IDENTIFICATION OF PREFERRED PERFORMANCE MEASURES FOR THE ASSESSMENT OF LEVEL OF SERVICE ON TWO-LANE HIGHWAYS

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ENGINEERING

UNIVERSITY OF FLORIDA

2005

I would like to dedicate my thesis to my parents, Jack and Debby Morriss, as well as my grandmother Celie Rueping and my best friend Becca Smith. I would never have been able to do this without their continued support and encouragement.

ACKNOWLEDGMENTS

I would like to thank my committee chair, Dr. Scott Washburn, and my committee members, Dr. Ageliki Elefteriadou and Mr. Bill Sampson.

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August 2005

Chair: Scott S. Washburn
Major Department: Civil and Coastal Engineering

The concept of level of service (LOS) is central to the *Highway Capacity Manual* (HCM) and is used to assess the performance of all types of roadway facilities. Many transportation infrastructure funding decisions are based on LOS analyses and the resulting LOS designations are intended to represent user perceived quality of service.

This paper provides an overview of the evolution of the two-lane highway LOS analysis methodology and identifies weaknesses in the methodology as perceived by the Florida Department of Transportation (FDOT), as well as other HCM users. In particular, this study focuses on deficiencies in the methodology (in terms of performance measures, LOS thresholds and service volumes) with respect to rural developed two-lane highways, such as those facilities through small towns or developed coastal areas.

Although the HCM intends for LOS designations to correlate with user perceived quality of service, little research has been done to ascertain what those perceptions are. Therefore, the objective of this study was to determine what performance measures

appear to be most appropriate (i.e., consistent with traveler perceptions and expectations) for assessing LOS on different types of two-lane highways. This objective was facilitated primarily through direct input from non-transportation specialist travelers in a series of three focus group sessions. Focus group participants watched a series of video clips depicting different two-lane highway driving situations. Audio recordings of focus group discussions and data collected from survey forms were analyzed.

Based on the data collected in this study, it is apparent that motorists consider several factors in their assessment of trip quality on a two-lane highway. The function and/or development setting of the facility also appears to dictate what their quality of service expectations are. At this time, two-lane highway classifications are largely based on expectations of travel speed. However, from this study, it appears that expectations for passing should also be considered, in addition to travel speed, when distinguishing among facilities. Also, the current classifications do not address rural developed two-lane highways (e.g., facilities through small towns, developed coastal areas, etc.). These types of facilities should receive their own classification (Class III) and their own specific performance measure.

Ultimately, the development of a more comprehensive LOS methodology should be pursued. The outcome of such research might be a level of service function, defined in terms of a series of variables (performance measures) and corresponding coefficients that could be applied to all categories of two-lane highways.

CHAPTER 1
INTRODUCTION

Background

The *Highway Capacity Manual* (HCM) [1] is widely accepted among governmental agencies in the United States as the definitive tool for level of service (LOS) analysis on all types of roadway facilities. The Florida Department of Transportation (FDOT) is no exception, and has committed itself to implementing the principles outlined in the HCM when evaluating the LOS for transportation facilities found within the state.

The HCM 2000 defines LOS as a "qualitative measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience" [1]. It also states that "each LOS designation (A through F) represents a range of operating conditions and the *driver's perception* of those conditions" [1]. In other words, the concept of LOS serves primarily as a means of evaluating the operating conditions and quality of service of a roadway as perceived by the traveling public.

Because decisions regarding transportation infrastructure investment are largely based on LOS analyses, roadways with poor LOS designations typically receive higher priority for funding. Therefore, LOS methodologies that accurately reflect the roadway user's perception of operating conditions are necessary to avoid spending taxpayer money where it is not necessary.

With this in mind, transportation researchers are continually trying to develop new or improved methods for accurately estimating roadway performance measures and translating those into LOS values that hopefully correlate well with the quality of service as perceived by the traveling public. Again, with better LOS analysis methodologies, transportation practitioners and funding decision makers will be able to make better infrastructure investment decisions in the eyes of the public.

Problem Statement

One area of special concern to the FDOT since the early 1990s has been the LOS analysis of two-lane highways in rural developed areas. Since the publication of the 1985 HCM, FDOT has questioned the applicability of the two-lane highway methodology to two-lane highways in rural developed areas.

This issue came very much into focus when officials in Monroe County, Florida had difficulty accepting the results of HCM LOS analyses for US-1 (Overseas Highway) from the Florida mainland to the Florida Keys. After applying the 1985 HCM methodology, state transportation officials felt that the resulting LOS determinations along this highway were unrealistically low and did not reflect actual user perceived quality of service. US-1, like many other two-lane highways in the United States, features uninterrupted flow with alternating sections of undeveloped and developed surrounding land use. However, as some transportation officials would later come to believe, the 1985 HCM two-lane highway methodology was not designed to account for developed sections of two-lane highway with uninterrupted flow.

These concerns did not apply only to US-1 however. In addition to FDOT officials, other HCM users were expressing dissatisfaction with the 1985 HCM two-lane highway methodology with respect to these types of facilities. Prior to the release of the

HCM 2000, the National Cooperative Highway Research Program (NCHRP) sponsored Project 3-55 Task 3 [2] to identify the strengths and weaknesses of the 1985 HCM two-lane highway chapter. As part of this project, a survey was conducted that asked HCM users to identify ways in which they would like to see the two-lane highway LOS methodologies improved. Among the responses, several comments were made regarding the lack of an explicit methodology for uninterrupted flow two-lane highways in rural developed areas as well as two-lane highways with reduced design speeds. One user stated, "There is a need to develop a consistent level of service measure to address situations where a rural two-lane road passes through 'village' areas where posted speeds are less than those considered in the current methodology. In many cases, these areas cannot be considered urban or suburban and, thus, there is not an appropriate method to assess level of service" [2]. Another comment was, "The procedure should address levels of service for roads with design speeds down to 25 mi/h" [2]. The project report also noted that several agencies felt inclined to invent their own procedures to deal with these types of facilities.

While the two-lane highway analysis methodology in the HCM 2000 was more robust than the previous methodology, transportation officials at the FDOT still felt that this revised methodology fell short of adequately addressing LOS analysis issues for two-lane highways in rural developed areas. Despite the introduction of two different classes and corresponding service measures, which allowed more flexibility in two-lane highway analyses, the FDOT still felt that traveler expectations on two-lane highways in rural developed areas were not consistent with the service measures, LOS thresholds, or

roadway travel functions defined for either of these two classes. This is essentially the core of the problem for the FDOT.

Although the HCM intends for LOS designations to correlate with user perceived quality of service, little research has been done to ascertain what those user perceptions are and rarely have user perceptions been compared to the current LOS designations assigned to a facility.

Research Objectives and Tasks

The objective of this study was to determine what performance measures appear to be most appropriate (i.e., consistent with traveler perceptions and expectations) for assessing LOS on different types of two-lane highways. This objective was facilitated primarily through direct input from non-transportation specialist travelers in a series of three focus group sessions. The following tasks were carried out in support of this research objective:

- Determine suitable two-lane highway segments from which to collect field data,
- Collect video footage of roadway and traffic conditions from these chosen two-lane highway segments,
- Produce short video clips to be shown to focus group participants,
- Recruit focus group participants,
- Conduct focus group sessions to solicit traveler opinions and perceptions about the factors most important to them for assessing trip quality on two-lane highways
- Perform an analysis of focus group participant responses, and
- Recommend performance measures for use in two-lane highway LOS analyses based upon the analysis of the focus group participant responses.

Chapter Organization

Chapter 2 includes an overview of existing literature relevant to this topic as well as a timeline describing the sequence of events that led up to the current research detailed in this paper. Chapter 3 is an extension of chapter 2 in that it provides a more comprehensive look at the methodology in terms of service measures, LOS thresholds and service volumes. This is achieved through a series of example LOS calculations. Chapter 4 describes the research approach used in this study, including the selection of two-lane highways, equipment setup, collection of video footage, video clip production, focus group participant recruitment and selection, and focus group implementation. Chapter 5 describes the analysis method as well as the results. Chapter 6 is comprised of conclusions and recommendations. Several appendices are also included with supporting data and information.

CHAPTER 2
METHODOLOGY REVIEW

This chapter provides an overview of the historical development of the two-lane highway analysis methodology in the HCM, deliberations by the Highway Capacity and Quality of Service (HCQS) committee on the topic, as well as other relevant literature. The material in this chapter is organized chronologically and traces the development of the methodology over approximately the last 20 years, as well as the related issues that ultimately motivated this research study.

Highway Capacity Manual (1985)

The 1985 publication of the HCM introduced the concept of percent time delay as the primary service measure to be used in the assessment of LOS for two-lane highways. Percent time delay is essentially a measure of decreased mobility as a result of traffic platooning, or more precisely, "the average percent of time that all vehicles are delayed while traveling in platoons due to the inability to pass" [3]. Average travel speed (ATS) and capacity utilization were named as secondary measures.

Also introduced in this edition was the concept of capacity as a function of the directional split of traffic. However, the capacity analysis procedure still only estimated capacity for both directions combined (two-way), such as in the 1965 HCM. Also discussed in this edition are several measures that can be implemented to improve operations by reducing platooning. One of the measures discussed is the usage of passing lanes; however, no corresponding procedure accounting for their effect on operations is incorporated into the methodology.

Another aspect of the methodology was that it appeared to focus mainly on uninterrupted flow two-lane highways with high design speeds and undeveloped surrounding land use. Under the methodology, two-lane highways with "design speeds greater than or equal to 60 mi/h" were considered ideal, and quality of service representative of LOS A would consist of "motorists being able to drive their desired speed" with "average travel speeds approaching 60 mi/h" [3]. However, many two-lane highways are not designed for high speed travel, either because of terrain, surrounding development, or other conditions. As discussed in the following sections, many users of this methodology came to believe that it did not adequately address these types of facilities.

Methodology to Assess Level of Service on US-1 in the Florida Keys (1993)

One such example, as described in a 1993 paper by De Arazoza and McLeod [4], was US-1 in the Florida Keys (Monroe County). US-1, the sole roadway connecting mainland Florida to the Florida Keys, is primarily an uninterrupted flow, two-lane facility with rural developed and suburban land use. US-1 passes through several small communities and developed areas, with alternating stretches of rural, open highway. When trying to assess the LOS on US-1 using the 1985 HCM, state of Florida and Monroe County transportation officials felt that the methodology presented in the HCM did not adequately address the unique aspects of US-1, nor did it produce LOS designations that realistically reflected user perceived quality of service.

Largely in response to this finding, the State of Florida and Monroe County formed the US-1 LOS Task Force in 1990, of which the authors, De Arazoza and McLeod, were members. Around the same time, the FDOT formed a subcommittee, comprised of

members from the previously established Florida LOS Task Team (1988), to deal specifically with issues regarding two-lane highways in developed areas.

As explained in the De Arazoza and McLeod paper, the Monroe County Task Force, as well as the Florida LOS Task Team, held the belief that on two-lane highways in developed areas "most drivers were more concerned with maintaining a decent travel speed under uninterrupted flow conditions than trying to pass." In other words, both task teams did not believe that the 1985 HCM LOS service measure of percent time delay was appropriate for this situation. As a result, the Monroe County US-1 LOS Task Force developed an alternative LOS methodology in which average travel speed (ATS) was used as the service measure, which they believed would reflect user expectations more effectively. The task force then developed LOS thresholds relative to the roadway's posted speed limit (weighted by segment length).

In 1991, and then again in 1992, the Monroe County Planning Department conducted a travel speed and delay study of US-1. The alternative methodology, using ATS as the service measure, was applied to the study data to assess the LOS on different segments of US-1, as well as the overall facility. Based on knowledge of the local area and the supporting travel speed and delay data, De Arazoza and McLeod found that using ATS as a means to determine the LOS on US-1 produced results that "accurately reflected traffic operations and perceived levels of congestion." Therefore, the authors recommended that ATS be used as the primary service measure in the assessment of LOS for uninterrupted flow two-lane highways in developed areas.

Level of Service of Two-Lane Rural Highways with Low Design Speeds (1994)

A 1994 paper by Botha et al. [5] also expressed concern with the two-lane highway chapter of the 1985 HCM. The authors noted the lack of an explicit methodology to

assess two-lane highways with lower design speeds (less than 60 mi/h) and questioned the appropriateness of percent time delay as a service measure. These concerns were brought about when the authors observed discrepancies in the LOS results after applying both the 1965 and the 1985 HCM methodologies to two-lane highways with design speeds less than 60 mi/h.

While this paper recognized the need to address two-lane highways with low design speeds, the authors do not refer specifically to two-lane highways through developed areas (small towns, coastal areas, etc.). Instead, the focus of the research described in this paper was on the "evaluation of methodological alternatives for defining the LOS for two-lane highways with 50 mi/h design speeds" [5]. The methodological alternatives, other than percent time delay as used in the 1985 HCM, included other service measures and concepts such as density (two-way), functional classification of the roadway, limitation on achievable LOS range for low design speeds, and a combination of percent time delay and density.

