, hurricane evacuation, and terrorist attacks), planned special events, and adverse weather and environmental conditions in order to design effective messages for display on dynamic message signs (DMSs). Focus group studies were conducted in six cities in Texas to obtain driver views of the above issues and to discuss driver information needs. The results of the focus group studies were used as the basis for more extensive human factors laboratory studies that were then conducted in six cities in Texas. The laboratory studies were administered using several different methods of participant interface including laptop computer programs, maps, card selection process, and a driving environment simulator. This report contains specific findings and recommendations concerning message design issues for DMSs for each of the topic areas identified.

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AMBER ALERT, DISASTER RESPONSE AND EVACUATION, PLANNED SPECIAL EVENTS, ADVERSE WEATHER AND ENVIRONMENTAL CONDITIONS, AND OTHER MESSAGES FOR DISPLAY ON DYNAMIC MESSAGE SIGNS

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DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT) or the Federal Highway Administration (FHWA). This report is not intended to constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. The engineer in charge of the study was Dr. Conrad L. Dudek, P.E. #24320.

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1. INTRODUCTION

BACKGROUND

As part of the TxDOT Project 0-4023 entitled "Automated Dynamic Message Signs (DMSs) Message Design and Display" focus group studies and human factors studies were conducted as a means of determining effective dynamic message sign (DMS) message design for special situations, namely America's Missing: Broadcast Emergency Response (AMBER) alerts, disaster response and evacuations, planned special events, and adverse weather and environmental conditions. The Project Advisory Committee provided the Texas Transportation Institute (TTI) research team with input from the perspective of their districts regarding difficulties and issues involved with displaying DMS messages during the aforementioned special situations. Indicators of possible information deficiencies with current DMS messages included observed driver behavioral problems and feedback from the motoring public (e.g., telephone calls).

The objectives of the focus group discussions held in six Texas cities were to obtain initial responses from drivers concerning information needs and to help develop and/or evaluate potential messages for DMSs. The focus group discussion process was the mechanism used to obtain driver feedback concerning DMS message needs and possible deficiencies.

The results of the focus group discussions were then used as a basis for the experimental design of subsequent human factors laboratory studies that were then conducted in six Texas cities during FY05. The laboratory studies provided more objective and detailed results that led to recommendations for effective DMS message design.

Statement of the Problem

Dynamic message signs are a key component of the freeway traffic management systems in communicating information to motorists. To be effective, a DMS must communicate meaningful messages that can be read and comprehended by motorists within a very short time period (constrained by the sight distance characteristics of the location and design features of the DMS). It is imperative, therefore, that the content, format, and application of information on the DMSs are of the highest possible quality and are consistent statewide.

Human factors and traffic operations research have been previously conducted to develop fundamental principles that led to the preparation of guidelines for effective DMS message design *(1-19)* for incidents and roadwork. The guidelines have proven to be very useful to practitioners. During an early phase of Project 0-4023, the Dynamic Message Sign Message Design and Display Manual was prepared for use by TxDOT personnel for designing and displaying effective messages for incidents and roadwork *(16)*. However, as more and more DMSs are implemented and operated, questions continue to arise concerning the best messages or terminology to use on these devices in other types of situations, such as AMBER alerts or flooding. Without a solid research basis upon which to base answers to these new questions, DMS operators must rely on their own instincts and best judgment. This subjectivity then leads

to inconsistencies from region to region that can confuse motorists who travel in multiple regions.

DISCUSSION

DMSs can be an effective tool for communicating with motorists. However, displaying messages that are too long for motorists to read at prevailing highway speeds or that are too complex or inappropriately designed leading to motorist confusion, can adversely affect both traffic flow and the transportation agency's credibility. The messages displayed must be "transparent" to travelers in the state or region. Therefore, messages need to be presented in a consistent manner and order based on motorist expectations.

Uninformed transportation personnel sometimes display messages that are too long for motorists, particularly slower readers, to read while driving at prevailing speeds. Research has indicated that the reading times for DMSs are higher than for static guide signs. The distinguishing factor is that motorists can scan guide signs for relevant information; whereas, they must read the entire message displayed on DMSs in order to understand the message. Often, trade-offs must be made as to what elements of the message should be omitted. There are many signing situations that require message design trade-offs, which need to be addressed in advancing the state-of-the-art of message design.

In developing messages, factors that enhance understanding of messages include the following:

- simplicity of words,
- brevity,
- standardized order of words,
- standardized order of message lines, and
- use of understood abbreviations when needed.

Formatting Effective DMS Messages

Message formatting refers to constructing the DMS message so that it contains the proper information in the expected order to allow motorists to easily read and interpret the information and make rational decisions based on that information. Placement of message elements on the wrong line or in the wrong sequence will result in driver confusion and will increase message reading times. Conversely, consistent formatting of information enhances motorist expectations and will reduce the time required to read and understand messages *(6)*.

The concepts of message load, message length, and message familiarity significantly affect message formatting requirements for a DMS. Message load refers to the number of informational "units" contained in a message. A unit of information refers to each separate data item given in a message that a driver could recall and could use as a basis for making a decision. Answers are

each one unit. The message in Table 1 has four units of information and serves to illustrate the concept of units of information. A unit of information typically is one to three words, but at times can be up to four words.

Table 1. Example of Information Units in a DMS Message.

INFORMATIONAL UNIT		
Question	**Answer**	**Info Unit**
1. What happened?	**ACCIDENT**	**1 unit**
2. Where?	**AT I-10**	**1 unit**
3. Who is advisory for?	**GALVESTON**	**1 unit**
4. What is advised?	**USE LOOP 610 W**	**1 unit**

Message length is related to message load, but it is not the same. Message length is the actual number of words or characters displayed. Two messages could contain the same amount of information (load) but have very different lengths, depending on the words and abbreviations used. This could also affect driver reading and comprehension time. Evidence suggests that at high vehicle operating speeds such as occurs on freeway facilities, eight-word messages of four to eight characters per word (excluding prepositions) may be approaching the limit of the average motorist's processing capability. Messages longer than eight words may lead to message overload conditions, leading to operational problems such as traffic slowing down in the vicinity of a DMS *(2, 6)*.

Message familiarity enhances motorist reading time. When information displayed on a DMS applies to unfamiliar motorists or when the information being presented to commuters is unusual, longer reading times will be required than for information posted frequently and seen repeatedly by commuting traffic. Obviously, site-specific characteristics and normal DMS operating procedures dictate what information is usual and what is not, and so this factor varies from location to location.

A final key concept of DMS message design that significantly influences motorist reading and comprehension times is the division of a DMS message into multiple parts, or "frames," that are shown sequentially on a DMS. Dudek and Huchingson reported that no more than three units of information should be displayed on one frame or sequence when all three units must be recalled by motorists *(6)*. Also, no more than two units of information should be shown on a single line of the sign. Since motorists can process only a limited amount of information during the brief time they are exposed to the DMS, they recommend that a complete DMS message be limited to no more than four units of information, divided into two frames having two lines of information each *(6)*.

Properly applied, these concepts and principles form the foundation for effective DMS message design. It is critical to develop an effective, transparent DMS system that is both consistently perceived and interpreted by motorists as they travel from one part of the state to another. At the

same time, this system must be able to adequately treat the unique information needs (both current and future) of each of the local areas in which DMSs are being operated. The key, then, is how well these principles are meshed to the needs and practices of motorists and the operating agency from both the statewide and the local level.

STUDY OBJECTIVES

The goal of this part of the project was to assist TxDOT in improving the effectiveness of messages displayed on DMSs during specific situations including AMBER alerts, flooding, and ozone alerts. Additionally, terms that identify the location of incidents were investigated to better understand how motorists associate location descriptors with cross streets and their associated exit and entrance ramps. To accomplish this goal, TTI researchers focused on identifying, developing, and evaluating DMS messages and terminology in current or proposed use. The research to determine those messages or terms that best convey information required and desired by motorists in the given situations was conducted to two phases. Phase 1 involved focus group studies that were conducted in six cities in Texas. Phase 2 involved more objective and extensive human factors laboratory studies

RESEARCH ISSUES

The research issues that were explored for the primary four categories of special DMS signing situations are listed below.

1. *AMBER Alerts*

    - What does a driver want to know when a child is abducted?
    - Are drivers confusing AMBER alert with the Homeland Security warning levels?
    - Are license plate and telephone numbers more difficult to read and recall?

2. *Disaster Response and Evacuation*

    Floods
    - What does a driver want to know when the road is flooded and impassible?
    - What are the most effective locations for providing this information?

    Hurricanes
    - What does a driver want to know during and after hurricane evacuations?
    - What are the most effective locations for providing this information?

Terrorist attack

- What does a driver want to know during terrorist attacks?
- What are the most effective locations for providing this information?

3. *Adverse Weather and Environmental Conditions*

- What types of weather conditions would drivers like to see displayed during adverse weather or environmental conditions?
- What types of information should be provided to drivers?
- What are the most effective messages for various situations (i.e., ozone alert and pavement break-up?)

4. *Planned Special Events*

- What type of information would drivers like to see displayed if attending the event?
- What type of information would drivers like to see displayed if not attending the event but are traveling on the affected freeway?
- What type of information would drivers like to see displayed for special events with arterial street closures?

In addition to the above, a secondary issue (listed below) was explored.

5. *Other Issue*

- How can messages for incidents be improved for greater understanding?

STUDY APPROACH

Phase 1: Focus Group Studies

Locations

The focus group discussions were held in the following six cities selected by the Project 0-4023 Advisory Committee: Amarillo, Arlington, El Paso, Houston, Laredo, and San Antonio. The discussions were held in the TTI facilities in Arlington, Houston, and San Antonio and in hotel meeting rooms in Amarillo, El Paso, and Laredo.

Participants

Participants were recruited using an advertisement flyer that was posted in each city prior to the scheduled focus group discussions. Seven to ten licensed drivers participated at each location for a total of 54 participants. The goal was to select a sample of drivers based on a demographic sample of the driving population of Texas with regard to gender, age, and education level. However, because of recruiting and scheduling difficulties at some of the study sites, the researchers did not quite reach this goal. The actual sample had a higher percentage of female drivers and drivers between the ages of 18 and 39 years old than the Texas driving demographics. The demographics of focus group participants are shown in Table 2.

Table 2. Number of Participants by Age and Education Level for Focus Group Study.

Age	High School Diploma or Less (50%)		Some College+ (50%)		Total
	Male	Female	Male	Female	
18-39 (47%)	4	5	6	11	25
40-54 (29%)	5	3	3	6	17
55+ (24%)	1	4	4	2	11
Total (100%)	10	12	13	19	54

Discussion Techniques

Five different techniques, listed below, were used during the focus group discussions.

1. *Listing* – The participants in each focus group were asked to list the types of situations and/or types of information they felt was important and what types of information should be displayed on a DMS during specific events.

2. *Rating* – After the lists were prepared, the participants were asked to rate each item in the list. The rating was a way to determine how each item listed (selection, alternatives, test messages, etc.) would be considered by each participant on its own merit.

3. *Ranking* – The participants were then asked to rank the items in the list according to either preference or importance. The ranking scale was an attempt to determine the relative importance of the items in the list.

4. *Recall* – Several messages were projected onto a screen to determine whether the participants were able to recall the information after it was displayed for 8 seconds. Eight seconds is the approximate amount of time that DMS messages are within the view of drivers as they travel at 65 mph. The moderator then queried the participants as to the specific information they could or could not remember.

5. *Building Test Messages* – This technique involved "building" a DMS message using the input from the participants. The process started by placing the group's preference for the most important information on the top line of a DMS that was projected on the screen. Following further discussion, the group's preference for the next unit of information was placed on the second line of the DMS. Then based on the further discussion, the third unit of information was placed on the third line. Finally, group discussion would continue until all different opinions were satisfied.

Focus Group Protocol

Two TTI research project team members participated in each focus group session. One served as the facilitator (moderator) while the other took notes and interjected questions when appropriate.

Upon arrival, participants were given a verbal explanation of the study and a subject information form to complete which included a request to write down the meaning of the term "AMBER ALERT." The objective of this latter request was for the TTI researchers to obtain an unbiased assessment of the drivers' understanding of the term prior to the focus group discussions. The outcome of this question is addressed in the AMBER Alert Messages section of this report.

The TTI facilitator started each group discussion by asking if any of the participants in the group had ever used the information provided on a DMS during situations such as special events, bad weather, or major catastrophes, and if so, how effective or ineffective the information was to them. This question was used to help motivate the participants to think of past experiences or events when they had seen and/or used this type of information when it was displayed on DMSs.

Following this initial lead-in for the discussion, the researchers addressed each of the identified topics individually through the use of a focus group guide. The focus group guide was developed to set the agenda for the group discussions and provide direction for the TTI facilitator. The topics were approached such that each situation allowed the participants to participate in an open

discussion of the topic. The focus group guide was tailored to the local area of the particular city in which the group discussion was held. In other words, street names and scenarios used within the group discussions were changed as appropriate for the area. Prior to beginning the discussion, several rating and ranking forms were distributed for use during the discussion. Copies of the focus group guide and rating and ranking forms are shown in Appendix A.

Phase 2: Human Factors Laboratory Studies

The human factors studies utilized several different methods of participant interface including laptop computer programs, card selection processes, and map studies. The method of interface selected depended on what was appropriate for the issue being addressed. Greater detail as to the tools used is provided in the section on the specific issue addressed.

Laboratory Instruments

The laboratory instrument developed for this study consisted of eight sessions, each addressing a specific topic. Each session contained between 7 and 15 messages to evaluate or presented different scenarios to the participants for them to evaluate and create appropriate messages. To avoid the occurrence of primacy bias, the order of the message displays was interchanged. There were two groups in each city, where Group A would view the messages in one order, and Group B would view the messages in the opposite order in all of the applicable sessions. There were two sessions where this application was not necessary as only situation descriptions were presented to the participants who were then instructed to create messages.

Pilot Study

A preliminary laboratory instrument was developed and tested with four individuals in the Bryan/College Station area. The purpose of the pilot study was to assess the administration procedures, determine the length of time needed for each participant to complete the laboratory session, assess the format of the laboratory instrument, and identify any question deficiencies. The preliminary laboratory instrument and procedures were modified based on the results and participants' comments. The final laboratory instrument is provided in Appendix B.

Study Locations

Researchers conducted studies in the following six cities: Arlington, Austin, El Paso, Houston, Laredo, and San Antonio. Note that although Amarillo was one of the locations for a focus group study, upon review of the results, the Project 0-4023 Advisory Committee recommended that Amarillo be replaced with Austin for the laboratory studies. Studies were conducted in community centers, senior citizen centers, private residences, rented hotel conference rooms (when necessary), and at TTI research implementation offices located in Arlington, Austin, Houston, and San Antonio.

Participant Recruitment

There were 192 individuals who participated in this study, 32 from each of the six study locations. Researchers made telephone contact with officials responsible for the potential study locations in each city. Upon official approval to conduct a study in a given location, public notices stating the requirements, compensation, and contact person and telephone number were provided for posting and distribution.

As most of the messages evaluated would be for DMSs that would be used on freeways or highways, all participants were required to have a current Texas driver's license, drive at least 8000 miles per year, and travel on a freeway or highway at least 12 times per year.

Demographics

A demographic sample of the Texas driving population based on age, gender, and education level was used as a guide for participant selection. The statistics utilized for age and gender were obtained from the United States Department of Transportation – Federal Highway Administration Statistics for 2003. The education level statistics were based on the Texas information from the United States Census Bureau for the year 2003. Gender statistics indicated that there is an even split of male versus female drivers. Table 3 contains the percentages for the education level and age category demographic splits along with the corresponding number of participants recruited within each category at each location.

Table 3. Demographic Sample of Participants for Laboratory Study at Each Study Site.

Age Category	Education Level				
	High School Diploma and Less		Some College and More		Total
	M	F	M	F	
<25	1	1	1	2	5 (16%)
25-54	5	5	5	4	19 (59%)
54+	2	2	2	2	8 (25%)
Total	8	8	8	8	32 (100%)

Laboratory Session Protocol

The study administrator recorded all responses during the survey on the study form. Although many of the laboratory sessions were conducted using laptop computers, it was not necessary for the participants to have any prior computer experience. The participants simply need to press the space bar and use the mouse to click on objects at certain points in the sessions. To ensure that participants were at ease with these skills, test messages were used at the start of the first session

employing this technique to familiarize participants with the procedure. The test messages could be viewed multiple times, if necessary, for a participant to be comfortable with the technique. The study took approximately two hours to complete, and the participants were compensated financially for their participation. Laboratory sessions were administered one at a time to participants. Overall, data collection occurred over a three-month period in spring/summer of 2005.

2. AMBER ALERT MESSAGES

PHASE 1: FOCUS GROUP STUDIES

Results

Basic Terms

As previously stated, the participants were asked prior to the group discussions to write down their understanding of the term AMBER ALERT. The answers to this query were not shared with the other participants but were analyzed after the focus group studies were completed. The analysis revealed that only 67 percent (37 of the 54) of the participants interpreted the meaning of AMBER ALERT as a situation when a child is abducted.

At the beginning of the group discussions, the participants from each group were asked to identify terms that they thought would be appropriate to use during a situation where a child had been taken by a stranger. (Note: the researchers recognize that a child need not be taken by a stranger for an AMBER alert to be in effect. A child may be abducted by a relative or a neighbor. However, the word "stranger" was used so that the participants would not be biased in their response by other descriptive terms that the researchers might use. For example, to explain the situation the researchers wanted to avoid using words such as KIDNAPPED or ABDUCTED.) The following terms were identified by the focus groups:

- AMBER Alert
- Abducted Child or Child Abducted
- Kidnapped Child or Child Kidnapped
- Missing Child or Child Missing

A summary of the identified terms by city is shown in Table 4. Note that the focus groups in El Paso, Houston, and San Antonio chose all of the above options for further discussion. With the exception of Laredo, all chose AMBER ALERT as an option. The group in Amarillo did not consider KIDNAPPED and the group in Arlington did not choose ABDUCTED or KIDNAPPED as options.

After a list of terms was compiled, the participants from each group were asked to select the term that best described the situation and in their opinion would be understood by other drivers. The preferences for the terms are summarized in Table 5. (Note: some participants selected multiple terms; some did not state a preference.)

Table 4. Terms Selected by the Focus Groups to Describe a Child Taken by a Stranger.

Terms Selected by Focus Group for Further Consideration	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of locations
Missing Child and/or Child Missing	X	X	X	X	X	X	6
AMBER Alert	X	X	X	X		X	5
Abducted Child and/or Child Abducted	X		X	X	X	X	5
Kidnapped Child and/or Child Kidnapped			X	X	X	X	4

Table 5. Preferences of the Focus Groups to Describe a Child Taken by a Stranger.

Terms Selected by Focus Group for Further Consideration	Number	Percent
AMBER Alert	24	44
Kidnapped Child and/or Child Kidnapped	22	43
Abducted Child and/or Child Abducted	8	17
Missing Child and/or Child Missing	1	2

The results from the individual preferences revealed that no term was selected by an acceptable majority of the participants. Thus, there was not a clear-cut consensus as to which term would be best, although AMBER ALERT and KIDNAPPED were selected by the highest percentage of the participants. Forty-four percent of the participants preferred AMBER ALERT and 43 percent preferred KIDNAPPED. Only 17 percent selected ABDUCTED and 2 percent selected MISSING.

Many of the participants who preferred the term AMBER ALERT felt that the term describes a situation that is life threatening to the child. In addition, they thought that most people would understand the term. The majority of the groups felt that both KIDNAPPED and ABDUCTED were also indications that a child was taken; however, some individuals commented that KIDNAPPED was too harsh or too long of a word. Individuals from three of the six groups said that MISSING CHILD could mean a runaway child or the child was taken by a family member and was not necessarily in a dangerous situation.

The participants in each group were asked to rate the alternative terms using a scale ranging from 1 to 5. The 1 meant that the term was well-understood for the situation and 5 meant that the term was not well-understood for the situation. The results, summarized in Table 3, revealed that the terms AMBER ALERT, KIDNAPPED, MISSING, and ABDUCTED were rated equally high.

The participants were then asked to rank the terms they had identified in the order that the term best described the situation and would most likely be understood by most drivers. The results,

summarized in Table 6, indicate that there was no descriptor that had a significantly higher ranking than the others. The average ranking for the terms AMBER ALERT and KIDNAPPED was 2.0, while the average rankings for MISSING and ABDUCTED were 2.3 and 2.6.

Table 6. Rating and Ranking of Alternative Terms Selected by Focus Group Participants for AMBER Alert Messages.*

Descriptor	Average Rating	Descriptor	Average Ranking
AMBER Alert	1.8	AMBER Alert	2.0
Kidnapped Child and/or Child Kidnapped	2.0	Kidnapped Child and/or Child Kidnapped	2.0
Missing Child and/or Child Missing	2.0	Missing Child and/or Child Missing	2.3
Abducted Child and/or Child Abducted	2.0	Abducted Child and/or Child Abducted	2.6

* Lower numbers indicate higher ranking and rating. Also, rankings and ratings are based on only those groups that identified the descriptor during the discussions.

Further discussion ensued relative to whether the participants thought the term AMBER ALERT could be confused with the Homeland Security warning levels. Sixty-eight percent (36) responded that the term could be confused with Homeland Security warning levels. They believed that the confusion could stem from the fact that both terms have color indicators.

Placement of the Word "Child" In the Message

The participants were asked whether the word, "Child" should precede or follow the incident description (i.e., KIDNAPPED, ABDUCTED, or MISSING). The results, summarized in Table 7, indicated that there was no clear favorite. Forty-eight percent (26) of the participants indicated that they preferred "Child" first (e.g., Child Kidnapped), while 37 percent (20) preferred the descriptive term first (e.g., Kidnapped Child). Also, 11 percent (6) of the group had no preference and the remaining 4 percent (2) selected the term AMBER ALERT exclusively and therefore had no preference.

Exposure to AMBER Alert Messages

To get a perspective of the participants' exposure to AMBER alert type of messages, the participants from each group were asked if they had previously seen this type of message. Only about 25 percent of all the participants and no participants from El Paso had previously seen a DMS message relating to a child abducted.

Most of the individuals that had previously seen an AMBER alert type message remembered the incident descriptor as AMBER ALERT, and several could remember that the message included the make and model of a vehicle. While four participants stated they knew a license plate number had been included in the message, none could remember the license plate number after they read the message. However, all of the participants who had viewed this type of message felt that there was enough information provided in the message they had seen.

Table 7. Focus Group Responses to Whether "Child" Should Be Before or After the Descriptor.

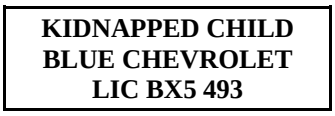
Reponses	Number	Percent
"Child" before descriptor (e.g., Child Kidnapped)	26	48
"Child" after descriptor (e.g., Kidnapped Child)	20	37
No preference	6	11
"AMBER Alert" exclusively	2	4
Total	54	100

Preliminary Message Content Issues

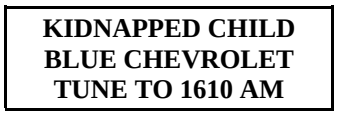
This part of the focus group discussion was designed to obtain preliminary information concerning the ability of drivers to read and recall certain elements of typical AMBER alert messages. In particular, there is speculation that drivers may have difficulty in reading and recalling license plate numbers and telephone numbers which are oftentimes displayed in AMBER alert messages.

The participants in each group were shown four examples of messages that could be used in a situation where a child had been abducted. Each message was displayed for 8 seconds. Eight seconds is the amount of time that is available to drivers to read messages displayed on DMSs with 18-inch high characters while traveling at 65 mph. After a message was displayed, the participants were asked what they could remember from the message.

Message 1



Phase 1



Phase 2

Message 2

Message 3

KIDNAPPED CHILD
LIC TP2 793
CALL 1-800-268-4000

Message 4

KIDNAPPED CHILD
RED TOYOTA
MA LIC KL4 362

All of the participants were able to remember the incident descriptor (e.g., KIDNAPPED CHILD). Most were also able to remember the vehicle description; however, at four study locations it was suggested that the vehicle type (e.g. pickup, sport utility vehicle [SUV]) should be included as part of the description to make it easier to identify the vehicle. Additionally, the majority of the participants preferred that a message direct them to the radio (e.g., Tune to 1610 AM) rather than display the license plate number. The radio would give them an opportunity to obtain further and more detailed information regarding the situation.

The majority of the participants were not able to recall the entire license plate number from any of the four messages. Of those that were able to remember part of the license pate number, typically they would remember the first half. The TTI researchers noted that the participants' ability to remember a license plate number improved as they progressed through the test messages. It was believed this was due to the fact that people were more vigilant about remembering the license plate number as they realized they would be asked to repeat the license plate number in the subsequent questions. Additionally, the majority of the participants agreed that it was easier to remember the letters than the numbers.

The overall reaction to Message 3 was that the amount of numbers contained in the message was overwhelming. One suggestion to partially remedy this problem was to use an acronym (e.g., 1-800-MISSING) for the telephone number to make it easier to remember.

After viewing Message 4, the majority of the participants were able to recognize that the third line displayed an out-of-state license plate (MA). After some discussion, the consensus of the groups was that most drivers did not know the abbreviations for the states; however, the participants agreed that it was important to know that they were looking for a vehicle with an out-of-state license plate. Several felt it would be easier to spot an out-of-state vehicle because such license plates are not as prevalent in a traffic stream. Furthermore, most participants believed that it was not important to know that the abduction took place out-of-state; the importance of the information was that they were looking for a vehicle with an out-of-state license plate.

Most participants agreed that too much information on a DMS will overload drivers. In addition, participants from four locations stated that they would dial 911 if no number was provided in the

DMS message. Most participants stated they preferred using 911 for its simplicity and familiarity.

When asked which of the four messages gave them the best information, the initial consensus was that Message 1 had too much information and Message 2 was the easiest to read. However, after further discussions the majority of the groups once again indicated a preference for a message that displayed the radio station, thus giving the drivers an opportunity to get more specific information.

The participants were asked what type of information they thought should be included in the message. The suggestions offered were as follows:

- vehicle make/model,
- vehicle color,
- vehicle license plate,
- child description,
- location of kidnapping or location last seen,
- radio station to tune to, and
- phone number to call.

Again, the TTI facilitator did not bias the participants by offering candidate message elements (information). Each group provided their own suggestions. Information needs offered by the participants and that were different than that shown in the DMS test messages presented to the participants during the earlier portion of the discussion were "Child Description" and "Location of Kidnapping or Location Last Seen." The suggested information needs by focus group location are summarized in Table 8. All of the above information needs were identified by each of the six focus groups, with the exception that the Houston group did not consider Location of Kidnapping or Location Last Seen and the Laredo group did not consider Radio Station as options.

The participants were then asked to rate and rank the information they chose. The average ratings and rankings are shown in Table 9.

The results of the rating indicated that the participants felt that all of the information listed in Table 5 was important. The ratings ranged from 1.4 to 2.2 except for Phone Number to Call, which received a medium rating of 3.0.

Table 8. Information Needs during AMBER Alert Events Shown by the Focus Group Location.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Vehicle Make/Model	X	X	X	X	X	X	6
Vehicle Color	X	X	X	X	X	X	6
Child Description	X	X	X	X	X	X	6
Vehicle License Plate	X	X	X	X	X	X	6
Phone Number to Call	X	X	X	X	X	X	6
Radio Station	X	X	X	X		X	5
Location of Kidnapping or Location Last Seen	X	X	X		X	X	5

The results of the ranking indicated that Vehicle Make/Model (2.0) and Vehicle Color (2.7) ranked the highest among the participants followed by Radio Station (3.2) and Child Description (3.7). The Location of the Kidnapping or the Location Last Seen, Vehicle License Plate, and Phone Number were considered the least important among the message elements (information) with rankings of 4.4, 5.0, and 6.8, respectively. Discussions with the participants provided some insight as to why these latter three information elements were ranked so low and were less relevant than other information on the list. Some participants stated that since the abductor would be moving, the location of the kidnapping and the location where the abductor was last seen would be less relevant than the other information. The participants also restated the belief that most drivers would not be able to recall license plate numbers. Also, most drivers would not recall long telephone numbers and thus would dial 911.

Table 9. Rating and Ranking of Information in AMBER Alert Messages.*

Descriptor	Average Rating	Descriptor	Average Ranking
Vehicle Color	1.4	Vehicle Make/Model	2.0
Vehicle Make/Model	1.6	Vehicle Color	2.7
Radio Station	1.6	Radio Station	3.2
Vehicle License Plate	2.0	Child Description	3.7
Child Description	2.2	Location of Kidnapping or Location Last Seen	4.4
Location of Kidnapping or Location Last Seen	2.2	Vehicle License Plate	5.0
Phone Number to Call	3.0	Phone Number to Call	6.8

* Lower numbers indicate higher ranking and rating. Also, rankings and ratings are based on only those groups that identified the descriptor during the discussions.

Implications of Results for Human Factors Laboratory Studies

The implications of the findings relative to possible human factors laboratory studies are listed below.

1. There was not a clear consensus as to which of four descriptor terms would best describe that a child was abducted. However, the term MISSING had connotations that a child would not be in a dangerous situation and thus should be eliminated from further study. The incident descriptor terms "AMBER Alert," "Kidnapped," and "Abduction" should be further evaluated to determine the "best" term to use in a message.

2. The placement of "Child" relative to the incident descriptor (i.e., Child Kidnapped vs. Kidnapped Child) should be further explored.

3. Assessment should be made of the ability of drivers to read and recall license plate numbers. Also, studies should be designed to determine the equivalency of license plate numbers in terms of units of information.

4. Assessment should be made of the ability of drivers to read and recall telephone numbers. Also, studies should be designed to determine the equivalency of telephone numbers in terms of units of information.

5. The utility and importance of the incident descriptor containing the gender of the child (e.g., Kidnapped Boy [Girl]) should be explored.

6. The relative importance of information to display should be further assessed.

7. Reading times and comprehension of alternative messages for AMBER alert situations should be determined.

PHASE 2: LABORATORY STUDIES

Study Approach

Using the above implications of results from the focus group studies, the TTI research team developed laboratory studies that consisted of two parts. Part 1 involved a card sort experiment to determine driver priorities and preferences for elements of AMBER alert messages. The experiment was similar to the one previously used by Dudek et al. in developing human factors DMS message guidelines (*2*). Part 2 was a series of experiments to determine the equivalent units of information of telephone and license plate numbers by measuring reading times and comprehension.

Driver Priorities and Preferences

The purpose of the card-sort study was to obtain priorities and preferences for message elements (terms) that would compose the AMBER alert message. Each message element shown in Table

10 was placed on a 3 × 5-inch card. Each group of message elements (1 through 5) was color coded and shuffled to randomize the order within each group. The cards, separated by color, were then given to the participant. The order in which each group was given to the participants was counterbalanced such that the order varied among the participants.

Each participant was told that the police had been notified that a child has been taken by a stranger, and to use the color cards to build a sign that gives as much information as possible about the situation to the drivers. The study administrator asked the participants to select one card from each of the five color sets and to place the selected cards on the table in the order that they would like to see the information shown on a DMS. A follow-up question as to why they did not select one of the other available candidates was asked.

Participants rated each of the cards from 1 (high) to 5 (low) to indicate how important the information on each card was for placement on the DMS. A ranking technique was then initiated by asking the participants to remove a card that contained information that was least important. Participants were asked why the card was removed and not the others. Participants repeated this process until only two cards remained on the table.

Table 10. Phrases for Each Message Element.

Message Element	Message Element Alternatives			
1	AMBER ALERT	ABDUCTED CHILD	MISSING CHILD	KIDNAPPED CHILD
		ABDUCTED BOY	MISSING BOY	KIDNAPPED BOY
2	BLUE MAZDA	BLUE PICKUP	MAZDA PICKUP	BLUE MAZDA PICKUP
	BLUE MAZDA 05 PICKUP			
3	LIC SR8 493	LIC # SR8-493		
4	CALL 511	DIAL 511	CALL 888 769 5000	DIAL 888 769 5000
5	TUNE TO 530 AM	TUNE TO RADIO	TUNE TO LOCAL RADIO	

Unit of Information Equivalents of Telephone and License Plate Numbers

Next, researchers utilized laptop computers to view a series of simulated dynamic message sign messages displayed on the computer monitor and the participants were asked questions by the test administrator about the content of the messages. Secondary task loading was accomplished with a push-button process, whereby the participants monitored and clicked buttons that appeared in a control panel. The participants clicked on the buttons using the mouse to deactivate them as they appeared on the monitor. The buttons appeared randomly at a rate of 1 button per 1.1 seconds. An example of a DMS message and push-button display is shown in Figure 1.

The following types of message elements that would typically be displayed in an AMBER alert message were evaluated:

- TUNE TO RADIO (Base),
- TUNE TO 1620 AM,
- CALL 511 (or 911),
- CALL [Telephone Number],
- LIC [License Number], and
- LIC [License Number] and CALL [Telephone Number] combination.

Figure 1. Screenshot of Monitor Showing DMS Message and Button-Pushing Secondary Task.

The message element TUNE TO RADIO was used as a base message element since previous studies have indicated that drivers can read and comprehend this message element in 2 seconds or less. In addition, the study included the base AMBER alert and base incident messages shown below for the purpose of comparing reading times and comprehension of the above message elements.

KIDNAPPED CHILD **YELLOW TOYOTA** **TUNE TO RADIO**	**FREEWAY CLOSED** **AT SILBER RD** **USE OTHER ROUTES**
Base AMBER Alert Message	*Base Incident Message*

There were two parts to this portion of the study. The first part involved assessment of reading times and comprehension of message elements that are typically found in AMBER alert messages observed in different parts of the U.S. This experimental approach is referred to as *self-paced* because the participant controlled the time that the message elements were displayed on the monitor. The study administrator told participants that they were driving on a specific freeway in the city where the study took place. As they traveled on this freeway, they would see messages on several dynamic message signs that would be shown on the computer monitor. Participants were reminded to continue clicking on the red dots, and to push the space bar once they had read the message and were ready to answer questions. The message elements tested in this experiment are shown in Table 11.

The second part of this study assessed message comprehension only over a fixed viewing time. Logically, this experimental approach is referred to as *fixed-time*. This part of the study was further divided to investigate the effect of different exposure times of the message elements. Depending on the message element or element combination being studied, researchers tested 2-second, 4-second, 6-second, and occasionally, 8-second exposure times (such as when the message contained both a telephone and a license plate number). Each of the above parts was presented at different times within the larger study to minimize possible learning effects. The message elements tested in the fixed-time part of the study are shown in Table 12.

Results and Findings

Driver Priorities and Preferences

To identify driver preferences for different formats or terms related to the message elements of an AMBER alert DMS message, participants were asked to select one option out of each series for five different types of message elements. These message elements represented the following information categories:

- situation descriptor,
- vehicle descriptor,
- license plate number,
- telephone number, and
- tune to radio action (highway advisory radio [HAR]) descriptor.

The options that participants felt would best communicate the information are summarized in Table 13. Detailed tables listing the reasons why the participants selected specific formats or terms are provided in Appendix C.

Table 11. AMBER Alert Message Elements and Message for Self-Paced Viewing Time Experiment.

Message 1D HAR	Message 2D Telephone No.	Message 3D License Plate No.	Message 4D 911	Message 5D License Plate/Tele No.	Message 6D Base Amber Alert	Message 7D Base Incident
TUNE TO 1350 AM	CALL 800 486 6300	LIC DS6 837	CALL 911	LIC 642 953 CALL 888 493 4000	KIDNAPPED CHILD YELLOW TOYOTA TUNE TO RADIO	FREEWAY CLOSED AT *POST OAK RD* USE OTHER ROUTES

Note: Italics indicates that word that was changed at each study site

Table 12. AMBER Alert Message Elements and Messages for Fixed Viewing Time Experiment.

Part 1: 4-Second Display Time

Message 1 HAR	Message 2 Telephone No.	Message 3 License Plate No.	Message 4 511	Message 5 License Plate/ Tele No.	Message 6 Base (2 sec)	Message 7 Base (2 sec)
TUNE TO 1620 AM	CALL 888 769 5000	LIC 739 452	CALL 511	LIC RG5 693 CALL 800 876 3200	TUNE TO RADIO	CALL 911

Part 2: 6-Second Display Time

Message 1 HAR	Message 2 Telephone No.	Message 3 License Plate No.	Message 4 License Plate/ Tele No.	Message 5 Base AMBER	Message 6 Base Incident	Message 7 License Plate/ Tele No. (8 sec)
TUNE TO 1580 AM	CALL 888 879 3000	LIC RG5 693	LIC 739 452 CALL 800 769 5300	KIDNAPPED CHILD *GREEN CHEVY* TUNE TO RADIO	MAJOR ACCIDENT AT *SILBER RD* 3 LANES CLOSED	LIC 739 452 CALL 888 769 5000

Note: Italics indicates that word that was changed at each study site

Table 13. Message Element Terms Selected by Participants for AMBER Alert Messages.

Message Element	Terms Selected by Participants	Participants Selecting Term (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
1	AMBER ALERT	31	25	47	38	28	25	32
	ABDUCTED CHILD	28	12	16	31	16	28	22
	KIDNAPPED CHILD	9	6	22	13	22	19	15
	MISSING CHILD	10	22	6	6	19	6	12
	KIDNAPPED BOY	16	13	3	6	6	19	10
	ABDUCTED BOY	6	13	3	6	9	0	6
	MISSING BOY	0	9	3	0	0	3	3
2	BLUE MAZDA 05 PICKUP	41	63	56	47	41	50	49
	BLUE MAZDA PICKUP	44	31	35	41	34	41	38
	BLUE PICKUP	12	6	6	12	25	6	11
	BLUE MAZDA	0	0	0	0	0	3	1
	MAZDA PICKUP	3	0	3	0	0	0	1
3	LIC # SR8-493	75	78	66	66	63	59	68
	LIC SR8 493	25	22	34	34	37	41	32
4	CALL 511	56	56	59	56	62	63	59
	DIAL 511	31	28	25	35	22	25	28
	CALL 888 769 5000	10	3	3	6	16	6	7
	DIAL 888 769 5000	3	13	13	3	0	6	6
5	TUNE TO 530 AM	63	88	41	62	66	59	63
	TUNE TO LOCAL RADIO	28	9	37	13	25	28	23
	TUNE TO RADIO	9	3	22	25	9	13	14

Situation Descriptor. Overall, there was no situation descriptor selected by the majority of the participants to best communicate the information that a child has been taken. Participants selected the term AMBER ALERT most often with 32 percent, followed by ABDUCTED CHILD (22 percent), and KIDNAPPED CHILD (15 percent). As shown in Table 13, only 15 percent of the participants selected MISSING CHILD or MISSING BOY as most preferable.

As expected, over a third (35 percent) of the participants stated their reason for not selecting AMBER ALERT as either they were not familiar with the term or they believed that other people would not be familiar with the term. Interestingly, about a quarter of the participants responded that AMBER ALERT means the same as all the other situation descriptors tested. Meanwhile, the primary reasons stated for the low response rate for MISSING CHILD or MISSING BOY descriptors was that the word MISSING has the connotation that a child would not be in a dangerous situation.

Very few subjects selected any of the three descriptors that described the gender (boy) of the child. Unfortunately, it was noted by some subjects (27 percent) that the study administrator used the term “child” during the introduction to the scenario, and concluded that the term “boy” would

not be appropriate. In addition, another 12 percent of those subjects who did not select from any of the CHILD descriptors specifically said they selected another descriptor because they preferred to know the gender of the child. If these percentages are added together, it does suggest that gender information would be useful to a significant portion of the driving population.

Vehicle Descriptors. Out of the five vehicle descriptors tested, 49 percent of the participants selected the description with the most information about the vehicle (i.e., BLUE MAZDA 05 PICKUP). For those who did not select this particular descriptor, the main reasons for not doing so were that the year of the vehicle was unnecessary information or would be too hard to determine (expressed by 37 percent of the subjects). The next most popular descriptor to be chosen was the one with the second most information (BLUE MAZDA PICKUP), selected by 38 percent of the participants. Overall, then, a total of 87 percent of the participants preferred the more detailed descriptors (BLUE MAZDA 05 PICKUP and BLUE MAZDA PICKUP).

License Numbers. The majority of the participants (68 percent) selected the license number containing the "#" and "-" signs. According to participants, this format separated the numbers and words so that they did not all run together (stated by 42 percent of the subjects), and/or that the version without these symbols was confusing (expressed by 35 percent of participants). Of course, the opposite view was held by the participant minority who selected the other alternative, indicating that the "#" and "-" signs were either not needed or were harder to read and memorize.

Telephone Numbers. Over 85 percent of the participants selected the shorter and easier-to-remember telephone numbers CALL 511 (59 percent) or DIAL 511 (28 percent). An additional 10 percent of the participants stated that they were not familiar with the number 511. As would be expected, the main reason for not selecting the longer telephone numbers was that more numbers were too hard to remember.

Tune to Radio. Of the three radio phrases tested, 63 percent of the participants selected TUNE TO 530 AM. It should be noted, though, that close to 6 percent confused the radio station 530 AM with the time of day (5:30 a.m.). The main reasons participants gave for not selecting this term were that the alert information should be available on all stations anyway, that the participant does not listen to AM radio, or that the term local in the message was more informative to them. For the other descriptor alternatives TUNE TO RADIO and TUNE TO LOCAL RADIO, the main reason given for not selecting them was that there was not a specific station number provided.

Message Element Importance. Table 14 shows the participants' selection of relative preference or importance of that category of information being displayed on the DMS.

Table 14. DMS Line Preference (Importance) of Message Elements for AMBER Alert Messages.

Message Element	DMS Line Preference	Participants Selecting Term (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Situation Descriptor	1	94	100	97	94	97	97	96
	2	6	0	3	6	0	3	3
	3	0	0	0	0	3	0	1
	4	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0
Vehicle Descriptor	1	3	0	0	0	3	0	1
	2	66	66	78	50	78	72	68
	3	22	31	16	38	13	16	22
	4	9	3	6	12	3	12	8
	5	0	0	0	0	3	0	1
License Number	1	0	0	0	0	0	0	0
	2	3	3	0	0	3	3	2
	3	56	56	75	53	72	63	63
	4	28	31	19	38	22	25	27
	5	13	10	6	9	3	9	8
Telephone Number	1	0	0	0	0	0	0	0
	2	6	9	6	16	3	3	7
	3	12	9	6	0	10	16	9
	4	44	53	63	37	56	34	48
	5	38	29	25	47	31	47	36
Tune to Radio	1	3	0	3	6	0	3	3
	2	19	22	12	28	16	19	19
	3	9	3	3	9	3	3	5
	4	19	13	13	13	19	31	18
	5	50	62	69	44	62	44	55

As shown by the shaded areas of the table, 96 percent of participants selected the situation descriptor to be placed first on the DMS. Next, 68 percent of the subjects selected the vehicle description to be placed second on the sign. For the third line, the descriptor receiving the higher preference percentage was a license plate number, selected by 63 percent of the participants. A telephone number was most preferred as the fourth line of information, selected by 48 percent of the participants. Finally, the tune to radio element was most preferred as the fifth line of the message, based on selection by 55 percent of the participants.

Rating. Next, subjects were asked to rate each of the message elements from 1 (most important) to 5 (least important) to include in an AMBER alert DMS message. Thus, low numbers indicate high importance. The results of these ratings are shown in Table 15.

Table 15. Average Ratings of Message Elements for AMBER Alert Messages.

Terms Selected by Participants	Rating						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
1. Situation Descriptor	1.0	1.0	1.0	1.1	1.1	1.0	1.0
2. Vehicle Descriptor	1.5	1.4	1.2	1.4	1.2	1.3	1.3
3. License Number	1.8	1.7	1.4	1.4	1.6	1.4	1.6
4. Telephone Number	2.1	2.2	1.9	1.7	1.6	1.7	1.9
5. Tune to Radio	2.9	3.4	2.8	2.8	2.5	2.8	2.9

Consistent with the importance rankings shown in Table 14, participants rated the situation descriptor as the most important and vehicle description as the second most important message element in this rating activity. License plate and telephone number were number three and four, respectively, in the order of ratings. Finally, the tune to radio descriptor was rated the lowest, indicating that participants judged that information to be less important than all of the other message elements. These ratings were consistent across all of the study locations.

Ranking. In this part of the experiment, the participants removed the least important message element out of the five that they had originally selected to be placed on the DMS. A detailed listing by city location of message elements removed is located in Appendix C. Table 16 shows a breakdown of the order of message element removal by all of the participants.

Table 16. Message Elements for AMBER Alert Messages Removed by Percent of Participants.

Message Elements	Percentage Removed			
	Message Element Removed First (n = 192)	Message Element Removed Second (n = 192)	Message Element Removed Third (n = 192)	Total Removed (n = 576)
1. Situation Descriptor	0	1	5	2
2. Vehicle Descriptor	2	17	31	17
3. License Number	6	29	27	21
4. Telephone Number	15	38	34	29
5. Tune to Radio	77	15	2	31

*Note: One person refused to remove the third card. Therefore, the percentages do not total 100.

As shown in Table 16, none of the participants selected the situation descriptor as the first element to remove. Similarly, vehicle descriptor was only selected by 2 percent of the participants to be the first element to remove. Conversely, 77 percent of the participants selected

the tune to radio element to be the first element removed. Common reasons stated for this choice were: you have all the information that you would need included in the other message elements, it is the least important element of information, and you could always call 911 or 511 for more information.

Obviously, the selection of an element reduced the pool of possible choices for the next selection, which did make the decision more difficult for some of the participants. In fact, one participant refused to choose a message element during the third removal process. The telephone number and tune to radio descriptors were selected the most by the participants for removal during this process, indicating that the participants felt these two message elements were the least important information to be placed on the DMS. Again, reasons stated for removal of the radio element were similar to those stated above. With regard to the removal of the telephone number element, common reasons stated were: could call 911, 511, or police; it is the least important element of information that you would need; and you have all the information you need without the telephone number.

Unit of Information Equivalents of Telephone and License Plate Numbers

As mentioned in the study design, participants viewed different message elements on a computer screen and were asked to recall the content of those message elements following each viewing. The message elements tested are provided earlier in this chapter in Tables 11 and 12. Initially, this task was completed at a self-paced rate, which means that the participant had control of how long the message element stayed on the screen. In subsequent sections, the messages were displayed for a fixed amount of time ranging from 2 to 8 seconds depending on the anticipated unit of information equivalents for the given message element. For example, researchers believed that CALL 911 is most likely a single unit of information and this element was, therefore, tested at 2- and 4-second display times to verify this hypothesis. Similarly, researchers initially hypothesized that the AMBER alert base message contains three units of information, and was therefore tested with a 6-second viewing time. The final three messages in this study contained license plate and telephone number information. It was uncertain what the equivalent units of information are for this type of message element. Therefore, researchers tested these messages at a variety of viewing times ranging from 4 to 8 seconds.

Table 17 summarizes the comprehension percentages for each of the fixed viewing times tested for a given message element, and also the self-paced results and the average viewing times for this task. Note that the license numbers, telephone numbers, and radio stations were changed from one session to the next to avoid participant familiarity and therefore are represented by Xs in the table. Also, the street names contained in the FREEWAY CLOSED and MAJOR ACCIDENT messages were changed based on the study location to be a local street name for that location. Tables containing the results for each of the individual locations regarding this portion of the study are located in Appendix B.

The first two message elements in Table 17, CALL 911 and TUNE TO RADIO, were considered base informational units for this study. Based on the results of previous research, these message elements are considered to be equivalent to one unit of information. The resulting high comprehension percentages for the message elements at the 2-second viewing times and in the

self-paced session (average reading time of 2.5 seconds) validate this hypothesis. The third message element (TUNE TO XXXX AM) was tested to determine its equivalent unit of information. The average reading times in the self-paced portion of the study for this message element were 3.8 seconds, and the comprehension percentages were lower (92 percent) than the previous two elements for both the self-paced and fixed-time (4 and 6 second) portions of the study, although still very high overall. Based on the results, researchers believe that this message element would most appropriately be evaluated as being two units of information.

Table 17. Comprehension Percentages of AMBER Alert Messages for Various Display Times.

Message Displayed	Percent Correct for Fixed-Time Displays				Self-Paced	
	2 seconds (n = 192)	4 seconds (n = 192)	6 seconds (n = 192)	8 seconds (n = 192)	Percent Correct (n = 192)	Average Reading Time
CALL 911 (511)	99	100			100	2.5
TUNE TO RADIO	99	99				
TUNE TO XXXX AM		95	93		92	3.8
KIDNAPPED CHILD [vehicle color and make] TUNE TO RADIO *All Lines Correct*			99 89 86 *80*		98 86 78 *69*	 *6.0*
FREEWAY CLOSED AT [street name] USE OTHER ROUTES *All Lines Correct*					89 83 80 *67*	 *6.3*
MAJOR ACCIDENT AT [street name] 3 LANES CLOSED *All Lines Correct*			94 88 68 *60*			
LIC XXX XXX		49	64		34	7.5
CALL 8XX XXX XXXX		46	60		68	6.1
LIC XXX XXX CALL 8XX XXX XXXX *All Lines Correct*		18 1 *0*	36 4 *1*	53 10 *6*	26 4 *1*	 *16.7*

The next three messages were full messages, each containing three units of information. The first message was a base AMBER alert message containing a situation descriptor, vehicle description, and an action to take (TUNE TO RADIO). Two versions of this message were used during the study, with the vehicle description being altered between the two. In the self-paced portion of the study, the vehicle description was YELLOW TOYOTA and in the fixed-time portion it was GREEN CHEVY. The following two messages were base incident messages. For these messages, all of the information changed from one message to the next. However, each message is considered to contain the same number of units of information (three).

Overall, the comprehension percentages for three of these messages were very similar with the self-paced AMBER alert message at 69 percent, self-paced incident message at 67 percent, and the fixed-time incident at 60 percent. It should be noted that the average reading times for each of the self-paced messages were approximately 6 seconds also, so the comprehension percentages are considered comparable to the fixed-time messages. However, the fixed-time AMBER alert message had a significantly higher comprehension level at 80 percent than the other three messages in this category. This high comprehension level is considered to be an idiosyncrasy within the data that may be attributed to either learning effect from the previous AMBER alert message or natural variation of the data sample.

Researchers identified one possible reason as to why the comprehension percentage for the self-paced incident message was higher than that of the fixed-time incident message. There were differences in the techniques for coding the correct responses for the third line of these messages. For the self-paced messages, where the third line displayed was USE OTHER ROUTES, researchers coded as correct the concept of needing to leave the roadway and use a different route. In other words, there was a means of giving credit for wording that did not exactly replicate what was in the message text. However, in the fixed-time message the third line was 3 LANES CLOSED. For this element, there was no possibility of giving credit for a partially correct response such as "lanes closed," since each part of the line was significant to the meaning and interpretation of the message.

The major focus of this portion of the study was to identify the equivalent units of information that should be assigned to either a telephone number or a license plate number when they are used in an AMBER alert message. To this end, the comprehension percentages of these elements were compared to those of other types of information within the same display time categories. Based on this analysis, one sees that the license plate number element and the telephone number element most closely compare to that of the three units of information message. More specifically, correct comprehension values of both the license plate number (64 percent) or the telephone number (60 percent) compare most closely to the comprehension percentage of the base incident message (60 percent) in the 6-second fixed-time category. Likewise, the comprehension rate of the telephone number (68 percent) is very similar to the base incident (67 percent) or AMBER alert (69 percent) messages in the self-paced category. Furthermore, the average reading times for the telephone number and the base messages in the self-paced portion of the study were approximately equal (within 0.2 second).

As shown in the table, researchers did note that the comprehension rate of the self-paced license plate number test (34 percent) was considerably lower than the other messages discussed here (range of 67–69 percent). This lower comprehension is believed by researchers to be attributable to a learning process that was necessary for this type of information (self-paced was the first session in this group viewed by participants). Specifically, participants were not as familiar with the abbreviation for license plate (LIC) or the number format of this information as they are with the formatting of telephone numbers or other typical messages, ultimately leading to the longer reading times and lower comprehension rates documented in Table 17.

In Table 18, researchers provide a breakdown of telephone number message element comprehension levels according to each piece or unit of information. This table shows that, as expected, the comprehension levels overall, as well as for each individual piece of the message,

increased as reading time increased. It should be noted that the average reading time for the self-paced message was 6.1 seconds.

Table 18. Comprehension Percentage of Telephone Number Message Element by Informational Piece.

Message Portion	Percent Correct		
	4 seconds (n = 192)	6 seconds (n = 192)	Self-Paced (n = 192) (Avg. 6.1 sec)
CALL	98	98	99
Prefix (e.g., 800)	84	88	94
Middle 3 Digits	69	77	80
Last 4 Digits	65	75	77
All	46	60	68

Nearly all of the participants were able to correctly respond that the message told them to "call" (98 percent or greater). Also, a significant portion identified the initial prefix of the telephone number (84 percent or greater). This is probably attributable to the familiarity of this type of prefix, either 800 or 888, when receiving an informational telephone number. Researchers believe that the familiarity of these two pieces of information in sequence would constitute this portion of the message to be considered as one unit of information. Based on the previous analysis that this type of telephone number display should be considered comparable to three units of information, researchers believe that each of the following two pieces of the telephone number (i.e., the middle three digits and the last four digits) should each be considered to be equivalent to one unit of information. This hypothesis is supported through the comparison of the comprehension levels for each piece (or unit of information) of the telephone number to each line of the three-unit base messages. Most comparable would be a comparison between the self-paced base messages and the self-paced telephone number comprehensions. Firstly, they all had average reading times within a few tenths of a second of each other (as shown in Table 17). Additionally, the comprehension percentages for each of the lines or pieces of information were within approximately 5 percent of each other.

Table 19 provides a breakdown of the license plate number message element comprehension levels according to each piece or unit of information.

Table 19. Comprehension Percentage of License Plate Message Element by Informational Piece.

Message Portion	Percent Correct		
	4 seconds (n = 192)	6 seconds (n = 192)	Self-Paced (n = 192) (Avg. 7.5 sec)
LIC	97	99	100
First 3 Digits	82	81	73
Second 3 Digits	58	69	37
All	49	64	34

Again, as expected the comprehension percentages increased as the amount of viewing time available to the participants increased. In this case there was one exception where the self-paced situation resulted in lower comprehension levels although the viewing time was greater than the other sessions (average time = 7.5 seconds). As previously noted, researchers believe that the lower comprehension rates for the self-paced session may be attributable to a learning process that occurred regarding the participant familiarity with the abbreviation for license plate as "LIC" and the general formatting of the license number as this was the first session completed related to this information.

If the comprehension level for each piece of information (e.g., assuming LIC is one piece or information unit) is compared to that of the individual lines of the three-unit base messages used, the comprehension percentages track a very similar course with decreasing comprehension at the later lines of the messages. Specifically, if one compares the 6-second fixed-time comprehensions for both the license plate number and the base incident message, the comprehension percentages are approximately equal at:

- 1st line/piece: MAJOR ACCIDENT – 94 percent versus LIC – 99 percent;
- 2nd line/piece: AT [street name] – 88 percent versus first three digits – 81 percent; and
- 3rd line/piece: 3 LANES CLOSED – 68 percent versus last three digits – 69 percent.

Also, the overall comprehensions are very comparable at 60 percent for the base incident message and 64 percent for the license plate number, strengthening the assertion that a license plate is equivalent to three units of information.

The final message element to be discussed is the combination of a telephone number and a license plate into one message. This was tested at three fixed-time intervals (4, 6, and 8 seconds) as well as in the self-paced session. For all of these experiments, the comprehension percentages of this element were very low, even at the 8-second exposure interval (6 percent). The other viewing times garnered 1 percent or lower comprehension rates. The researchers believe that

some of the increase shown for the 8-second interval may be attributable to a learning effect also, as the self-paced session had a much higher average reading time of 16.7 seconds, but a lower comprehension rate of only 1 percent. The use of these two pieces of information together appeared to overwhelm the study participants and should be considered to be equivalent to a much higher number of units of information than would be appropriate for DMS message use.

Summary

Driver Preference and Priority

Message Element Preferences. The objective of this portion of the laboratory study was to evaluate different formats and message elements to be included in AMBER alert messages. There were two different parts of this session; the first was to identify which of a series of different elements would be the most appropriate within a specific category of information to use in the DMS message. The following are the most commonly selected options for each of the categories:

- Situation Description – AMBER ALERT (32 percent), ABDUCTED CHILD (22 percent)
- Vehicle Description – BLUE MAZDA 05 PICKUP (49 percent), BLUE MAZDA PICKUP (38 percent)
- License Plate Number – LIC # SR8-493 (includes # and -) (68 percent)
- Telephone Number – CALL 511 (59 percent)
- Radio – TUNE TO 530 AM (63 percent)

The results of this study do not show a majority opinion for what term should be used as a situation descriptor, although AMBER ALERT was the most commonly selected. Also, the results do support earlier focus group findings that the term MISSING has the connotation that a child would not be in a dangerous situation and so would not be a preferable descriptor for AMBER alert messages.

With regard to a vehicle description, participants typically indicated that they would prefer to have as much information as possible with which to identify the vehicle and therefore favored the more detailed options consisting of vehicle color, make, body type, and possibly year. For the vehicle license plate, participants believed the inclusion of the symbols "#" and "-" helped to keep the words from visually running together. Finally, for a telephone number, participants selected the shorter number (i.e., 511) 87 percent of the time because it was easier to remember than a typical nine-digit telephone number.

Message Element Importance. The results of the message element order, rating, and rankings all indicated to researchers that the following order of importance exists for the message elements to be included in AMBER alert messages:

1. Situation Description
2. Vehicle Description
3. License Plate Number
4. Telephone Number
5. Radio Information

Unit of Information Equivalents of Telephone and License Plate Numbers

Researchers observed difficulty during the focus group studies with participants being able to recall either long telephone numbers, such as 800-numbers, or license plate numbers. Based on this information, researchers determined that a reading time and comprehension study would be conducted to determine the unit of information equivalents for both telephone and licenses plate numbers when included in a DMS message. The following bullets outline the findings of this study:

- Long telephone numbers (e.g., 800-numbers) should be considered to be equivalent to three units of information.
- Short telephone numbers (e.g., CALL 511) should be considered as one unit of information.
- License plate numbers have a learning curve necessary to recognize the formatting and possibly the abbreviation (LIC) used; however, once the format becomes familiar to motorists it should be considered to be equivalent to three units of information.

Also, researchers investigated the use of both license plate numbers and long telephone numbers combined in a message. Based on the exceedingly low comprehension levels recorded, the use of this combination of information is not recommended for DMS messages. This amount of information appeared to be overwhelming to the study participants and would have a much higher unit of information equivalency than would be appropriate for use on a DMS.

3. FLOODS

PHASE 1: FOCUS GROUP STUDIES

Results and Findings

The focus groups in each of the six cities were shown the message below and asked if they would continue to drive on the highway if they had seen the message.

I-45 NORTH
FLOODED

Excluding six participants who did not comment on this topic, the participants were split evenly as to whether they would continue to drive on the highway or not. The consensus of those that would continue to drive was that there needed to be information in the message that told the driver the location of the flooding or gave an exit that should be used. Other suggestions included stating "Road Closed" or "Driving Discouraged" to inform drivers that they should not continue on that road.

The participants were then shown the message below. Participants at five of the six locations indicated that they would not continue to drive if they had seen the message. The final group (Arlington) felt that the message still needed to provide a specific alternate route or a specific location on the highway where the flooding was before they would exit. Three other groups agreed that a specific alternate route or a location where the flooding had occurred would improve the message.

I-45 NORTH
FLOODED
USE OTHER ROUTES

Most of the participants agreed that knowledge of the specific highway was important. The Houston group did state that if the flooding occurred on the highway they were traveling on, the highway name only needed to be displayed in the message if there were freeway interchanges downstream. Also, participants from the El Paso group indicated that the cardinal direction was not needed as it would be understood that the flooding in the direction the driver is traveling.

The participants were asked whether "Flooded" best described a situation when the highway was impassible and then were asked to state the term they preferred. The results are shown in Table 20.

The word "Flooded" was preferred by most of the participants from Arlington, Houston, and Laredo. The San Antonio group was evenly divided between "Flooded" and "High Water." Amarillo participants preferred "High Water" and El Paso participants preferred "Deep Water."

Table 20. Term That Describes Impassible Highway Due to Flooding.

Term	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Flooded		X		X	X	√	4
High Water	X					√	2
Deep Water			X				1

√ Indicates 50-50 split.

As a final step in the discussion, the participants were asked to create a message for a situation where the highway was flooded and therefore impassable. The specific messages developed by each group are contained in Appendix D. The majority of the groups included the following information in the messages:

- highway number;
- incident descriptor (FLOODED, except San Antonio used HIGH WATER), and
- location of the flooding (except Amarillo).

Four of the five groups also included the cardinal direction with the highway number and two used the term "closed" in the message. One comment from the group in San Antonio was that using exit numbers could be confusing to drivers.

Implications of Results for Human Factors Laboratory Studies

The implications of the findings relative to possible human factors laboratory studies are listed below.

1. No clear consensus was found for preference among the six cities for the three terms studied, although "Flooded" was used in messages designed by five of the six groups and "High Water" was used by one group. The three message terms "Flooding," High Water," and "Deep Water" should be further evaluated to determine the "best" term to use on DMSs.

2. Studies should be conducted to determine the words and/or terms that best describe flooding situations. In particular, to determine the best way to communicate:

   a. that the highway is impassable or passable,

b. that the frontage road is flooded and impassable,
c. the location of flooding downstream of the DMS,
d. ramp closures due to flooding, and
e. instructions as to where to exit.

3. Message content should be further evaluated to determine the most effective message in conveying the necessary information.

PHASE 2: HUMAN FACTORS LABORATORY STUDIES

Study Approach

There were two parts to the study. Part 1 involved a study in which the participants looked at schematic maps of a freeway corridor and created DMS messages or message elements that would be appropriate to the given situation. Part 2 involved a laptop computer study in which the participants were asked their preferences among sets of messages displayed and the reasons for their selections. No secondary task loading was used during the laptop part of this study.

Participants in each of the study cities were divided into two groups (Group A and Group B) for the purposes of counterbalancing. Group A consisted of 50 percent of the participants in the city, and Group B consisted of the other 50 percent. The participants in each group were balanced as much as possible according to age, education, and gender.

Map Study

During this part of the study, the participants were asked to assume that they were traveling on a specified freeway in the city in which the survey was conducted. The participants were given a series of 11 × 17-inch schematic maps one at a time that show a freeway with frontage roads on both sides, several cross streets, a cross freeway, and a parallel alternative street. The study administrator asked participants a series of questions while they viewed each map. The questions were designed to ascertain the:

- term they would use to describe the roadway next to the freeway (e.g., frontage road, feeder road, etc.);
- terms they would use to describe a passable situation when water collects on or flows across the freeway in low areas and drivers can still travel on the road;
- terms they would use to describe an impassable situation when water collects on or flows across the freeway in low areas and drivers cannot travel on that road;
- terms they would use to describe an impassable situation when water collects on or flows across the frontage road in low areas and drivers cannot travel on that road; and

- terms they would use to describe an impassable situation when water collects on or flows across both the freeway and frontage road in low areas and drivers cannot travel on those roads.

The maps used were altered for each location so that road names and locations were familiar to the study participants. For the discussion of this part of the study, the cross streets represented in the tables and text will be those used at the Houston study location. The maps for Houston are shown in Figures 2 through 4.

Term to Describe Frontage Road. The first question asked was the name of the roadway next to the freeway. Each participant was asked to identify the name for the road that was familiar to them.

Water on Freeway but Passable. A map was then shown to the participants that illustrated water across the freeway. The participants were told that when it rains sometimes water collects on or flows across the freeway in low areas. In this situation, vehicles are still able to drive on the freeway through the water. They were then asked the questions below.

1. Do you feel that it is necessary to display a message on the dynamic message sign for this condition? Why or why not?

2. If TxDOT would like to display a message on the dynamic message sign that has three lines and can display about three short words on each line:

    a. How would you describe the situation so that drivers understand the condition on the freeway? Remember, use as few words as possible because of the limited space on the sign. Also, keep in mind that the dynamic message sign is a mile or so before the water and drivers cannot see the water on the road.

    b. How would you describe the location of the water across the road?

    c. What words would you use to give the drivers confidence that they will not have to leave the freeway?

Water on Freeway and Impassable. In the next situation, the participants were told that water has collected on and flows across the low area of the freeway, and that it is not possible to drive through the water. They were then asked the questions below.

1. How would you describe the situation so that drivers understand the condition on the freeway?

2. What would you tell other drivers on the dynamic message sign to convince them that they should leave the freeway before they reach the water across the road?

3. How would you describe the location of the standing water to drivers so they could make a decision as to which exit ramps can be used?