Ultimately, the authors did not recommend any specific service measure or methodology. However, one of the main points that can be deduced from this paper is that the 1985 two-lane highway analysis methodology was insufficient in terms of evaluating two-lane highways with low design speeds and that further research needed to be conducted in an effort to remedy this issue.

Highway Capacity Manual (2000)

In 1994 and 1997, the Transportation Research Board (TRB) released updated editions of the HCM. However, there were no changes to the two-lane highway methodology introduced in either of these updates. In 1999, research conducted as part of NCHRP 3-55 Task 3 [2] resulted in the development of a new two-lane highway

analysis methodology for the HCM. This methodology was incorporated into the 2000 edition of the HCM and with it came many significant changes. The two most significant changes involved the introduction of a directional procedure for capacity analysis and the introduction of a classification scheme defined in terms of user expectations of travel speed and roadway function. The classification scheme and the corresponding service measures outlined in the HCM 2000 are the focus of this section.

When following the current HCM methodology, the first step in determining the LOS of a two-lane highway is to classify the roadway. There are presently two classifications, which are defined below (directly from the HCM 2000):

- Class I highways are defined as two-lane highways in which drivers expect to travel at relatively high speeds. Two-lane highways that are major intercity routes, primary arterials connecting major traffic generators, daily commuter routes, or primary links in state or national highway networks generally are assigned to Class I. These highways are often used in long-distance trips or as links between highways that serve long-distance trips.

- Class II highways are defined as two-lane highways in which drivers do not expect to travel at high speeds. Two-lane highways that function as access routes to Class I facilities, serve as scenic or recreational routes that are not primary arterials, or pass through rugged terrain generally are assigned to Class II. These roadways are often used for relatively short trips, the beginning and ending portions of longer trips, or for trips that include sightseeing, such as trips along scenic routes.

Once the classification is selected, the LOS can be determined by calculating the appropriate service measure(s) and applying the corresponding thresholds. Two service measures are used to determine the LOS of a Class I highway: percent time spent following (PTSF) and ATS. The definition of PTSF is essentially the same as that for percent time delay. The term was changed to percent time spent following to more clearly communicate the meaning of the service measure [2]. However, only PTSF is used to determine the LOS of a Class II highway.

While the two-lane highway analysis methodology in the HCM 2000 was more robust than the previous methodology, transportation officials at the FDOT still felt that this revised methodology fell short of adequately addressing LOS analysis issues for two-lane highways in rural developed areas. Despite the introduction of two different classes and corresponding service measures, which allowed more flexibility in two-lane highway analyses, the FDOT still felt that traveler expectations on two-lane highways in rural developed areas were not consistent with the service measures or LOS thresholds for either of these two classes.

More specifically, the FDOT felt that these types of facilities did not seem to easily fit into the new classification scheme. In accordance with the HCM's intent that LOS methodologies, and corresponding service measures, reflect user perceived quality of service, the two classifications (Class I and Class II) are defined in terms of user expectations of travel speed. Class I facilities are those in which motorists expect to travel at high speeds, while on Class II facilities motorists do not necessarily have this expectation.

User expectations are in large part tied to roadway function. Roadways that function as major intercity routes or primary arterials are often synonymous with high speed travel, and are therefore usually designated Class I facilities. Local collectors, scenic or recreational routes, and mountainous roadways often do not carry the same expectations for high speed travel and are therefore usually designated as Class II facilities.

However, the primary travel function of the roadway is not always consistent with user expectations of travel speed. In fact, Chapter 12 of the HCM 2000 states, "The

classes of two-lane roads closely relate to their functions – most arterials are considered Class I, and most collectors and local roads are considered Class II. However, the primary determinant of a facility's classification in an operational analysis is the motorist's expectations, which might not agree with the functional classification" [1]. This discrepancy between traveler expectation and roadway travel function formed the basis of the FDOT's concern with the two-lane highway analysis methodology.

Adaptation of the HCM2000 for Planning Level Analysis of Two-Lane and Multilane Highways in Florida (2002)

A 2002 paper by Washburn et al. [6] further explained this sentiment and outlined the FDOT's attempt to remedy it by revising the LOS determination aspect of the HCM 2000 two-lane highway methodology. The authors note, "Many of the state's two-lane highways are in areas that would be considered scenic in nature (e.g., along the coasts, the Florida Keys route), implying a Class II classification, yet many of these highways also serve well-developed areas, which would imply a Class I classification" [6]. As a result, FDOT LOS Task Team members "had to decide if either one of these classifications would be appropriate for these types of highways, or if a new classification needed to be developed" [6].

As mentioned previously, FDOT's LOS Task Team members believed that the primary concern of drivers on rural developed two-lane highways was the ability to maintain a decent travel speed rather than the ability to pass. Consequently, the FDOT decided to revise the two-lane highway LOS methodology of the HCM 2000, based on recommendations from researchers at the University of Florida Transportation Research Center, to more adequately address their needs. These revisions were ultimately

incorporated into the FDOT's two-lane and multilane highway level of service analysis software package (HIGHPLAN).

One of the principal changes dealt with the addition of a third class of two-lane highway that used percent of free flow speed (PFFS) as its primary service measure. The third class of two-lane highway was intended to represent those roadways in rural developed areas (e.g., along the coasts, through small communities/towns). The proposed service measure, PFFS, gives the average travel speed relative to the free flow speed. The authors note that the use of relative speed, as opposed to an absolute speed, provides a more accurate gauge of LOS than the ATS measure recommended in the US-1 methodology. Additionally, the authors proposed that the LOS thresholds also be based on PFFS.

Ultimately, the authors concluded that there is great need for the HCM to recognize that a third class of two-lane highway exists and they recommended the use of PFFS as the corresponding service measure to be used in LOS analyses.

NCHRP Project 20-7 Task 160 (2003)

In April of 2002, the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Traffic Engineering issued an emergency contract[1] to the Midwest Research Institute (MRI) to address issues regarding the two-lane highway LOS methodology in the HCM 2000. The prime contractor, MRI, was to deal with two main concerns, initially raised by the FDOT, but also echoed by some other HCM users. The first concern involved the overestimation of PTSF in the directional segment methodology. The second concern (which is relevant to this methodology

[1] NCHRP Project 20-7 Task 160: Two-Lane Highway Analysis Methodology in the Highway Capacity Manual: Final Report. Midwest Research Institute. Kansas City, Missouri, 2003.

review) dealt with the fact that the HCM 2000 methodology did not appear to address two-lane highways in developed areas. Appendix A contains copies of letters from representatives of FDOT and the North Central Florida Regional Planning Council (NCFRPC) regarding this concern.

The project report identified three scenarios not directly addressed by the HCM's two-lane highway methodology:

1. a two-lane highway with continuous urban/suburban development but with no traffic signals or traffic signals spaced at intervals greater than 2 miles,
2. a two-lane highway through a small town with a reduced speed limit, located on a major road with speeds of 55 mi/h or more, and
3. a two-lane highway in a transition area between rural and urban/suburban development, with reduced speeds and low-to-medium density development.

Alternative conceptual methodologies were outlined in an attempt to address these three scenarios. The contractor also made recommendations as to where the new procedures should appear in the HCM. While reviewers of the report felt that the first issue regarding directional segment PTSF was addressed adequately by the contractor, there were still concerns with the second issue regarding two-lane highways in developed areas and questions still remained on how to proceed. Therefore, the final report was never officially published by the TRB. The correction to the PTSF estimation for the directional analysis methodology was incorporated into the official errata of the HCM, but the potential methodologies for analyzing two-lane highways in the situations listed above were not published.

Highway Capacity and Quality of Service Committee Workshop on Developed Two-Lane Highways (2004)

In January 2004, at the annual TRB Conference in Washington D.C., the HCQS committee held a workshop to discuss the results of NCHRP Project 20-7 Task 160. At

the workshop, both Mr. Douglas Harwood of MRI and Mr. Doug McLeod of the FDOT presented their respective opinions and recommendations of how to handle LOS analysis for two-lane highways in rural developed areas. Dr. Scott Washburn of the University of Florida was the workshop moderator. The following sections summarize the presentations by Mr. Harwood and Mr. McLeod and the outcome of this workshop.

Mr. Douglas Harwood's Presentation

Mr. Harwood's presentation (refer to appendix B) summarized the results of NCHRP Project 20-7 Task 160 and addressed all three of the two-lane highway scenarios described above in which the current HCM methodology does not apply. For scenario 1 (two-lane highway with continuous suburban/urban development), Mr. Harwood argued that this type of facility was essentially the same as an urban street, except for the absence or wide spacing of signals. Therefore, he recommended that an approach similar to the urban street analysis methodology be used, with ATS as the service measure. An estimated (or measured) ATS was then to be compared to speed values representing percentages of the facility's FFS, such as in Chapter 15 (Urban Streets) of the HCM.

He recommended that ATS be calculated using procedures from either Chapter 15 or Chapter 20 (Two-Lane Highways), depending on the presence or spacing of signals. The proposed LOS threshold values were the same as those used in Chapter 15 to assess LOS for urban streets. Because the recommended service measure and threshold values were the same as those found in Chapter 15, Mr. Harwood also recommended that the procedure be incorporated into that chapter.

Because scenarios 2 (two-lane highway through a small town) and 3 (two-lane highway in a transition area) share similar characteristics, Mr. Harwood issued the same recommendations for each. The recommendations for these types of facilities were based

on two factors: 1) the length of the developed area with reduced speeds and 2) the amount of through traffic versus locally circulating traffic. The extent of development and the amount of through and/or local traffic is reasoned to be important because of the differing user expectations involved.

If the developed area with reduced speeds extends for 2 miles or less and most traffic is through traffic, then Mr. Harwood argued that the roadway should be evaluated as a Class II two-lane highway. Through motorists on a Class I facility, who travel through a small town or transition area most likely expect to return to Class I conditions shortly. Therefore, Mr. Harwood contended that the reduced speed does not affect their perception of quality of service as much as the platooning that occurs as a result of it, which in turn hinders passing ability once Class I conditions are resumed.

If the developed area with reduced speeds extends for more than 2 miles, with mostly local circulating traffic, Mr. Harwood argued that the procedure described above for two-lane highways with continuous development (scenario 1) should be used. He contended that if the majority of users are local, traveler expectations may more closely relate to expectations of urban streets, thereby suggesting ATS be used as the service measure.

Mr. Doug McLeod's Presentation

Mr. Doug McLeod's presentation [refer to appendix B] consisted of recommendations in contrast to those outlined by Mr. Harwood. The recommendations presented were essentially those expressed by Washburn et al. in the paper described in a previous section. These recommendations included the introduction of a third classification of two-lane highway that applied to all uninterrupted flow two-lane highways in developed areas and the use of PFFS as both the service measure and basis

of LOS threshold values. Mr. McLeod also argued that these types of facilities should be addressed in an uninterrupted flow chapter as opposed to Mr. Harwood's recommendation of addressing them in Chapter 15, an interrupted flow chapter.

Mr. McLeod suggested that the use of PFFS is more consistent with user expectations while traveling on a two-lane highway through a developed area. He explained that PFFS reflects the "desire to maintain a speed reflective of specific roadway/area circumstances, while PTSF "largely reflects the desire to pass," and ATS "largely reflects the desire to maintain a set speed." Mr. McLeod argued that motorists traveling through small towns or other developed areas do not have an expectation to pass, and in many cases are restricted from passing, thereby rendering PTSF inappropriate. By that same token he suggested that motorists "do not expect to go the same speed regardless of roadway/surrounding conditions," which is what the use of ATS implies.

Additionally, Mr. McLeod called attention to the differences between the current Class II two-lane highway methodology (as revised by the NCHRP 20-7 Task 160 results) and the FDOT's proposed methodology, in terms of service volumes on a rural developed two-lane highway. He argued that the resulting service volumes using the PTSF service measure were largely underestimated for this type of facility and are inconsistent with user expectations.

Workshop Outcome

In conclusion, workshop participants were unable to reach consensus on the best way to proceed. Some participants felt that the mixed use of Chapters 15 and 20 of the HCM, as recommended by Mr. Harwood, would potentially cause added confusion for users. Many workshop participants felt that more specific research should be conducted

to address the issue, and that a long term solution should be sought and released in a future edition, rather than a temporary fix released as errata. Recognizing that a great deal of time would be required to perform additional research, the participants decided that some language be included in Chapter 20 cautioning users that the existing methodology does not address two-lane highways in developed areas.

In reaction to this workshop, the FDOT sponsored quality of service research to explore preliminarily what roadway performance measures are appropriate for assessing the level of service for two-lane highways. This research was performed by soliciting information from the travelers themselves. The details of this research are the subject of chapter 4.

The next chapter provides a more comprehensive look at the differences between the HCM 2000 Class II methodology and the FDOT's proposed methodology with respect to levels of service and service volumes. Numerical examples illustrating these differences are presented through a series of LOS calculations using both PTSF and PFFS service measures.

CHAPTER 3
LEVEL OF SERVICE EXAMPLES: PERCENT TIME SPENT FOLLOWING VERSUS PERCENT FREE FLOW SPEED

This chapter provides a detailed review of the computational procedures and resulting level of service (LOS) determinations for the PTSF and PFFS service measures. Two-lane highways that travel through small towns or along the coast clearly do not fit the HCM Class I definition, as discussed previously. Thus, by default, they must be considered as Class II under the current HCM methodology. The service measure for Class II two-lane highways is PTSF. However, the FDOT does not believe that this service measure or the corresponding LOS thresholds are appropriate for these types of highways. In response, the FDOT has created a third classification (Class III) in which PFFS is used as the primary service measure.

The practical differences between the application of the PTSF service measure[1] and the PFFS service measure[2] to these types of highways can best be illustrated by an example LOS calculation and corresponding service volumes for a given set of input conditions.

Example LOS Calculations

The following example calculations utilize the input conditions outlined in Table 1. The LOS thresholds for Class II and Class III two-lane highways are included in Table 2.

[1]Based on the revised methodology from NCHRP 20-7 Task 160

[2]As outlined in Washburn et al. [6]

Table 1. Input Roadway and Traffic Data

Roadway Variables	**Traffic Variables**
Area Type = Rural developed	AADT = 5,000 veh/day
Number of Lanes = 2	K factor = 0.097
Analysis Type = Segment	D factor = 0.55
Terrain = Level	PHF = 0.895
Posted Speed = 50 mph	% Heavy Vehicles = 4%
Presence of Median = No	Base Capacity = 1700
Presence of Left Turn Lanes = Yes	Local Adjustment Factor = 0.92
% No Passing Zone = 40%	Adjusted Capacity (calculated) = 1475
Presence of Passing Lanes = No	

Table 2. LOS Thresholds for Class II and Class III Two-Lane Highways

	Class II[a]	**Class III**
LOS	**PTSF**	**PFFS[b,c]**
A	≤ 40	> 91.7
B	> 40-55	> 83.3
C	> 55-70	> 75.0
D	> 70-85	> 66.7
E	> 85	> 58.3

[a.] Values are directly from the HCM [1]
[b.] Values are directly from Washburn et al. [6].
[c.] PFFS Values derived by assuming a FFS of 60 mi/h and dividing into the Average Travel Speed thresholds in Exhibit 20-2 of the HCM 2000 [6]

Initial Computations

1. Calculate DDHV

$$DDHV = AADT \times K \times D$$

$$DDHV = 5000 \times 0.097 \times 0.55 = 266.75 \text{ veh/h}$$

2. Determine adjustment for the presence of a median and/or left turn lanes

Left Turn Lane Adjustment (LTadj) = 0.0

Median Adjustment (MedAdj) = 0.0

$$AdjMedLTL = 1 + LTadj + MedAdj$$

$$AdjMedLTL = 1 + 0.0 + 0.0 = 1.0$$

3. Determine Facility Adjustment Factor (FacAdj)

   FacAdj = 1.0 for Analysis Type = Segment

4. Calculate Adjusted Volume (AdjVol)

   AdjVol = DDHV / (PHF × LAF × AdjMedLTL × FacAdj)

   AdjVol = 266.75 / (0.895 × 0.92 × 1.0 × 1.0) = 323.96veh/h

Calculations For PTSF

5. Determine E_T (Truck passenger car equivalency factor)

   Look up value from HCM Exhibit 20-10 (no interpolation necessary)

   Directional flow rate (323.96) > 300 - 600, terrain = level, ∴ $E_T = 1.1$

6. Calculate f_{HV} (heavy vehicle factor)

$$f_{HV} = \frac{1}{1 + P_T\left(E_T - 1\right)} \quad \text{HCM Equation 20-4}$$

$$f_{HV} = \frac{1}{1 + 0.04\left(1.1 - 1\right)} = 0.9960159$$

7. Determine f_G (grade adjustment factor)

   Look up value from HCM Exhibit 20-8 (no interpolation necessary)

   Directional flow rate (323.96) > 300 - 600, terrain = level, ∴ $f_G = 1.00$

8. Calculate forward direction volume (v_d)

$$v_d = \frac{V}{PHF * f_G * f_{HV}} \quad \text{HCM Equation 20-12}$$

Since the PHF was already accounted for in Step 4, the following equation is used:

$$v_d = \frac{AdjVol}{f_G * f_{HV}} \qquad v_d = \frac{323.96}{1.0 * 0.9960159} = 325.26 \text{ veh/h}$$

Check this value against flow range used for Exhibits 20-10 and 20-8, and repeat steps 6 through 9 as necessary. No further iterations are necessary

9. Calculate opposing direction volume (v_o)

$$v_o = \frac{v_p * (1 - D)}{D} \qquad v_o = \frac{325.26 * (1 - 0.55)}{0.55} = 266.12 \text{ veh/h}$$

10. Determine values of coefficients 'a' and 'b' for HCM equation 20-17

Look up values from HCM Exhibit 20-21 (linear interpolation if necessary).

v_o is rounded to nearest 10 veh/h, $\therefore$ 266.12 $\rightarrow$ 270.0 veh/h

From exhibit, for v_o = 200; a = -0.0014, b = 0.973

From exhibit, for v_o = 400; a = -0.0022, b = 0.923

For v_o = 270 veh/h,

$$a = -0.0014 + (270 - 200)\left(\frac{-0.0014 - (-0.0022)}{200 - 400}\right) = -0.00168$$

$$b = 0.973 + (270 - 200)\left(\frac{0.973 - (0.923)}{200 - 400}\right) = 0.9555$$

11. Calculate base percent time spent following (BPTSF)

$$BPTSF_d = 100\left(1 - e^{av_d^b}\right) \quad \text{HCM Equation 20-17}$$

$$BPTSF_d = 100\left(1 - e^{-0.00168*325.26^{0.9555}}\right) = 34.454$$

12. Determine value of f_{adj} for HCM equation 20-16

Determine f_{adj} value from HCM Exhibit 20-20 (linear interpolation if necessary, by % no passing zone, directional split and two-way flow rate).

For FFS = 55 (posted speed + 5), %NPZ = 40, v_o = 266.12 veh/h

This example only calls for interpolation by volume,

f_{adj} = 46.05521

13. Calculate percent time spent following (PTSF)

$$PTSF_d = BPTSF_d + f_{adj}\left(\frac{v_d}{v_d + v_o}\right)$$ HCM Equation 20-16

v_d = 325.26 from Step 9

v_o = 266.12 from Step 10

$BPTSF_d$ = 34.454 from Step 12

f_{np} = 46.05521 from Step 13

$$PTSF_d = 34.454 + 46.05521\left(\frac{325.26}{325.26 + 266.12}\right)$$

$PTSF_d$ = 34.454 + 25.330 = 59.78

14. Determine Level of Service (LOS)

LOS from Table 2 is C

Calculations For PFFS

5. Determine E_T (Truck passenger car equivalency factor)

Look up value from HCM Exhibit 20-9 (no interpolation necessary)

Directional flow rate (323.96) > 300 - 600, terrain = level, ∴ E_T = 1.2

6. Calculate f_{HV} (heavy vehicle factor)

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1)}$$ HCM Equation 20-4

$$f_{HV} = \frac{1}{1 + 0.04(1.2 - 1)} = 0.9920635$$

7. Determine f_G (grade adjustment factor)

Look up value from HCM Exhibit 20-7 (no interpolation necessary)

Directional flow rate (323.96) > 300 - 600, terrain = level, ∴ f_G = 1.0

8. Calculate forward direction volume (v_d)

$$v_d = \frac{V}{PHF * f_G * f_{HV}}$$ HCM Equation 20-12

Since the PHF was already accounted for in Step 4, the following equation is used:

$$v_d = \frac{AdjVol}{f_G * f_{HV}} \qquad v_d = \frac{323.96}{1.0 * 0.9920635} = 326.55 \text{ veh/h}$$

Check this value against flow range used for Exhibits 20-10 and 20-8, and repeat steps 6 through 9 as necessary. No further iterations necessary.

9. Calculate opposing direction volume (v_o)

$$v_o = \frac{v_p * (1 - D)}{D} \qquad v_o = \frac{326.55 * (1 - 0.55)}{0.55} = 267.18 \text{ veh/h}$$

10. Determine adjustment for % no-passing zones in analysis direction (f_{np}) for HCM equation 20-15

Look up value from HCM Exhibit 20-19 (linear interpolation if necessary, by both volume and % no passing zone).

For FFS = 55 (posted speed + 5), %NPZ = 40, v_o = 267.18 veh/h

This example only calls for interpolation by volume,

$$f_{np} = 2.4 + (267.18 - 200)\left(\frac{2.4 - 1.9}{200 - 400}\right) = 2.23$$

11. Calculate average travel speed (ATS)

$$ATS_d = FFS_d - 0.00776(v_d + v_o) - f_{np}$$ HCM Equation 20-15

FFS_d	= 55	from inputs
v_d	= 326.55	from Step 9
v_o	= 267.18	from Step 10
f_{np}	= 2.23	from Step 11

$ATS_d = 55 - 0.00776(326.55 + 267.18) - 2.23 = 48.16$ mi/h

12. Calculate the Percent Free Flow Speed (PFFS)

$$PFFS = \frac{ATS_d}{FFS_d} \times 100$$

$$PFFS = \frac{48.16}{55} \times 100 = 87.56$$

13. Determine Level of Service (LOS)

LOS from Table 2 is B

Comparison of PTSF and PFFS Service Measures

The above example calculations (the results are also shown in the HIGHPLAN output in Figures 1 and 2) demonstrate the difference in LOS when evaluating the given input conditions as a Class II roadway with PTSF versus a Class III with PFFS. In the former case, the resulting LOS is C (PTSF = 59.8). However, the average travel speed is only 1.8 mi/h below the posted speed limit, which indicates that roadway users are maintaining a reasonable speed even though they are following nearly 60 percent of the time.

When evaluated with PFFS as the service measure, the resulting LOS is B (PFFS = 87.6), which seems to be a more accurate representation of operating conditions given that the ATS is so close to the posted speed limit. This example illustrates the FDOT belief that drivers on rural developed two-lane highways are primarily concerned with maintaining a reasonable travel speed and are not as concerned with following or passing other vehicles.. Thus, the LOS C designation that results from applying PTSF is considered to be overly penalizing, whereas the LOS B designation that results from PFFS is thought to be more consistent with traveler perceptions. The LOS B result

reflects that travelers are maintaining a speed close to the posted speed limit, but operational conditions are not representative of LOS A since they are traveling somewhat slower than the posted speed limit.