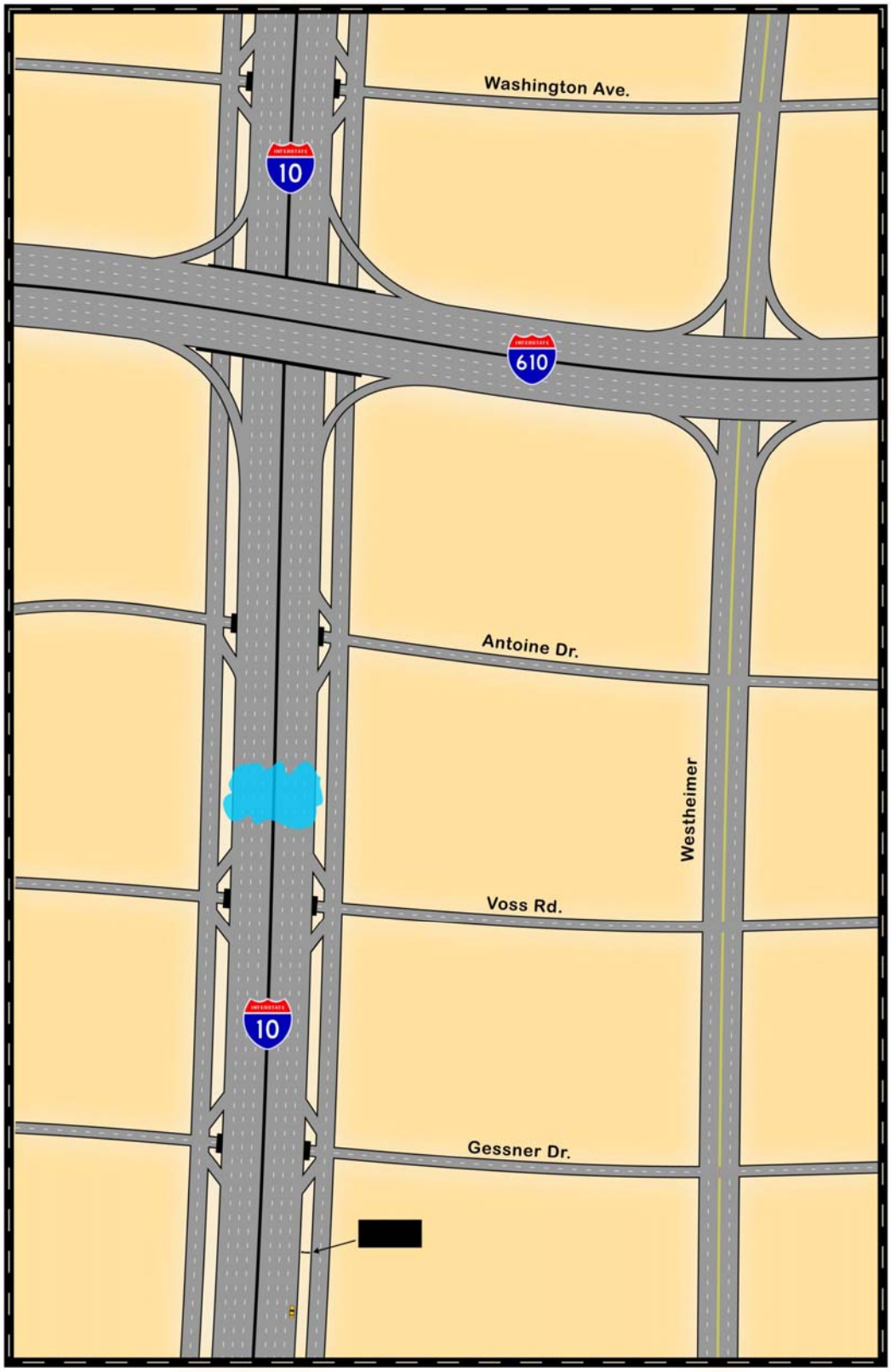


Figure 2. Water across Freeway.

Figure 3. Water across Frontage Road.

Figure 4. Water across Freeway and Frontage Road.

Water on the Frontage Road and Impassable. The next map shown to the participants had water across the frontage road only. The participants were told that in this situation water has collected on and flows across the low area and it is not possible to drive through the water on the road next to the freeway. They were then asked the following questions:

1. How would you describe the situation so that drivers understand the condition on the road next to the freeway?

2. How would you describe the location of the standing water to drivers so they could make a decision as to which exit ramps can be used and how to drive around the standing water?

Water on Both the Freeway and Frontage Road and Impassable. The next map shown to the participants had water on both the freeway and the frontage road. The participants were told that in this situation vehicles are not able to drive through the water. The following questions were asked the participants:

1. How would you describe the situation so that drivers understand the condition on the freeway and the road next to it?

2. What would you tell other drivers on the dynamic message sign to convince them that they should leave the freeway before they reach the water?

3. How would you describe the location of the standing water to drivers so they could make a decision as to which exit ramps can be used and how to drive around the standing water?

Results

Map Study

Term to Describe Frontage Road. A summary of the terms suggested by the participants to describe the road next to the freeway is shown in Table 21. It should be noted that many of the participants supplied more than one response to this question as they believed the road had multiple names associated with it.

Table 21. Terms Selected by Participants to Describe the Road Next to the Freeway.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Access Road	38	34	28	0	50	81	39
Feeder Road	3	31	3	75	6	9	21
Frontage Road	31	28	6	13	9	9	16
Service Road	47	9	0	22	9	3	15
Gateway	0	0	66	0	0	0	11
Side Street	0	0	16	0	13	6	6
Other	0	3	19	0	19	3	7

From this questioning, there was no clear consensus as to what term should be used to describe the road next to the freeway. The term that received the greatest overall percentage was Access Road; however, this only included 39 percent of the participants. At the individual sites, there were a few instances where greater agreement regarding the appropriate term was reached. In San Antonio, Access Road was the term identified by 81 percent of the participants, and by 50 percent of the participants in Laredo. However, 75 percent of the participants in Houston selected the term Feeder Road, and no one selected Access Road. Finally, the greatest percent of participants (66 percent) in El Paso selected the term Gateway, which is a local specific name assigned to the frontage roads in the El Paso area.

Water on Freeway but Passable. Initially, study administrators asked the participants whether they believed it was necessary to display a message on a DMS to describe a condition where there is water on the road, but that people were still able to drive through that location. Table 22 summarizes the responses to this question, showing that 91 percent of participants believed that a message should be displayed.

Table 22. Necessary to Inform Driver of Water on the Freeway but Passable.

Response	Percent (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Yes	91	94	94	75	97	97	91
No	9	6	6	25	3	3	9

The reasoning provided as to why these messages should be displayed centered on the idea that the condition was still hazardous and that people could lose control of their vehicles in even a small amount of water. To this end, participants believed that motorists should be warned about conditions so that they could reduce their speed or use caution as they approached the area. For the small percentage of participants who responded that the message should not be displayed, they believed primarily that if the area was passable then drivers do not need to have advance warning of the situation.

Participants then created a message that they believed should be used in this situation. Table 23 summarizes the terms and/or phrases used by participants as the situation descriptor. Any category that had less than 3 percent of the participant response was grouped in an "other" category. It should be noted that not all columns will equal 100 percent as many participants included more than one situation descriptor in their message.

Table 23. Terms Selected by Participants to Describe the Situation of Water on the Freeway but Passable.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Water on Road	44	56	25	31	44	69	45
Water Ahead	9	6	16	25	9	0	11
Wet Road	9	3	6	0	9	13	7
Slippery Road	3	3	19	3	9	0	6
Standing Water	6	6	6	9	0	3	5
High Water	3	9	0	13	0	6	5
Puddle of Water	3	0	6	3	16	0	5
Flooding	3	3	16	0	3	3	5
Low Water	6	0	0	6	0	3	3
Other	16	13	9	16	13	6	13

The above table shows that there was no clear choice as to what term should be used to describe water on the road that is still passable. Of the responses given by participants, the greatest percent that was attributed to any single response was 45 percent for the phrase WATER ON ROAD.

Following the completion of the initial message creation by the participants, study administrators asked how they had or would describe the location of the water. Table 24 summarizes the responses. Again, any response under 3 percent was grouped in an "other" category (this category included nine different responses). It should be noted that the map schematic used in the study had the water as upstream of the Voss Road entrance ramp and prior to Antoine Drive.

Table 24. Terms Selected by Participants to Describe the Location of Water on the Freeway.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
1 Mile Ahead	31	59	34	31	59	28	41
Reference to Voss Rd. (past, after, near, at, direction, beyond)	31	16	19	19	13	22	20
Between Voss Rd. and Antoine Dr.	9	3	16	28	16	31	17
Ahead	9	16	16	16	6	6	11
On Road (all lanes)	6	3	9	9	3	15	10
Other	6	3	9	0	9	3	5

Once again, there was no majority opinion as to what description should be used to describe the location of the water. At most, 41 percent of the participants indicated the distance ahead to identify the location of the water, followed by 20 percent who indicated a reference to the nearest cross street prior to the water.

Lastly, study administrators asked participants what part of the message they had created would tell drivers that they did not have to leave the freeway, or what they would add to the message to provide drivers with this direction. This information is contained in Table 25. Responses that gained less than 3 percent of the participant answers were grouped together in the "other" category, which included 18 different answer groups.

Table 25. Terms Selected by the Participants to Tell Drivers That They Did Not Have to Leave the Freeway.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Reduce Speed	31	31	22	34	50	28	33
Use Caution	19	13	34	22	34	56	30
Proceed with Caution	13	31	16	22	13	0	16
Passable/Drivable	9	3	3	9	6	3	6
Not told to exit	0	13	9	6	3	6	6
Water Shallow	6	6	0	6	0	0	3
Wet/Slick Road	3	3	6	0	6	0	3
Other	22	9	28	9	6	19	16

The responses indicated that what drivers desire most in order to know that they can still drive through the water on the freeway is a simple cautionary statement that either tells the motorist to slow down (33 percent) or to use caution while driving (30 percent). There were also location-specific trends with regard to these types of statements. Specifically, 50 percent of the participants in Laredo identified the phrase REDUCE SPEED as what is needed to let a driver know that they can stay on the freeway, and 56 percent of the participants in San Antonio stated USE CAUTION. Researchers believe that these trends may be attributable to current TxDOT district practices regarding the use of such statements regularly in DMS messages.

Water on Freeway and Impassable. The next situation presented to the participants was that there is water on the mainlanes of the freeway and that drivers can not drive through it. Initially, participants were asked to create a message that would describe this situation to motorists. Table 26 summarizes the terms used in these messages as situation descriptors. It should be noted that many of the participants used more than one term for this function, and therefore the percentages do not always add to 100 percent. Also, responses that garnered less than 3 percent of the sample were grouped in an "other" category, which included 11 answer groups.

Table 26. Terms Selected by the Participants to Describe the Flood Situation on the Freeway.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Freeway (Road) Closed	25	25	31	16	28	44	28
Flooded	19	9	41	13	13	16	18
High Water	19	13	0	53	6	9	17
Water on Road	13	25	13	3	9	22	14
Water over Road	9	0	0	3	6	9	5
Impassable	6	3	0	3	0	3	3
Deep Water	3	3	3	3	3	0	3
Water Ahead	0	6	0	3	6	0	3
Dangerous/Hazardous Road	0	6	3	0	3	3	3
Other	19	12	9	9	16	9	13

During this evaluation, the most commonly selected situation descriptor was simply the word CLOSED in reference to the roadway. This term was utilized by 28 percent of the participants. The next most common situation descriptors were the terms FLOODED or HIGH WATER at 18 and 17 percent, respectively. However, there was a relatively high percentage of participants in El Paso who used the term FLOODED in their messages (41 percent).

To follow up with the message created by the participants, researchers asked how the location of the water had been identified in the message so that drivers could make a decision about which

exit ramps to take. Table 27 summarizes the location information garnered from this question. Responses not exceeding 2 percent were grouped in the "other" category, which represented 10 response groups.

None of the answers in response to the question of the location of the water received a majority reply from the participants. The responses that were given by the highest percentage of participants were a distance ahead (1 mile) and to EXIT VOSS RD, which was the exit immediately upstream from the water. Both of these answers received a 21 percent response rate overall. However, there was a range of responses with regard to the different exit ramp locations that were identified to be used based on the city where the study was administered. Specifically, EXIT VOSS RD had a range from 0 to 47 percent, EXIT GESSNER DR OR VOSS RD ranged from 0 to 25 percent, and EXIT GESSNER DR ranged from 0 to 16 percent. Researchers believe that these variations may be the result of participants' familiarity with the cross streets selected for use on the map. Principally, if one of the streets identified within the schematic map was a major thoroughfare within the community or was near a familiar landmark participants may have identified with the location better and been more likely to reference that street in their message.

Table 27. Terms Selected by Participants to Describe the Location of Flood on the Freeway So That Drivers Can Decide Which Exit Ramps to Take.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
1 Mile	13	28	31	19	22	13	21
Exit Voss Rd.	0	16	19	16	31	47	21
Reference to Voss Rd. (after, at, past, near, beyond, etc.)	9	13	19	16	13	9	13
Exit Gessner Dr. or Voss Rd.	25	13	13	0	9	3	10
Exit Gessner Dr.	0	9	9	16	3	6	7
Exit Now	0	6	6	6	13	3	6
Between Voss Rd. and Antoine Dr.	3	0	6	19	0	9	6
Next 2 Exits	3	9	0	6	6	3	5
Exit #	3	0	0	3	9	0	3
Ahead	0	3	3	3	0	6	3
Other	16	9	9	9	3	0	8

Participants also frequently included an action message element in their created messages. The information regarding this component is summarized in Table 28. Responses not exceeding 2 percent were grouped in the "other" category, which represents 10 groups of responses.

Table 28. Terms Selected by Participants to Describe an Action to Take Due to Water on the Freeway.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Exit Voss Rd.	38	25	31	38	31	38	33
Exit Immediately/Now	3	16	9	13	25	19	14
Must Exit	13	9	22	9	9	16	13
Exit Gessner Dr.	3	19	19	9	9	3	10
Exit Gessner Dr. or Voss Rd.	22	16	13	3	6	3	10
Do Not Pass (no through traffic)	9	9	13	6	3	9	8
Use Next Exit	0	13	9	6	9	3	7
Detour	9	6	3	6	3	3	5
Use Frontage (etc.) Road	6	0	0	6	3	6	4
Alternate Route	3	0	3	0	3	6	3
Reduce Speed	0	6	0	3	3	3	3
Use Caution/Drive Safely	0	3	3	3	3	6	3
Other	6	9	3	16	9	6	8

Again, the most frequent response given by participants was information regarding where to exit. This was accomplished through the use of many different phrases, but was included by 87 percent of the participants overall in some form (i.e., summing the percentages from all of the terms including the term EXIT). When the freeway is impassable, the most-often used form of exit information was to direct motorists to the nearest exit prior to the location of the water (i.e., Voss Road). This was used by 33 percent of the participants. The phrase EXIT VOSS RD was also common in the above discussion regarding location. This would not imply that the information should be used twice in the message (both as an action and a location with the same message), but that when one of these message elements is included in a message motorists have a greater desire to know exit information so that they can make decisions on how to react to the message.

Finally, participants were asked what element was included in their message, or what they would add to the message, that would convince drivers to leave the freeway. This information is contained in Table 29. Responses not exceeding 2 percent were grouped in the "other" category, which represented 16 groups of responses.

Table 29. Terms Selected by the Participants to Convince Drivers That They Need to Leave the Freeway.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Closed	16	25	25	16	31	34	24
Exit Immediately	0	22	9	13	16	19	13
Must Exit	9	13	13	13	16	16	13
Exit at Voss Rd.	6	13	19	9	3	13	10
Flooded	13	6	9	6	9	0	7
Danger/Alert/Hazard	3	3	0	0	28	6	7
High Water	6	0	0	22	3	0	5
Do Not Enter/Pass	6	6	3	6	0	6	5
Detour	9	6	0	3	3	3	4
Exit Freeway	9	0	0	9	0	0	3
Unsafe Conditions	6	6	0	3	0	0	3
Impassable	6	3	0	3	0	3	3
Exit Gessner Dr.	0	6	6	3	0	3	3
Water on Road	16	3	0	0	0	0	3
Other	22	9	22	9	16	6	14

The responses as to what part of the message would convince drivers that they needed to leave the freeway varied widely. Again, no one response garnered a majority opinion of the participants. The term CLOSED garnered the greatest percentage (24 percent). Also, in many different forms, the participants believed that providing exit information would convince motorists that they needed to leave the freeway. If all of the exit variations are totaled together (both the responses shown and variations included in the other category), this total represents 45 percent of the participants believing exit information will convince a motorist to leave the freeway. This information reflects the choices given above as specific message elements that participants would include in a flood-related message

Water on Frontage Road and Impassable. The next situation presented to the participants was that there is water on the frontage road of the freeway and that drivers can not pass through it. Table 30 summarizes the terms used in these messages as situation descriptors. In this table, the term FRONTAGE is used to represent the road next to the highway; however, it should be noted that the participants' responses in the situation descriptor reflected the earlier split of terms related to the road next to the freeway summarized in Table 21. Again, many of the participants used more than one term as a situation descriptor and therefore the percentages do not total 100 percent. Responses that garnered less than 3 percent of the sample were grouped in an "other" category, which included 18 answer groups.

Table 30. Terms Selected by the Participants to Describe the Flood Situation on Frontage Road.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Frontage (etc.) Closed	34	28	31	47	34	41	35
Frontage (etc.) Flooded	25	13	34	16	6	13	18
Voss Rd. Exit Closed	19	22	22	16	13	13	17
High Water	25	9	0	50	6	6	16
Water on Frontage Road	3	9	3	0	9	16	7
Frontage Road Blocked	3	3	3	0	3	6	3
Water over Frontage Road	0	0	0	0	3	16	3
Other	13	34	16	9	16	16	17

Although there was no majority opinion as to what situation descriptor should be used in this situation, the greatest percent response was 35 percent indicating CLOSED. Next, 18 percent of the participants overall selected the term FLOODED. Interestingly, 17 percent of the participants believed that if there was water on the frontage road, the best situation descriptor would be to indicate that the exit ramp nearest the location of the water was closed. Sixteen percent indicated that they would prefer to know that there is HIGH WATER on the frontage road.

To follow up with the messages created by the participants, researchers asked them how they had identified the location of the water so that drivers could make a decision about which exit ramps to take. Table 31 summarizes the location information. Responses not exceeding 2 percent were grouped in the other category, which represented 20 groups of responses.

In this situation, 28 percent of the participants indicated that they would identify the location of the water as BETWEEN VOSS RD AND ANTOINE DR. The second most common answer was a reference to the road it was immediately after (25 percent). Again, there was no clear choice by the participants as to the best description of the water location.

Water on Both the Freeway and Frontage Road and Impassable. The next situation presented to the participants was that there is water on the freeway and the frontage road and that both are impassable. Again, participants were asked to create a message to describe this situation to other motorists. Table 32 summarizes the terms used in these messages as situation descriptors. It should be noted that many of the participants used more than one term for this function, and therefore the percentages do not always add to 100 percent. Also, responses that garnered less than 3 percent of the sample were grouped in the “other” category, which included 14 answer groups.

Table 31. Terms Selected by Participants to Describe the Location of Flood on the Frontage Road So That Drivers Can Decide Which Exit Ramps to Take.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Between Voss Rd. and Antoine Dr.	47	19	22	44	9	25	28
Reference to Voss Rd. (on, after, at, past, beyond, direction)	28	31	13	28	19	34	25
Voss Rd. Exit Closed	3	16	38	13	6	9	14
On Frontage Road	16	6	9	6	16	3	9
Voss Rd. to Antoine Dr.	6	9	9	3	6	9	7
Exit Antoine Dr.	9	6	6	0	9	3	6
Stay on Highway	0	0	0	0	16	3	3
Other	6	19	13	9	34	16	16

In this case, a significant number of the participants (50 percent) used the term CLOSED as a situation descriptor. The term FLOODED was the second most popular descriptor, but participants overall selected this term only 25 percent of the time. Only 12 percent of the participants selected the term HIGH WATER, although participants in Houston used this term quite a bit more frequently (31 percent).

Table 32. Terms Selected by the Participants to Describe the Flood Situation on the Freeway and Frontage Road.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Closed	47	44	53	56	53	47	50
Flooded	28	16	38	25	22	22	25
High Water	13	13	0	31	6	9	12
Water on Road	6	9	3	0	0	9	5
Water Ahead	3	6	0	3	6	0	3
No Thru Traffic	0	3	0	0	6	6	3
Other	22	16	3	6	13	16	13

Researchers again asked participants to identify the location of the water so that drivers could make a decision about which exit ramps to take. Table 33 summarizes the location information. Responses not exceeding 2 percent were grouped in the "other" category, which represented 12

groups of responses. This question did not garner a majority opinion among the participants. However, 24 percent of the participants did indicate a location by stating the exit that is nearest the water.

Table 33. Terms Selected by Participants to Describe the Location of Flood on the Freeway and Frontage Road So That Drivers Can Decide Which Exit Ramps to Take.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Exit Voss Rd.	34	13	19	16	31	31	24
Detour to [lateral road right]	22	0	16	16	22	25	17
Between Voss Rd. and Antoine Dr.	13	19	28	6	3	16	14
Reference to Voss Rd. (after, at, past, near, beyond, etc.)	19	16	6	19	6	9	13
Exit Gessner Dr.	16	6	16	16	9	16	13
Exit at Gessner Dr. or Voss Rd.	9	9	16	13	25	3	13
1 Mile Ahead	6	19	13	0	9	9	9
Alternate Route	6	13	0	6	0	9	6
Exit Immediately	0	6	6	9	9	0	5
Voss Rd. to Antoine Dr.	0	0	3	13	0	6	4
On Highway and Frontage Road	0	0	6	6	0	3	3
Other	6	19	0	6	9	6	8

Participants also frequently included an action message element in their created messages. The information regarding this component is summarized in Table 34. Responses not exceeding 2 percent were grouped in the "other" category, which represented 14 groups of responses.

In this case, a significant number of the participants indicated that motorists should exit the roadway (87 percent). This number was determined by adding all of the different actions given that either included the term EXIT or would imply that a motorist needed to exit, such as DETOUR. More specifically, 42 percent of the participants specified the USE ALTERNATE ROUTE or USE DETOUR action terms.

Table 34. Terms Selected by Participants to Describe an Action to Take Due to Water on the Freeway and Frontage Road.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Use Alternate Route (Detour)	41	31	41	50	31	59	42
Exit Voss Rd.	16	25	31	13	41	28	26
Exit Gessner Dr.	16	19	25	13	9	16	16
Exit Gessner Dr. or Voss Rd.	25	6	9	9	13	0	10
Exit Immediately	3	16	0	9	13	3	7
Reenter at Antoine Dr.	0	3	6	0	6	0	3
Other	16	0	16	9	6	13	10

Finally, participants were asked what was in their message, or what they would add to the message, that would convince drivers to leave the freeway. This information is contained in Table 35. Responses not exceeding 2 percent were grouped in the "other" category, which represented 20 groups of responses.

In this case, nearly 50 percent of the participants indicated that the word CLOSED would convince a motorist to leave the freeway. The next closest alternative was the use of the term FLOODED with responses equaling 16 percent.

Table 35. Terms Selected by the Participants to Convince Drivers That They Must Leave the Freeway Because of the Impassable Situation.

Terms Selected by Participants	Percent Selecting Term (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Closed	47	41	44	59	47	53	48
Flooded	22	6	31	13	9	16	16
Alternate Route/Detour	9	6	9	6	9	6	8
Exit Immediately	13	9	6	9	13	0	8
Must Exit	6	9	3	6	0	3	5
Exit Gessner Dr.	0	9	3	3	3	3	4
Danger/Hazard	6	9	3	0	3	3	4
Exit Voss Rd.	0	6	3	0	0	9	3
Other	22	19	13	19	25	22	20

Terms to Describe a Flooded Condition

In this portion of the study, participants were shown three different messages one at a time and asked after each one if they would continue to drive on the freeway through the water or get off the freeway. The messages were:

Flood Message 1		*Flood Message 2*		*Flood Message 3*
FREEWAY HIGH WATER		**FREEWAY FLOODED**		**FREEWAY DEEP WATER**

Table 36 illustrates the percent of people who would leave the freeway based on each of the above messages.

Table 36. Percentage of Participants Who Would Get Off the Freeway.

Message	Percent That Would Get Off the Freeway (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Flood Message 1: High Water	56	81	75	81	78	78	75
Flood Message 2: Flooded	78	100	94	100	94	97	94
Flood Message 3: Deep Water	84	88	91	91	81	91	88

Of the three terms examined in this part of the study, the one that would appear to have the greatest impact on getting motorists to leave the freeway is FLOODED with 94 percent indicating that they would not continue to drive on the freeway. However, 88 percent of participants also indicated that DEEP WATER would influence them to leave the freeway.

The primary reason given by participants for leaving the freeway with all of the above messages was that they believed the terms indicated the road was impassable. This response was given by between 28 and 38 percent of the participants, depending on the message. Of those participants who would continue, the primary reason that they gave for this decision was that the message did not contain any information that told drivers to exit the freeway or that it was closed. For the messages indicating high water and flooded, 54 and 58 percent of the participants, respectively, gave this reason. Similarly, 21 percent of the participants gave this reason for continuing in response to the DEEP WATER message.

Message Format Preferences

In the next section of the study, researchers presented the participants with pairs or groupings of messages and asked them to state which format of the message they preferred. Administrators told the participants that the situation for all of the messages was that there was water is across the road that you could not drive through. The following sections summarize the participants' preferences and the primary reasons stated for those preferences. Detailed tables containing all of the reasons given by participants regarding these selections can be found in Appendix D.

Roadway Terms. Participants were presented with three messages simultaneously that each utilized different terms to identify the roadway where the flooding was located. The messages are illustrated below. Table 37 shows the message preferences for this message set.

Flood Message 2		*Flood Message 4*		*Flood Message 5*
FREEWAY FLOODED		**I-XX [direction] FLOODED**		**I-XX FLOODED**

Table 37. Message Preference for Roadway Terms

Message	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Flood Message 2: Freeway	6	6	25	16	13	25	15
Flood Message 4: I-XX [direction]	59	75	66	78	84	66	71
Flood Message 5: I-XX	34	19	9	6	3	9	14

The majority of the participants at all of the locations (71 percent overall) preferred the message that included the name of the roadway and the direction of travel (e.g., I-10 East). The participants who selected this message indicated the following reasons for their preference:

- It is more specific or descriptive (38 percent).
- A driver would know the direction or location of the flood (36 percent).
- It tells the direction of the road (16 percent).

Of the participants that selected the message that said FREEWAY the primary reasons indicated were:

- People know the name of the road they are on (38 percent).
- You would know the whole freeway is flooded and not just one direction (28 percent).
- It is easier (24 percent).

Finally, participants selecting the message that indicated the specific freeway name but not the direction gave the following responses as to why they had selected this message:

- It is clear and to the point (35 percent).
- A driver needs to know the freeway name (15 percent).

Following this selection, participants were asked specifically if they believed the direction of the freeway needed to be included in the message. Overall, 70 percent of the participants believed that the direction should be included in this message. Table 38 shows all of the responses by location.

Table 38. Including Direction Indications in the Roadway Term.

Response	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Yes	50	75	75	78	75	69	70
No	50	25	25	22	25	31	30

Again, the participants were asked their reasons for believing the direction should or should not be included in the message. The primary reason stated for including the direction in the message was that it would let a driver know the direction of the road that is flooded (50 percent). The second most common response was that it would allow drivers to know that they are affected by the message (19 percent).

The participants who believed that the message should not include the direction indicated that they do not need to be given the direction if they are already traveling on the road in the given direction (37 percent) or that drivers should already know the direction they are traveling (30 percent).

One final question was asked regarding this set of messages. Participants indicated other information they thought should be included in the given message, if anything. Table 39 includes a summary of the information that was suggested by the participants.

Table 39. Other Information to Include in Flooding Messages.

Response	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Exit Information	50	75	53	47	66	50	57
Closed	31	9	6	13	6	16	14
Location of Flooding	9	22	3	16	16	9	13
Detour Information	9	6	3	19	13	9	10
Danger	9	0	9	0	9	6	6
Caution	3	3	9	6	3	6	5
Nothing	3	3	6	6	6	6	5
If Passable or Not	3	3	6	0	0	6	3
Other	0	0	19	3	9	0	5

Of the total participants, 57 percent believed that the message should contain some form of exit information. The next most desired information to be included in the messages was the term CLOSED. However, only 14 percent of the participants wanted this information.

Message Element Order. The next pair of messages presented the participants with identical message elements, but changed to order of these elements to identify driver preference. The messages shown to the participants are given below. In these messages, the street names (both freeway and cross street) were changed to be familiar to the local driver participants.

Flood Message 6		*Flood Message 7*
FLOODED **I-XX** **AT [street name]**		**I-XX** **FLOODED** **AT [street name]**

Table 40 summarizes the participant preferences regarding this message set. Eighty percent of the participants selected Flood Message 7 where the highway indication was the first message element.

Table 40. Message Preference for Order of Message Elements.

Message	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Flood Message 6: First Line FLOODED	34	16	16	6	25	34	20
Flood Message 7: First Line Highway Name	66	84	84	94	75	66	80

Following their selections, participants were asked the reason that they preferred the given message. For the message containing the highway name on the first line (the message selected by the greater amount of participants), the participants gave the following primary reasons for their selection:

- This message is easier to read or better formatted (54 percent).
- It would allow them to know it is their road first (36 percent).

Of the participants who had selected the message with the situation descriptor (i.e., FLOODED) listed first, they believed this message would be better primarily because:

- It would catch your attention more (42 percent).
- The situation is listed first (37 percent).

Abbreviation of Interstate Highway. Next, participants viewed a set of messages where the difference was the abbreviation of interstate highway. The messages are shown below; again, the road names were changed according to the location so that they were familiar to study participants.

Flood Message 8		*Flood Message 9*
I-XX FLOODED AT [street name]		**IH-XX FLOODED AT [street name]**

Table 41 summarizes the participant preferences related to this message set. Overall, 68 percent of the participants preferred the message where interstate was abbreviated as "I." However, for this message set there were some variations in preference based on location. Austin, Laredo, and San Antonio participants were split approximately evenly as to a preference. Conversely, Arlington, El Paso, and Houston participants had distinct preferences for the "I" abbreviation. More than 80 percent of the participants at those locations selected this option.

Table 41. Message Preference for Order of Message Elements.

Message	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Flood Message 8: I-XX	81	53	100	81	47	44	68
Flood Message 9: IH-XX	19	47	0	19	53	56	32

The primary reasoning behind the message selection of the "I" abbreviation was that it was familiar (51 percent) and that participants would prefer the simpler format (31 percent). Additionally, 13 percent indicated that they did not understand what "IH" meant and/or that they had never seen this abbreviation before.

Of the participants who selected "IH" as the preferred abbreviation, they indicated that this abbreviation was more familiar (48 percent) or that it was the correct or formal name of the roadway (15 percent).

Flooded versus Closed. The next set of messages presented to the study participants compared the use of the word FLOODED versus CLOSED to describe a situation where there is water on the road that could not be driven through. The messages used for this comparison were:

Flood Message 10		*Flood Message 11*
I-XX [direction] FLOODED AT [street name] USE NEXT 2 EXITS		**I-XX [direction] CLOSED AT [street name] USE NEXT 2 EXITS**

Table 42 summarizes the participant preferences for this message set. Overall, 69 percent of the participants preferred the use of the word "closed" for a situation where vehicles can not pass through the water. These results are consistent with participant selections of preferred situation descriptors in Tables 26, 30, and 32.

Of the participants who selected CLOSED, the primary reason stated for this preference was that drivers would know that they can not continue on the road and that it did not give them an option (80 percent). Alternatively, the participants who selected the message that contained the word FLOODED believed that the message should include a reason or problem as to why the road is closed (90 percent).

Table 42. Message Preference for Situation Descriptors.

Message	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Flood Message 10: Flooded	19	44	25	31	44	22	31
Flood Message 11: Closed	81	56	75	69	56	78	69

Flooded Plus Exit Information versus Flooded and Closed. The next set of messages presented to the participants contained different message descriptors plus the inclusion of exit information in one of the two messages. These messages were:

Flood Message 10		*Flood Message 12*
I-XX [direction] FLOODED AT [street name] USE NEXT 2 EXITS		**I-XX [direction] FLOODED AND CLOSED AT [street name]**

Table 43 summarizes the participant preferences for this message set. There was a clear preference overall and at all individual locations for the message that used only the word FLOODED and also included information regarding where to exit. Seventy-nine percent of the total participants preferred this message. Primarily, the participants stated that the selection of this message was based on the fact that it told drivers what to do or what exits to use (77 percent).

Table 43. Message Preference Flooded and Closed vs. Flooded Plus Exit Information.

Message	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Flood Message 10: Flooded + Exit Information	72	91	75	72	84	78	79
Flood Message 12: Flooded and Closed	28	9	25	28	16	22	21

Of the participants who selected the other message, they gave two primary reasons: flooded and closed is a better situation description (37 percent) and that drivers would know to exit the highway if it is closed (39 percent).