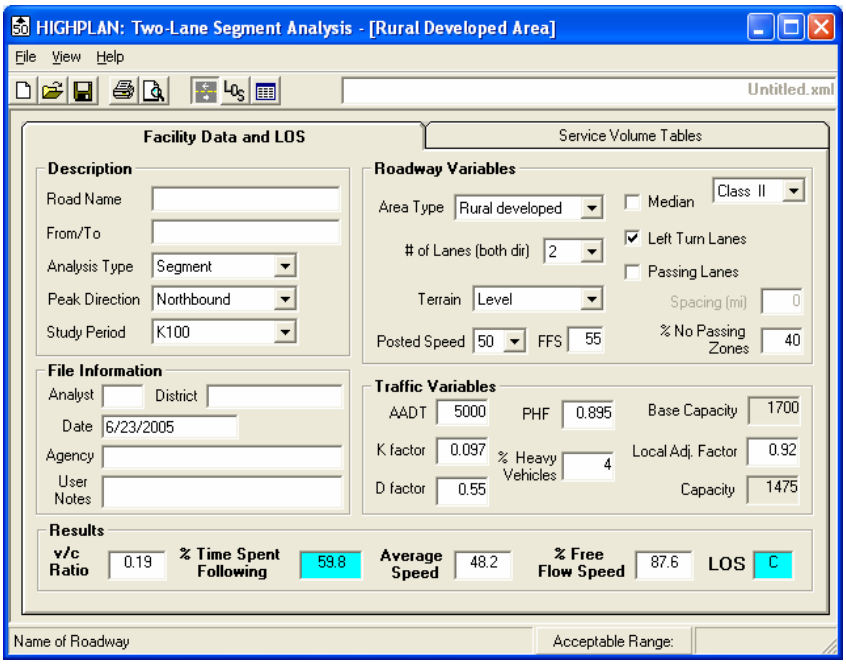

Figure 1. Class II LOS Calculation in HIGHPLAN

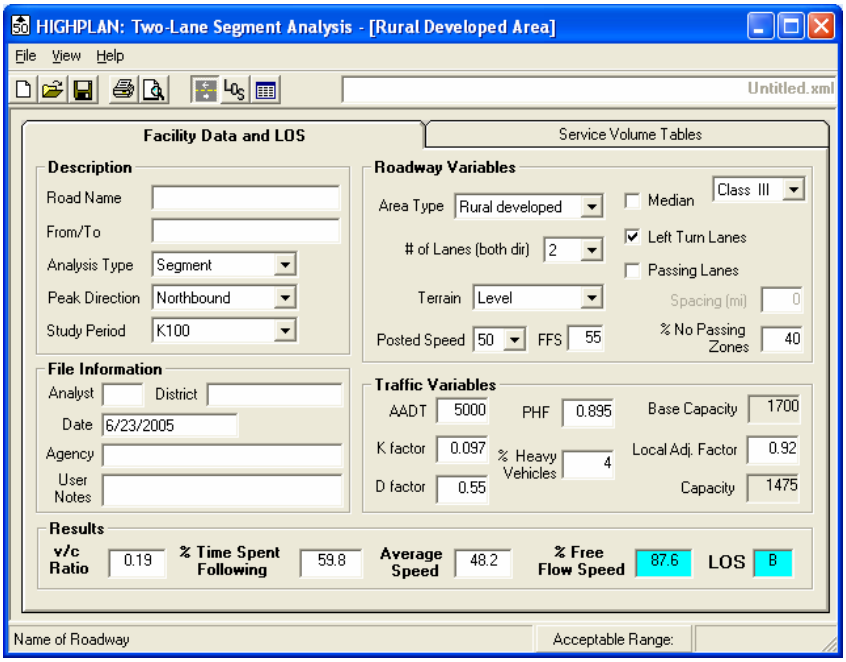

Figure 2. Class III LOS Calculation in HIGHPLAN

Comparison of Service Volumes

Service volumes indicate the maximum volume that can be accommodated for a given set of roadway, traffic, and control conditions, for a specified level of service. As can be seen in Table 3, the Class II service volumes are much lower than the Class III service volumes for the given input conditions used in the above example calculations. The volumes in this table represent the annual average daily traffic (AADT).

Many transportation agencies, such as the FDOT, use service volumes at LOS C to design and plan future facilities and to assess the operations of existing facilities. Facilities with flow rates in excess of the LOS C volume threshold would be considered operationally deficient and in need of improvement. In many cases, the design improvements required to bring a facility up to operational standards are of great expense. This reinforces the importance of accurately estimating roadway performance measures that translate into LOS threshold values which correlate well with the quality of service as perceived by the traveling public.

Table 3. Class II and Class III Service Volumes (AADT)

	Class II	**Class III**
LOS	**PTSF**	**PFFS**
A	2100	2800
B	4200	8000
C	8000	14100
D	14800	19300
E	26100	24300

CHAPTER 4
RESEARCH APPROACH

This chapter describes the research approach used in this study. The sections that follow will describe the method used for collecting example two-lane highway driving data as well as the process used to gather roadway user opinions and perceptions with regard to trip quality on two-lane highways.

Survey Method

This study used an approach that combined aspects of both a video survey and a focus group. Video surveys allow survey participants to watch pre-recorded video footage of actual two-lane highways. When video is taken from the driver's perspective, participants are presented with a reasonably realistic representation of two-lane highway travel. Because all participants view the same video footage, survey responses are based upon the same conditions, thereby establishing a baseline. Video data collection is less costly and involves no liability on the part of the researchers (with respect to survey participants).

Focus groups allow survey participants to engage in roundtable-like discussion. Discussion is usually led by a moderator, who attempts to solicit participant opinions in an unbiased way, while simultaneously attempting to keep the discussion focused on the topic. Focus groups offer a more flexible approach to data collection by allowing the participants to present issues of importance to them and to discuss their opinions in an open environment. They also give the researcher the opportunity to prompt further discussion about certain topics or ask for clarification if necessary.

In this study, survey participants watched a series of video clips depicting travel on two-lane highways (from a driver's perspective) and then participated in a group discussion facilitated by a moderator. This approach combined the control of a video survey with the flexibility of a focus group. The following sections describe the video data collection process and focus group implementation in more detail.

Video Data Collection

In this study, sample driving scenes from two-lane highways were viewed in a focus group setting to facilitate discussion on potentially important performance measures used in the assessment of trip quality. Video data collection included four specific tasks: selection of two-lane highways, equipment setup, collection of video footage, and video clip production.

Selection of Two-Lane Highways

The first step of the video data collection process involved the selection of several two-lane highways from which video footage were to be collected. The intent was to choose a representative sample of two-lane highways within reasonable proximity to the University of Florida. The 2003 Florida Highway Data (FHD) CD-ROM [7] as well as the 2003 Florida Traffic Information (FTI) CD-ROM [8], provided by the FDOT, were used in the preliminary stages of the two-lane highway selection process. Both CDs employ a Geographic Information Systems (GIS) based user interface in which users can access information on roadway characteristics and traffic data for nearly every roadway in the state of Florida.

The FHD CD-ROM provides roadway characteristic information including, but not limited to: functional classification, number of roadway lanes, median widths and types, shoulder widths and types, speed limits, and locations of intersecting roadways.

The FTI CD-ROM provides roadway traffic information collected through the use of traffic monitoring stations located throughout the state. Each traffic monitoring station uses Inductance Loop Detectors (ILD) to gather traffic data such as Average Annual Daily Traffic (AADT), truck percentage, K_{30} and D_{30}. K_{30} is defined as the proportion of AADT occurring during the 30th highest hour of the design year. D_{30} is defined as the proportion of traffic in the 30th highest hour of the year traveling in the peak direction.

Through the use of these two CD-ROMs, as well as the FDOT Roadway Characteristic Inventory (RCI) Field handbook [9], numerous two-lane highways within proximity to the University of Florida (approximately a 60 mile radius) were identified and selected for use in the collection of video footage. The selected two-lane highways consisted of a diverse range of roadway and traffic characteristics as well as functional characteristics.

Equipment Setup

The next step of the video collection process was the instrumentation of the data collection vehicle. A 4-door Chevrolet Cavalier was rented and outfitted with two video cameras, two portable VCRs, a microphone, a monitor, an A/V selector switch and two batteries used to power all of the equipment. The video camera setup was intended to portray two-lane highway travel from the driver's perspective. Therefore, one camera was set up to capture the windshield view, which also included a view of the interior rear-view mirror, while the second camera recorded the view of the speedometer. During a later step, images recorded from the two cameras would be combined into one image for the creation of the video clips.

The camera capturing the windshield view was attached to a pole which was secured between the floor and ceiling behind the driver's seat. The camera capturing the

speedometer view was mounted to the steering column. See Figure 3 for photos of the in-vehicle camera setup. The two VCRs recorded the images captured by the two video cameras. A microphone was also connected to one of the VCRs, allowing the researcher to verbally identify which two-lane highway was being driven as well as changes in the posted speed limit. The monitor and A/V selector allowed the researcher to switch between VCRs to see if the cameras and other equipment were functioning properly. A schematic depicting the in-vehicle data collection equipment setup is shown in appendix C.

Figure 3. In-vehicle Video Camera Setup

Collection of Video Footage

Video footage was collected over three separate days between January 20th and January 23rd, 2005. Approximately 450 miles of two-lane highway were driven and about 9 to 10 hours of video footage were recorded over the three-day period. The weather on all three days was sunny and dry. Table 4 lists the route number, the county

in which the two-lane highway is located, the direction of travel, and the approximate distance driven on each of the two-lane highways during the three day period. Appendix D contains maps of the driving routes.

The video footage was collected from a representative sample of two-lane highways throughout the north-central Florida area. These two-lane highway facilities can generally be divided into four categories which are described below:

- High Speed Roadways - generally used for inter-city travel.
- Medium to Lower Speed Roadways - generally connect to higher speed facilities or are used for intra-city travel.
- Lower Speed Roadways that are scenic - could be coastal, or with a tree canopy, etc.
- Lower Speed Roadways that go through a small town - either with or without the presence of a signal.

Video Clip Production

As mentioned previously, survey participants were to be shown a series of video clips depicting travel on two-lane highways from a driver's perspective. After all video footage was collected, the researcher reviewed all of the footage—entering specific roadway and traffic characteristic information for each roadway into a spreadsheet. This spreadsheet was then used to determine which footage would be edited into video clips.

In an attempt to more accurately portray the driver's perspective, video footage of the front windshield view and interior rear-view mirror, as well as the speedometer, was compiled into a single video display to be shown to survey participants. Also, a graphic display of the roadway's speed limit was included in the composite video image. This graphic changed as the roadway's speed limit changed during the progression of the video clip. A screenshot from one of the video clips is shown in Figure 4.

Table 4. Two-Lane Highway Driving Routes

Date of Travel	Route Number	County	Direction of Travel	Approximate Distance (mi)
January 20, 2005	SR 326	Marion	East	10
	SR 40	Marion, Lake, Volusia	East	65
	SR 19	Marion	North and South	16
	SR A1A	Volusia, Flagler	North	14
	SR 100	Flagler, Putnam	West	80
	SR 26	Putnam, Alachua	West	22
January 22, 2005	CR 219	Putnam	North	4
	SR 100	Bradford	East	16
	SR 16	Bradford, Clay, St. John's	East	40
	Int'l Golf Pkwy	St. John's	East	7
	SR 207	St. John's, Putnam	South	24
	SR 20	Putnam, Alachua	West	43
January 23, 2005	SR 121	Alachua, Union	North	12
	SR 18	Union, Bradford	East	7
	SR 231	Bradford, Union	North	10
	SR 238	Union, Columbia	West	15
	US 41	Columbia	South	5
	CR 18	Columbia	West	6
	SR 47	Columbia, Gilchrist	South	22
	CR 339	Gilchrist, Levy	South	15
	SR 24	Levy, Alachua	East	10
	US 27	Alachua	North	10

The video footage was then edited into 16 clips, with each clip being between 1.5 and 2 minutes in length. As a whole, the video clips were intended to showcase two things: 1) the four different categories of two-lane highway facilities described above, and 2) the various roadway and traffic conditions that one may typically experience while driving on a two-lane highway. However, a significant number of the video clips featured roadways in small towns and in coastal areas. This was done because it was felt that there were a larger number of questions about user perceptions with regard to these types of facilities.

Figure 4. Screenshot of Composite Video Image

Three separate focus group sessions were held in which the video clips were viewed. However, as a result of time limitations, each focus group was not able to view all 16 video clips. Therefore, the 16 video clips were divided into three separate groups, or blocks. Clip blocks 1 and 2 were each comprised of five video clips. Clip block 3 was comprised of six video clips. Focus group session 1 was shown a total of 10 clips (clip blocks 1 and 2). Focus group session 2 was shown a total of 11 clips (clip blocks 2 and 3). Focus group session 3 was shown a total of 11 clips (clip blocks 1 and 3). This

system of viewing clips ensured that each clip block would be viewed by 2 separate focus groups. Table 5 describes the 16 video clips (by clip block) shown during the three focus group sessions.

Focus Group Implementation

As mentioned earlier, three focus group sessions were held in which participants watched a series of video clips depicting travel on two-lane highways. The following sections will discuss the participant recruitment process, the participant selection process, and the implementation of the focus group sessions.

Participant Recruitment

Participants were selected from those who responded to an advertisement placed in the *Local* section of the *Gainesville Sun* newspaper. The *Gainesville Sun* serves the local Gainesville area as well as the University of Florida and many of the surrounding counties. The advertisement ran for three consecutive days, between Friday, March 18th and Sunday, March 20th. This allowed those who receive only the Sunday paper, as well as those who receive the paper throughout the rest of the week to have the opportunity to view the advertisement. The newspaper is also available for purchase through coin-operated machines found at popular locations throughout the local area. In addition to appearing in print, the advertisement was also placed in the *Online Marketplace* section of the *Gainesville Sun's* website.

The advertisement solicited individuals interested in participating in a focus group as part of a University of Florida transportation study. The advertisement requested that individuals be over the age of 25 and have previous experience driving on two-lane highways. See appendix E for a copy of the advertisement. Interested individuals were to respond by contacting the Transportation Research Center of the Civil and Coastal

Table 5. Video Clip Descriptions

Clip Block	Clip #	Dir. Of Travel	Route #	County	Clip Length	Shoulder Type 1		Shoulder Type 2		Speed Limit (mi/h)	Description of Video Clip
						Type	Width (ft)	Type	Width (ft)		
1	Clip 1	North	SR 121	Alachua	1:40	Paved	4-5	Lawn	20-30	60	Open road, no traffic, many passing zones, wide shoulders.
	Clip 2	North	SR 121	Union	2:10	Paved	4-5	Lawn	15-20	60,55,45,35	Approaching small town, decreasing speed limit, passing and no passing zones, no traffic, side parking. No signals.
	Clip 3	East	Int'l Golf Pkwy	St. John's	1:30	Lawn	8-10	na	na	50	Designated scenic roadway, tree canopy, narrow lanes, little to no shoulder.
	Clip 4	East	SR 100	Bradford	2:00	Paved	4-5	Lawn	10-15	45,35,25	Approach medium sized town, decreasing speed limit, following large vehicle, no passing zone, driveways and roadside development, side parking.
	Clip 5	West	SR 100	Flagler	1:35	Paved	2-4	Lawn	5-6	60	Guardrail on right side, paved shoulder, passing zones, car following, pavement quality is poor.
2	Clip 6	North	CR 219	Putnam	1:50	Lawn	2-10	na	na	45	Rolling terrain, narrow lanes, alternating passing/no passing zones.
	Clip 7	East	SR 100	Clay	1:45	Paved	3-5	Lawn	10	45,35,45	Approaching small town, decreasing speed limit, traffic signal, moderate traffic, driveways and roadside development.
	Clip 8	North	SR A1A	Volusia	1:40	Paved	4-5	na	na	40,45	Atlantic ocean on right, view of water, moderate traffic, parking pullout areas on right, dunes, no passing zone, alternating shoulder/no shoulder, pedestrian crossing zones,some pedestrian
	Clip 9	East	SR 24	Levy	1:45	Lawn	20	na	na	35	Near small town, no traffic, lawn shoulder, low speed residential area. 35 mph for extended distance.
	Clip 10	East	SR 16	Bradford	1:45	Lawn	15-20	na	na	60	Following slower vehicle. Light traffic, passing zones.
3	Clip 11	North	SR A1A	Flagler	1:52	Lawn	3-4	na	na	45,35,30	Atlantic ocean on right, passing zone in beginning, lower roadside activity/development, transitions into higher activity/development, no passing, pedestrian activity. Traffic signal.
	Clip 12	East	SR 16	Clay, St. John's	1:50	Paved	3-4	Lawn	15-20	55	Following vehicles traveling at speed limit or above. Go over 2 lane bridge with guardrails and no shoulder. St. Johns river.
	Clip 13	West	SR 20	Putnam	2:00	Paved	3	Lawn	10-15	45,35,45	Approaching small town, decreasing speed limit, following slower vehicle, roadside development, moderate traffic, traffic signal.
	Clip 14	East	SR 18	Bradford	1:40	Lawn	20-30	na	na	50	No traffic, narrow lanes, no paved shoulder, passing zones.
	Clip 15	East	SR 40	Volusia	1:40	Paved	2-3	Lawn	4-10	45,55	Following vehicles, moderate opposing traffic, passing zones, ditch & trees on both sides, some roadside development.
	Clip 16	West	SR 100	Putnam	2:00	Park Ln	8	Curb		45,35,	Approaching medium sized town, decreasing speed limit, moderate traffic, following vehicles, side parking. Approaching traffic signal.

Engineering Department at the University of Florida. Approximately 60 responses were received within one week of the ad's placement.

A researcher then contacted all individuals who responded to the advertisement. Each person was given information about the study and the purpose of the focus group sessions. Also at that time, the researcher collected demographic information from each respondent, as well as information regarding their two-lane highway driving experience. Demographic information was requested in an attempt to secure a reasonably representative sample. Respondents were also asked about their availability and scheduling preferences. All information was recorded on a preliminary survey form. See appendix F for a copy of the preliminary survey form.

Participant Selection

Participant selection was based on the desire to obtain a representative sample for use in the three focus group sessions. A total of 36 individuals were invited to participate in the study, 12 for each session. Those chosen to participate were divided into the three sessions based upon their two-lane highway driving experience and demographic information collected in their preliminary survey form. This was done in an attempt to create a balance of personal backgrounds and driving experience between the 12 participants in each session. A special effort was made to accommodate scheduling preferences. Tables 6 and 7 summarize the demographic information and the two-lane highway driving characteristics respectively, for participants in each of the three focus group sessions, as well as the overall study.

The abundance of responses to the newspaper advertisement allowed for the selection of a demographically diverse group of participants. The majority of participants (17) were between the ages of 46 and 65, with an equal number of participants (8) over

the age of 65 and between the ages of 26 and 45. Additionally, participants were asked to rate their typical driving style on a scale of 1 to 5 (1-very conservative, 5-very aggressive). As can be seen in Table 7, the results of this survey question indicate that most participants rated their driving style as more conservative. Therefore, it is possible that the higher number of "older" participants contributed to the high percentage of conservative driving styles. Thus, it is also possible that the opinions expressed in the focus group discussions and on the survey forms, may have a more conservative overtone than if there were a larger number of younger participants.

Table 6. Summary of Participant Demographic Characteristics

Participant Information	Focus Group 1	Focus Group 2	Focus Group 3	All
Total # of Participants	12	12	10	34
# Yrs. with Driver's Lic.	35.4	36.5	32.6	36
Gender				
Male	7	5	2	14
Female	5	7	8	20
Age Range				
16 to 25	0	0	1	1
26 to 45	3	4	1	8
46 to 65	7	4	6	17
Over 65	2	4	2	8
Marital Status				
Single	1	1	6	8
Married	8	7	2	17
Separated/Divorced	1	3	2	6
Widowed	2	1	0	3
Highest Education Level				
Some or no HS	0	0	0	0
HS diploma or equivalent	1	4	0	5
Tech. College (A.A.)	1	2	7	10
College Degree	5	3	1	9
Post-graduate Degree	5	3	2	10
Household Income				
No Income	0	1	1	2
Under $25,000	2	1	2	5
$25,000 - $49,999	3	8	6	17
$50,000 - $74,999	5	2	1	8
$75,000 - $99,999	1	0	0	1
$100,000 - $149,999	0	0	0	0
Over $150,000	1	0	0	1
Ethnicity				
White	9	11	8	28
Black	2	1	2	5
Other	1	0	0	1

Table 7. Summary of Participant Two-Lane Highway Driving Characteristics

Participant Information	Focus Group 1	Focus Group 2	Focus Group 3	All
Total # of Participants	12	12	10	34
Average Percentage of Trips as Driver	93.7	77.3	84.1	85
Vehicle Most Often Used	na	na	na	Sedan
Most Common Trip	na	na	na	Business & Personal
Driving Style (1-very conservative, 5-very aggressive)				
1	3	1	2	6
2	3	5	5	13
3	6	5	3	14
4	0	1	0	1
5	0	0	0	0
Typical # of Passengers for Two-Lane Highway Trips				
0	5	5	4	14
1	2	1	3	6
2	5	5	3	13
3	0	1	0	1
Typical # of Two-Lane Highway Round Trips Per Month				
1 to 2	0	0	1	1
3 to 4	0	1	1	2
5 to 6	1	1	0	2
7 to 8	2	1	0	3
9 to 10	3	1	1	5
11 to 12	1	0	0	1
Over 12	5	8	7	20
Typical One-Way Length of Trip (miles)				
less than 5	1	1	1	3
6 to 10	4	2	3	9
11 to 20	2	7	3	12
21-40	3	1	2	6
41-60	0	0	1	1
Over 60	2	1	0	3

All respondents were contacted within one week of initial contact and told whether or not they had been selected to participate in the study. Those who had been selected to participate were told when and where their focus group session was to be held. The selected participants were also sent a letter of confirmation with more detailed

information. Those who had not been selected were thanked for their interest and were told that their contact information would be kept on file if there were any cancellations.

Focus Group Implementation

The two main objectives for conducting the focus group sessions were: 1) to identify the factors (e.g., roadway and/or traffic conditions) that are important in the assessment of trip quality provided on a two-lane highway, and 2) to identify the relative differences, if any, between the importance of these factors in the assessment of trip quality for different types of two-lane highways (i.e., the four categories discussed previously).

All three focus group sessions were held on Saturday April 23, 2005 on the University of Florida campus in the Civil and Coastal Engineering Department's main conference room. The room was equipped with a video projector and large screen for viewing the video clips. All focus groups sessions were audio recorded with the permission of the participants. Focus groups sessions 1 and 2 had twelve participants. Focus group session 3 had ten participants (two persons failed to show and did not previously cancel). Each session was approximately 1.5 to 2 hours in length and was audio recorded. The duration of each focus group session provided ample time for the moderator to engage the members in meaningful discussion and obtain the information sought for this research study. Dr. Scott Washburn, the principal investigator, was the moderator of each focus group to ensure consistency across each of the three sessions.

A one page written instruction sheet was developed and given to participants upon arrival. The instruction sheet described the purpose, objectives, and format of the focus group session. See appendix G for a copy of the instruction sheet. Participants were also given a survey form (Form 1) that was comprised of two sections. The first section was

similar to that of the preliminary survey conducted over the phone during the participant selection process. In this section, participants were to provide information about their personal background and two-lane highway travel habits. Examples of this information include income level, education level, marital status, typical number of two-lane highway trips taken per month, typical number of passengers for two-lane highway trips, etc. This information was summarized previously in Tables 6 and 7. The second section of the survey form was used by participants to write down their responses to each of the video clips. See appendix G for a copy of the survey form.

Each focus group session began with some brief introductory statements by the moderator pertaining to the purpose and objectives of the focus group. Prior to viewing the video clips, the moderator verbally reviewed the instruction sheet and survey form for each session of focus group participants. After reviewing all instructions and answering questions, the participants began watching the video clips.

Each video clip was between 1.5 and 2 minutes in length. Immediately following the conclusion of the video clip, the moderator facilitated group discussion about the conditions observed in the clip and what the important factors are for the assessment of trip quality. Approximately 5 minutes of discussion time was allotted for each clip. After the group discussion, participants wrote down their opinions on the survey form. The above steps were repeated for all of the video clips.

After watching all of the video clips, there was an additional 10 to 15 minute discussion about the overall performance measures, or factors, that group members felt were important in their assessment of trip quality on a two-lane highway. This discussion served more as a summary, and was not in reference to any particular video clip.

Finally, the session moderator facilitated a short group discussion about the different types of two-lane highway classifications, or categories. Participants were given a second survey form (Form 2), asking them to rank the importance of certain factors to the assessment of their trip quality on different types of two-lane highways. Examples of these factors include: the ability to consistently maintain desired travel speed, ability to travel at a speed no less than the posted speed limit, frequent passing zones, wide travel lanes, wide shoulders, etc. Refer to appendix G for a copy of the second survey form.

CHAPTER 5
ANALYSIS AND RESULTS

As discussed in the previous chapter, the two main objectives for conducting the focus group sessions were: 1) to identify the factors (e.g., roadway and/or traffic conditions) that are important in the assessment of trip quality provided on a two-lane highway, and 2) to identify the relative differences, if any between the importance of these factors in the assessment of trip quality for different types of two-lane highways.

This information was obtained from focus groups, where participants engaged in a roundtable-like discussion led by a moderator and recorded written responses on survey forms. The following sections describe the methodology used to analyze the focus group discussion and survey form data, as well as the results of these analyses.

Analysis Method

Focus Group Discussions

Audio recordings from each focus group session were reviewed thoroughly and all relevant discussion material was transcribed to a word processor. As is the case with most group discussions, there is a natural tendency for discussion to get side-tracked. Discussion that was not relevant to the topic was not transcribed or analyzed.

The discussions were transcribed in sections, with each section corresponding to a different video clip. Resulting discussion could then be more easily interpreted by referring back to the video clips. Important themes from each video clip discussion were identified and direct quotations supporting those themes were extracted.

Some common focus group analyses include the usage of computer software programs that determine the frequency in which certain words, phrases or themes appear in discussion. While counting the frequency in which certain topics are discussed is sometimes an important component of qualitative analyses, it does not always accurately reflect the level of importance in which participants view these topics. For example, more discussions pertaining to lane width than the presence of SUVs, does not necessarily mean that participants consider lane width to be a more important factor in their assessment of trip quality. In fact, in this study, certain topics were sometimes raised by the moderator either because they didn't arise naturally or because further discussion or elaboration was deemed necessary. Therefore, the frequency in which certain topics were raised was noted but not strictly counted.

Instead, the responses of the participants to the video clips and related questions posed by the moderator were judged solely on their own merit. Themes or points that were raised and received agreement (or disagreement) among participants were noted, as well as the emphasis participants placed on those themes. The results section of this chapter describes, on a clip-by-clip basis, the discussions and corresponding themes or points that emerged during each of the focus group sessions.