Road Name versus Exit Number. The next set of messages presented to the study participants compared the use of street names versus exit numbers in providing the driver with information about exiting the highway. The messages used were:

Flood Message 13		*Flood Message 14*
I-XX [direction] FLOODED AT [street name] TAKE EXIT XX		**I-XX [direction] FLOODED AT [street name] TAKE [street name 2] EXIT**

Table 44 summarizes the participant preferences for this message set. Overall, 75 percent of the participants preferred the use of street names when providing exit information. The participants at two locations (Arlington and Austin) were more evenly split on their format preferences, but they still selected the street name message more often than the exit number message.

Table 44. Message Preference for Exit Information

Message	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Flood Message 13: Exit Number	38	41	22	13	19	19	25
Flood Message 14: Road Name	63	59	78	88	81	81	75

The primary reasons given for preferring the use of street names as exit information were:

- street names are more familiar to drivers (36 percent),
- prefer street names to exit number (26 percent), and
- street names are more visible on signs than exit numbers (10 percent).

With regard to the message containing an exit number, the main reason given for selecting this message was that it is easier or less to read (65 percent).

Exit Information versus Tune to Radio. The next set of messages presented to the study participants compared the option of providing drivers with either a specific location to exit the highway or information to tune to the radio for further details. The messages used for this comparison were:

Flood Message 13		*Flood Message 15*
I-XX [direction] FLOODED AT [street name] TAKE [street name 2] EXIT		**I-XX [direction] FLOODED AT [street name] TUNE TO 1610 AM**

Table 45 summarizes the participant preferences for this message set. For this message set, there was an overwhelming preference for the use of specific exit information in the message over giving a radio station to which to tune.

Table 45. Message Preference for Exit or Radio Information.

Message	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Flood Message 14: Exit Information	97	100	100	100	94	100	98
Flood Message 15: Tune to Radio	3	0	0	0	6	0	2

Reasoning given for the selection of the message containing exit information was that it told a driver what they needed to do (63 percent). Secondly, participants indicated that they did not want to have to change a radio station or listen to the radio to determine what they should do in this situation (13 percent). Many of the participants went on to state that it may be too late to make the choice to exit by the time they received the information from a radio station (9 percent).

Summary

This study relating to the use of DMSs in flooded situations was done in two parts. The first part required participants to create a message for a given situation presented on a schematic map, and the second part explored participant preferences between alternative flooding message formats. Researchers first asked participants to identify the common name used to identify the roadway next to the freeway (e.g., frontage road). The results of this question showed no majority opinion existed among the participants overall as to a term for this roadway, although 39 percent of participants did identify it as an access road. Instead, researchers found that the most common term selected was highly location specific. In Arlington, the most common term selected was SERVICE ROAD (47 percent); in Austin, Laredo, and San Antonio the most common term was ACCESS ROAD (34 percent, 50 percent, and 81 percent, respectively). In Houston, the term FEEDER ROAD was selected most often (75 percent), while participants in El Paso most often selected GATEWAY as the term of choice (66 percent).

Water is Passable

For situations where water is on the road but it is passable to traffic, researchers found that 91 percent of the participants believed a message should be displayed to alert drivers of the conditions. The most preferred information elements to include in that message were:

- Situation Description: WATER ON ROAD (given by 45 percent of the participants), and
- Location: [distance] AHEAD (given by 41 percent of the participants).

The participants also stated that telling drivers to either reduce speed or use caution would let them know that they can continue on the road and not need to exit.

Water Impassable Situation Descriptor

In a situation where the water on the roadway is impassable, no clear consensus was garnered from the participants as to the situation description that should be used in a DMS message. However, in all three situations presented to the participants, the highest percentage response was to use the term CLOSED. This was selected by:

- 28 percent when only freeway is impassable,
- 35 percent when frontage road is impassable, and
- 50 percent when both freeway and frontage road are impassable.

The use of this term was further supported in the preference selections of the study where 69 percent of the participants preferred the term CLOSED over FLOODED when the driver could not continue on the road.

Researchers also presented participants with three different terms for water on the road and asked them if they would continue or get off the road based on the given message. This was done to identify which term would be more appropriate for alerting motorists that they needed to exit the freeway for the conditions. The following were the percent of people who would leave the freeway in response to each term.

- FLOODED – 94 percent;
- DEEP WATER – 88 percent; and
- HIGH WATER – 75 percent.

These results indicate that the term FLOODED would likely be the most effective term of those studied in convincing drivers to leave the freeway. However, from the questions related to the creation of a message, many participants also believed that the term CLOSED would convince drivers that they needed to leave the freeway.

One final comparison was made of situation descriptions FLOODED AND CLOSED or FLOODED with the inclusion of exit information. Given this option, 79 percent of the participants indicated that they would prefer the message that included exit information, indicating the importance that motorists place on the inclusion of an action to take in this type of message.

Flooding Location Description

Another portion of the study investigated participant preferences regarding the specification of the location of the flood water on the road. For each situation, at least one of the primary responses made reference to the road nearest to the flooding, either as the location (e.g., at, near, after) or as an exit. Another common response was to give a distance away from the flooding. It is likely that this preference is dependent upon the condition and familiarity of the road nearest the flooding. Specifically, if the road is less well known to drivers, researchers hypothesize that it may be less desirable as a location identifier in a flooding message. On the other hand, if the road is well known to drivers, it is likely to be more preferred in the flooding message.

Action to Take Due to Flooding

Within the messages created by the participants, the inclusion of an action term was common both when only the freeway was flooded and when both the freeway and frontage road were flooded. The common action terms used by participants in creating their messages are listed below.

- Freeway Flooded – 87 percent included exit information.
- Freeway and Frontage Road Flooded:
    - Exit information – 59 percent; and
    - Use Alternate Route – 42 percent.

Also, when asked to identify what information should be added to certain standard messages (which included situation description and road name), 57 percent of the participants believed that flood messages should include exit information.

The preference part of the study further investigated different formats or terms to use regarding an action in a flooding message. When given a choice between the inclusion of the term CLOSED or exit information, 79 percent of participants preferred to have the exit information. Additionally, researchers identified an overwhelming preference (98 percent) for specific exit information over the use of the phrase TUNE TO RADIO in flooding messages. As a final comparison related to this topic, researchers presented two different formats of exit information to participants. The first included an exit number and the second included the street name associated with exit. In this case, 75 percent preferred the use of a street name with regard to identifying an exit.

Freeway Indicator

Finally, researchers investigated different methods for identifying the roadway on which the flooding was located. Initially, researchers asked participants which of three formats was preferred for indicating the roadway itself, the results of which were:

- I-XX [direction] – 71 percent;
- FREEWAY – 15 percent; and
- I-XX – 14 percent.

Participants stated their primary reason for this selection was that it allowed the driver to know which direction of the freeway was flooded (50 percent).

Researchers also looked at a preference for abbreviations of interstate as either I or IH. In this case, 68 percent stated a preference for the abbreviation "I"; however, regional differences did exist for this question. Austin, Laredo, and San Antonio participants were split nearly 50/50 in preference; whereas, Arlington, El Paso, and Houston participants preferred the use of the abbreviation "I" by more than an 80/20 percent margin.

Finally, researchers queried participants as to their preference for the message element placement of both the incident descriptor (i.e., FLOODED) and the freeway indicator. In this case, the two messages contained the same element in reverse order for lines 1 and 2 of the message. Eighty percent of participants preferred to have the freeway indicator on the top line and FLOODED on the second line. They believed this was easier to read (54 percent) and allowed them to know it applied to their road first (36 percent).

4. HURRICANES

FOCUS GROUP STUDIES

During the focus group studies, the participants were asked to imagine themselves in two different situations related to hurricane events. The first was that they were evacuating during a hurricane and there was bumper-to-bumper traffic moving at a very slow pace on the highway they were traveling. The second situation related to returning to an area where a hurricane had just passed. In both of these cases, the participants were asked what information they thought would be vital for a driver to have. It should be noted that the participants in the focus groups had a difficult time placing themselves in these types of situations because they had never experienced these types of events.

Results

Hurricane Evacuation

The groups at each location were asked to create a list of different pieces of information they believed would be important in a hurricane evacuation. Upon consolidating the information from all of the locations, there were 10 pieces of information, shown in Table 46, that were primarily mentioned by the groups as being important. Evacuation Routes, Travel Time/Delay, and Time until Hurricane were identified by all six focus groups. Road Closures, Shelters, and Gas Stations were identified by five of the groups. A Radio Station to tune to was selected by four groups. Interestingly, the group in Houston did not choose Gas Stations and Shelters. The need for Food/Lodging information was identified by only two groups (El Paso and Laredo), and only one group identified Restroom (Laredo) and Hospital (San Antonio).

Table 46. Information Needs during Hurricane Evacuations.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Evacuation Routes	X	X	X	X	X	X	6
Travel Time/Delay	X	X	X	X	X	X	6
Time Until Hurricane	X	X	X	X	X	X	6
Radio Station	X		X	X		X	5
Shelters	X	X	X		X	X	5
Road Closures	X	X		X	X	X	5
Gas Station	X	X	X		X	X	5
Food/Lodging			X		X		2
Restrooms					X		1
Hospitals						X	1

The rating and ranking of the 10 information needs are shown in Table 47. The results in the table show that all 10 types of information were rated as important by those groups that selected the item. The ratings were between 1.1 and 2.5. The rankings in terms of the relative importance of information indicated that Gas Station (5.6), Food/Lodging (6.5), and Restrooms (7.0) were least important among the information needs. Of additional interest is that Radio Station was rated and ranked very high, which confirms the interest of the drivers to be able to obtain more detailed information via radio.

Table 47. Rating and Ranking of Hurricane Evacuation Information.*

Descriptor	Average Rating	Descriptor	Average Ranking
Evacuation Routes	1.1	Evacuation Routes	1.3
Road Closures	1.6	Radio Station	3.0
Radio Station	1.7	Shelters	3.3
Shelters	1.9	Road Closures	3.8
Travel Time/Delay	2.0	Travel Time/Delay	3.8
Time Until Hurricane	2.0	Time Until Hurricane	3.8
Restrooms	2.1	Gas Station	5.6
Gas Station	2.4	Food/Lodging	6.5
Food/Lodging	2.5	Restrooms	7.0

* Lower numbers indicate higher ranking and rating. Also, rankings and ratings are based on only those groups that identified the descriptor during the discussions.

There were also several things that, when asked, some of the groups felt should not be included on DMSs in this type of situation. These items included the location of hotels, restrooms, and restaurants. Several of the groups mentioned that these types of amenities are listed on highway logo signs and therefore are not necessary on a DMS.

Returning after a Hurricane Event

Again, the participants from each group were asked to create a list of important information for the situation where the hurricane has passed, and people are returning to the area. The 17 items of information needs listed by the participants of each group are shown in Table 48.

The participants were then asked to rate and rank the information needs. A summary of the results is presented in Table 49. All 17 items of information were rated very high, with ratings between 1.2 and 2.8. A review of the ranking results shows that Road Closures (1.2), Areas Affected/Closed (2.3), and Safe Return Routes/Areas and Detours (2.3) were ranked the highest among the 17 items. Information about Hospital (7.5), Available Merchants (8.0), Safe Water (9.0), and Curfew (9.0) were ranked the lowest.

Table 48. Information Needs after Hurricane Passes.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Downed Power Lines or Debris	X	X	X	X	X	X	6
Curfew	X	X	X	X	X	X	6
Emergency Telephone Number (Hotline)		X	X	X		X	4
Safe Water		X	X		X	X	4
Red Cross	X	X	X			X	4
Road Closures	X		X			X	3
Road Conditions			X		X	X	3
Areas Affected/Closed	X		X		X		3
Shelters		X			X	X	3
Flooding	X			X		X	3
Safe Return Routes/Areas & Detours			X	X	X		3
Available Merchants		X	X				3
Radio Station	X		X				2
Utilities Available			X	X	X		2
Weather		X			X		2
Hospitals					X	X	2
If People Allowed Back	X		X				2

Table 49. Rating and Ranking of Information Needs after Hurricane Passes.*

Information	Average Rating	Information	Average Ranking
Road Closures	1.2	Road Closures	1.2
Radio Station	1.3	Areas Affected/Closed	2.3
Areas Affected/Closed	1.4	Safe Return Routes/Areas & Detours	2.3
Safe Return Routes/Areas & Detours	1.4	Weather	3.0
Red Cross	1.4	Road Conditions	3.7
Road Conditions	1.5	Flooding	4.3
Flooding	1.5	Radio Station	4.5
Weather	1.5	Red Cross	4.6
Emergency Telephone Number (Hotline)	1.6	Shelters	5.0
If People Allowed Back	1.7	Utilities Available	5.7
Downed Power Lines or Debris	1.8	Downed Power Lines or Debris	5.7
Shelters	1.8	Emergency Telephone Number (Hotline)	6.5
Safe Water	1.9	If People Allowed Back	6.5
Hospital	2.0	Hospital	7.5
Utilities Available	2.2	Available Merchants	8.0
Curfew	2.6	Safe Water	9.0
Available Merchants	2.8	Curfew	9.0

* Lower numbers indicate higher ranking and rating. Also, rankings and ratings are based on only those groups that identified the descriptor during the discussions.

Implications of Focus Group Results

As previously noted, none of the focus group participants had been in a situation where they had to evacuate because of a hurricane and had a difficult time imagining themselves in this type of emergency. The information needs they cited and the subsequent ratings and rankings may be different had they experienced a hurricane evacuation. Thus, the results should be interpreted with this limitation in mind.

The focus groups identified seven 10 information needs during a hurricane evacuation and 17 after the hurricane passes. The amount of information needed is much more than can be accommodated via DMSs. There is a need to determine the specific information that should be and can be accommodated via DMSs and the information that should be provided by other modes of communication with drivers.

After meeting and discussing the focus group results with the Project 0-4023 Advisory Committee, the committee recommended that laboratory studies should not be conducted on this topic. Instead, the researchers were instructed to rely on information based on the experiences of state departments of transportation (DOTs) along the East Coast and the Gulf Coast that have had major hurricanes and implemented evacuations in 2004 and 2005.

5. TERRORIST ATTACKS

FOCUS GROUP STUDIES

During the focus group studies, the participants were also asked to imagine themselves in two different situations involving terrorist attacks on a roadway in a major metropolitan area. In the first situation, the participants were instructed to imagine that they were driving on the highway and approaching the area where a terrorist attack had just occurred. For the second situation they were told to imagine that they were within the affected area of the terrorist attack. Comparable to hurricanes, the participants in the focus groups had a difficult time placing themselves in these types of situations because they had never experienced these types of events.

Results

Driving toward an Affected Area

In the first situation, there were 12 pieces of information that were mentioned by the groups as being important. These are summarized in Table 50. The results show that Event Alert, Location of Attack, Roads/Areas Closed, Type of Attack, and What to Do were identified by four or more of the focus groups as being important.

Table 50. Information Needs for Terrorist Attacks for Drivers Traveling toward the Affected Area.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Event Alert	X	X	X	X	X		5
Location of Attack	X	X	X		X	X	5
Roads/Areas Closed	X		X		X	X	4
Type of Attack (including chemical/biological)	X	X			X	X	4
What To Do (e.g., do not enter city, exit now, etc.)	X	X	X	X			4
Security Level	X	X	X				3
Alternate Routes				X		X	2
Shelters				X		X	2
Radio Station					X	X	2
Hospitals/Medical Station				X	X		2
Safe Locations			X		X		2
Schools Affected						X	1
Safe Water						X	1

The ratings and the ranking of the information are shown in Tables 51. All of the information was rated high with the exception of Schools Affected (3.5) and Safe Water (3.6), which was rated lower than the other information in the table. With respect to relative importance, information about Event Alert (1.8), Location of Attack (2.4), Security Level (2.7), Type of Attack (3.0), and Alternate Route (3.5) was ranked the highest, while information about Hospital/Medical Station (7.0), Schools Affected (7.0), and Safe Water (8.0) was ranked much lower than the other information.

Table 51. Rating and Ranking of Information Needs after Terrorist Attack: Drivers Approaching Area.*

Information	Average Rating	Information	Average Ranking
Event Alert	1.3	Event Alert	1.8
Location of Attack	1.3	Location of Attack	2.4
What To Do	1.4	Security Level	2.7
Safe Locations	1.4	Type of Attack	3.0
Roads/Areas Closed	1.6	Alternate Routes	3.5
Alternate Routes	1.6	Roads/Areas Closed	4.0
Hospitals/Medical Station	1.6	What To Do	4.2
Security Level	1.7	Safe Locations	5.0
Type of Attack	1.7	Radio Station	5.0
Radio Station	1.9	Shelters	5.0
Shelters	2.2	Hospitals/Medical Station	7.0
Schools Affected	3.5	Schools Affected	7.0
Safe Water	3.6	Safe Water	8.0

* Lower numbers indicate higher ranking and rating. Also, rankings and ratings are based on only those groups that identified the descriptor during the discussions.

Driver in an Affected Area

The second situation that was presented to the participants was that they were currently driving in the area where the terrorist attack had occurred. For this situation, it was the feeling of the majority of the focus groups that the information provided to a driver would need to be more detailed than in the first situation. This was due to the fact that the situation of being in the area was viewed as more urgent and that it could be a threat to their health (as in the case of biological or chemical weapons).

The information identified by the participants is summarized in Table 52. The ratings and the ranking of the information are shown in Tables 53. All of the information was rated high with the exception of Schools Affected (3.5) and Safe Water (3.6), which was rated lower than the other information in the table. With respect to relative importance, information about What To Do (1.0), Evacuation Routes (2.3), Areas Affected (2.5), Safe Areas (3.0), and Type of Attack (3.5) was ranked the highest, while information about Security Level (7.0), Schools Affected (8.0), and Safe Water (9.0) was ranked much lower than the other information.

Table 52. Information Needs for Terrorist Attacks for Drivers Traveling in the Affected Area.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Type of Attack	X	X	X	X	X	X	6
Where to Find Information	X	X	X	X		X	5
Hospital Location	X	X	X	X			4
Areas Affected		X	X	X		X	4
Evacuation Routes		X		X	X	X	4
Road Closures	X		X		X	X	4
Shelters		X		X		X	3
What To Do	X	X					2
Safe Areas			X		X		2
Red Cross	X			X			2
Security Level			X				1
Alternate Routes						X	1
Schools Affected						X	1
Safe Water						X	1

Table 53. Rating and Ranking of Information Needs after Terrorist Attack: Drivers in the Affected Area.*

Information	Average Rating	Information	Average Ranking
What To Do	1.1	What To Do	1.0
Areas Affected	1.2	Evacuation Routes	2.3
Safe Areas	1.2	Areas Affected	2.5
Evacuation Routes	1.4	Safe Areas	3.0
Red Cross	1.4	Type of Attack	3.5
Hospitals	1.5	Hospitals	4.3
Type of Attack	1.7	Road Closures	4.5
Road Closures	1.7	Shelters	4.7
Security Level	1.7	Where to Find Information	5.0
Shelters	1.9	Red Cross	5.0
Alternate Routes	2.0	Alternate Routes	6.0
Where to Find Information	2.1	Security Level	7.0
Schools Affected	3.5	Schools Affected	8.0
Safe Water	3.6	Safe Water	9.0

* Lower numbers indicate higher ranking and rating. Also, rankings and ratings are based on only those groups that identified the descriptor during the discussions.

Implications of Results

Comparable to hurricanes, none of the focus group participants had been in a terrorist attack situation. The information needs they cited and the subsequent ratings and rankings may be different had they experienced a terrorist attack. Thus, the results should be interpreted with this limitation in mind.

Because of these limitations, the Project Advisory Committee recommended that the TTI researchers contact and interview personnel from New Jersey, New York, and Virginia that were affected by the 9/11 attack. The objective is to obtain information about their experiences with the use of and effectiveness of permanent and portable DMSs and DMS messages during and after the terrorist attack.

With respect to subsequent human factors laboratory studies, the results suggest that there is a list of 13 information needs for situations when a driver is approaching an area attacked by terrorists; 14 information needs were identified for situations when the driver is in the affected area. The information needed far exceeds that which can be accommodated via DMSs. There is a need to determine the specific information that should be and can be accommodated via DMSs and the information that should be provided by other means. Although the information needs cited by the focus group participants can provide initial perspectives of needs, data gathered from New Jersey, New York, and Virginia will most likely prove more relevant information.

6. ADVERSE WEATHER AND ENVIRONMENTAL CONDITIONS: GENERAL

FOCUS GROUP STUDIES

Types of Conditions

The participants in the focus group studies were asked to identify the types of conditions (adverse weather and environmental) they felt were important enough to provide additional travel information to drivers via DMSs. The number of study locations that selected each type of condition is summarized in Table 54. Flooding was the only condition that was selected by individuals from all six study locations; with fog, ice, and severe storm warnings being selected by five of the six groups.

The participants were also asked what type of information they thought would be important for the driver to be provided with during any of the conditions discussed. The results are shown in Table 55. At four of the six locations, the participants selected Reduced Visibility, Alternate Routes, Reduce Speeds, Slippery, Lanes/Roads Closed, and Location of Problem as important information.

Participants from five of the six locations agreed that, as the conditions improved or changed, the message should be turned off when there is no longer a threat to driver safety

Table 54. Type of Adverse Weather and Environmental Conditions for Which Information is Needed.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Flooding	X	X	X	X	X	X	6
Fog		X	X	X	X	X	5
Ice	X	X		X	X	X	5
Severe Storm Warnings (Hurricanes, Tornado, etc.)	X	X	X	X	X		5
Snow	X	X	X	X			4
High Winds	X	X	X		X		4
Chemical Spill				X	X	X	3
Hail	X	X	X				3
Dust Storm	X	X	X				3
Air Pollution				X		X	2
Rain	X				X		2
Chemical or Industrial Fire				X			1
Broken Pavement				X			1
Falling Rocks or Debris			X				1

Table 55. Information Needs during Adverse Weather and Environmental Conditions.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Reduced Visibility		X		X	X	X	4
Alternate Routes		X	X	X		X	4
Reduce Speeds (Slow Down)		X	X		X	X	4
Slippery or Water on Road			X	X	X	X	4
Lanes/Roads Closed	X	X		X		X	4
Location (of the Problem)	X			X	X	X	4
Use Caution			X		X		2
Accident	X					X	2
Roadway Conditions (i.e., icy, fog, etc.)	X		X				2
Radio Station for Information	X					X	2
Turn on Headlights					X		1

Because it was necessary to keep the administration time of the human factors laboratory studies to a reasonable limit, only ozone alert messages were evaluated in the laboratory studies. The results of ozone alert messages are presented in the next chapter of the report.

7. OZONE ALERT

PART 1: FOCUS GROUP STUDIES

Results

The participants in the focus groups were shown the message below and were asked to provide their understanding. Specifically: If you saw this message, what does it mean to you? Would you change your driving behavior? Why or why not?

OZONE WATCH

Only 57 percent of the participants indicated that they knew what the term "ozone" meant. Some of the participants that did not understand the meaning stated they believed it was associated with respiratory problems or the atmosphere, but did not feel it would be related with traffic or traffic conditions.

The majority of the participants stated they would not change their driving behavior based on this message. Three participants remarked that they might change their driving behavior if they had advance warning. Additional comments made by participants who felt this message would alter their driving behavior were: they would slow down, they would go home, or they would carpool. The consensus of the participants from Arlington was that the message meant nothing related to travel behavior.

Next, the three ozone messages shown below were displayed to the participants and they were asked the following questions: Would you react differently for each of these messages? If so, what would you do differently?

OZONE WARNING	**OZONE WATCH**	**OZONE ALERT**
Message 1	*Message 2*	*Message 3*

Ninety-four percent (51) of the participants felt that the three messages had different meanings. Twenty-eight percent (15) thought that Ozone Warning was the most severe. Twenty percent (11) felt that Ozone Alert was the most severe, and 13 percent (7) stated that Ozone Watch was the least severe but could develop to a warning situation. Interestingly, 24 percent (13) of the participants felt that the different meanings of the ozone messages were related to when the event would occur, now or in the future. Participants from the groups in Amarillo, Arlington, and El

Paso stated that their interpretation of the ozone messages was based on the current advisory system used for severe storms.

Implications of Results for Human Factors Laboratory Studies

The results suggest the following with respect to the human factors laboratory studies:

1. The information needs for adverse weather and environmental conditions far exceed that which can be accommodated via DMSs. There is a need to determine the specific information that should be and can be accommodated via DMSs and the information that should be provided by other means. The information needs cited by the focus group participants provide a base that can be used to design the laboratory studies.

2. Driver comprehension and possibly reading times of candidate messages should be evaluated.

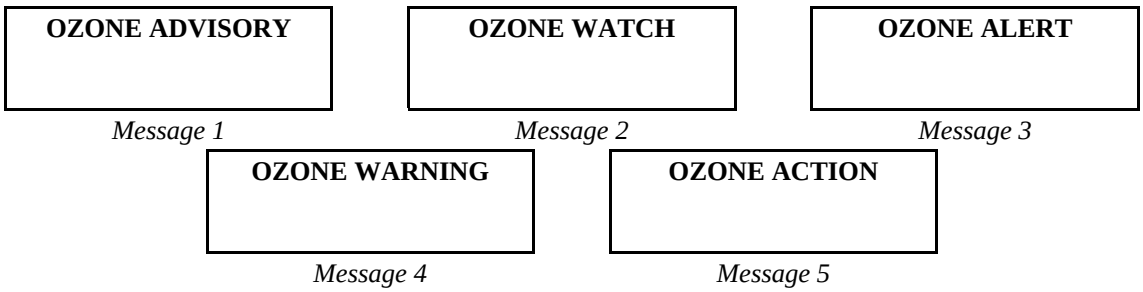
3. There seems to be a misunderstanding by a high percentage of drivers of the meaning and possible actions related to ozone alert messages displayed on DMSs. In addition, the descriptors tested to indicate the degree of health danger because of ozone levels did not adequately describe the situation. These issues should be further explored.

PHASE 2: HUMAN FACTORS LABORATORY STUDIES

Study Protocol

To begin the study, researchers first asked participants if they knew what the term "ozone" meant. For those participants that did not know the meaning, researchers provided a standard definition indicating that the term refers to conditions when the ozone or pollution levels are expected to reach unhealthy levels and are also a hazard to the environment.

In this study, researchers utilized laptop computers in a manner similar to the approach used in experiments described earlier in this report, with one exception. For this study of ozone messages, researchers did not utilize secondary task loading of the participants. The study evaluated five primary ozone message descriptors in the first part of the experiment. These messages are shown below.



The participants were shown combinations of two of the five descriptors side-by-side on the monitor and were asked the following questions:

1. Do these messages mean the same?

    a. *(If the participant's answer to Number 1 was "No"): Briefly explain the difference.*

2. Would you expect that the message is for today or tomorrow?

3. What would you do different in terms of your driving plans?

4. Is one message more severe than the other?

    a. (*If the participant's answer was "Yes): Briefly explain why.*

The participants were then shown each of the two messages below that contained an action message element (i.e., what to do).

OZONE ACTION DAY TODAY	**RIDE THE BUS REDUCE TRIPS WALK TO LUNCH**
Phase 1	*Phase 2*
OZONE ACTION DAY TOMORROW	**RIDE BUS (FREE) ON OZONE DAYS SHARE A RIDE**
Phase 1	*Phase 2*

Following presentation of each of the messages, the participants were asked to respond to the following questions:

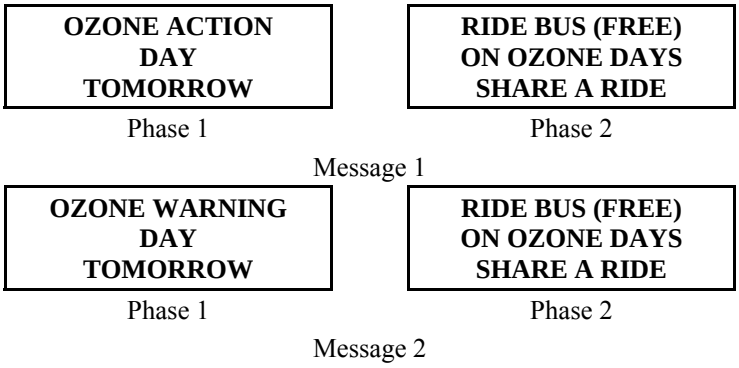
1. What would you do different in terms of your driving plans?

2. How important is it that the second part of the message be displayed? "Very important," "Important," "It's OK to display," "Not important," or "Very unimportant."

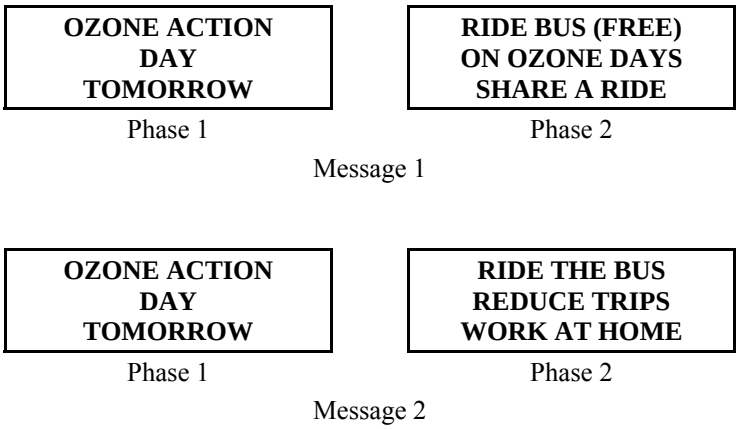
3. Please tell me why?

In the next part of the experiment, the participants were shown the following two sets of messages one set at a time and were asked to respond to questions. The two message sets are shown below.

Message Set 1



Message Set 2



The following question was asked after the participants viewed each of the two message sets:

1. Which of the two messages would have the greatest impact on getting drivers to use a bus, car pool and share a ride, or do something else to keep from driving to work tomorrow?

Results

Understanding of the Word "Ozone"

Initially, participants were questioned to ensure that they recognized the meaning of the word ozone. Table 56 shows the breakdown by location of those people who did or did not know what this term meant. Overall, 68 percent did understand the term. This was a greater percentage than had been identified during the focus groups where 57 percent of the participants indicated that they knew what the term ozone meant. However, 32 percent of the participants in this study had to have the word ozone defined to them before the rest of the session was administered. Most of these participants lived in Austin, Houston, or Laredo.

Table 56. Participants Who Understood Definition of Ozone.

Response	Percent (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
No	19	59	6	34	64	6	32
Yes	81	41	94	66	36	94	68

Comparison of Descriptor Terms

In the next section of the study, researchers tested different terms to identify which would be the most appropriate to use when there is an ozone alert day. Table 57 shows the participants' responses when asked if the two ozone message descriptors displayed on the monitor had the same meaning. For all of the comparisons, one-half or more of the participants believed that the terms had different meanings. The terms OZONE WARNING and OZONE ACTION appear to be the most dissimilar, with 86 percent of the participants indicating that these terms are not the same.

Table 57. Participant Responses to Question "Are These Message the Same?".

Ozone Descriptor	Response	Percent (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
ADVISORY vs. WATCH	Yes	53	34	37	59	37	28	42
	No	47	66	63	41	63	72	58
ALERT vs. WARNING	Yes	53	53	47	47	63	41	50
	No	47	47	53	53	37	59	50
WARNING vs. ACTION	Yes	25	16	9	13	16	6	14
	No	75	84	91	87	84	94	86

Those participants who felt the message terms were different answered an additional question to explain how they felt the message terms were different. The reasons stated for each of the different comparisons are shown in Table 58. For the first comparison (ADVISORY vs. WATCH), 69 percent of the participants who felt these terms were not the same included the given descriptor term in their explanation of the differences. Researchers believe this could indicate that participants were unsure of what the difference between the descriptors was or that they were unsure of the meaning of the individual descriptors. However, many of the participants indicated the difference between the terms was based on the severity (24 percent), but there was

not a clear response as to which of the terms was the most severe. Thirteen percent of the participants indicated that ADVISORY was more severe, while 11 percent felt WATCH was more severe.

Table 58. Participant Responses to Differences between Ozone Descriptors.