Survey Forms

As discussed previously, there were two different survey forms filled out by participants during the focus group sessions. The first form consisted of merely blank spaces, one for each video clip. On this form (Form 1), participants could write down what they felt were important factors in the assessment of trip quality for the roadway segments depicted in each clip. These written comments served as summaries and as further support of the verbal discussions. Comparisons between the written responses

and corresponding dialogue contained in the transcripts helped to analyze and interpret the results. Refer to appendix F for a copy of this survey form.

The second form (Form 2) asked participants to rank the importance of certain factors to the assessment of their trip quality for different types of two-lane highways. As discussed previously, four different types, or categories, of two-lane highways were included on the form, ranging from high-speed, intercity facilities to low-speed facilities through small towns or scenic areas. For each type of two-lane highway, participants assigned numbers, from 1 to 7 (1-not at all important, 7-extremely important), to different items listed on the form, indicating how those items affect the quality of their trip. Examples of these items, or factors, include: the ability to consistently maintain desired travel speed, ability to travel at a speed no less than the posted speed limit, frequent passing zones, wide travel lanes, wide shoulders, etc. Refer to appendix F for a copy of this survey form. The data collected on this form served as quantitative reinforcement of the verbal discussions and was entered into a spreadsheet for further analysis. Results from these survey forms are discussed in the latter part of this chapter.

Results

Focus Group Discussions

Below are descriptions of the roadway and traffic conditions depicted in each video clip as well as the results of the focus group discussions. Each video clip was watched by two of the three focus groups.

Video clip 1

Description: A high-speed facility with a 60-mi/h speed limit and very little traffic in either direction. The roadway has well maintained pavement and markings, standard-width lanes (12 feet), paved shoulder (4-5 feet), large clearance zone between pavement

and other obstacles, and many marked ‘passing’ zones (as indicated by a dashed-yellow center line).

Figure 5. Screenshot of Video Clip 1.

Discussion results: One of the major themes that emerged in the discussion about this clip was the importance of pavement quality and positive guidance through lane markings. Members of both focus groups made comments about the high quality of the pavement saying “pavement quality good” and “the road itself looked good, no pot holes or anything.” Other comments focused on the lane markings, such as “the outside white lines are painted, which I think is real good so you know where you’re at on the road” and “the markings on the outside of the lanes were great.”

Another major theme, which was raised by the moderator, concerned the speed of the facility. The moderator asked both focus groups if they felt the posted speed limit was reasonable. Several participants from both groups seemed to agree that the speed

was reasonable for this section of roadway, saying “60 mi/h was a good speed limit” and “it’s rural out there, so yes.”

Another issue that was raised by one person from each group concerned passing opportunities. One person said that one of the most important things in terms of trip quality was that there be “lots of places to pass.” The other person only noted that the roadway depicted in the clip offered “good proviso for passing.”

In summary, pavement quality and positive guidance were two issues initiated by members of both groups. Participants also seemed to agree that the posted speed was appropriate and was consistent with the rural context of the facility. The importance of passing opportunities was also raised by a couple of participants. Given the lack of traffic present in the video scene, there was little discussion about specific traffic factors.

Video clip 2

Description: The speed limit transitions from 60 to 35 mi/h (60-55-45-35) as the roadway approaches a small town. No traffic in either direction was present in the video scene. The roadway has well maintained pavement and markings, and standard-width lanes. Pavement markings in town area indicate ‘no-passing’ (solid-yellow center line). No traffic control is present on the mainline in town.

Discussion results: Two major themes emerged in the discussion following this video clip. One dealt with expectations of travel speed in a small town and the other dealt with expectations for passing.

In one session, members were asked if they felt the posted speed of 35 mi/h within the small town was acceptable and what speed would they go if they were traveling on that section of roadway. Several people agreed that they would travel at a speed around

35 mi/h. One person said, “The 35-mi/h [speed limit] seems consistent with the fact that it’s a smaller town, it’s a shorter span, and it’s only a two-lane road.”

Figure 6. Screenshot of Video Clip 2.

When asked how they felt about the speed reduction upon entering a small town area, two participants commented negatively about this type of situation. One person said, “Often times the speed reductions come too rapidly and you don’t have enough time to reduce to the posted speed.” Another person expressed frustration about having to constantly change speeds when traveling on these types of highways, saying “As soon as you get up to speed you’re having to slow down again.”

Members of this group were also prompted to discuss their expectations for passing in this situation. Several participants stated that they felt no expectation to pass in a small town area. One person said, “It just wouldn’t be safe, you might have people crossing the

roadway, you may have cars coming in from the side." Another said frankly, "I don't feel compelled to pass anybody in those small towns."

In summary, many participants felt that the reduced speed in a small town was both acceptable and expected. For this particular video clip, only members from one group discussed their expectations for passing and most agreed that they would not feel compelled to pass in that type of situation.

Video clip 3

Description: A designated scenic roadway with extensive tree canopy and a 50-mi/h speed limit. The roadway has narrow lanes (10-11 feet), no paved shoulder and very little clearance zone between pavement and trees. Light traffic was present in the video scene.

Figure 7. Screenshot of Video Clip 3.

Discussion results: Members of both focus groups spoke positively about the scenic nature of this tree canopy roadway, referring to the beauty of the surrounding trees. However, in one session, several participants mentioned that the lack of a shoulder or clearance zone was of concern to them. One person stated that there were "no paved shoulders, not much right-of-way, and tree and brush growth was close to the road." Others said that there was no "escape route" or "breakdown area," illustrating a desire for increased shoulder space or clearance between the roadway and the trees.

For members of the other focus group, the main topic of discussion centered on their expectations for passing other vehicles on a roadway such as this. When asked if passing restrictions on the roadway, as indicated by lane markings, decrease their perception of the trip quality, a few group members said "no" with one person saying, "No, not if it is for a short length." Another person stated that, "There should be no passing on a road like this because people do not have a good enough sense of speed and distance."

Most members of this group expressed that they would not feel compelled to pass, as long as the surrounding cars were going the speed limit or above. One person said that someone would have to be going "15 or 20 below" for them to want to pass in that situation. For this reason, one member expressed that passing should not be restricted by saying, "Sometimes you'll be behind someone who's going very slow and if it is safe to pass [then you should be able to]."

Another interesting comment that was made dealt with the different perspectives of local travelers versus through travelers. One person stated, "I think all of us enjoyed the

scenic part, but if you drove it everyday going back and forth to work or whatever, you're not thinking 'oh this is a beautiful road' because you're late to work or whatever."

In summary, many participants enjoyed the scenic nature of the roadway in the video clip however they did not feel comfortable with the lack of shoulder or clearance area. Additionally, most participants (with the exception of a few) felt that passing restrictions on a roadway such as the one depicted in the video clip did not lower the trip quality because they had no expectation for passing in that situation.

Video clip 4

Description: The speed limit transitions from 45 to 25 mi/h (45-35-25) as the roadway approaches a medium-sized town. A significant amount of roadside development and many driveways are present in the town area. The pavement markings in this area also indicate 'no-passing' (solid-yellow center line). Moderate opposing traffic is present in the video scene. The video vehicle is following a large vehicle traveling approximately 5 mi/h under the speed limit and is also being followed. There are two traffic signals present in town.

Discussion results: Two major themes emerged in the discussion following this video clip. One dealt with expectations of travel speed in a small town, such as with video clip 2, and the other dealt with the relative importance between travel speed and following or being followed by other cars.

While most people agreed that a slower speed was appropriate while traveling through the developed town area, there was some disagreement as to what that travel speed should be. Many participants, from both groups, remarked that the posted speed limit, including transitions, was appropriate. However, one person from each group said

that the 25-mi/h speed limit through the busiest part of the town was too slow. One person commented that in that situation, a "constant speed" was the most important thing to them. When asked "What speed?", they replied, "30 mi/h in a small town like that." When asked "If it were posted 40 mi/h what speed would you go?", the same individual said, "Still slower, 30 mi/h."

Figure 8. Screenshot of Video Clip 4.

In one session, the moderator posed a hypothetical question involving the relative importance between speed and following. He asked, "For example, with the speed limit at 35 mi/h, would you prefer to be doing maybe 25 mi/h and not be following anybody or having anybody follow you, than to be doing 35 mi/h and be following other people?" A few participants said that they preferred the former situation, with a few mentioning tailgating and the high number of vehicles as reasons.

Also, many members of both groups stated that they had no expectation for passing in this situation, saying "there was too much traffic" and "there's no way you're going to be able to pass in town like that, you'll have to wait until you get back onto the rural part."

When asked if the presence of the occasional traffic signal influenced their perception of the trip quality, several members of one group said that it did not and that it was "no big deal." However, one person said, "I think it depends on how long you know your overall trip is going to be. For example, traveling on [US] 301 up toward Jacksonville, you feel like you're stopping and going. The presence of more of those I think decreases the value of your trip."

In summary, members from both groups felt that a slower travel speed was appropriate and that there was no expectation for passing due to the high level of development and surrounding vehicular activity depicted in the video clip. This sentiment is consistent with the discussions from video clip 2. It also seemed that the occasional or rare presence of a traffic signal was not a large factor in their perceived trip quality, but for a couple of people, the "stop and go" on long trips is frustrating and lowers the trip quality. In reference to the discussion about speed and following, it appears that a few participants in one of the focus groups do not feel comfortable having to follow or be followed by other vehicles and that in this case speed is a secondary consideration. However, this may be attributable to tailgating fears and the generally conservative driving style of many of the participants.

Video clip 5

Description: A high-speed facility with a 60-mi/h speed limit. The roadway has standard-width lanes with a 5-6 foot grass shoulder bordered by a guardrail, and many marked 'passing' zones (indicated by a dashed-yellow center line). The pavement quality is poor with visible rutting and degradation. Minimal opposing traffic was present in the video scene. The video vehicle is traveling 5 mi/h over speed limit with two cars following closely. The second car back passes both the video vehicle and the vehicle behind it.

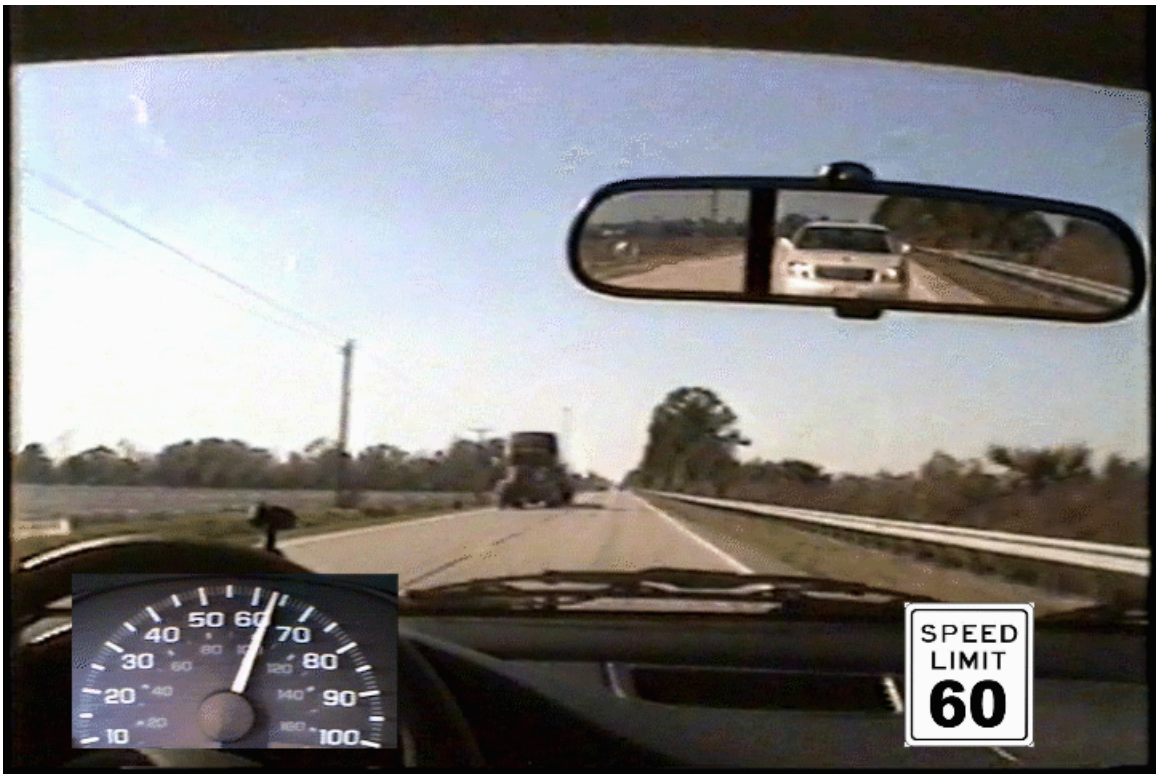

Figure 9. Screenshot of Video Clip 5.

Discussion results: One major theme that arose again was the importance of pavement quality. Members of both groups remarked about the poor pavement quality of the roadway depicted in this video clip. When asked about the significance of pavement quality, the majority of participants stated that it was "very important."