Ozone Descriptor	Difference (n = 372)	
	Statement	**(%)**
ADVISORY vs. WATCH (n = 112)	ADVISORY	
	• advises about the ozone	26
	• problem in the future	15
	• more severe	13
	• use caution	9
	• it's happening now	8
	• other miscellaneous responses*	5
	WATCH	
	• look out for/just watching for it	43
	• be cautious	14
	• more severe	11
	• problem in the future	10
	• it's happening now	10
	• don't know what that means	5
ALERT vs. WARNING (n = 95)	ALERT	
	• more severe	31
	• happening now	15
	• caution	14
	• could happen in the future	13
	• like a watch	12
	WARNING	
	• could happen in the future	24
	• more severe	20
	• gets your attention	16
	• happening now	7
	• caution	4
WARNING vs. ACTION (n = 165)	WARNING	
	• just a warning	32
	• it is going to happen	22
	• could be use caution	19
	• tells you something about the ozone level	8
	• more severe	7
	ACTION	
	• need to do something	58
	• don't know what that means	19
	• something is going to happen	7
	• more severe	4

*No other single category contained more than 2 percent of the responses.
Note: Multiple responses were possible for each participant. Therefore, percentages will not equal 100.

The primary reasons listed for the differences between the ALERT and WARNING descriptors again focused on the severity of the messages. As shown in Table 58, 51 percent of the participants based their distinction between the terms on severity; however, there was no consensus as to which term was the most severe. Thirty-one percent of the participants felt ALERT was more severe compared to 20 percent stating WARNING was more severe.

As noted above, the majority of the participants felt that the last two terms (WARNING vs. ACTION) had different meanings. Responses indicated that a WARNING was not urgent or that the event would occur in the future. In contrast, the majority of comments about the term ACTION indicated that it implied that drivers needed to do something now. However, 19 percent of the participants stated they did not know what ACTION meant, even though they believed the meaning would be different than WARNING.

Overall, approximately 20 percent of the participants out of each message comparison set felt that the different meanings of the ozone messages were related to when the event would occur, either now or in the future. This interpretation is consistent with comments received during the focus group studies conducted in the six Texas cities. Additional details regarding participant comments from each study location are contained in Appendix E.

Descriptor Severity. In Table 59, researchers show how participants viewed the different ozone terms of interest with respect to their implied severity. Overall, none of the terms garnered a majority opinion with participants. Rather, participants appear to be fairly divided as to whether the various terms imply similar levels of severity, or whether one or another term implies a more severe condition than the other. This trend was apparent across each of the six cities as well.

Table 59. Participant Responses to Severity of Ozone Descriptors.

Ozone Descriptor	Severity of Ozone	Percent (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
ADVISORY vs. WATCH	No difference	37	37	34	47	28	34	36
	Advisory more severe	44	38	41	28	41	44	40
	Watch more severe	19	25	25	25	31	22	24
ALERT vs. WARNING	No difference	31	31	31	37	37	37	34
	Alert more severe	47	38	47	34	38	57	43
	Warning more severe	22	31	22	29	25	6	22
WARNING vs. ACTION	No difference	28	9	16	31	12	16	19
	Warning more severe	41	44	50	34	44	31	41
	Action more severe	31	47	34	34	44	53	41

Event Timing: Today versus Tomorrow. Researchers then asked the participants whether the terms reflected conditions today or tomorrow. More than 87 percent of the participants viewed both terms in each comparison as implying a condition that exists currently (today). Five percent

or less felt it would be for tomorrow, and the remaining small percent felt the time of the meaning was influenced by the different terms shown in the comparisons, oftentimes with one term meaning today and the other indicating tomorrow. Details regarding participant responses are summarized in Table 60.

Table 60. Participant Responses to "Is Message for Today or Tomorrow?".

Ozone Descriptor	Response	Percent (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
ADVISORY vs. WATCH	Today	97	88	91	94	91	91	92
	Tomorrow	0	6	0	3	0	9	3
	Today – watch / Tomorrow – advisory	3	0	9	3	9	0	4
	Today – advisory / Tomorrow – watch	0	6	0	0	0	0	1
ALERT vs. WARNING	Today	97	91	84	91	88	91	90
	Tomorrow	0	3	6	6	6	9	5
	Today – alert / Tomorrow – warning	3	3	9	3	6	0	4
	Today – Warning / Tomorrow – alert	0	3	0	0	0	0	1
WARNING vs. ACTION	Today	94	91	72	94	90	81	87
	Tomorrow	3	0	9	0	3	13	5
	Today – action / Tomorrow – warning	3	9	13	6	3	6	7
	Today – warning / Tomorrow – action	0	0	6	0	3	0	1

Driving Behavior Changes

In Table 61, researchers show the participant comments on what they would do differently if they saw the different ozone terms. Approximately 50 percent of the participants stated that they would do nothing different. Only about a quarter of the participants indicated they would reduce trips, carpool, or ride the bus. Given that the majority of participants relate such terms with current conditions (i.e., today) when they would presumably already be in their vehicle viewing the message on the DMS, such responses are indeed reasonable.

Table 61. Participant Responses to the Question "What Would You Do Different?".

Ozone Descriptor	Responses	Percent (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Overall (n = 192)
ADVISORY vs. WATCH	• nothing	59	72	69	72	34	25	55
	• reduce trips, carpool, ride the bus	31	25	16	22	28	44	28
	• caution, slow down	0	3	6	3	38	16	11
	• try to stay at home	9	0	0	0	13	3	4
	• close windows and turn on AC or heat	3	3	6	3	3	3	4
	• drive at a different time	3	0	3	0	3	3	2
	• other *	0	3	0	0	3	13	3
ALERT vs. WARNING	• nothing	56	56	50	59	31	22	46
	• reduce trips, carpool, ride the bus	38	28	16	13	28	47	28
	• caution, slow down	3	9	19	3	22	16	12
	• would change outdoor plans	9	13	6	3	22	6	10
	• drive with windows up and put on AC	0	3	6	6	0	3	3
	• other *	6	0	3	0	9	6	4
WARNING vs. ACTION	• nothing	59	59	44	63	25	19	45
	• reduce trips, carpool, ride the bus	25	31	22	22	19	44	27
	• would be more responsive	13	3	13	6	38	0	12
	• stay home, do not go outside	3	0	6	3	16	19	8
	• slow down	0	3	9	0	0	13	4
	• close the windows, turn on AC, and keep on going	3	3	3	6	0	0	3
	• other *	0	0	6	0	6	9	4

* No other single category contained more than 2 percent of the responses.
Note: Multiple responses were possible for each participant. Therefore, percentages will not equal 100.

Researchers then asked participants to make one final direct comparison of messages to determine which of the two descriptors, ACTION or WARNING, would have the greatest impact on getting drivers to change their behavior. The answers to this question are presented in Table 62. Overall, the participants were evenly split as to which of the two messages would have the greatest impact on getting drivers to change their behavior.

Table 62. Message Selected by Participants as Having the Greatest Impact: Different Ozone Descriptors.

Message	Percent Selecting Message (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Overall (n = 192)
ACTION	44	62	53	44	56	41	50
WARNING	56	38	47	56	44	59	50

Inclusion of Action Element

In the next portion of the study, participants were shown a single message that had two phases. The second phase of this message was an action element (i.e., what to do). In Table 63, researchers show the participants' comments regarding different actions they would take based on the action element.

For the first message shown, the action term indicated that drivers should RIDE THE BUS, REDUCE TRIPS, or WALK TO LUNCH. For this message, 92 percent of the participants stated that they would comply with the actions included in the message by reducing trips (47 percent), riding the bus (27 percent), and/or walking to lunch (18 percent). An additional 9 percent of the participants indicated that they would carpool; however, 18 percent would do nothing different in terms of their driving plans.

The second message included actions to either RIDE BUS (FREE) or SHARE A RIDE. For this message, 74 percent of the participants indicated that they would follow the given suggestions. Researchers did note that stating that riding the bus would be free in Message 2 was the primary reason that more participants selected that action than in Message 1 (39 percent in Message 2 compared to 27 percent in Message 1). An additional 17 percent of the participants stated they would reduce trips as the previous message suggested. However, 28 percent of the participants indicated they would do nothing different in terms of their driving plans in response to Message 2, an increase of 10 percent over those who made a similar statement in response to Message 1.

Table 63. Participant Responses to the Question "What Would You Do Different?".

Ozone Message	Response	Percent (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Overall (n = 192)
OZONE ACTION DAY TODAY Phase 1 **RIDE THE BUS REDUCE TRIPS WALK TO LUNCH** Phase 2	• Reduce trips	50	38	53	50	50	43	47
	• Walk to lunch	34	16	16	6	19	19	18
	• Nothing	9	19	6	12	41	22	18
	• Ride the bus	28	47	22	31	12	22	27
	• Carpool	13	6	16	3	0	19	9
	• Other *	6	6	3	3	9	12	7
OZONE ACTION DAY TOMORROW Phase 1 **RIDE BUS (FREE) ON OZONE DAYS SHARE A RIDE** Phase 2	• Ride the bus	38	25	25	34	56	56	39
	• Share a ride	28	34	34	34	44	32	35
	• Nothing	28	41	28	44	9	19	28
	• Reduce trips	13	13	22	19	13	25	17
	• Other *	9	3	0	0	9	3	4

*No other single category contained more than 2 percent of the responses.
Note: Multiple responses were possible for each participant. Therefore, percentages will not equal 100.

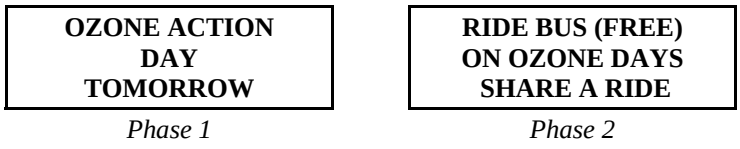
Importance of Action Element. Researchers also asked participants the importance of including the action statements in the above messages. Overall, participant responses were fairly consistent between both messages. In Table 64, researchers found that more than 65 percent of the participants believed that the action information in either message was very important or important to display. The majority (greater than 90 percent) of those who felt this way stated that the information gave motorists good suggestions on what actions to take. Only 9 to 11 percent of the participants felt that the action information was unimportant or very unimportant to display.

Table 64. Rating for the Importance of Second Part of Message.

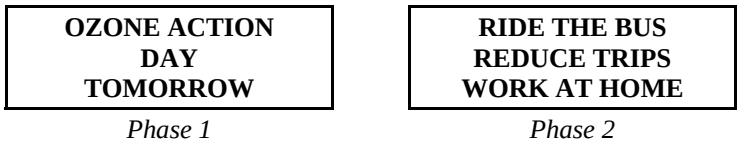
Ozone Message	Importance Rating	Percent Rating (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Overall (n = 192)
OZONE ACTION DAY TODAY Part 1 / **RIDE THE BUS REDUCE TRIPS WALK TO LUNCH** Part 2	Very Important	28	31	34	38	34	28	32
	Important	44	31	25	28	38	41	35
	OK to Display	22	31	19	25	19	19	22
	Not Important	6	7	9	3	9	9	7
	Very Unimportant	0	0	13	6	0	3	4
OZONE ACTION DAY TOMORROW Part 1 / **RIDE BUS (FREE) ON OZONE DAYS SHARE A RIDE** Part 2	Very Important	28	41	44	38	40	35	37
	Important	50	19	25	28	25	53	33
	OK to Display	16	34	22	25	22	6	21
	Not Important	6	3	6	3	13	3	6
	Very Unimportant	0	3	3	6	0	3	3

The reasons given by those participants who felt the action information was either not important or very unimportant varied by the action element that was displayed. For the first message, the primary reasons given by participants were that people should know what to do, that the recommendations were not specific enough, or that people do not pay attention to the signs anyway. With regard to the second message, most (88 percent) of the participants who felt the action information was not important believed that the action information does not apply to most drivers.

As a final activity in this study, researchers queried participants which of the following two messages would most likely have the greatest success in getting drivers to avoid driving alone to work tomorrow.



Message 1



Message 2

The results of this questioning are presented in Table 65. Overall, 63 percent of the participants believed that Message 1 would have the greatest impact on motorist behaviors.

Table 65. Message Selected by Participants as Having the Greatest Impact: Different Action Message Elements.

Message	Percent Selecting Message (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Overall (n = 192)
Message 1	63	59	69	78	69	41	63
Message 2	37	41	31	22	31	59	37

SUMMARY

The objective of this section of the study was to determine drivers' understanding of alternative ozone messages and their potential reactions to the messages. The study was conducted in two parts, with the first part designed to evaluate five primary ozone message descriptors. The second part was designed to examine messages that contained an action element.

With regard to the five primary ozone message descriptors evaluated, researchers found that there were no clear distinctions among the participants between the terms ADVISORY and WATCH, between ALERT and WARNING, or between WARNING and ACTION. In the absence of any indication of when such terms are valid, most motorists will assume that the message pertains to current conditions (i.e., conditions today). In response to the display of these terms, approximately one-half of the motorists indicated that they would do nothing different in terms of their driving plans.

When given suggestions for actions to take in an ozone message, most participants are able to restate those actions (i.e., ride a bus, carpool, etc.). Furthermore, most participants felt it was very important, important, or OK to display the action part of the message. Only about 10 percent stated that such action information was not important to include in the message.

8. PLANNED SPECIAL EVENTS

FOCUS GROUP STUDIES

Results

The participants from five of the six focus groups believed that DMSs should be used to display information regarding planned special events. Participants from the sixth location, Amarillo, felt that the signs could be used during special events if there was a major impact on traffic to warn a driver about traffic conditions, but that they should not give information regarding any upcoming events because this seemed like advertising.

Drivers Attending the Event

For the five groups that believed information should be provided on DMSs regarding planned special events, the types of information the group felt would be important to drivers if they were attending the event are summarized in Table 66.

Table 66. Information Needs for Drivers Attending a Planned Special Event.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Parking Information (cost, availability)		X	X	X	X	X	5
Directions (exits to use, routes)			X		X	X	3
Park and Ride Information		X		X	X		3
Alternate Routes		X	X				2
Travel Time to Event					X	X	2
Event Descriptor						X	1
Duration of Event					X		1
Closed Roads					X		1
Passenger Pick-up and Drop-off Locations				X			1
Time of Event				X			1
Date of Event					X		1

The groups were divided as to how long prior to an event information should be displayed. The Arlington group indicated that for most events one day would be enough advance notice; however, for larger events they felt that this should be extended up to a week as people traveling from out of town to attending a larger event might arrive a few days prior to the event. Two other groups agreed that one day would be a sufficient amount of advance warning. The final two groups indicated that a week or five days would be the appropriate amount of time to display

messages. Again, the participants from Amarillo did not feel that the DMSs should be used to give advance warning of an event, only to respond to traffic conditions and road closures.

The participants were also asked to determine where they thought the messages should be displayed. Four of the five groups who believed the signs should be used thought that the information should be provided on all of the routes that are in the region of the event. The actual distance away that the messages should be displayed varied from 3 to 15 miles. Specific locations mentioned by the groups included: at exits near the event, at park and ride locations, and at the airport for people traveling into the area. It was noted in several different groups that the distance should be far enough away so that people are able to select alternate routes if necessary.

Drivers Not Attending the Event

The participants were then given the situation where they are a driver that is not attending the event, but is passing by the venue. The types of information the groups felt would be important to drivers in this situation are summarized in Table 67. The Arlington group noted that the advanced warning for a special event should be similar to that given for upcoming work zone road closures.

Table 67. Information Needs for Drivers Not Attending the Planned Special Event.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Alternate Routes	X	X		X	X	X	5
Time and Date of Event				X	X	X	3
Roads Closed					X	X	2
Event Descriptor			X				1
Duration of Event					X		1
Expected Delay			X				1

The groups indicated that the amount of time for the information to be displayed is similar to the previous situation. Again, two of the groups felt that drivers should be given one day of advance warning regarding the special event. In one of the locations, the participants noted that the one day should be a business day (i.e., if the event will be on a Monday the warning should be displayed on a Friday) so that commuters will have advance notice if their routes are going to be affected. The other three groups indicated that they believed that the message should be displayed anywhere from five days to two weeks prior to the event. One group mentioned that it would depend on the type of event and the anticipated impact it would have on the roads (i.e., more impact should have a longer warning time). The Amarillo group was not asked this

question due to the fact that they did not believe the signs should be used for advance warning of special events.

The responses for where the messages should be displayed are also very similar to the previous section on Drivers Attending the Event. One difference noted was that the distances preferred for the warning messages were not as far as for the attendee information messages. In this situation, the number of miles ranged from 2 to 10 miles, with the majority of the responses being 5 miles or less. One group still mentioned exits affected by the event as a specific location where the messages should be displayed.

Downtown Events with Arterial Street Closures

Finally, the group was asked about events that are held in downtown areas that will involve closures on local streets. The participants in Amarillo were still of the opinion that unless the highway where the DMS is located was affected, they should not be used for these special events. All of the other groups believed that the DMSs should be used for such events. The types of information that they thought would be important for drivers are summarized in Table 68.

At the Houston focus group, the participants indicated that they believed this type of information should be displayed for drivers one week prior to the event so that people have an opportunity to change their travel plans in the area of the event.

Table 68. Information Needs for Special Events with Arterial Street Closures.

Information Needs	Amarillo	Arlington	El Paso	Houston	Laredo	San Antonio	Number of Locations
Road Closures			X	X	X	X	4
Alternate Routes			X	X	X		3
Time of Closures				X	X	X	3
Highway Exits Affected		X			X		2
Parking Information			X		X		2
Where to Get Further Information (TV, Radio, Phone Number)				X		X	2
Congestion			X				1
“Watch for Pedestrian” Warning					X		1

Implications of Results for Human Factors Laboratory Studies

The results suggest the following with respect to the human factors laboratory studies:

1. The information needed far exceeds that which can be accommodated via DMSs. There is a need to determine the specific information that should be and can be accommodated via DMSs and the information that should be provided by other means. The information needs cited by the focus group participants provide a base that can be used to design the laboratory studies.

2. Driver reading times and comprehension of candidate messages should be evaluated.

After meeting and discussing the focus group results with the Project Advisory Committee, the committee recommended that laboratory studies should not be conducted on this topic. Instead, the researchers were instructed to rely on information based on the experiences of within TxDOT and by other state DOTs.

9. SPECIFYING LOCATION OF AN INCIDENT

The word "incident" is used in this section of the report in a general sense. It refers to events such as a crash, roadwork, flooding, etc.

BACKGROUND

The guidelines in TxDOT's Dynamic Message Sign Message Design and Display Manual specify that acceptable terms for the incident location in a DMS message include AT [highway, street name], BEFORE [highway, street name], and PAST [highway, street name] (*16*). Recent unpublished results of DMS messages in Toronto, Canada, indicate that some drivers may not understand that the word PAST means that the incident/roadwork is past the cross street and that drivers are able to use the exit ramp to the cross street. Although the word BEYOND was used in the studies, the result may have implications concerning the use of the word PAST. In the Canadian study, the following questions were asked of participants when the message "QEW CLOSED/BEYOND EVANS/TO HWY 47" was displayed:

- Do you need to exit before Evans? and
- Can you exit at Evans?

Only 35 percent of the participants indicated that they did not have to exit before Evans (scored as a correct answer by the Canadian researchers). Also, only 74 percent stated that they can exit at Evans (scored as a correct answer by the Canadian researchers). The lack of understanding of the term BEYOND EVANS indicates that using the term PAST EVANS as recommended in the Dynamic Message Sign Message Design and Display Manual may result in similar misinterpretations.

A question arises with respect to whether the participants in the study understood the questions posed. For example, with the first question, did the participants in the study interpret the question to mean "Do you need to exit before you arrive at the Evans cross street?" Or did the participants interpret it to mean "Do you need to exit before you arrive at the Evans exit ramp?" A lack of understanding could possibly explain the low scores for driver understanding of the message. The uncertainty indicates that care must be exercised in the manner in which such questions are asked.

Another issue and weakness of the Canadian study is that the DMS message implies that the QEW is closed between cross streets. In reality, a freeway will always be closed at an exit ramp. Thus care must be exercised in selecting a proper message to use in the study. For example, the message FREEWAY CLOSED/AT EVANS would be an acceptable message because the freeway is closed at an exit ramp. The message FREEWAY CLOSED/PAST EVANS would not be acceptable.

Another issue that needs to be resolved is whether drivers understand the location of a road closure or flooding when the limits of the activities are displayed. For example, the following

message elements may be posted: FLOOD/BETWEEN C ROAD AND D ROAD or FLOOD/FROM C ROAD TO D ROAD. Just as in the Canadian study, questions arise as to driver interpretation of these types of statements.

PHASE 1: FOCUS GROUP STUDIES

Results

Participants in the focus groups were asked to select between three different options for the unit of information that gave an incident location. The three options are shown below, the directions and street names were changed as necessary for the location.

ACCIDENT AT EVANS RD RGT 2 LANES CLOSED	ACCIDENT N OF EVANS RD RGT 2 LANES CLOSED	ACCIDENT PAST EVANS RD RGT 2 LANES CLOSED
Message 1	*Message 2*	*Message 3*

The results revealed that 83 percent preferred the term AT for the location descriptor. The reasoning behind their selection is that this term seems to give a more specific location. With both of the other options, the accident could have occurred a great distance away (e.g., PAST could be many miles farther). Also, with respect to the message where cardinal directions are used, several of the participants mentioned that drivers are not always aware of the direction they are traveling.

PHASE 2: HUMAN FACTORS LABORATORY STUDIES

Study Objectives

There are questions regarding drivers' interpretation of the words PAST, BEYOND, BEFORE, and AT when attempting to inform drivers of the location of an incident or roadwork relative to an exit ramp leading to a cross street. That is, do drivers get a mental picture of the location of the incident/roadwork relative to the exit ramp so that they can judge whether they are able to use the ramp to exit or whether they can use the entrance ramp to enter the freeway? Likewise, there are questions about drivers' interpretation of the beginning and ending points of a freeway (or lane) closure or the limits of an event such as a flood.

The objectives of this study are to evaluate driver understanding and preferences for the words PAST, BEYOND, AT, BEFORE, BEYOND-TO, FROM-TO, and BETWEEN-AND in the context of the location of incident/roadwork or flooding messages.

Study Approach

Participants in each study location were divided into two groups (Group A and Group B) for the purposes of counterbalancing. Participants were shown each of the following messages one at a time. The order of the messages was counterbalanced between Groups A and B. The road names given in the messages below and used in the following discussion were those provided for the Austin study; street names were changed for each location. Participants were asked questions to determine their understanding of the location of the incident and whether they believed they could exit at the cross street ramp.

MAJOR ACCIDENT PAST 38 1/2 ST	**MAJOR ACCIDENT BEYOND 38 1/2 ST**	**MAJOR ACCIDENT AT 38 1/2 ST**	**MAJOR ACCIDENT BEFORE 38 1/2 ST**
Message 1	*Message 2*	*Message 3*	*Message 4*
FREEWAY CLOSED FROM 38 1/2 ST TO 51ST ST	**FREEWAY CLOSED BETWEEN 38 1/2 ST AND 51ST ST**	**FREEWAY CLOSED BEYOND 38 1/2 ST TO 51ST ST**	
Message 5	*Message 6*	*Message 7*	

Study Protocol

During this study, participants looked at schematic maps of a freeway corridor. Researchers asked the participants to assume that they were traveling on a specified freeway in the city in which the survey was being conducted. Researchers presented the participants with a series of 8.5 × 11-inch schematic maps that illustrated a freeway with frontage roads on both sides, several cross streets, a cross freeway, and a parallel alternative street. Each map also illustrated a DMS displaying one of the messages presented above for study. Examples of these maps for the Austin study are shown in Figures 5 and 6. Researchers used local road names that would be familiar to the participants for these maps. During this discussion, the cross streets referenced will be those that were used in the Austin study.

Located on these schematics were small boxes on the roadway. For Messages 1 through 4, researchers asked participants to select the one box that they believed best represented the location of the accident. For this application, participants could select one of the following five locations (boxes):

1. approximately ½ mile upstream of 38 1/2 Street,
2. just prior to the 38 1/2 Street exit ramp,
3. between the exit ramp and 38 1/2 Street,
4. between 38 1/2 Street and the 38 1/2 Street entrance ramp, or
5. downstream of the 38 1/2 Street entrance ramp.

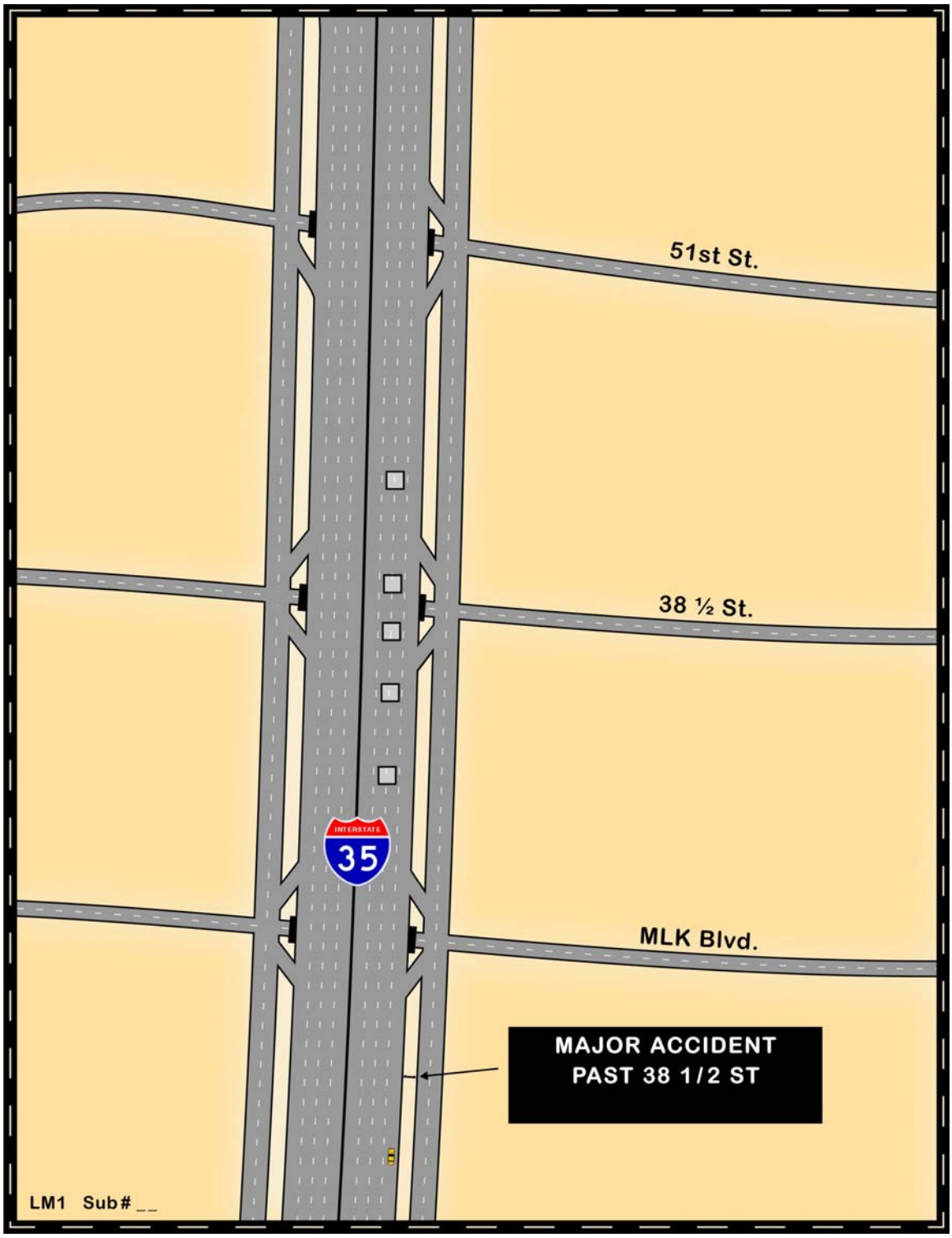


Figure 5. Spot Incident Location Example Map.

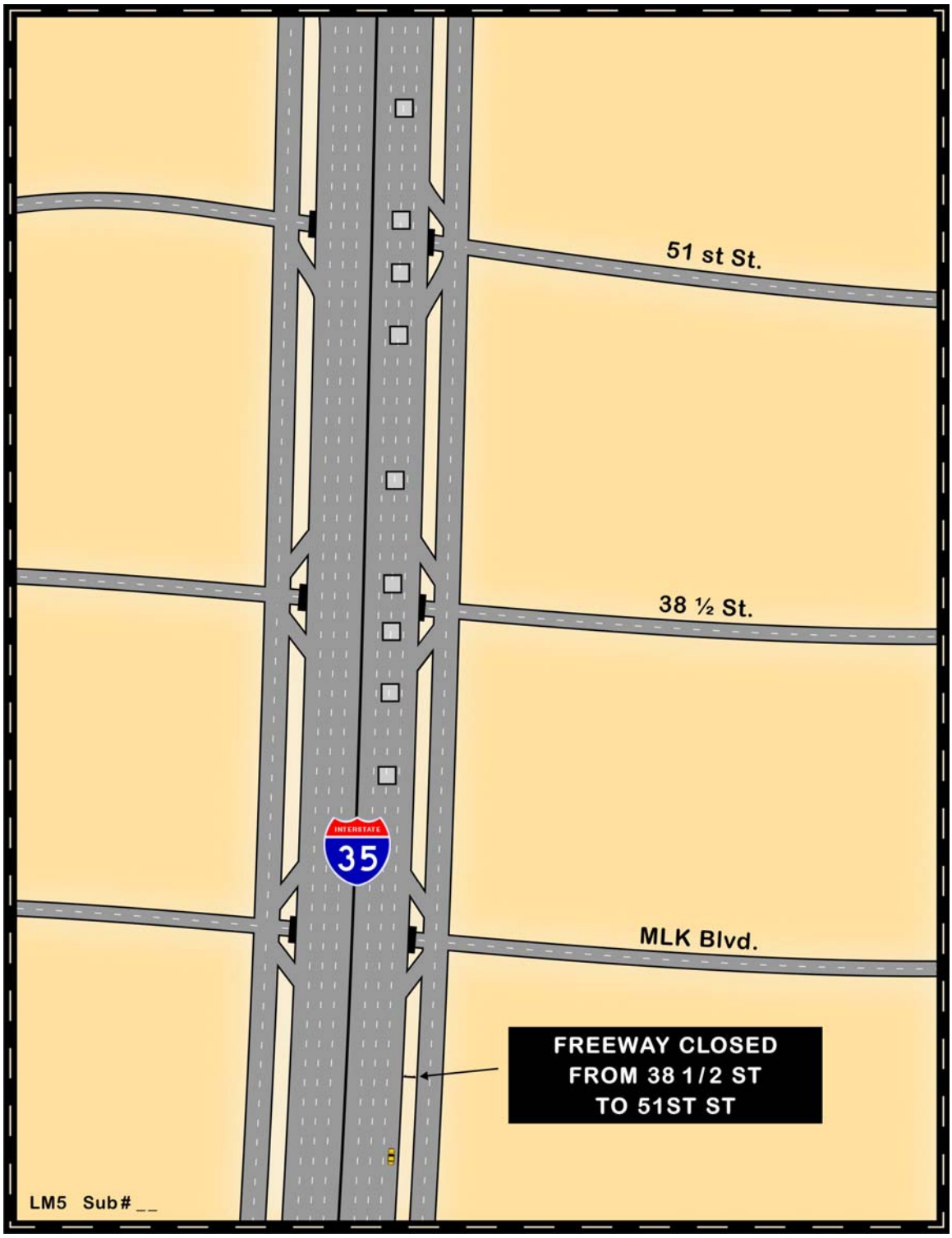


Figure 6. Incident Start-End Location Example Map.

With Messages 5 through 7, participants marked all boxes that they believed were within the area where the freeway was closed. For this exercise, participants selected from nine available locations (boxes):

1. approximately ½ mile upstream of 38 1/2 Street,
2. just prior to the 38 1/2 Street exit ramp,
3. between the exit ramp and 38 1/2 Street,
4. between 38 1/2 Street and the 38 1/2 Street entrance ramp,
5. upstream of the 38 1/2 Street entrance ramp,
6. just prior to the 51st Street exit ramp,
7. between the exit ramp and 51st Street,
8. between 51st Street and the 51st Street entrance ramp, or
9. downstream of the 51st Street entrance ramp.

Results

Spot Incident Locations

Researchers evaluated several terms to gauge motorist interpretation of incident location. The first term evaluated was "past." Researchers considered participant answers to be correct if they identified the location of the incident as being beyond the exit ramp for the cross street referenced in the message. The responses are summarized in Table 69.

Since the interpretation we are trying to evaluate is if the participant believes they would be able to use the exit ramp to the cross street referenced in the message, all responses of locations 3 through 5 would be considered to be correct in this regard. Therefore, the term past was correctly interpreted by 99 percent of the participants. Additional analysis also shows that this term is interpreted by 95 percent of the participants to mean that the incident has occurred beyond the given cross street.