Another major theme dealt with the passing situation shown in the video clip. Members of one group were asked to express their feelings about passing. Several people said that it does not bother them to get passed by other vehicles and that they have no problem passing other vehicles themselves. However, in reference to the scenario in the clip, one person said "I am fearful of passing, especially two cars and if they are at least going in that 5-mi/h range of the speed limit, then I'm not going to pass." When asked how much slower than the speed limit would someone have to be going for them to consider passing, several people say "10 mi/h."

Another comment that was made dealt with the use of cruise control, a common feature on cars that allows the driver to set a nearly-constant vehicle travel speed. This issue arose when one person remarked that they liked the conditions depicted in the video clip because "you could set your cruise control." The moderator prompted further discussion by asking about the use of this feature on a two-lane highway. Many participants said that they do not expect to be able to use it on a two-lane road. However a couple of people said that they use it sometimes, if there is no traffic.

A minor theme that was discussed involved the presence of the guardrail. The majority of participants liked the guardrail, saying that they would rather the guardrail be there to prevent them from running into the trees along the roadway. A couple of people did not like it, however.

In summary, the importance of high quality pavement was reiterated. This was one of the first things that the participants noticed when viewing the clip, and these feelings are consistent with the discussion about pavement quality for video clip 1. Many people do not seem to be bothered by passing maneuvers; however they do not feel compelled to

pass unless they are following a vehicle going approximately 5-10 mi/h under the speed limit.

Video clip 6

Description: The speed limit is 45 mi/h with rolling terrain. The roadway has narrow lanes (10-11 feet), no paved shoulder, and alternating 'passing' and 'no-passing' zones. In the video scene, there is moderate residential development present, driveways on both sides of the roadway, and minimal traffic in either direction.

Figure 10. Screenshot of Video Clip 6.

Discussion results: One major topic that was discussed in both of the focus groups was the relationship between lane width, shoulder area, terrain and speed. Several members of one group expressed concern with the narrow lanes and lack of shoulder area. A few people agreed that they "wouldn't go faster than the speed limit" due to the rolling terrain. Another group member stated that they "wouldn't feel comfortable going

faster [than the speed limit]" because "there are a lot of houses." However a couple of people felt that the speed limit was too low because there was "no traffic" and "good visibility." Further discussion was prompted when the moderator asked one group of participants, "If there were no posted speed limit, or even if there was one posted, would you be wanting to drive faster if there was a wider lane and more shoulder area?" Several people said, "Yes, of course." One person added however, that if they "were unfamiliar with the road, they would drive more conservatively, but if they were used to it then their speed would pick up."

Another issue that was discussed in reference to this clip was the effect of overhanging tree limbs on the drivers. Although this roadway was not a "tree canopy" roadway such as the one depicted in video clip 3, there were several overhanging tree limbs present. One person said that they are "very distracting" and that they affect visibility. Someone else continued by saying, "I think the psychological aspect of the tree canopy is key. I believe that when you travel through an area that has a tree canopy, traffic slows down much more."

In summary, lane width, shoulder area, terrain, and level of roadside development are factors that appear to influence the choice in travel speed for many of the participants. Also, some members of one group felt that presence of overhanging tree limbs or a tree canopy affected visibility and travel speed.

Video clip 7

Description: The speed limit decreases from 45 to 35 mi/h as the roadway approaches a small town with moderate roadside development, many driveways and a traffic signal. After the traffic signal, the speed limit returns to 45 mi/h. The roadway

has well maintained pavement and markings. In the video scene, there is moderate traffic in both directions and the video vehicle is following other vehicles and is being followed.

Figure 11. Screenshot of Video Clip 7.

Discussion results: As in the discussions about similar video clips, such as clip 2 and clip 4, where there were small or medium-sized towns with reduced speed limits, the two major themes that were discussed dealt with expectations of travel speed and passing.

Again, members of both groups seemed to agree that the speed limit reduction approaching the small town and signal was appropriate for the situation. Several people in one of the groups said that it was fine because of the surrounding "commercial development." In the other group, most people felt that the posted speed limit, including transitions, was appropriate, with one person saying, "When you're going through a town it's fine to slow down, unless you've got a tornado behind you." When asked if going

below the posted speed limit was bad, there were some audible groans of discontent, indicating agreement with the statement, but no one elaborated.

Additionally, members of both groups reiterated that they had no expectation to be able to pass in a town area such as the one in the video clip, citing "too much traffic" and the "urban context with the strip development…and the exits and entrances (driveways)" as reasons. To clarify responses, the moderator asked one group of participants, "If you're going about the speed limit, are you going to be happy, whether you're following cars or not?" A few people confirmed the moderator's assessment and one person said, "Yes, there's nothing you can do, you just accept it."

In summary, the discussions resulting from this video clip seem to be consistent with those from other similar clips, in that most people accept the fact that they will have to reduce their speed and do not expect to be able to pass in a town or developed area.

Video clip 8

Description: Coastal roadway with a speed limit that increases from 40 to 45 mi/h and a view of the ocean. There are dunes and pull-over parking areas on the edge of the roadway, however there is no paved shoulder. Moderate traffic in both directions, some pedestrian activity, and continuous roadside development was present in the video scene.

Discussion results: The main topic of discussion for both groups about this clip was speed. A majority felt that the speed limit of 40-45 mi/h was appropriate. Members of both groups also commented on the "recreational" character of the roadway, and took this into consideration when assessing the speed. For instance, one person said "I don't mind going a slower speed here because half the time people are looking at the ocean." A person from the other group commented on speed, following, and passing implications

by saying, “If I were following and being followed and [the person in front of me] was going below the speed limit, I could appreciate that [that person] was trying to enjoy the scenery and I wouldn’t be trying to pass them.”

Figure 12. Screenshot of Video Clip 8.

However, a couple people did not agree with the prospect of having to travel at a slower speed just because of the “recreational” context of the facility. Their comments included, “I don’t mind going 40 mi/h (the posted speed limit), but I don’t want to have to follow someone [going] 20 mi/h” and “In terms of speed limit, I’m trying to get from point A to point B. So ultimately, I’m either going to exceed the speed limit or at least definitely go the speed limit. That would be my desired goal.” In relation to this topic, someone else stated, “If I were going on a recreational trip, I wouldn’t be as concerned with speed. But if it was a business type trip I would be more concerned.”

The lack of shoulder area was another key concern for members of one group, stating that "having someplace to go is important" and that "when you add the fact that there is no shoulder, coupled with the dunes, that makes me feel like I have to be more cautious cause I really don't have anywhere to go." Additionally, when asked if passing was a concern and if they had and expectation to pass on this type of roadway, members of this group said "no."

In summary, a majority of participants felt that the posted speed of the facility was appropriate. The recreational nature of the roadway also seemed to be a factor in their assessment of speed in relation to trip quality, with some members being more tolerant of slower vehicles, and others not. The importance of a shoulder area was also reiterated.

Video clip 9

Description: The roadway has a speed limit of 35 mi/h, standard-width lanes, well maintained pavement and markings, and a wide grass shoulder (15-20 feet). In the video scene, there is minimal residential development on both sides of roadway and minimal traffic in either direction present.

Discussion results: The main topic of discussion, which was initiated by both groups after viewing this video clip, was speed. A majority of the participants seemed to feel that the posted speed of 35 mi/h was "too low" or "too slow." However a few people felt that the presence of residences along the roadway (although set back at a significant distance) warranted the lower speed limit. When asked how much higher the speed limit should be if the roadway could accommodate a higher speed, many people in one group said "45 mi/h." Additionally, a few group members said that they would not restrict their speed based on the posted speed. However an equal number said they would.

Figure 13. Screenshot of Video Clip 9.

With regard to these feelings, the moderator asked one group of participants to describe how much of a factor law enforcement (getting a ticket) would play in their speed choice and perceived trip quality. One person said, "I follow the posted speeds, but in that situation I would be frustrated because I thought the speed was too low." Several other people agreed with this sentiment by saying that they would have gone faster "if they didn't have to worry about getting a ticket."

In summary, the majority of participants felt the posted speed limit was unreasonably low for the segment of roadway depicted in the video clip. While some said that the posted speed would not cause them to restrict their speed, others said that it would, however many of these same individuals expressed that they would feel uncomfortable and frustrated traveling at such a slow speed.

Video clip 10

Description: A high-speed facility with a speed limit of 60 mi/h. The roadway has standard-width lanes, a 15-20 foot grass shoulder, well maintained pavement and markings, and many marked 'passing' zones (indicated by a dashed-yellow center line). The video vehicle is following a vehicle traveling approximately 5 mi/h under the speed limit and there is minimal opposing traffic present in the video scene.

Figure 14. Screenshot of Video Clip 10.

Discussion results: After viewing this video clip, the vast majority of participants from both focus groups expressed "frustration" and "irritation" with the situation depicted in the video clip, where the video vehicle was following a pickup truck traveling under the speed limit. The moderator asked one group of participants, "Given that the speed limit was 60 mi/h and he was going about 5 mi/h under, how many of you would have wanted to pass that truck?" The moderator stated for the record that just about everyone raised their hand.

Both groups were asked if they would feel compelled to pass if the pickup truck was traveling at 65 mi/h (5 mi/h over the speed limit. Members of both groups said "no" with one person saying, "No, there's no reason to, because he'd be going at least the speed limit." One of the focus groups was asked if they would feel compelled to pass if the truck was going 60 mi/h (the speed limit) and several people stated that they would not. To follow up, the moderator said, "So the threshold seems to be the speed limit. As long as they're doing the speed limit then you're OK." Several people said "yes."

As an aside, the moderator asked if the presence of large semi-trucks was a big issue for members of one of the groups. The majority of the group acknowledged that they were uncomfortable around large semi-trucks and one person said, "They slow up your speed and limit your visibility."

In summary, most participants felt frustrated and dissatisfied with the prospect of having to follow the slow-moving pickup truck. In this situation the threshold between feeling compelled and not compelled to pass seems to be the posted speed limit. This appears to be consistent with the discussions resulting from video clip 5, where several people said they would feel no desire to pass unless the vehicle in front of them was going approximately 5-10 mi/h under the speed limit. Also, large trucks seem to play a negative role in their perceived trip quality.

Video clip 11

Description: Coastal roadway with a speed limit that transitions from 45 to 30 mi/h (45-35-30) as the roadway approaches a moderate pedestrian/development activity area with a traffic signal and parking lot off to one side. The roadway also transitions from a 'passing' to a 'no-passing' zone near the more densely developed and active area. In the

video scene, the ocean can be seen from the roadway and there is moderate traffic in both directions.

Figure 15. Screenshot of Video Clip 11.

Discussion results: In this discussion a couple of people from both focus groups mentioned that they thought the speed limit was appropriate but that it should have been lower in the area where there was higher density development, more pedestrian activity, and vehicle activity, such as near the parking lot.

Many members of one group remarked that even though the pavement markings indicated that passing was permitted, they would not do so because of the increased level of traffic and pedestrian activity. One person said, “I would be less likely [to pass] due to the fact that we were in a resort area and the activity is going to dictate.”

When asked how the number of vehicles would influence their trip quality, a couple of people from one group said that the quality would “go down with lots of cars.”

One person took a different stance by saying, “The number of cars would not be a problem if traffic was moving.”

In summary, although there was no lengthy discussion about any one of the topics mentioned above, it appears that most people expect to travel at slower speed because of the higher level of roadside development and activity. There also seems to be no expectation for passing for the same reasons. These discussions are generally consistent with those of other similar video clips, such as clip 2, clip 4, and clip 7, which all depicted travel through small or medium-sized towns.

Video clip 12

Description: Two-lane bridge with a speed limit of 55 mi/h and no shoulder, only a guardrail. The roadway has well maintained pavement and markings and standard-width lanes. The pavement markings on the bridge indicate ‘no-passing’ (solid-yellow center line). The video vehicle is following other vehicles (but not closely) traveling at the speed limit or above.

Discussion results: A few issues emerged in the discussion about this video clip. Members of both groups expressed concern with the lack of a shoulder or pull-off area for disabled vehicles or other incidents. Additionally, when asked about passing expectations in this situation, members of both groups resoundingly said that they would not feel compelled to do so.

Members of one group were asked if the following situation depicted in the video clip, where the video vehicle was traveling in a well-dispersed platoon at speeds at or above the speed limit, was an undesirable situation. The only audible responses were from a few who said “no.”