Table 69. Interpretation of the Term PAST.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	0	0	0	0	0	0	0
Location 2: Just prior to 38 1/2 St. exit ramp	0	3	0	0	0	0	1
Location 3: Between the exit ramp and 38 1/2 St.	6	9	3	3	3	0	4
Location 4: Between 38 1/2 St. and the entrance ramp	16	31	22	31	13	16	21
Location 5: Downstream of 38 1/2 St. entrance ramp	78	56	75	66	84	84	74

The second term tested for this application was BEYOND. Table 70 contains the responses regarding the interpretation of the location inferred by this term.

Table 70. Interpretation of the Term BEYOND.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	0	3	0	3	3	0	2
Location 2: Just prior to 38 1/2 St. exit ramp	3	0	0	3	6	6	3
Location 3: Between the exit ramp and 38 1/2 St.	13	6	6	6	3	0	6
Location 4: Between 38 1/2 St. and the entrance ramp	9	16	13	25	13	16	15
Location 5: Downstream of 38 1/2 St. entrance ramp	75	75	81	63	75	78	74

In this instance, 95 percent of the participants correctly interpreted the location of this incident as being after the cross-street exit ramp. Also, 89 percent of the participants interpreted this term to indicate a location that is beyond the cross street given in the message.

For comparative purposes, researchers also included the location terms AT and BEFORE in this analysis. Participant responses to each of these terms are summarized in Tables 71 and 72.

With regard to interpretations of the term AT, 82 percent of the participants identified the location of this incident as being beyond the exit ramp, but prior to the entrance ramp for the cross street referenced in the message. Also, one sees that 85 percent of the participants interpret the term to imply that the exit ramp to the 38 1/2 Street is not blocked by the incident and can still be used. However, they also believed that by the time they passed the cross street and had arrived at the entrance ramp upstream of the cross street that the accident would be behind them.

Only 3 percent of the participants believed that the incident would be located beyond the entrance ramp.

Table 71. Interpretation of the Term AT.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	3	6	3	3	0	0	3
Location 2: Just prior to 38 1/2 St. exit ramp	19	13	13	13	13	9	13
Location 3: Between the exit ramp and 38 1/2 St.	34	56	41	56	25	50	44
Location 4: Between 38 1/2 St. and the entrance ramp	44	25	41	25	53	38	38
Location 5: Downstream of 38 1/2 St. entrance ramp	0	0	3	3	9	3	3

Table 72. Interpretation of the Term BEFORE.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	28	22	25	19	25	25	24
Location 2: Just prior to 38 1/2 St. exit ramp	38	53	34	34	41	44	41
Location 3: Between the exit ramp and 38 1/2 St.	34	25	41	41	31	31	34
Location 4: Between 38 1/2 St. and the entrance ramp	0	0	0	0	0	0	0
Location 5: Downstream of 38 1/2 St. entrance ramp	0	0	0	6	3	0	2

Finally, when presented with the term BEFORE, 65 percent of the participants believed this message would mean that the incident was located prior to the exit ramp; thereby making it impossible to exit at the street that is referenced in the message. However, another 34 percent interpreted the message to mean that the incident was located between the exit ramp and the cross street, which implies that those participants believed they could still use the exit ramp for the cross street referenced in the message. In this case, there was no clear interpretation by participants as to whether or not motorists would be able to use the exit.

Closure/Incident Start and End Points

Researchers designed the final three messages examined in this study to identify participant interpretation of beginning and end points of closures or incidents such as flooding. The first

message looked at the interpretation of the word set FROM/TO. The message used for this study was:

Location Message 5
FREEWAY CLOSED FROM 38 1/2 ST TO 51ST ST

Tables 73 and 74 summarize the participant interpretations of the start and end points of the closure referred to in the message.

Table 73. Interpretation of the Start Point for FROM/TO Word Pair.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	3	6	0	3	6	0	3
Location 2: Just prior to 38 1/2 St. exit ramp	9	18	3	9	16	12	11
Location 3: Between the exit ramp and 38 1/2 St.	44	38	28	41	22	44	36
Location 4: Between 38 1/2 St. and the entrance ramp	41	38	47	41	50	41	43
Location 5: Downstream of 38 1/2 St. entrance ramp	3	0	22	6	6	3	7
Location 6: Just prior to the 51st St. exit ramp	0	0	0	0	0	0	0
Location 7: Between the exit ramp and 51st St.	0	0	0	0	0	0	0
Location 8: Between 51st St. and the entrance ramp	0	0	0	0	0	0	0
Location 9: Downstream of the 51st St. entrance ramp	0	0	0	0	0	0	0

Table 74. Interpretation of the End Point for FROM/TO Word Pair.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	0	0	0	0	0	0	0
Location 2: Just prior to 38 1/2 St. exit ramp	0	0	0	0	0	0	0
Location 3: Between the exit ramp and 38 1/2 St.	0	0	0	0	0	0	0
Location 4: Between 38 1/2 St. and the entrance ramp	0	0	0	0	0	0	0
Location 5: Downstream of 38 1/2 St. entrance ramp	0	0	0	3	0	0	1
Location 6: Just prior to the 51st St. exit ramp	16	25	6	13	3	9	12
Location 7: Between the exit ramp and 51st St.	34	44	44	53	41	47	44
Location 8: Between 51st St. and the entrance ramp	50	31	50	31	34	44	40
Location 9: Downstream of the 51st St. entrance ramp	0	0	0	0	22	0	3

As shown in Table 73, the majority of participants interpreted the word pair FROM/TO as beginning after the exit ramp for the first cross street referenced. This area (locations 3, 4, and 5) was selected by 86 percent of the participants. Meanwhile, participants interpreted the end of this closure as being prior to the entrance ramp from the second referenced cross street in the message but after the entrance from the first referenced street. This area was selected by 97 percent of the participants. This result would imply that the participants interpreted the message to mean they could reenter the freeway immediately after the second referenced roadway.

The second word set examined for this purpose was BETWEEN/AND. This word set was used in the following message for the study:

Location Message 6
FREEWAY CLOSED BETWEEN 38 1/2 ST AND 51ST ST

The responses from the participants regarding the start and end locations of this closure are summarized in Tables 75 and 76.

Table 75. Interpretation of the Start Point for BETWEEN/AND Word Pair.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	0	0	0	3	3	3	2
Location 2: Just prior to 38 1/2 St. exit ramp	3	6	0	6	3	6	4
Location 3: Between the exit ramp and 38 1/2 St.	41	41	31	22	9	19	27
Location 4: Between 38 1/2 St. and the entrance ramp	50	47	50	59	44	63	52
Location 5: Downstream of 38 1/2 St. entrance ramp	6	6	19	9	41	9	15
Location 6: Just prior to the 51st St. exit ramp	0	0	0	0	0	0	0
Location 7: Between the exit ramp and 51st St.	0	0	0	0	0	0	0
Location 8: Between 51st St. and the entrance ramp	0	0	0	0	0	0	0
Location 9: Downstream of the 51st St. entrance ramp	0	0	0	0	0	0	0

The interpretation of this location word set, BETWEEN/AND, was similar to the FROM/TO word set. The majority of participants (94 percent) indicated that it began in the area after the exit ramp for the first reference street, and ended prior to the entrance ramp for the second street referenced in the message (97 percent). Again, this result implies that motorists interpreted the meaning of the message to be that they must exit at the ramp for the first referenced street and that they could enter again using the entrance ramp from the second referenced street.

Table 76. Interpretation of the End Point for BETWEEN/AND Word Pair.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	0	0	0	0	0	0	0
Location 2: Just prior to 38 1/2 St. exit ramp	0	0	0	0	0	0	0
Location 3: Between the exit ramp and 38 1/2 St.	0	0	0	0	0	0	0
Location 4: Between 38 1/2 St. and the entrance ramp	0	0	0	0	0	0	0
Location 5: Downstream of 38 1/2 St. entrance ramp	3	0	0	0	0	3	1
Location 6: Just prior to the 51st St. exit ramp	16	22	9	13	3	13	13
Location 7: Between the exit ramp and 51st St.	41	53	50	56	47	41	48
Location 8: Between 51st St. and the entrance ramp	41	22	41	31	41	41	36
Location 9: Downstream of the 51st St. entrance ramp	0	3	0	0	9	3	3

The final word set that was examined in this portion of the study was BEYOND/TO, as represented in the following message.

Location Message 7
FREEWAY CLOSED BEYOND 38 1/2 ST TO 51ST ST

The responses from the participants regarding the location of this closure are summarized in Tables 77 and 78.

In this case, the participants interpreted the location of the start of this incident as being slightly further downstream than in the previous two cases. For the word set BEYOND/TO, 79 percent of the participants believed that the start of this closure would be after the cross street (locations 4 and 5). Perhaps more importantly, though, 97 percent of the participants again believed that the message would mean that the closure began after the exit ramp to the initially referenced roadway. Regarding the end of this incident, the majority of the participants interpreted the location the same as the previous two word sets. Specifically, 90 percent of the participants interpreted the word set to indicate the end as being prior to the entrance ramp for the second road referenced in the message.

Table 77. Interpretation of the Start Point for BEYOND/TO Word Pair.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	3	0	0	0	0	0	1
Location 2: Just prior to 38 1/2 St. exit ramp	3	0	0	0	6	0	2
Location 3: Between the exit ramp and 38 1/2 St.	19	31	9	22	13	16	18
Location 4: Between 38 1/2 St. and the entrance ramp	56	50	53	59	41	50	52
Location 5: Downstream of 38 1/2 St. entrance ramp	19	19	34	16	41	31	27
Location 6: Just prior to the 51st St. exit ramp	0	0	0	0	0	3	1
Location 7: Between the exit ramp and 51st St.	0	0	3	0	0	0	1
Location 8: Between 51st St. and the entrance ramp	0	0	0	3	0	0	1
Location 9: Downstream of the 51st St. entrance ramp	0	0	0	0	0	0	0

Table 78. Interpretation of the End Point for BEYOND/TO Word Pair.

Location	Percent Selecting Location (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average (n = 192)
Location 1: Upstream of 38 1/2 St.	0	0	0	0	0	0	0
Location 2: Just prior to 38 1/2 St. exit ramp	0	0	0	0	0	0	0
Location 3: Between the exit ramp and 38 1/2 St.	0	0	0	0	0	0	0
Location 4: Between 38 1/2 St. and the entrance ramp	0	0	0	0	0	0	0
Location 5: Downstream of 38 1/2 St. entrance ramp	0	3	0	3	0	3	2
Location 6: Just prior to the 51st St. exit ramp	16	25	0	9	0	6	9
Location 7: Between the exit ramp and 51st St.	38	47	53	47	41	53	46
Location 8: Between 51st St. and the entrance ramp	44	22	34	34	31	31	33
Location 9: Downstream of the 51st St. entrance ramp	3	3	13	6	28	6	10

SUMMARY

In this section, researchers strived to decipher motorist interpretations of different terms used on DMSs to identify locations of incidents or roadwork. Overall, seven messages were evaluated. The first four messages presented to participants identified the location of a MAJOR ACCIDENT as either PAST, BEYOND, AT, or BEFORE a specifically referenced street. The results of the analysis indicate the following:

- PAST – 99 percent of participants believed this term implies a location after the exit ramp for the street referenced in the message;

- BEYOND – 95 percent of participants believed this term implies a location after the exit ramp for the street referenced in the message;

- AT – 82 percent of the participants identified the location of this incident as being beyond the exit ramp, but prior to the entrance ramp for the cross street referenced in the message; and

- BEFORE – 65 percent of the participants believed this message implies that the incident is located prior to the exit ramp.

Researchers were especially concerned in this study whether participants believed it is possible to use an exit ramp based on the location term used in the message. In this regard, all three terms (PAST, BEYOND, and AT) appear to be interpreted by drivers as implying the accident is after the exit ramp, thereby allowing motorists to exit at the referenced cross street. Furthermore, the terms PAST and BEYOND are interpreted by the majority of motorists as the incident being located after the referenced cross street.

The final three messages tested used word sets to identify a section or area of the freeway that was closed, or affected by, an incident or roadwork. The three word sets examined were FROM/TO, BETWEEN/AND, and BEYOND/TO. For all three of the messages, more than 85 percent of the participants interpreted the start of the incident to be after the exit ramp to the first street referenced in the message and ending prior to the entrance ramp from the second street.

10. OTHER DMS MESSAGE ISSUES

In addition to the information needs or the primary situations discussed previously, the researchers took the opportunity of the focus groups to examine other DMS message issues that are either currently unresolved or should be explored to validate previous research findings. Limitation of administration time did not allow further assessment in the human factors laboratory studies. The additional issues examined were:

- use of the term CRASH versus ACCIDENT,
- use of the phrase RIGHT (LEFT) 2 LANES CLOSED versus 2 RIGHT (LEFT) LANES CLOSED,
- interpretation of the phrase TRUCK ACCIDENT versus MAJOR ACCIDENT,
- formatting two-phase messages containing four units of information,
- understanding of USE OTHER ROUTES,
- blank DMSs, and
- public service announcements.

FOCUS GROUP STUDIES

ACCIDENT versus CRASH

The participants in the focus groups were presented with a scenario where an accident had occurred in their local area involving a semi-truck and two passenger vehicles. The participants were asked to select their preference of wording for messages to be displayed on DMSs. First, the groups saw the two messages below (street names were changed as appropriate for the area) and were asked to select their preference for both the first and third lines.

CRASH AT EVANS RD RGT 2 LANES CLOSED

Message 1

ACCIDENT AT EVANS RD 2 RGT LANES CLOSED

Message 2

For the incident descriptor, all of the participants preferred the term ACCIDENT over CRASH. Several reasons commonly given by the participants for this preference included:

- CRASH sounds like slang or is juvenile,
- ACCIDENT is a more familiar term for this situation, and
- CRASH reminded some of the participants of an airplane incident.

RIGHT 2 LANES versus 2 RIGHT LANES

In displaying the unit of information regarding the closed lanes, five of the groups preferred RGT 2 LANES CLOSED. Reasoning for this preference was that the direction was the most important part of the information. For the group that preferred 2 RGT LANES CLOSED, they believed that the number should be at the front of the line, otherwise it gets lost in the text.

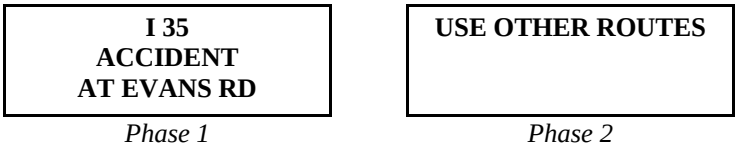
A brief discussion was also had regarding the abbreviation for the word "right." In two of the groups it was stated that they believed RT was the standard abbreviation for right. However, the majority of the participants who commented on this subject had no problem understanding the abbreviation RGT as right. At one location it was stated that RT would mean route and not right.

TRUCK ACCIDENT versus MAJOR ACCIDENT

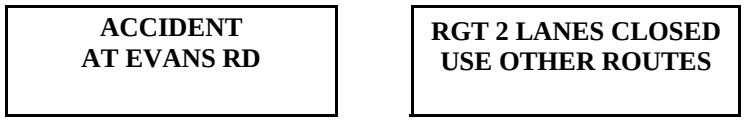
The next part of the scenario related to the incident descriptor portion of the message. In this situation participants were asked if they preferred TRUCK ACCIDENT or MAJOR ACCIDENT as an incident descriptor for a situation where a semi-truck and two passenger vehicles were involved in the incident. All of the participants preferred MAJOR ACCIDENT as the incident descriptor. The groups believed that this would cover a severe situation, including an incident that would cause multiple hours of delay for the driver. Other comments in support of this were that TRUCK ACCIDENT could imply that only a single small truck was involved in the crash, which is not necessarily a serious situation. It was also commented that the term MAJOR covers more situations that might occur on the roadway and that the specific circumstances of the incident (i.e., that a truck is involved) are not critical for the driver to know. The one exception to this was that if there is a chemical spill involved with the crash then drivers should be provided with information so that they can evacuate the area.

Format for Two-Phase, Four Unit Messages

The final set of messages displayed for the groups incorporated all of their preferences from the previous parts of this section. Examples of the two messages presented to the participants are shown BELOW.



Message 1



Message 2

The majority of the groups (4 of 6) preferred Message 2. Message 2 was preferred primarily because it provides the driver with information regarding which lanes are closed due to the incident. For the two groups who preferred a different message, they believed Message 1 was shorter and simpler. However, one of groups that preferred Message 1 eliminated the highway name from this message to suit their preferences. Overall, 87 percent of the participants believed that the message did not need to include the name of the highway if it was the same road that the driver was traveling on.

Understanding of USE OTHER ROUTES

Finally, the groups discussed the term USE OTHER ROUTES. Eighty-four percent of the participants who were asked this question believed that the term was a suggestion and not a requirement for the driver. One group did note that in Message 1 USE OTHER ROUTES seems more like a requirement due to the fact that the message does not include information regarding what lanes are closed. Suggestions as to how to make it a requirement that a driver change routes included:

- Must Use Other Routes,
- Detour [road name], and
- Closed.

Public Service Announcements

In order to obtain the participant's opinions of public service announcements (PSAs) with regard to their use on DMSs, the participants were shown the following PSA that could be displayed on a DMS:

The participants were asked if they thought that the DMSs should be used for this type of message rather than a blank sign. Five of the six focus groups agreed that they preferred to have PSAs displayed on the DMS versus seeing them blank. In San Antonio they specified that although the DMSs should be used for messages rather than being blank, the only messages that should be allowed would be related to driver safety or traffic information. Also, in Houston, the

entire group agreed that before using PSAs, they would prefer to see travel time information displayed. However, all of the groups agreed that if PSAs are used the messages must be changed frequently to ensure that people continue to pay attention to the DMSs. Five of the groups agreed that the messages should be changed daily.

Summary

The results suggest the following:

1. The word ACCIDENT was preferred to CRASH by all of the participants.

2. The phrase RIGHT (LEFT) 2 LANES was preferred to 2 RIGHT (LEFT) LANES by a majority of the participants.

3. The phrase MAJOR ACCIDENT seems to imply a more serious incident than TRUCK ACCIDENT and was preferred by most of the participants. This finding should be validated in the laboratory studies.

4. The majority of the participants stated that the name of the highway need not be displayed on a DMS when the incident is on the same highway. There is more relevant and useful information that can be displayed instead. This finding validates current message design guidelines.

5. A high percentage of the participants understood the term USE OTHER ROUTES to be a suggestion and not a requirement. The participants offered alternative terms that could be used in case the diversion was mandatory. Laboratory experiments should be designed to evaluate these latter candidate terms.

6. There was indication from the focus groups that drivers prefer to see a message displayed on DMSs versus seeing blank signs. This is contrary to some published recommendations. Although the preference is for traffic related information (e.g., travel time), there appeared to be an acceptance by many participants for public service announcements that are related to drive safety or traffic. This issue should be further explored.

11. CONCLUSIONS AND RECOMMENDATIONS

DMSs are vital components in the motorist information system. Using these signs, authorities are able to quickly and effectively disseminate information to the general public. The laboratory study documented in this report focused on the use of DMSs during AMBER alerts, flooding, and ozone alerts, and also on how to identify the location of incidents. The base knowledge for this human factors laboratory study was gained through focus group discussions held during the previous year of this project. Through these discussions, researchers identified the following topics to be addressed in the laboratory studies:

- AMBER Alerts
    - Evaluate best term to use as a situation descriptor.
    - Assess relative importance of different units of information to be included.
    - Identify ability of motorists to recall telephone or license plate numbers.
    - Identify the equivalent units of information appropriate for telephone or license plate numbers.
    - Evaluate reading time and comprehension of alternative messages.
- Flooding
    - Identify best terminology to convey that roadway is impassable/passable.
    - Assess message content.
- Ozone Alert Messages
    - Assess message meaning and severity.
    - Identify possible actions drivers would take.
- Incident Location
    - Identify a term that is interpreted by motorists to mean upstream of the given cross street and exit.

Researchers conducted the human factors laboratory study in six locations throughout Texas (Arlington, Austin, El Paso, Houston, Laredo, and San Antonio) and addressed the topics listed above. The following sections identify the key findings and recommendations that were gained from these studies for each topic area.

AMBER ALERT

Driver Preference and Priority

There were two different parts of this session; the first was to identify which of a series of message elements would be the most appropriate within a specific category of information to use in the DMS message. The following are the primary points gained from this study:

- there was no majority opinion for what term should be used as a situation descriptor, although AMBER ALERT was the most commonly selected;
- results supported the earlier focus group findings that the term MISSING has the connotation that a child would not be in a dangerous situation and so would not be a preferable descriptor for AMBER alert messages;
- participants preferred more detailed vehicle descriptions consisting of vehicle color, make, body type, and possibly year;
- regarding vehicle license plate, participants believed the inclusion of the symbols "#" and "-" helped to keep the words from visually running together; and
- participants preferred the shorter telephone number (i.e., 511) because it was easier to remember.

Additionally, researchers identified through several different avenues that the following order of importance exists for the message elements to be displayed in AMBER alert messages:

1. Situation Description
2. Vehicle Description
3. License Plate Number
4. Telephone Number
5. Radio Information

Unit of Information Equivalents of Telephone and License Plate Numbers

A reading time and comprehension study was conducted to determine the unit of information equivalents for both telephone and license plate numbers when included in a DMS message. The following bullets outline the findings of this study:

- Long telephone numbers (e.g., 800-numbers) should be considered to be equivalent to three units of information.

- Short telephone numbers (e.g., CALL 511) should be considered as one unit of information.

- License plate numbers have a learning curve necessary to recognize the formatting and possibly the abbreviation (LIC) used; however, once the format becomes familiar to motorists it should be considered to be equivalent to three units of information.

- The combination of license plate and telephone numbers in a message would have a much higher unit of information equivalency than would be appropriate for use on a DMS.

Recommendations

Based on the findings summarized above, researchers make the following recommendations regarding the design of AMBER alert messages for DMSs:

- No clear preference was determined for a situation descriptor; however, it is recommended that the term MISSING is not used for this situation.

- When possible, a message should include a detailed description of the vehicle involved in the situation.

- License plate and long telephone numbers should not be included in AMBER alert messages. The use of short telephone numbers (e.g., 511) is recommended for these messages.

- Use of the message element TUNE TO RADIO or a specific radio station indicator is recommended as a means of providing motorists with further details regarding the situation.

FLOODS

The study relating to the use of DMSs in flood situations was done in two parts. The first part required participants to create a message for a given situation presented on a schematic map, and the second part explored participant preferences between alternative flooding message formats. The findings of these two studies were as follows:

- Motorists would prefer to have messages displayed when water is present but is passable. The most common situation description identified for this event was WATER ON ROAD and the location was identified as a distance ahead.

- Participants stated that telling drivers to either REDUCE SPEED or USE CAUTION would let them know that they can continue on the road and do not need to exit.

- CLOSED was the most common situation descriptor for flood events that are impassable.

- The term FLOODED would likely be the most effective term of those studied in convincing drivers to leave the freeway when compared to DEEP WATER and HIGH WATER.

- Participants felt the inclusion of an action term (e.g., EXIT AT VOSS RD) was very important when the roadway was impassable; also the use of a street name is preferred over an exit number.

- Regarding the location description of a flood, researchers believe this is highly situation dependent. Specifically, if the road is less well known to drivers, it may be less desirable as a location identifier versus a distance or other nearby street. On the other hand, if the road is well known to drivers, it is likely to be more preferred in the flooding message.

- The majority of participants preferred for the roadway indicator to have a format that included both the highway number and direction and they believed that this information should be contained on the first line of a message.

- For an interstate abbreviation there was a slight preference for I over IH; however, there were regional differences regarding this preference.

Recommendations

Based on the findings summarized above, researchers make the following recommendations regarding the design of flooding messages for DMSs.

- Messages should be displayed when there is standing water on the road, even if the water is passable. The situation descriptor "water on road" may be used in this situation.

- If water on the road is impassable, use of either the term CLOSED or FLOODED are recommended to alert drivers to exit the roadway.

- Include action terms (specifically exit information) in flood messages and use street names over exit numbers in reference to exit information.

- If a roadway indicator is to be included in the messages, it should be the first line of the message and have the format of I-XX [direction].

OZONE

The objective of this section of the study was to determine drivers' understanding of alternative ozone messages and their potential reactions to the messages. The study had two parts, with the

first part designed to evaluate five primary ozone message descriptors. The following were the key findings of this study:

- The participants had no clear distinction between the terms ADVISORY and WATCH, between ALERT and WARNING, or between WARNING and ACTION.
- If not indicated otherwise, motorists will assume that the message pertains to current conditions.
- In response to the display of these terms, the majority of the motorists indicated that they would do nothing different in terms of their driving plans.

The second part examined messages that contained an action element. When given suggestions for actions to take in an ozone message, most participants are able to restate those actions (i.e., ride a bus, carpool, etc.). Furthermore, the majority of the participants felt this information should be included in the message.

Recommendations

Based on the findings summarized above, researchers make the following recommendations regarding the design of ozone alert messages.

- If the alert is for other than current conditions (i.e., conditions tomorrow), specify this in the message.
- Include driving behavior suggestions in the message.

INCIDENT LOCATION

In this section, researchers strived to decipher motorist interpretations of different terms used on DMSs to identify locations of incidents or roadwork. Researchers were especially concerned in this study whether participants believed it is possible to use an exit ramp based on the location term used in the message. Overall, the study evaluated seven messages. The first four messages presented to participants identified the location of a MAJOR ACCIDENT as either PAST, BEYOND, AT, or BEFORE a specifically referenced street. The results indicate:

- three terms (PAST, BEYOND, and AT) were interpreted as being after the exit ramp, thereby allowing motorists to exit at the referenced cross street,
- two terms (PAST and BEYOND) were interpreted as being after the cross street, and
- BEFORE was interpreted as being prior to the exit ramp for the referenced cross street.

The final three messages tested used word sets to identify a section or area of the freeway that was closed, or affected by, an incident or roadwork. The three word sets examined were

FROM/TO, BETWEEN/AND, and BEYOND/TO. For all three of the messages, the start and end points were identified as:

- Start Point – after the exit ramp to the first street referenced in the message, and
- End Point – prior to the entrance ramp from the second street.

Recommendations

Based on the findings summarized above, researchers make the following recommendations regarding the terms to be used to identify the location of an incident:

- Use of any of the terms PAST, BEYOND, or AT to indicate that the incident is after the referenced cross-street exit ramp.
- Use PAST or BEYOND to indicate that the incident is after the cross street.
- Use the term BEFORE if it is not possible to use the referenced street exit ramp.
- Any of the term combinations studied (FROM/TO, BETWEEN/AND, and BEYOND/TO) indicate a start point that is past the first referenced street exit and the incident area that ends prior to the entrance ramp from the second referenced street.

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APPENDIX A
FOCUS GROUP ADMINISTRATION MATERIALS

Introduction to Focus Group

Hello, my name is Nada Trout and this is Brooke Ullman. We are here today to conduct a group discussion for the Texas Department of Transportation (TxDOT). Our objective is to obtain your opinions on various sign messages used on changeable message signs to provide information to drivers for a variety of specific situations, such as special events, adverse weather, and major catastrophes. Before we get started, if you have not turned in the **forms** you were given as you arrived, please turn them in at this time.

You will notice that we are **recording** this session. The recording will be used as a backup to the notes we will be taking. In addition, it will allow us to concentrate on what you are saying in the group. I want to assure you that you will not be quoted by name. We would like you to remember that this discussion group session is to obtain **your personal opinion as a driver**. We need to know what you think and how you personally feel about the topics we're going to be discussing. Beyond your own initial responses and impressions, I want you to feel free to respond to whatever anyone else says. Remember, you do not have to agree with us or with one another.

Now, I'd like to go over a few items before we begin.

- The role of the moderator is to **lead the discussion** and ensure that everyone in the group has the opportunity to share his/her point of view about the topics being discussed. The session should last about one and a half to two hours.
- **Only one person should talk at a time** because it becomes impossible to understand the tape when more than one person is talking. Also, if only one person is talking, it is much easier for the rest of us to focus on what that person is saying.
- Please **refrain from having side conversations** during the session, as it tends to be very distracting.
- Please **speak loud enough** so that the tape recorder can pick up your comments.
- Please **share your personal feelings** about the topic, **even if you have a negative comment or you disagree with others in the room**. Remember, this discussion is being conducted to obtain **your opinions** on information given to drivers during specific situations.

- Please make your responses as **clear and precise** as possible.

Now, I'd like to take just a few minutes and go around the room and have you introduce yourselves. Please state your first name only and tell us your most recent encounter with a changeable message sign.

Focus Group Guide

Section 1. AMBER Alerts

Question 1. We want to describe a situation where a child is taken by a stranger and to display this information on a changeable message sign. What do you feel is the best term to use so that most drivers would understand the message? (*Discuss each term.*)

Kidnapped Child
Abducted child
Missing child
AMBER ALERT

Question 2. Discuss the suggested alternatives as options in a message.

a) Does the order of the words make a difference in your ability to quickly understand the message?

b) Do you have a preference as to the order of the words? Why?

ABDUCTED CHILD vs. CHILD ABDUCTED
KIDNAPPED CHILD vs. CHILD KIDNAPPED
MISSING CHILD vs. CHILD MISSING
AMBER ALERT

Question 3. As we just discussed, there are many possible terms that could be used to describe this situation. Would each of you rank these alternatives from 1 to X according to your preference as a driver? (Give a handout for ranking.)

Question 4. Now, go back and rate each of the alternatives from 1 to 5 depending upon how well you feel drivers will understand the situation. (*Have each person write rating for each term.*)

Question 5. While driving, have you ever seen a CMS message indicating that a child has been taken by a stranger?

If yes, what information do you remember being provided in that message?
(Distinguish in the discussion information that was related to different messages.)

a) Was the information provided adequate for you as a driver?

b) Do you feel that the information was necessary or helpful to you?

c) Was there other information that you would have liked to have had in this situation?

Vehicle Description (make distinction for make, color, model, year)

License Plate Number
Phone Number to Call
Radio Station for Information

Question 6. What other information do you think is important for a driver to be provided with during this type of situation?

Vehicle Description (make distinction for make, color, model, year)
License Plate Number
Phone Number to Call
Radio Station for Information
Location Where Incident Occurred (local, state, regional, out-of-state)

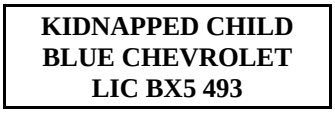
Note: Government agencies refer to these types of situations as "Amber Alerts" and they apply strictly to children.

Question 7. Do you think that the term AMBER ALERT could be confused with the homeland security warning levels? If so, explain?

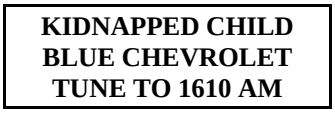
In the next part of our discussion, we will show several different changeable message sign messages on the screen. Each message will be displayed for a period of time. This time is equal to how long a driver traveling at 55 mph can read the sign. Following each message, I will ask some questions.

Show message 1 for 8 seconds.

Message 1



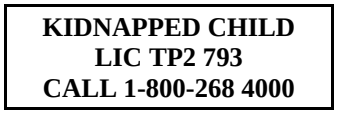
Phase 1



Phase 2

Message 2

Message 3



Question 1. What do you remember from the message?

a) Why do you think you remembered these portions of the message?
   Words are easier to remember than numbers.
   Colors easy to remember
   First line first thing I read (saw)

Question 2. What parts of the message were you not able to remember?

a) Why do you thing you did not remember that portion of the message?
   Too much information.
   Hard to remember sequences of numbers/letters (phone # or license plate)
   Too short of time.

b) Can you remember any part of the license plate number shown?

Question 3. How would you change the message to make it easier to understand/read (*length or content*)?

Get rid of XXXX.
Add XXXXX.
More time (not possible, explain).
Don't need all of the information provided.

a) If the message is too long, what should be omitted? Why?

Show message 2 and 3 and ask similar questions.

Question 4. *Show all messages at one time.* Which message do you feel is the best? Why?

Question 5. *Turn off overhead display*. Can anyone tell me the license plate numbers we were just looking at?

If no, since none (or very few) of you remembered it, do you still think it is important information to provide to a driver?

Question 6. (*Show message using an out-of-state license plate)* If you saw this message what does the third line tell you?

Where the incident occurred
The car that was used in the incident is from X state
Texas license plate of vehicle
X license plate of vehicle

KIDNAPPED CHILD
RED TOYOTA
MA LIC KL4 362

Question 7. We now want you to rank and rate the importance of each of the types of information that could be provided to a driver during this type of situation. (1 – Most Important, X – Least Important).

Section 2. Adverse Weather, Environmental, and Roadway Conditions

We are going to change subjects and discuss CMS messages and driver information during adverse weather, environmental, and roadway conditions.

Question 3. During what types of adverse weather, environmental, or roadway conditions do you feel it is important to provide additional travel information to drivers? (*if discussion goes too far into the disaster response or evacuation ideas (i.e., hurricanes, flooding) mention that we will be discussing this type of situation in more depth in the next section).*

Poll responses as to the number of participants who believe information is important for different situations/conditions and severity of the situation.

Rain
Fog
Ice
Sleet
Wind
Smoke (Grass Fires)
Hail
Snow
Standing Water on Road (minor flooding)
Tornado
Smog/Ozone Warning
Forest Fires
Dust Storms
Broken Pavement

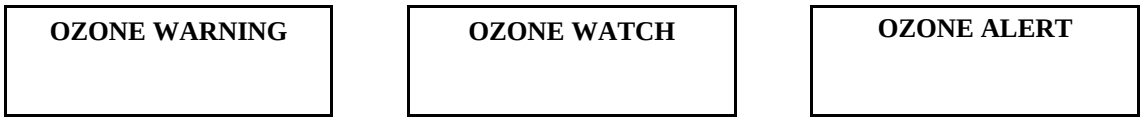
Question 4. In these types of situations, what information do you think is important to be provided on a CMS? Why?

Road Conditions – slippery, water on road, icy
Visibility Reduced
Road Closures
Alternative Routes
Reduced Speed Warnings

Question 6. *For each situation*: As conditions improve or change, when should the message be turned off?

Question 7. *(Display ozone message)* If you saw this message, what does it mean to you? Would you change your driving behavior? Why or why not?

Question 8. (*Display library of ozone messages using alert, warning, and watch*.) Would you react differently for each of these messages? If so, what would you do differently?



Message 1 **Message 2** **Message 3**

Question 10. Sometimes because of the heat or ground thawing cycles in north Texas, the pavement breaks up and one or more lanes must be closed. What term is best to describe the event so that it can be posted on a changeable message sign?

Lane/Road Hazard
Lane/Road Damage
Potholes

Section 3. Disaster Response and Evacuation

We are now moving onto more serious types of situations including: hurricanes, flooding, severe winter storms, and terrorist attacks. We will discuss each of these topics individually.

Hurricane situation 1: We need you to put yourself into a situation where you are on vacation in Galveston and the area is threatened by a hurricane. (Different for Houston, they live close enough to think about it as an at-home situation.)

Question 1. If a mandatory evacuation of the area was required, what type of information do you think should be displayed on a CMS, remember that the roadway will be very congested (~3 hours of delay) due to the evacuation? *Rank suggested information for importance to a driver.*

Evacuation Information – routes, notices
Road Closures
Island or Area Closures
Ferry Information

Curfew Information
Debris/Wires Down in Road
Hotel Accommodations
Restroom Facilities
Gasoline Availability
Travel Time

Rank and Rate information importance.

Hurricane Situation 2: Assume now that the hurricane event has passed and you are returning or have already returned to Galveston.

Question 2. As a driver in the affected area, what information do you think should be displayed on a CMS after the hurricane?

Closed Roads/Areas
Curfew Times
Debris in Road
Electrical Lines Down

Rank and Rate information importance.

Question 3. As a driver, what type of information do you think should be provided on a CMS during a **severe flooding event**? *Rank suggested information for importance to a driver.*

Road Closures
Alternative Routes
Evacuations
Warnings

Question 4. *(Display current flood/high water messages)* What does this message tell you? Would you continue to drive on this road? Why or why not?

a) *If they would continue to drive*, how would you change the message to alert drivers that the road is under water and unsafe to drive on.

b) How would you change the message to encourage drivers not to continue traveling on the highway?

If they suggest closed: What does the term closed mean to them? Does it imply roadblocks and or officers involved? Is there an alternative word?

c) *If they would not continue to drive*, how would you change the message to alert drivers that there is water across the road but passable, and to proceed using caution.

d) What does flooded mean to them? Impassable? High water mean anything different to them? Why?

e) How does the addition of the third line change your driving decisions? Why?

f) Would you continue to drive on this road?

g) Assuming you are traveling on I-30, does the highway name need to be included in the message? Why or why not?

Build Messages – discuss and rank with group. Alter the messages based on suggestions and discussion. Remember we can only provide four pieces of information on the CMS.

Again, we are going to put you into a special situation for the following questions. Imagine that you are in a city (New York or Washington D.C., could be closer to home, for example, Dallas) that has just been **attacked by terrorists**. Many roads are affected by the attack, and the driver has not seen or heard other reports of the attack before seeing the CMS.

Question 6. Assume that you are a driver approaching the affected area, what type of information do you think should be provided on a CMS? *Rank suggested information for importance to a driver.*

Road Closures
Areas/Roads with Increased Threat
Security Level
Radio Station Information
Type of Attack
Location of Attack

Question 7. Assume that you are a driver already in the affected area, what type of information do you think should be provided on a CMS? *Rank suggested information for importance to a driver.*

a) How is this information you need now different than in the previous situation?

Section 4. Planned Special Events

Create specific situations (particular to each area) that the participants can put themselves into:

1. *Discrete/Recurring Event: (Example Football Game)- Baseball Game*
2. *Continuous Event: (Example Rodeo) – State Fair*
3. *Street Use Event: (Example Parade) – Festival*
4. *Regional/Multi-venue Event: (Example Fireworks Display) – July 4 Fireworks*

Special Event Target Audiences:

Driver Attending the Event
Driver Not Attending Event (local driver passing the event area)

We want you to imagine that the (name particular event) is occurring in the area and that you are (one of the target audiences).

Address Q2-4 for each of the target audiences:

Question 2. What information do you think should be provided on a CMS during this type of special event?

Alternative Routes around Event
Directions to Location
Parking
Time of Event

Question 3. When should the information about a special event be provided?

The day of the event
Week before the event
During the event

Question 4. Where (at what location) should special event information be provided?

Near Exits to the Event
On All the Roads Leading to Events
At Interchanges to Make Decisions

On street use situation only: If an event is happening that has closed off streets in the downtown area (or on the local city streets) what information do you need as a driver on the nearby highway, if any? Why?

Section 5. Message Credibility and Other Issues

Sometimes changeable message signs on urban freeways are left blank for several days because there are no incidents or roadwork to report to the drivers.

Question 1: In your opinion, is it better to leave the signs blank or to post messages such as which would be displayed for several days until an incident occurs

RIDESHARE
1 800 268 5000

Question 2. What would your reaction be if you saw this message every day for several days?

Question 3. How would this message and the time length that it was displayed affect your confidence in the changeable message sign system?

Finally, we would like to ask you some questions about a couple of specific messages. *(Show diagram of the accident area.)* Imagine that you are traveling westbound on I-30 from Dallas to Fort Worth. You do not know it yet, but there has been a collision involving a semi-truck and two cars that and is blocking the right two lanes between Cooper St. and Fielder Rd. near the Cooper St. entrance ramp. As you approach Collins St. traffic is flowing normally. You see a CMS displaying one of the following signs.

CRASH
AT COOPER ST
RGT 2 LANES CLOSED

Message 1

CRASH
AT COOPER ST
2 RGT LANES CLOSED

Message 2

Question 1. In the given situation, which of these messages do you prefer? Why?
Preference based on *(need to id preference for each piece of information)*:

Crash vs. Accident
Right 2 vs. 2 Right

Question 2. Do you like the use of "crash" vs. "accident"? Why?

Question 3. Do you have a preference for how the third line is displayed? Why?

(best from 1)
AT COOPER ST
(best from 1)

Message 1

(best from 1)
W OF COOPER ST
(best from 1)

Message 2

(best from 1)
PAST COOPER ST
(best from 1)

Message 3

Question 4. In the given situation, which of these messages do you prefer? Why?

MAJOR (best from 1)
(best from 2)
(best from 1)

Message 1

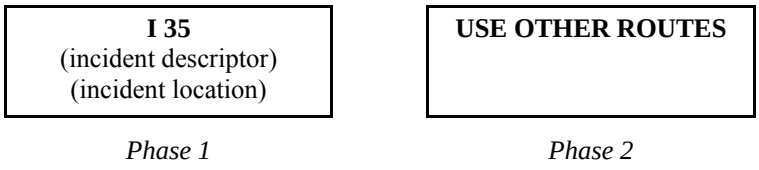
TRUCK ACCIDENT
(best from 2)
(best from 1)

Message 2

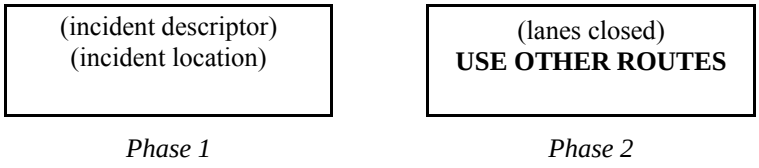
Question 5. Okay, now in this situation, which of these messages do you prefer? Why?

Question 6. Does “major (accident/crash)” mean something different to you than “truck accident”? What? Does “major (accident/crash) mean that it is more severe than the other?

a) What other wording would you use (besides “truck accident”) to indicate that an accident involving a semi-truck has occurred and will create two or more hours of delay?



Message 1



Message 2

Question 7. This is last set, in the given situation, which of these messages do you prefer? Why?

Question 8. Do you feel that you need the name of the highway if you are on the same road as the incident?

Question 9. How will you change your driving decisions based on “use other routes”?

a) Do you think this is a suggestion or are you required to leave the road?

Section 6. Closing

In closing, are there any further suggestions or remarks that you would like to make regarding any of the topics that we have discussed?

THANK YOU !

Focus Group Participant Information Sheet
Project 0-4023

City:_____ Zip Code: _____

Age: _____ Last Education Level Completed: _____

Gender: M F How long have you been driving? _____

If you were traveling on a road and saw the term "AMBER ALERT" what would it mean to you?
_____
_____
_____
_____

As a driver, do you use Changeable Message Signs as a tool for getting traveler information during any of the following situations? (check all that apply)

__ Work Zones
__ Accidents
__ Commuter Travel Times
__ Special Events
__ Adverse Weather
__ Flooding
__ Terrorist Attacks
__ Evacuations
__ Other _____

4023 Focus Group

	Ratings
Rank	**1 Excellent 2 Good 3 Fair 4 Bad 5 Terrible**

1 _____ (1 2 3 4 5)

2 _____ (1 2 3 4 5)

3 _____ (1 2 3 4 5)

4 _____ (1 2 3 4 5)

5 _____ (1 2 3 4 5)

6 _____ (1 2 3 4 5)

7 _____ (1 2 3 4 5)

8 _____ (1 2 3 4 5)

9 _____ (1 2 3 4 5)

10 _____ (1 2 3 4 5)

11 _____ (1 2 3 4 5)

12 _____ (1 2 3 4 5)

APPENDIX B
HUMAN FACTORS LABORATORY STUDY INSTRUMENT

Date: _____ **Number: _____**

SESSION 1: AMBER ALERT (CARD SORT)

Part 1: Message Content

We need your advice on making up a message that would be displayed on an electronic message sign. Such as the signs you may have seen that tell you an accident has occurred.

The police have been notified that a child has been taken by a stranger. We need you and other drivers to be able to help in this situation. We are going to build a sign that gives as much information as possible to drivers.

The pack of 3x5 cards in front of you has the makings of such a sign. Each set of colored cards consists of several different ways of saying the same thing. You may choose any one of the cards from each color group, but no more than one from each color set. The colors have no meaning except as a way of grouping the same kind of things together.

Place the cards you select in the order that you would like to see the information shown on the sign. Remember, you must use one card from each color set.

Hand out 3x5 cards. After they have selected their cards, check and make sure that one card from each color is selected and record the information and order of cards below. The sign should have 5 lines.

Circle the cards selected and indicate the line order number established by the participant:

Set 1 (Red)	*Line*	*Set 2 (Blue)*	*Line*	*Set 3 (Green)*	*Line*	*Set 4 (Yellow)*	*Line*	*Set 5 (Orange)*	*Line*
a. AMBER ALERT		**a. BLUE MAZDA**		**a. LIC SR8 493**		**a. CALL 511**		**a. TUNE TO 535 AM**	
b. ABDUCTED CHILD		**b. BLUE PICKUP**		**b. LIC # SR8-493**		**b. DIAL 511**		**b. TUNE TO RADIO**	
c. ABDUCTED BOY		**c. BLUE MAZDA PICKUP**				**c. CALL 888 769 5000**		**c. TUNE TO LOCAL RADIO**	
d. MISSING CHILD		**d. MAZDA PICKUP**				**d. DIAL 888 769 5000**			
e. MISSING BOY		**e. BLUE MAZDA 05 PICKUP**							
f. KIDNAPPED CHILD									
g. KIDNAPPED BOY									

Part 2: Rating

Here are the five cards that you selected in the order that you created for your message. Look at the cards and the message. Now for each card, I want you to give me a number from 1 to 5 to let me know how important the information is to have on the sign. A "1" is high and means it is very important; a "5" is low and means it is not important.

Line #	Card	Rate of Importance (1-5)
1		
2		
3		
4		
5		

Part 3: Reasons for Message Line Choices

We are still looking at the five cards that you selected in the order that you created for the message.

You chose from the _____Set, _____ for the first line of your message. **These are the other possibilities that you could have selected for that line.** *(Give the participant the other cards with the same color.)*

Would you tell me why you selected this option rather than the other cards? *(Record the reason why EACH OTHER CARD IN THE SET was not selected.)*

a. _____

_____

*b.*_____

_____

*c.*_____

_____

*d.*_____

_____

*e.*_____

_____

f. _____

_____

*g.*_____

_____

You chose from the _____Set, _____ for the second line of your message. **These are the other possibilities that you could have selected for that line.** *(Give the participant the other cards with the same color.)*

Would you tell me why you selected this option rather than the other cards? *(Record the reason why EACH OTHER CARD IN THE SET was not selected.)*

a. _____

_____

*b.*_____

_____

*c.*_____

_____

*d.*_____

_____

*e.*_____

_____

f. _____

_____

*g.*_____

_____

You chose from the _____Set, _____ for <u>the third line</u> of your message. **These are the other possibilities that you could have selected for that line.** *(Give the participant the other cards with the same color.)*

Would you tell me why you selected this option rather than the other cards? *(Record the reason why EACH OTHER CARD IN THE SET was not selected.)*

a. _____

_____

*b.*_____

_____

*c.*_____

_____

*d.*_____

_____

*e.*_____

_____

f. _____

_____

*g.*_____

_____

You chose from the _____Set, _____ for <u>the fourth line</u> of your message. **These are the other possibilities that you could have selected for that line.** *(Give the participant the other cards with the same color.)*

Would you tell me why you selected this option rather than the other cards? *(Record the reason why EACH OTHER CARD IN THE SET was not selected.)*

a. _____

_____

*b.*_____

_____

*c.*_____

_____

*d.*_____

_____

*e.*_____

_____

f. _____

_____

*g.*_____

_____

Finally you chose from the _____Set, _____ for <u>the fifth line</u> of your message. **These are the other possibilities that you could have selected for that line.** *(Give the participant the other cards with the same color.)*

Would you tell me why you selected this option rather than the other cards? *(Record the reason why EACH OTHER CARD IN THE SET was not selected.)*

a. _____
_____
*b.*_____
_____
*c.*_____
_____
*d.*_____
_____
*e.*_____
_____
f. _____
_____
*g.*_____
_____

<u>Part 4: Ranking</u>

Now remove the card that is least important to you.
Card Removed: _____

Can you tell me why you removed this particular card? _____
_____
_____

Now, with the cards that you have left, remove the card that is least important to you.
Card Removed: _____

Can you tell me why you removed this particular card? _____
_____
_____

Finally, remove another card that would be the least important to you.
Card Removed: _____

Can you tell me why you removed this particular card? _____
_____
_____

Collect cards and set them aside.

END OF SESSION 1

SESSION 2: AMBER ALERT SELF-PACED
(Laptop - Surveyor)

During this study, you are to assume that you are in [Laredo] and driving [northbound] on [Interstate 35]. As you travel on the freeway you will occasionally see changeable message sign messages displayed on the computer monitor.

You are going to use the mouse to click on red dots that appear in a box on the screen. Your job is to click on as many of the red dots as possible. The number of dots you click, along with your average time, will be displayed after you have answered questions for each changeable message sign displayed.

We are going to go through an example. Remember to click on the red dots that appear on the screen. *(Show an example of DMS messages and have the participant go through the driving scenario described above—clicking on the red dots—while the message is shown on the screen.)*

OK, we are now ready to begin the session. When you press the space bar you will be shown a message on the screen. In this session you have control over how long you view the message. The instant you have read the message, you will need to press the space bar to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Press the space bar to view the message.

Answer for Test Message 1 – *(CONSTRUCTION - AT ROSEWOOD DR)*

What was the message on the screen? ☐ - ☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.

Answer for Test Message 2 – *(I-35 CLOSED – MON-FRI)*

What was the message on the screen? ☐☐☐ - ☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.

Answer for SIGN 1D HAR *(TUNE TO 1350 AM)*

What was the message on the screen? ☐☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 2D Tel. *(CALL 800 391-7000)*

What was the message on the screen? ☐☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message
Answer for SIGN 3D Lic. *(LIC DS6-837)*

What was the message on the screen? ☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 4D *(CALL 911)*

What was the message on the screen? ☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 5D (Lic/Tel) *(LIC 642-953 CALL 888 493 4000)*

What was the message on the screen? ☐☐☐ - ☐☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 6D Base AMBER Alert *(KIDNAPPED CHILD-YELLOW TOYOTA-TUNE TO RADIO)*

What was the message on the screen? ☐☐ - ☐☐ - ☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 7D BASE INCIDENT *(FREEWAY CLOSED-AT CALTON RD -USE OTHER ROUTES)*

What was the message on the screen? ☐☐ - ☐☐☐ - ☐☐☐

_____

_____

Press the space bar to view your button pushing score.

This is the end of the session. We can take a break if you need one.

END OF SESSION 2

SESSION 3: FLOODING (MAP STUDY)

Base Map

During this part of the study, you are to again assume that you are in [Laredo] driving [northbound] on [Interstate 35]. *(Give the participant the Base Map.)*

This map shows a section of [Interstate 35]. Take a few minutes to look at the map. On this map is [Interstate 35] which has four lanes in each direction. You also see three cross streets, [Loop 20], and one of the major roads to the right of [Interstate 35]. If you were driving on [northbound Interstate 35] you would be traveling from the bottom of the page to the top of the page.

At the bottom of the map is the changeable message sign that will display messages for drivers headed [north] on [Interstate 35]. The changeable message sign has three lines and about three short words can fit on each line.

Let me know when you feel that you are familiar with the freeway and streets. *(Give participant time to get oriented with the map and wait for an indication from the participant that he/she is ready.)*

Now point to the [northbound] lanes of [Interstate 35]. Correct Not Correct
(Make sure that the participant has correctly identified the [northbound] lanes of [Interstate 35]. If not, show the participant the [northbound] lanes of [Interstate 35] and discuss the map again to clarify).

(Point to the roadway next to [northbound] [Interstate 35].)

What do you normally call this? _____
(If you must prompt the participant, DO NOT use words such as road, drive, etc.)

Now point to the [Mann Road] exit ramp. Correct Not Correct
(Make sure that the participant's answer is correct. If incorrect, point to the correct exit ramp.)

Now point to the [Del Mar Boulevard] exit ramp. Correct Not Correct
(Make sure that the participant's answer is correct. If incorrect, point to the correct exit ramp.)

Now I want you to point to the entrance ramp from [Mann Road] to get onto [northbound Interstate 35]. Correct Not Correct
(Make sure that the participant's answer is correct. If incorrect, point to the correct entrance ramp.)

Now, point to the entrance ramp from [Del Mar Boulevard] to get onto [northbound Interstate 35]. Correct Not Correct *(Make sure that the participant's answer is correct.)*

Map 1: (Give participant Map 1 with water on freeway only.)

Now this is a map just like the one you looked at but with one change. As shown on the map, when it rains sometimes water collects on or flows across the freeway in low areas. In this situation, vehicles are still able to drive on the freeway through the water.

1. **Do you feel that it is necessary to display a message on the changeable message sign for this condition?** Yes No
   Why or why not?_____
   _____
   _____

2. **If TxDOT would like to display a message on the changeable message sign that has three lines and can display about three short words on each line,**

   a. **How would you describe the situation so that drivers understand the condition on the freeway? Remember, use as few words as possible because of the limited space on the changeable message sign. Also, keep in mind that the changeable message sign is a mile or so before the water and drivers cannot see the water on the road.**
   _____
   _____
   _____

   b. *(If participant does not include information about the location of the water ask the following)*
   How would you describe the location of the water across the freeway?
   _____
   _____
   _____

   c. *(If participant does not include words of assurance that drivers do not have to leave the freeway ask the following):* **What words would you use to give the drivers confidence that they will not have to leave the freeway?**
   _____
   _____
   _____

In the next situation, water has collected on and flows across the low area of the freeway. It is <u>not possible to drive</u> through the water. Remember, there is limited space on the changeable message sign so use as few words as possible, and the sign is a mile or so before the water so drivers cannot see the water across the road.

1. **How would you describe the situation so that drivers understand the condition on the freeway?** _____
   _____
   _____

2. **What did you or would you tell other drivers on the changeable message sign to convince them that they should leave the freeway before they reach the water across the road?**_____
   _____
   _____

3. **How did you or would you describe the location of the standing water to drivers so they could make a decision as to which exit ramps can be used?** _____
   _____
   _____

<u>Map 2: (Give participant Map 2 with water on frontage road.)</u>

OK, now let's look at another similar map. You are still driving on Interstate 35 northbound. The only difference here is that the water is on the road next to the freeway *(use term selected by the participant)*. In this situation water has collected on and flows across the low areas and it is <u>not possible to drive</u> through the water on the road next to the freeway *(use term selected by the participant)*. Keep in mind that the information must fit on the changeable message sign and that the drivers cannot see the water on the freeway:

1. **How would you describe the situation so that drivers understand the condition on the road next to the freeway?**
   _____
   _____
   _____

2. **How did you or would you describe the location of the standing water to drivers so they could make a decision as to which exit ramps can be used and how to drive around the water?**
   _____
   _____
   _____

Map 3: (*Give participant Map 3 with water on freeway and frontage road.)*

OK, now let's look at a final similar map. This time, the water is on both the freeway and the road next to it *(use term selected by the participant)*. In this situation, vehicles are NOT able to drive through the water. Again, keep in mind that the information must fit on the changeable message sign and that the drivers cannot see the water from their current location.

1. **How would you describe the situation so that drivers understand the condition on the freeway and the road next to it? _____**
   _____
   _____

2. **What did you or would you tell other drivers on the changeable message sign to convince them that they should leave the freeway before they reach the water? _____**
   _____
   _____

3. **How did you or would you describe the location of the standing water to drivers so they could make a decision as to which exit ramps can be used and how to drive around the standing water?**
   _____
   _____

This is the end of this session. We can take a break if you would like.

END OF SESSION 3

SESSION 4: FLOODING PREFERENCES

(Laptop – PowerPoint, Self-paced with displayed questions)

During this part of the study, you are to again assume that you are in [Laredo] driving [northbound] on [Interstate 35] freeway. As you travel on the freeway you will see changeable message sign messages as displayed on the computer monitor. Questions will appear on the screen with the message and you will state your answers out loud to me. You will not be clicking on the red dots in this part of the study. Do you have any questions?

Press the space bar when you are ready to begin.

Answer for Flood Message 1 (FREEWAY – HIGH WATER)

1. **Can you continue to drive on the freeway through the water or will you have to get off?**
   Continue Have to get off
   Explain:_____
   _____

Press the space bar to view the next message.

Answer for Flood Message 2 (FREEWAY – FLOODED)

1. **Can you continue to drive on the freeway through the water or will you have to get off?**
   Continue Have to get off
   Explain:_____
   _____

Press the space bar to view the next message.

Answer for Flood Message 3 (FREEWAY – DEEP WATER)

1. **Can you continue to drive on the freeway through the water or will you have to get off?**
   Continue Have to get off
   Explain:_____
   _____

Press the space bar to view the next message.

Remember you are in [Laredo] driving on [northbound Interstate 35]. The next time you press the space bar, you will see three messages side-by-side that are intended to give you information about water on the freeway that you will <u>not</u> be able to drive through.

Press the space bar to see the three messages.

Answers for Flood Message 2 (FREEWAY–FLOODED), Flood Message 4, ([I-35 NORTH]-FLOODED) and Flood Message 5 ([I-35]-FLOODED)

1. **Which message do you prefer?** FM 2 FM 4 FM 5

2. **Why do you prefer the message you selected? Be very specific**. _____
   _____
   _____

3. **Is it necessary to display "North" on the sign?** Yes No
   Why or why not?_____
   _____

4. **Given your selection, what other information would you like to have to help you make the decision to leave the freeway or not?** _____
   _____
   _____

The next time you press the space bar, you will see two messages side-by-side that are intended to give you information about water on the freeway that you will not be able to drive through.

Press the space bar to see the two messages.

Answers for Flood Message 6 (FLOODED-[I- 35]-AT [DEL MAR BLVD]) and Flood Message 7 ([I- 35]-FLOODED-AT [DEL MAR BLVD])

1. **Which message do you prefer?** FM 6 FM 7

2. **Why do you prefer the message you selected? Be very specific.** _____
   _____
   _____

Again, when you press the space bar, you will see two messages side-by-side that are intended to give you information about water on the freeway that you will not be able to drive through.

Press the space bar to see the two messages

Answers for Flood Message 8 ([I- 35]- FLOODED- AT [DEL MAR BLVD]) and Flood Message 9 ([IH-35]-FLOODED-AT [DEL MAR BLVD])

1. **Which message do you prefer?** FM 8 FM 9

2. **Why do you prefer the message you selected? Be very specific.** _____
   _____
   _____

When you press the space bar, you will see two messages side-by-side that are intended to give you information about the water on the freeway that you will not be able to drive through. I will ask you some questions about the two messages.

Press the space bar to see the two messages.

Answers for Flood Message 10 ([I- 35 NORTH] FLOODED-AT [DEL MAR BLVD]-USE NEXT 2 EXITS) and Flood Message 11 ([I- 35 NORTH] CLOSED-AT [DEL MAR BLVD]-USE NEXT 2 EXITS)

1. **Which message do you prefer?** FM 10 FM 11

2. **Why do you prefer the message you selected? Be very specific. _____**
   _____
   _____

The next time you press the space bar, you will see two messages side-by-side that are intended to give you information about the water on the freeway that you will not be able to drive through. I will ask you some questions about the two messages.

Press the space bar to see the two messages.

Answers for Flood Message 13 ([I- 35 NORTH] FLOODED-AT [DEL MAR BLVD]-TAKE EXIT [3B]) and Flood Message 14 ([I- 35 NORTH] FLOODED-AT [DEL MAR BLVD]-TAKE [MANN RD] EXIT)

1. **Which message do you prefer?** FM 13 FM 14

2. **Why do you prefer the message you selected? Be very specific. _____**
   _____
   _____

The next time you press the space bar, you will see two messages side-by-side that are intended to give you information about the water on the freeway that you will not be able to drive through. I will ask you some questions about the two messages.

Press the space bar to see the two messages.

Answers for Flood Message 10 ([I- 35 NORTH] FLOODED-AT [DEL MAR BLVD]-USE NEXT 2 EXITS) and Flood Message 12 ([I- 35 NORTH]-FLOODED AND CLOSED-AT [DEL MAR BLVD])

1. **Which message do you prefer?** FM 10 FM 12

2. **Why do you prefer the message you selected? Be very specific. _____**
   _____
   _____

The next time you press the space bar, you will see two messages side-by-side that are intended to give you information about the water on the freeway that you will not be able to drive through. I will ask you some questions about the two messages.

Press the space bar to see the two messages.

Answers for Flood Message 14 ([I - 35 NORTH] FLOODED - AT [DEL MAR BLVD] - TAKE [MANN RD] EXIT) and Flood Message 15 ([I - 35 NORTH] FLOODED - AT [DEL MAR BLVD] - TUNE TO 1610 AM)

1. **Which message do you prefer?** FM 14 FM 15

2. **Why do you prefer the message you selected? Be very specific. _____**
   _____
   _____

Press the space bar and we will take a break if you would like one.

END OF SESSION 4

SESSION 5: AMBER ALERT PART 1 COMPREHENSION
(Laptop-Surveyor, Fixed Time – 2/4 seconds, no repeat)

We are now ready to begin another session. Remember, you are in [Laredo] and driving [northbound] on [Interstate 35]. As you travel this route, you will see messages on several changeable message signs that will be shown on the computer monitor.

You will use the mouse to click on the red dots as you did in the previous session. When you press the space bar, you will be shown a message on the screen. It will stay on for a few seconds and then will automatically turn off. You will then be asked questions about the information in the message. Do you have any questions?

Press the space bar when you are ready to begin.

Answer for Test Message 4 (MAJOR ACCIDENT – AT [DEL MAR BLVD]) 4 seconds

What was the message on the screen? ☐☐ - ☐☐☐_____
_____
_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for Base Message 1 (CALL 911) 2 seconds

What was the message on the screen? ☐☐

_____
_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for Base Message 2 (TUNE TO RADIO) 2 seconds

What was the message on the screen? ☐☐☐

_____
_____
____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 1A HAR (TUNE TO 1620 AM) 4 seconds

What was the message on the screen? ☐☐☐☐

_____
_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 2A Tel. (CALL 888 769 5000) 4 seconds

What was the message on the screen? ☐☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 3A Lic. (LIC 739 452) 4 seconds

What was the message on the screen? ☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 4A (CALL 511) 4 seconds

What was the message on the screen? ☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 5A (Lic/Tel) (LIC RG5 693-CALL 800 876 3200) 4 seconds

What was the message on the screen? ☐☐☐ - ☐☐☐☐

_____

_____

Press the space bar to view your button pushing score.

Press the space bar to view the next message.
Answer for SIGN 6A Base (TUNE TO RADIO) 4 seconds

What was the message on the screen? ☐☐☐

_____

_____

This is the end of this session. We can take a break if you would like.

END OF SESSION 5

SESSION 6: LOCATION OF INCIDENTS AND ROADWORK (Map Study)

During this study, you are again to assume that you are in [Laredo] driving [northbound] on the [Interstate 35]. **I am going to give you a map that is a small part of the larger map that you used earlier. On the map is a message displayed on the changeable message sign. You will also note that there are boxes in the middle of [northbound Interstate 35]. For the message that is displayed on the changeable message sign, place a check mark in the ONE box where you feel is the location of the major accident.** *(Study supervisor gives Map LM1 to participant to check the one box. Note: give only one map at a time.)*

*Message on map LM1: (MAJOR ACCIDENT – PAST [*DEL MAR BLVD*])*

Here is an identical map, but with a different message on the sign. Place a check mark in the ONE box where you feel is the location of the major accident. *(Study supervisor gives Map LM2 to participant to check one box.)*

*Message on map LM2 (MAJOR ACCIDENT – BEYOND [*DEL MAR BLVD*])*

Here is another map. Place a check mark in the ONE box where you feel is the location of the major accident. *(Study supervisor gives Map LM3 to participant to check one box.)*

*Message on map LM3 (MAJOR ACCIDENT – AT [*DEL MAR BLVD*])*

Here is another map. Place a check mark in the ONE box where you feel is the location of the major accident. *(Study supervisor gives Map L4 to participant to check one box.)*

*Message on map LM4 (MAJOR ACCIDENT – BEFORE [*DEL MAR BLVD*])*

Now, this map has many more boxes on [northbound Interstate 35]. Read the message on the changeable message sign and mark ALL of the boxes which are in the area where the freeway is closed. *(Study supervisor gives Map LM5 to participant to check the boxes. Make sure the participant marks successive boxes.)*

*Message on Map LM5 (FREEWAY CLOSED – FROM [*DEL MAR BLVD*] TO [*SHILOH DR*])*

Here is another map. Read the message on the changeable message sign and mark ALL of the boxes which are in the area where the freeway is closed. *(Study supervisor gives Map LM6 to participant to check the boxes. Make sure the participant marks successive boxes.)*

*Message on map LM6 (FREEWAY CLOSED –BETWEEN [*DEL MAR BLVD*] AND [*SHILOH DR*])*

Here is the last map. Read the message on the changeable message sign and mark ALL of the boxes which are in the area where the freeway is closed. *(Study supervisor gives Map LM7 to participant to check the boxes. Make sure the participant marks successive boxes.)*

*Message on map LM7 (FREEWAY CLOSED – BEYOND [*DEL MAR BLVD*] – TO [*SHILOH DR*])*
This is the end of the session. We can take a rest if you need to.

END OF SESSION 6

SESSION 7: OZONE COMPARISON & PREFERENCE
(Laptop – PowerPoint, Self-Paced with questions displayed)

During this part of the study, you are again to assume that you are in [Laredo] driving [northbound] on [Interstate 35]. You will be shown two short messages on the screen and asked to answer questions about them. You will not be asked to click on red dots during this session.

Did you define ozone for participant? *Yes* *No*

Definition: This is when the ozone or pollution levels are expected to reach unhealthy levels and are also a hazard to the environment.

Press the space bar when you are ready to begin.

Ozone Message 1 (OZONE ADVISORY) and Ozone Message 2 (OZONE WATCH)

1. **Do these messages mean the same?** Yes No
   ***If no,* briefly explain the difference.** _____
   _____
   _____

2. **Would you expect that the message is for today or tomorrow?** Today Tomorrow

3. **What would you do different in terms of your driving plans?** _____
   _____
   _____

4. **Is one message more severe than the other?** Yes No
   If yes, why?_____
   _____

Press the space bar to view the next two short messages.

Ozone Message 3 (OZONE ALERT) and Ozone Message 4 (OZONE WARNING)

1. **Do these messages mean the same?** Yes No
   ***If no,* briefly explain the difference.** _____
   _____
   _____

2. **Would you expect that the message is for today or tomorrow?** Today Tomorrow

3. **What would you do different in terms of your driving plans?**_____
   _____
   _____

5. **Is one message more severe than the other?** Yes No

If yes, why?_____

_____

Press the space bar to view the next two short messages.

Ozone Message 4 (OZONE WARNING) and Ozone Message 5 (OZONE ACTION)

1. **Do these messages mean the same?** Yes No
   ***If No,* briefly explain the difference.**_____

   _____

   _____

2. **Would you expect that the message is for today or tomorrow?** Today Tomorrow

3. **What would you do different in terms of your driving plans?**_____

   _____

   _____

4. **Is one message more severe than the other?** Yes No
   If yes, why?_____

   _____

Now you will be seeing one message at a time on the screen. However, each message will have two parts. I will again ask you questions about the information in each message.

Ozone Message 6 (OZONE ACTION – DAY – TODAY) (RIDE THE BUS – REDUCE TRIPS – WALK TO LUNCH)

1. **What would you do different in terms of your driving plans?**_____

   _____

   _____

2. **How important is it that the second part of the message be displayed?** *(Circle one)*
   Very important - Important - It's OK to display - Not important - Very unimportant
   Why? _____

   _____

Press the space bar to view the next message.

Ozone Message 7 (OZONE ACTION – DAY – TOMORROW) (RIDE BUS (FREE) – ON OZONE DAYS – SHARE A RIDE)

1. **What would you do different in terms of your driving plans?**_____

   _____

   _____

2. **How important is it that the second part of the message be displayed?** *(Circle one)*
   Very important - Important - It's OK to display - Not important - Very unimportant
   Why? _____

   _____

For the next signs, you will see two messages. Both messages have two parts. I will again ask you questions about the two messages. Press the space bar to view the next message.

Ozone Message 7 (OZONE ACTION- DAY - TOMORROW) (RIDE BUS (FREE) – ON OZONE DAYS – SHARE A RIDE) and
Ozone Message 8 (OZONE WARNING – DAY – TOMORROW) (RIDE BUS (FREE)- ON OZONE DAYS – SHARE A RIDE)

1. **Which of the two messages would have the greatest impact on getting drivers to use a bus, car pool, share a ride, or doing something else to keep them from driving alone to work tomorrow? OM 7 OM 8**

Press the space bar to view the next message.

Ozone Message 7 (OZONE ACTION - DAY - TOMORROW) (RIDE BUS (FREE) – ON OZONE DAYS – SHARE A RIDE) and
Ozone Message 9 (OZONE ACTION – DAY – TOMORROW) (RIDE THE BUS-REDUCE TRIPS – WORK AT HOME)

1. **Which of the two messages would have the greatest impact on getting drivers to use a bus, car pool, share a ride, or doing something else to keep them from driving alone to work tomorrow? OM 7 OM 9**

This is the end of this part of the study. We will take a break if you would like.

END OF SESSION 7

SESSION 8: AMBER ALERT PART 2 COMPREHENSION
(Laptop - Surveyor, Fixed-Time 6 and 8 sec, no repeat)

We are now ready to begin the next session. Remember you are in [Laredo] and driving [northbound Interstate 35]. As you travel this route, you will again see messages on several changeable message signs.

In this part of the study, the messages will stay on for a few seconds and then will automatically turn off. After the message turns off, you will be asked questions about the information in the message. You will again be pushing the red dots as you go through this session. Do you have any questions at this time?

Press the space bar when you are ready to begin.

Answer for Message 7B Base Incident (MAJOR ACCIDENT-AT SCOTT ST -3 LANES CLOSED) 6 seconds

What was the message on the screen? ☐☐ - ☐☐☐ - ☐☐☐

_____

_____

Press the space bar to see your button pushing score.

Press the space bar to view the next message.
Answer for Message 6B Base AMBER (KIDNAPPED CHILD-GREEN CHEVY-TUNE TO RADIO) 6 seconds

What was the message on the screen? ☐☐ - ☐☐ - ☐☐☐

_____

_____

Press the space bar to see your button pushing score.

Press the space bar to view the next message.
Answer for Message 5B Lic/Tel (LIC 739 452-CALL 800 769 5350) 6 seconds

What was the message on the screen? ☐☐☐ - ☐☐☐☐

_____

_____

Press the space bar to see your button pushing score.

Press the space bar to view the next message.
Answer for Message 3B Lic (LIC RG5 693) 6 seconds

What was the message on the screen? ☐☐☐

_____

_____

Press the space bar to see your button pushing score.

Press the space bar to view the next message.
Answer for Message 2B Tel (CALL 888 879 3500) 6 seconds

What was the message on the screen? ☐☐☐☐

_____

_____

Press the space bar to see your button pushing score.

Press the space bar to view the next message.
Answer for Message 1B HAR (TUNE TO 1580 AM) 6 seconds

What was the message on the screen? ☐☐☐☐

_____

_____

Press the space bar to see your button pushing score.

Press the space bar to view the next message.
Answer for Message 5C Lic and Telephone (LIC 739 452 – CALL 888 769 5000) 8 seconds

What was the message on the screen? ☐☐☐-☐☐☐☐

_____

_____

This is the end of this session of the study.

END OF SESSION 8

APPENDIX C
AMBER ALERT

REASONS PARTICIPANTS SELECTED MESSAGE TERMS

Table C-1. Reasons Participants Did Not Select AMBER ALERT.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	31	25	47	38	28	25	32
some people may not know what it means	25	13	28	28	22	31	25
less descriptive, too general, vague, not attention getter	19	31	0	6	22	28	18
do not know what it means, not familiar with	9	22	0	9	9	9	10
abducted more urgent, serious, gets attention, to the point	9	6	13	6	9	13	9
kidnapped child recognized better, to the point, more serious, urgent	0	6	6	9	6	9	6
missing stands out more, specific, clearer	0	3	9	0	3	0	3
confusing (Homeland Security, weather, color)	0	3	3	3	3	0	2
"boy" gives more information, more specific	3	0	3	0	3	0	2
other *	9	3	0	0	0	3	3

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-2. Reasons Participants Did Not Select ABDUCTED CHILD.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	28	13	16	31	16	28	22
Amber Alert means all other terms, well known	25	19	44	34	22	16	27
kidnapped stands out more, specific, easier, sounds better	16	3	16	9	19	16	13
prefer to know gender	9	22	6	9	9	9	11
too complicated, not as common, do not like	0	19	3	0	19	22	10
not enough information, specific, or attention getter	6	6	6	16	6	9	8
missing is easier, reported faster, good general term	6	13	3	3	9	0	6
do not know if child was abducted	3	6	3	0	3	9	4
sounds like parent/family member took child	6	3	3	0	6	6	4
never seen, do not know what that means	3	3	3	3	6	0	3
other *	0	0	6	3	0	3	2

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-3. Reasons Participants Did Not Select ABDUCTED BOY.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	6	13	3	6	9	0	6
Amber Alert means all other terms, well known	22	22	31	28	19	16	23
do not need gender, doesn't matter boy or girl	28	16	19	34	6	19	20
not as dramatic, common, or easy as kidnapped	19	6	6	16	9	13	12
some may not know meaning, too complicated	6	16	16	0	19	9	11
didn't specify gender, might be a girl	19	9	6	3	6	13	9
could disguise gender, hard to tell	3	3	9	9	6	3	6
not attention getter	0	9	6	6	3	6	5
missing is a good general term, easy to understand	3	9	3	0	9	0	4
do not know if abducted or missing	3	6	0	3	0	6	3
sounds like family member took child	6	3	3	0	6	3	4
would have selected if gender was specified	0	3	0	0	6	3	2
other miscellaneous responses*	0	3	3	3	16	13	6

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-4. Reasons Participants Did Not Select MISSING CHILD.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	9	22	6	6	19	6	12
not taken (run-away, lost, wandered off)	31	22	34	25	31	50	32
Amber Alert means all other terms, well known	31	22	28	34	22	13	25
didn't specify gender, could be teenager	6	16	13	9	9	19	12
kidnapped more specific, urgent, serious	13	6	13	6	16	13	11
abducted sounds more important, serious	13	19	9	16	6	0	10
not a recent event, has to be hours to report	3	0	3	9	9	9	6
not an attention getter	3	0	0	13	3	6	4
other *	0	3	3	0	0	0	1

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-5. Reasons Participants Did Not Select MISSING BOY.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	0	9	3	0	0	3	3
Amber Alert means all other terms, well known	38	31	38	7	31	13	32
not taken (run-away, lost, wandered off)	28	22	31	25	16	38	27
child better general term, doesn't matter boy/girl	13	19	9	22	6	13	14
abducted sounds more appropriate, important, serious	13	16	9	13	13	3	11
kidnapped more urgent, serious	13	6	6	9	9	16	10
didn't specify gender, might be a girl	19	3	9	0	9	9	8
could disguise gender, hard to tell	0	6	3	9	13	6	6
not a recent event	0	0	3	9	13	6	5
other miscellaneous responses*	3	3	3	0	3	0	2

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-6. Reasons Participants Did Not Select KIDNAPPED CHILD.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	9	6	22	13	22	19	15
Amber Alert means all other terms, well known	28	25	34	41	28	22	30
abducted sounds more important, urgent, serious	19	22	13	25	9	22	18
didn't specify gender, could be teenager	16	22	6	6	13	22	14
too general, not important, urgent, attention getter	22	9	6	19	0	6	10
too long, emotional, aggressive	0	9	13	3	6	6	6
missing easier to understand, shorter	6	6	3	3	13	3	6
not sure child was kidnapped	6	6	9	0	9	3	6
sounds like family member took child	3	0	3	6	0	6	3
not a recent event, need more info to report	6	0	0	0	3	0	2

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-7. Reasons Participants Did Not Select KIDNAPPED BOY.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	19	13	3	6	6	19	11
Amber Alert means all other terms, well known	25	22	31	38	25	13	26
abducted sounds more important, urgent	16	19	9	16	9	16	14
child better general term, doesn't matter boy/girl	0	13	6	31	13	16	13
didn't specific gender, if specified boy	6	3	28	0	6	19	10
too general, not important, urgent, attention getter	19	13	9	16	3	0	10
could disguise gender, hard to tell	9	3	0	6	6	16	7
not sure child was kidnapped	0	9	6	0	16	0	5
too long, emotional, aggressive	6	6	3	3	9	3	5
missing easier to read	3	6	3	9	6	0	5
sounds like family member took child	3	0	3	0	3	0	2
not a recent event	3	0	0	0	0	0	01

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-8. Reasons Participants Did Not Select BLUE MAZDA.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n =32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	0	0	0	0	0	3	1
did not state vehicle type (pickup-car)	47	19	69	44	53	69	50
not enough information, not specific, too general, not descriptive	53	78	34	53	41	31	48
people do not know makes/models of vehicles	3	6	6	9	19	0	7
did not state year	3	0	16	9	3	6	6
didn't like	0	0	0	0	6	0	1

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-9. Reasons Participants Did Not Select BLUE PICKUP.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	13	6	6	13	25	6	12
not enough information, not specific, too general, not descriptive	53	84	38	44	31	38	48
did not state make/model	34	13	63	31	44	56	40
did not state year	3	3	6	13	3	6	6

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-10. Reasons Participants Did Not Select BLUE MAZDA PICKUP.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	44	31	34	41	34	41	38
did not state year	16	13	44	28	28	28	26
not enough information, not descriptive	25	53	19	22	16	22	26
people do not know makes/models of vehicles	9	6	0	13	13	0	7
didn't like, too long, to many shades of blue	3	0	9	0	9	0	4
too much information	3	0	0		6	9	3

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-11. Reasons Participants Did Not Select MAZDA PICKUP.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	3	0	3	0	0	0	1
no color	47	22	66	53	50	69	51
not enough information, not descriptive	41	75	38	41	31	31	43
no year	3	3	3	6	6	6	5
people do not know makes/models of vehicles	13	6	0	9	13	3	7
other miscellaneous responses*	6	0	0	0	6	0	2

*No other single category contained more than 1 percent of the responses.

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-12. Reasons Participants Did Not Select BLUE MAZDA 05 PICKUP.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	41	63	56	47	41	50	50
do not need the year, too hard to tell	47	31	31	34	41	38	37
too much information, harder to remember	19	13	9	16	13	16	14
people do not know makes/models of vehicles	6	6	6	13	9	0	7
other miscellaneous responses*	0	0	0	3	6	3	2

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-13. Reasons Participants Did Not Select LIC SR8 493.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	25	22	34	34	38	41	32
all run together, need "#" and "-"	34	53	41	41	44	41	42
not clear/confusing, harder to recognize as a number	50	31	38	28	38	28	35

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-14. Reasons Participants Did Not Select LIC #SR8-493.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
harder to read, memorize, busy, distracting, confusing	9	6	16	22	25	25	17
do not need the "#" and "-" signs	9	16	28	19	6	22	17
do not like	13	3	0	0	6	0	4

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-15. Reasons Participants Did Not Select CALL 511.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	56	56	56	56	63	63	58
prefer dial, easier, more urgent	28	34	28	34	19	25	28
not familiar with 511, can not use w/cell or payphone	6	6	9	6	9	6	7
just picked one	3	0	3	9	0	3	3
would select if 911	6	0	6	0	0	3	3
other miscellaneous responses*	0	6	0	6	13	0	4

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-16. Reasons Participants Did Not Select DIAL 511.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	31	28	28	34	22	25	28
prefer call, easier, specific, and urgent	41	53	53	50	75	66	56
not familiar with 511, can not use w/cell or payphone	6	13	9	6	3	6	7
doesn't stand out, not attention getter	6	3	0	3	0	3	3
sounds like old rotary phones	6	0	0	3	0	6	3
if 911 would select	6	3	3	0	0	3	3
just picked one	3	0	9	0	0	3	3
other miscellaneous responses*	3	0	3	3	9	0	3

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-17. Reasons Participants Did Not Select CALL 888 769 5000.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	9	3	3	6	16	6	7
too many numbers, too long to remember	72	69	66	91	69	78	74
511 is faster, simpler	13	13	16	0	9	13	10
prefer dial	0	13	16	0	0	3	5
national but not local	6	3	3	3	6	0	4

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-18. Reasons Participants Did Not Select DIAL 888 769 5000.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	3	13	13	3	0	6	6
too many numbers, too long to remember	75	78	81	94	75	75	80
call easier, more important than dial	9	6	3	16	16	19	12
511 is faster, simple, easier	9	9	3	0	3	9	6
other *	9	0	6	0	6	0	5

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-19. Reasons Participants Did Not Select TUNE TO 530 AM.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	63	88	41	63	66	59	63
should be on any station/local station	16	6	28	9	3	19	14
do not listen to AM, have to look for, do not get that station	16	3	9	16	13	13	12
local gives more information, easier	3	0	16	13	6	3	7
associated 530 with time (5:30 a.m.)	3	3	6	0	13	963	6

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-20. Reasons Participants Did Not Select TUNE TO RADIO.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	1	9	9	25	9	13	18
no specific station	66	94	9	63	78	72	68
should be local, need to know, local more information	28	3	9	13	16	16	19
could be citizen's band (CB) radio	0	0	9	0	0	0	0

Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

Table C-21. Reasons Participants Did Not Select TUNE TO LOCAL RADIO.

Reasons	Percentage by City						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Average Total (n = 192)
selected	28	9	38	13	25	28	23
no specific station	56	72	25	59	56	53	54
may not know local stations	3	16	16	6	9	9	10
should be national, do not need local, should be on any station	9	0	9	13	9	9	8
other *	3	3	13	9	0	0	57

*No other single category contained more than 1 percent of the responses.
Note: Multiple responses were possible for each subject. Therefore, percentages will not equal 100.

PERCENTAGE OF MESSAGE TERMS REMOVED

Table C-22. Percentage of Message Terms Moved First.

Removal Item	Percentage Removed for First Item						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
1. AMBER Alert Descriptor	0	0	0	0	0	0	0
2. Vehicle Descriptor	0	0	0	3	0	6	2
3. License Number	9	3	3	3	16	3	6
4. Telephone Number	22	6	19	16	6	22	15
5. Tune to Radio	69	91	78	78	78	69	77

Table C-23. Percentage of Message Terms Moved Second.

Removal Item	Percentage Removed for Second Item						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
1. AMBER Alert Descriptor	0	3	0	0	6	0	2
2. Vehicle Descriptor	16	13	13	25	19	19	17
3. License Number	25	41	25	22	38	22	29
4. Telephone Number	44	38	50	41	19	38	38
5. Tune to Radio	16	6	13	13	19	22	15

Table C-24. Percentage of Message Terms Moved Third.

Removal Item	Percentage Removed for Third Item						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
1. AMBER Alert Descriptor	3	6	3	3	9	3	5
2. Vehicle Descriptor	34	31	34	31	31	25	31
3. License Number	25	16	41	34	9	38	27
4. Telephone Number	31	41	19	31	50	34	34
5. Tune to Radio	6	3	3	0	0	0	2
Can't decide	0	3	0	0	0	0	1

Table C-25. Reading Times for AMBER Alert Message Elements.

Message Element	Reading Time (sec) (n = 192)		
	Average	Median	Standard Deviation
TUNE TO 1350 AM	3.83	3.33	2.15
CALL 911	2.49	2.18	1.22
CALL 800 486 6300	6.06	5.46	3.12
LIC DS6 837	7.49	6.83	3.75
LIC 642 953 CALL 888 493 4000	16.66	14.73	8.80
KIDNAPPED CHILD YELLOW TOYOTA TUNE TO RADIO	5.99	5.46	3.07
FREEWAY CLOSED AT *POST OAK RD* USE OTHER ROUTES	6.32	5.38	3.54

Table C-26. Comprehension of Message Elements for AMBER Alert Messages: Self-Paced.

Terms Selected by Subjects	Subjects Providing Correct Answer (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
TUNE TO 1350 AM	91	100	94	91	91	88	92
CALL 911	100	100	100	100	100	100	100
CALL 800 486 6300	72	81	59	63	59	72	68
LIC DS6 837	28	44	31	44	22	38	34
LIC 642 953 CALL 888 493 4000	0	0	0	0	0	0	0
KIDNAPPED CHILD YELLOW TOYOTA TUNE TO RADIO	72	75	66	69	69	63	69
FREEWAY CLOSED AT *POST OAK RD* USE OTHER ROUTES	72	72	69	72	56	59	67

Table C-27. Comprehension of Message Elements for AMBER Alert Messages: 4-Second Display Time.

Terms Selected by Subjects	Subjects Providing Correct Answer (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
TUNE TO RADIO (2 sec)	97	100	100	100	100	100	99
TUNE TO 1620 AM	88	94	100	100	91	97	95
CALL 911 (2 sec)	97	100	100	100	100	100	99
CALL 511	100	100	100	100	100	100	100
CALL 888 769 5000	66	59	31	56	34	31	46
LIC 739 452	66	41	44	41	44	63	49
LIC 642 953 CALL 888 493 4000	0	0	0	0	0	0	0

Table C-28. Comprehension of Message Elements for AMBER Alert Messages: 6-Second Display Time.

Terms Selected by Subjects	Subjects Providing Correct Answer (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
TUNE TO 1580 AM	94	94	97	94	91	88	93
CALL 888 879 3000	75	72	53	56	44	63	60
LIC RG5 693	84	75	56	53	59	56	64
LIC 739 452 CALL 800 796 5300	0	0	0	3	0	0	1
LIC 739 452 CALL 888 769 5000 (8 sec)	9	9	0	6	6	3	6
KIDNAPPED CHILD YELLOW TOYOTA TUNE TO RADIO	81	84	72	81	78	81	80
FREEWAY CLOSED AT *POST OAK RD* USE OTHER ROUTES	78	75	38	59	50	63	60

APPENDIX D
FLOODS

Focus Group Flood Messages Created:

Amarillo

I-40 WEST
FLOODED
USE NEXT 3 EXITS

Arlington

FLOODED
I 30 WESTBOUND
AT MEACHUM

El Paso

I 10 WEST AT RED RD
FLOODED
USE NEXT 3 EXITS

Houston

I 45 NORTH
FLOOD AHEAD
EXIT 322

Laredo

I 35 MI-46
FLOODED TURN BACK
TUNE TO 1610 AM

Message 1

I-35 MI 46
FLOODED AND CLOSED
TUNE TO 1610 AM

Message 2

San Antonio

I – 35 CLOSED
EXIT X TO X
HIGH WATER

Table D-1. Reasons Participants Would Get Off the Freeway for HIGH WATER Message.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Impassable	33	38	8	46	20	20	28
High water	28	4	33	15	16	24	19
Is dangerous, won't take a chance going thru water	22	19	17	4	28	12	17
Would damage vehicle	6	0	4	19	12	4	8
Impassable for cars only	6	4	8	8	4	4	6
Don't know the depth of the Water	0	8	4	0	8	12	6
To avoid water	0	15	8	4	0	8	6
Means flooded	0	0	4	0	4	8	3
Other	6	12	13	4	8	8	8

Table D-2. Reasons Participants Would Continue on the Freeway for HIGH WATER Message.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
No exit information/ not closed	57	33	75	17	57	71	54
Use caution	7	33	0	17	43	14	17
Have large vehicle	21	0	0	33	0	14	13
Not urgent or dangerous	7	17	25	0	0	0	8
Means passable	7	0	0	17	0	0	4
Other	0	17	0	17	0	0	4

Table D-3. Reasons Participants Would Get Off the Freeway for FLOODED Message.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Impassable	24	59	7	44	43	45	38
Flooded	4	3	43	16	17	26	18
Is dangerous, won't take a chance going thru water	24	9	13	25	7	6	14
Is a lot of water	12	3	13	3	10	6	8
Is severe and covering road	16	3	3	0	7	6	6
Would damage vehicle	8	0	10	6	3	0	4
To avoid water	0	9	3	0	0	3	3
Other	12	13	7	6	13	6	9

Table D-4. Reasons Participants Would Continue on the Freeway for FLOODED Message.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Does not say to exit or closed	57	0	50	0	50	100	58
Road is passable	14	0	0	0	50	0	17
Don't know how much water	14	0	0	0	0	0	8
They want to see the flood	14	0	0	0	0	0	8
Just need to use caution			50				8

Table D-5. Reasons Participants Would Get Off the Freeway for DEEP WATER Message.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Road not passable	26	46	14	59	35	41	37
Is unsafe	33	14	10	17	8	14	16
Deep	15	4	28	10	15	21	15
Is a lot of water	11	4	3	7	12	0	6
Would harm vehicle	4	0	3	7	8	3	4
Small car can not pass	7	4	3	0	8	0	4
Won't drive through water	0	11	3	0	0	7	4
Don't know how deep the water is	0	4	14	0	8	0	4
Other	4	14	21	0	8	14	10

Table D-6. Reasons Participants Would Continue on the Freeway for DEEP WATER Message.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Does not say to exit	20	25	33	0	17	33	21
Large/high vehicle passable	0	0	0	67	17	33	17
Is not flooded or closed	20	0	33	33	0	0	13
Not urgent or threatening	40	0	33	0	0	0	13
Other	20	75	0	0	67	33	38

Table D-7. Reasons Participants Selected Flood Message 2 vs. 4 or 5.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Know what road you are on	100	100	25	20	25	38	38
Whole freeway is flooded	0	0	25	20	75	25	28
Easier	0	0	13	60	0	38	24
Other	0	0	29	0	0	0	9

Table D-8. Reasons Participants Selected Flood Message 4 vs. 2 or 5.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Mot specific or descriptive	16	38	38	52	52	24	38
Know what direction/location of flood	58	33	33	40	22	38	36
Tells direction of the road	26	13	10	8	15	29	16
Know the message applies to you	0	17	19	0	7	10	9
Tells where I am going	0	0	0	0	4	0	1

Table D-9. Reasons Participants Selected Flood Message 5 vs. 2 or 4.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
To the point/clear	45	33	33	0	0	33	35
Need to know freeway name	9	0	33	50	0	33	15
More specific	18	0	33	0	0	0	12
Know it is the road I am on	18	0	0	50	0	0	12
Whole freeway is flooded	9	33	0	0	0	0	12
Other	0	33	0	0	100	33	15

Table D-10. Reasons Participants Selected Flood Message 6 vs. 7.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Catches your attention more	55	60	40	50	25	29	42
Situation listed first	27	20	40	50	38	57	37
Flooded most importation	9	0	0	0	13	14	8
Other	9	20	20	0	25	0	13

Table D-11. Reasons Participants Selected Flood Message 7 vs. 6.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Reads better or easier	57	63	56	53	50	44	54
Know it is my road first	33	30	33	33	50	40	36
Gets your attention more	5	4	0	13	0	4	5
Other	5	4	11	0	0	12	5

Table D-12. Reasons Participants Selected Flood Message 8 vs. 9.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Familiar	54	47	47	54	93	14	52
Simpler format	31	47	22	35	7	50	31
Have never seen IH, don't understand	8	0	31	4	0	29	13
Other	8	6	0	8	0	7	5

Table D-13. Reasons Participants Selected Flood Message 9 vs. 8.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Familiar	17	53	0	50	53	50	48
Formal or correct name	0	13	0	17	6	28	15
Prefer IH	33	7	0	17	12	11	13
More specific	0	7	0	0	12	6	6
Other	50	20	0	17	18	6	18

Table D-14. Reasons Participants Selected Flood Message 10 vs. 11.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Gives reason/problem	83	93	63	100	93	100	90
More specific or informative	0	7	13	0	7	0	5
Other	17	25	0	0	0	0	5

Table D-15. Reasons Participants Selected Flood Message 11 vs. 10.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
No option to continue on road	81	83	75	82	78	80	80
Don't need to know why	12	17	8	5	11	8	10
Easier or shorter	4	0	8	5	11	4	5
Other	4	0	8	9	0	8	5

Table D-16. Reasons Participants Selected Flood Message 10 vs. 12.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Tells exits/what to do	87	79	67	78	70	80	77
More choices/alternatives	9	0	13	13	4	8	7
More information	0	0	8	0	15	4	5
Shorter/easier	4	7	4	4	4	0	4
Other	0	14	8	4	7	8	7

Table D-17. Reasons Participants Selected Flood Message 12 vs. 10.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Know to get off, is closed	67	33	50	33	20	14	39
Better situation description	11	0	38	56	40	57	37
More concise, simpler	22	33	13	11	0	14	15
Other	0	33	0	0	40	14	10

Table D-18. Reasons Participants Selected Flood Message 13 vs. 14.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Easier, less to read	83	54	43	75	50	83	65
Prefer exit number	0	15	29	0	17	0	10
Better if driver unfamiliar with area	0	23	14	0	17	0	10
Exits usually have numbers	8	0	0	25	17	0	6
Other	8	8	14	0	0	17	8

Table D-19. Reasons Participants Selected Flood Message 14 vs. 13.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Name is more familiar	35	32	40	43	27	38	36
Prefer street name	25	32	28	36	19	15	26
Name is more visible on the sign	0	21	0	0	27	12	10
Don't remember exit numbers	15	11	8	0	0	15	8
Don't like number	15	0	0	7	4	0	4
More descriptive/specific	5	0	12	0	4	4	4
Other	5	5	12	14	19	15	13

Table D-20. Reasons Participants Selected Flood Message 14 vs. 15.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Tells exits/what to do	68	66	63	53	73	59	63
Don't want to change/listen to radio	16	9	9	9	10	22	13
Radio will take to long, may miss exit	10	0	16	13	3	13	9
May not have a radio	0	9	0	9	10	3	5
Better information, more specific	6	6	6	9	3	0	5
Other	0	9	6	6	0	3	4

Table D-21. Reasons Participants Selected Flood Message 15 vs. 14.

Reason	Percent of Participants (%)						
	Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Total (n = 192)
Easier to read	100	0	0	0	0	0	33
Would get more information from radio	0	0	0	0	50	0	33
Like to listen to radio news	0	0	0	0	50	0	33

APPENDIX E
OZONE ALERT

Table E-1. Reason for the Importance Rating of Second Part of Message.

Ozone Message	Reason for Importance Rating	Percent (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Overall (n = 192)
OZONE ACTION DAY TODAY *Part 1* **RIDE THE BUS REDUCE TRIPS WALK TO LUNCH** *Part 2*	**Very Important (n = 62)**							
	• gives suggestions	14	16	16	16	17	13	92
	• tells do not use vehicle	0	0	2	0	0	0	2
	• 1st part doesn't tell anything	0	0	0	2	0	0	2
	• talking about ozone	0	0	0	2	0	0	2
	• for your health	0	0	0	0	0	2	2
	Important (n = 66)							
	• gives suggestions	21	15	10	13	17	20	96
	• too much information	0	0	2	0	0	0	2
	• hazard in road	0	0	0	0	2	0	2
	OK to Display (n = 43)							
	• gives suggestions	16	23	11	18	14	14	96
	• people do not ride the bus	0	2	0	0	0	0	2
	• no response	0	0	2	0	0	0	2
	Not Important (n = 15)							
	• people know about ozone	7	0	0	0	0	13	20
	• gives them something to relate to	6	0	0	0	0	0	6
	• not helpful if driving	0	7	7	0	0	0	14
	• ridership does not increase	0	7	0	0	0	0	7
	• people do not pay attention to signs	0	0	13	0	0	6	19
	• too much to read	0	0	7	0	0	0	7
	• not specific enough	0	0	0	0	20	0	20
	• no response	0	0	0	7	0	0	7
	Very Unimportant (n = 5)							
	• people should know what to do	0	0	17	0	0	17	34
	• nothing can be done about ozone	0	0	17	0	0	0	17
	• DMS for freeway activities only	0	0	16	0	0	0	16
	• does not apply to everyone	0	0	0	16	0	0	16
	• no response	0	0	0	17	0	0	17

Table E-2. Reason for the Importance Rating of Second Part of Message.

Ozone Message	Reason for Importance Rating	Percent (%)						
		Arlington (n = 32)	Austin (n = 32)	El Paso (n = 32)	Houston (n = 32)	Laredo (n = 32)	San Antonio (n = 32)	Overall (n = 192)
OZONE ACTION DAY TOMORROW *Part 1* RIDE BUS (FREE) ON OZONE DAYS SHARE A RIDE *Part 2*	**Very Important (n = 62)**							
	• gives suggestions	12	18	18	18	18	14	98
	• tells do not use vehicle	0	0	1	0	0	0	1
	• for your health	0	0	0	0	0	1	1
	Important (n = 66)							
	• gives suggestions	25	7	11	12	12	25	92
	• people might follow guideline	0	2	0	0	0	0	2
	• prevent exhaust in ozone area	0	0	2	0	0	0	2
	• because you are with someone	0	0	0	2	0	0	2
	• do not have to use your vehicle	0	0	0	0	0	2	2
	OK to Display (n = 43)							
	• gives suggestions	13	23	16	13	16	3	84
	• tells bus is free	0	3	0	0	0	0	3
	• confusing sign	0	3	0	0	0	0	3
	• do not live near bus stop	0	0	0	0	0	3	3
	• not really necessary	0	0	2	0	2	0	4
	• people do not ride the bus	0	3	0	0	0	0	3
	Not Important (n = 15)							
	• not helpful if driving	8	0	0	0	0	0	8
	• ridership does not increase	0	0	0	8	0	0	8
	• bus routs does not go to all areas	0	8	0	0	0	0	8
	• does not apply to everyone	0	0	0	15	23	0	38
	• too much to read	8	0	0	0	0	7	15
	• can read in newspaper	0	0	8	0	0	0	8
	• no response	0	0	0	8	7	0	15
	Very Unimportant (n = 5)							
	• DMS for freeway activities only	0	0	25	0	0	0	25
	• no increase in ridership on buses	0	25	0	0	0	0	25
	• does not apply to everyone	0	0	25	0	0	25	50