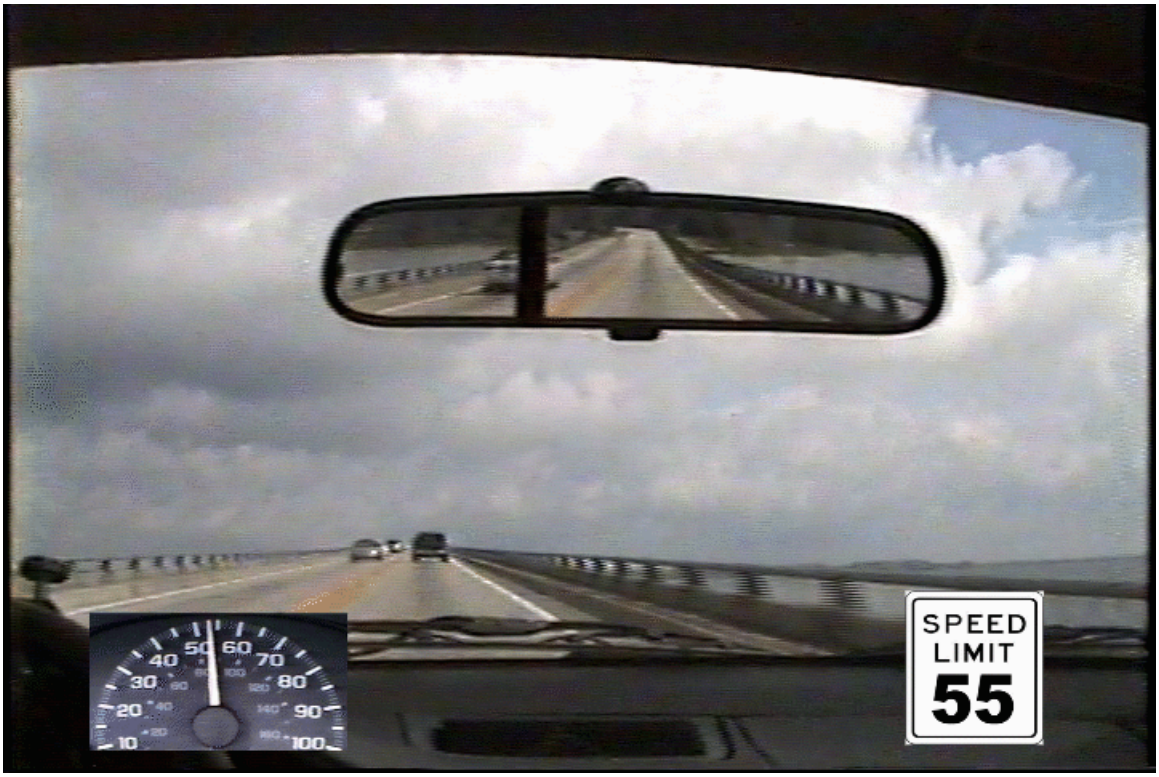

Figure 16. Screenshot of Video Clip 12.

Another issue involved the posted speed limit of the facility as well as the expected travel speed. In one group, several participants felt that the posted speed was too high for the type of bridge, citing safety concerns. However, many others felt that the posted speed limit was appropriate. When asked if the "primary thing in terms of delineating between poor and good trip quality would be maintaining a speed close to the posted speed limit", most members of one group said "yes" with one person saying "because you don't have to worry about people coming in and out."

In summary, the importance of a shoulder is once again reiterated. There also seems to be no expectation for passing on a facility such as this. Participants did not seem to be bothered that the video vehicle was following other vehicles because the other vehicles in the platoon were not closely spaced and were traveling at a reasonable speed. Participants also noted that a travel speed close to the speed limit was desired.

Video clip 13

Description: The speed limit transitions from 45 to 35 mi/h as the roadway approaches a small town with moderate roadside development, many driveways and a traffic signal. After the traffic signal, the speed limit returns to 45 mi/h. In the video scene, the video vehicle is following a vehicle traveling between the speed limit and 5 mi/h under and there is moderate traffic present in both directions.

Figure 17. Screenshot of Video Clip 13.

Discussion results: Two major themes emerged in the discussion following this clip. One dealt with perceptions of trip quality with respect to traffic signals on two-lane highways and the other dealt with the relationship between speed and following.

Members of both groups were prompted to discuss how the occasional presence of traffic signals (once every 5-10 miles) on two-lane highways impacts their perception of trip quality. The majority of member said that traffic signals “didn’t bother” them or that

they were “not a big deal.” However, one person said that the presence of a traffic signal was a “big impact, negatively.” Another individual said that it was a “medium impact” and followed by saying, “If it was every 5 miles and the light was red it would start to become an issue. If it were a longer interval and half of them were green, that would be better.”

When asked if anyone would feel compelled to pass in the situation depicted in the video clip, several members of one group said “no.” One person said, “That person in front was going 35 in a 45-mi/h zone and that was getting me a little bit antsy, but I wouldn’t have passed either way.” A couple more people indicated that they too were frustrated with having to follow at a lower speed than the speed limit, as depicted in the video. When asked the same question, a member from the other group said, “It frustrates me. I would rather do what the speed limit says, and if [the speed limit] is slow, then fine, but I don’t want somebody in front of me going 15 miles below the speed limit.”

In summary, the occasional or rare presence of a traffic signal on two-lane highway trips does not seem to bother the majority of the participants. However, a couple of participants expressed that the presence of signals does downgrade the quality of their trip. Most group members agreed that they would not feel an expectation to pass in the small town area, however, several members were frustrated by having to follow a vehicle traveling well below the speed limit. These comments are consistent with those discussions for similar video clips.

Video clip 14

Description: A high-speed facility with a 50-mi/h speed limit. The roadway has narrow lanes (10-11 feet), no paved shoulder, well maintained pavement and markings,

and many marked ‘passing’ zones (indicated by a dashed-yellow center line). In the video scene, there is minimal traffic present in either direction.

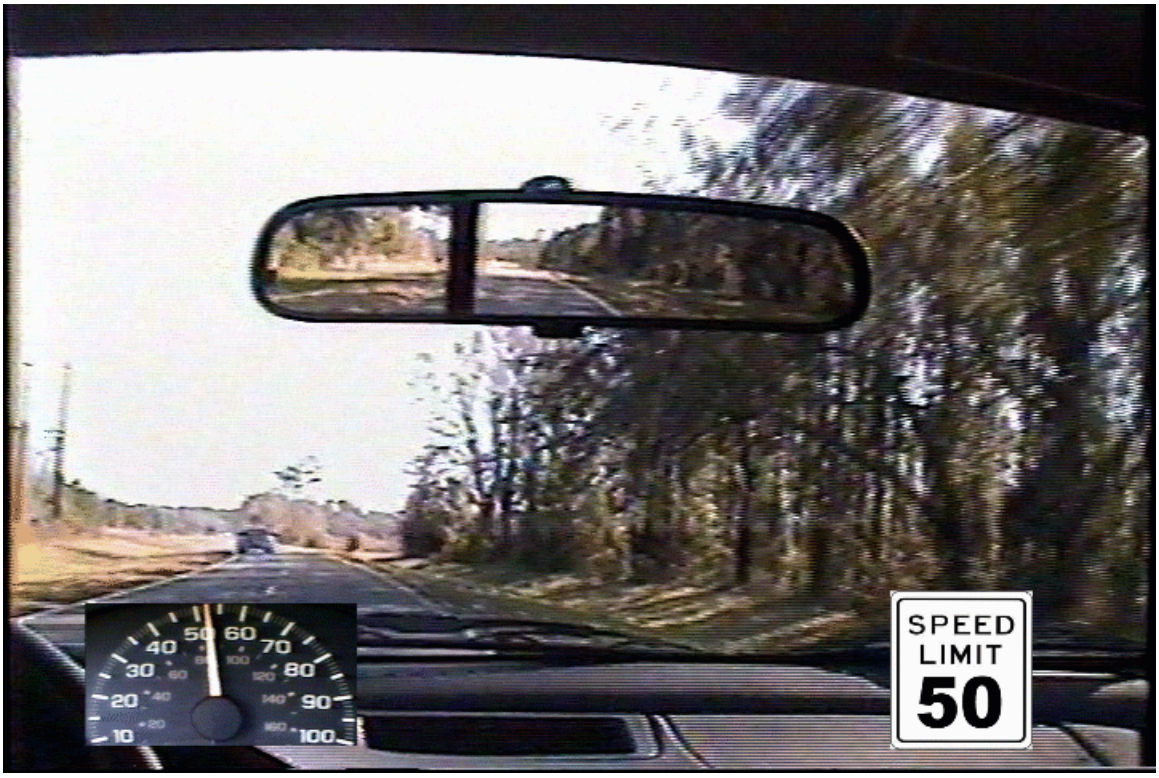

Figure 18. Screenshot of Video Clip 14.

Discussion results: The main topic of discussion for this video clip involved the impact of narrow lanes and lack of shoulders on the participants’ perceived trip quality and choice of travel speed.

As was the case with many of the other video clips, many people commented about the lack of shoulders, indicating that it may have some impact on perceived trip quality. However, as the moderator prompted further discussion, many of those participants began to acknowledge that their concerns were related more to safety than operations. When asked to consider a hypothetical situation in which the same road was being judged, but there was no chance of a ‘crisis situation’ occurring, thereby requiring the

driver to pull over, many people said that the lack of shoulder would not lower their trip quality, calling it “a fine road” and “a good road.”

Furthering the conversation, the moderator attempted to get information about how roadway characteristics such as narrow lanes and lack of shoulder area impacts the participants choice of travel speed. To do so, the moderator, once again, described a hypothetical situation in which he asked participants to compare between a straight roadway with 12 foot lanes and a paved shoulder, and a straight roadway with 10 foot lanes and no paved shoulder. The moderator then asked, “Who would drive slower than that posted speed limit because of the narrower lane and lack of shoulder?” Several people said that they would, with two people saying “especially at night.” The moderator stated for the record that four people raised their hand to indicate that narrow lanes and lack of shoulders would not affect their speed.

In summary, it appears that narrow lanes and lack of shoulder do impact the choice of travel speed for some participants, but others claimed that it has no effect. However, previous discussion indicated that these characteristics did not necessarily lower their perceived trip quality.

Video clip 15

Description: A high-speed facility with a speed limit that increases from 45 to 55 mi/h, standard-width lanes, well maintained pavement and markings, and moderate roadside development. In the video scene there is moderate traffic present in both directions and the video vehicle is being followed by another vehicle (but not closely).

Figure 19. Screenshot of Video Clip 15.

Discussion results: While there was no lengthy discussion about any particular topic, a couple of issues were discussed briefly. Most people seemed to feel that the speed limit on the facility was appropriate and that the adjacent driveways were easy to see. Only one person seemed to be bothered that the video vehicle was being followed by another vehicle, and said that maybe this indicated that the speed limit was not high enough.

One person mentioned that the addition of deceleration lanes would be an improvement because "…there were so many driveways turning off, and having a lot of people slowing down in front of me to turn into driveways, they would have to slow down really slow and that would bother me."

In summary, most participants felt that the speed limit was appropriate given that there was some roadside development. The suggestion made by one participant

regarding the addition of deceleration lanes indicates that having to slow down for vehicles exiting the roadway would lower the quality of the trip.

Video clip 16

Description: The speed limit transitions from 45 to 35 mi/h as the roadway approaches a medium-sized town. The roadway has standard-width lanes, well-maintained pavement and markings, moderate roadside development, and many driveways. In the video scene, there is moderate traffic present in both directions. Also, the video vehicle being followed closely and is following other vehicles traveling 5 to 10 mi/h under the speed limit.

Figure 20. Screenshot of Video Clip 16.

Discussion results: Both focus groups did not have much to say in reference to this clip. A couple of people mentioned that they did not like that the video vehicle had to travel so far under the speed limit due to the vehicles ahead of it. One person said, “If

people were going the speed limit there would have been no problem, but the people were just going 10 mi/h under." Another group member said that they "wouldn't dare go over the speed limit" because there was a lot of "activity going on off to the sides." As a result of the activity and traffic volume, most people said that they would not feel the need to pass.

In summary, although there was little discussion about this clip, what was said, however, was consistent with previous statements about passing expectations within small to medium-sized towns. Also, the statements about expectations of travel speed are consistent in that most participants do not like having to travel at a reduced speed (relative to the posted speed limit) as a result of following other vehicles.

Survey Forms

Form 1

For Form 1, participants were asked to use the spaces provided on the form to: "Describe what you consider to be the primary indicators of the trip quality for each of the two-lane highway video clips. Please be specific as possible when describing what you feel are the important factors used in your assessment of trip quality. Factors you should consider include traffic conditions and/or characteristics of the roadway itself."

While the written comments proved useful in some situations, helping to interpret and back up the data collected from the focus group discussions, many of the comments were either vague, irrelevant, or sometimes illegible. In some cases, participants wrote down merely what they saw in the video clip. For instance, if there was a railroad crossing in the video clip, some people simply wrote "RRXing" or if there was a guardrail, they would write "guardrail." For this reason, some of the responses were difficult or impossible to interpret.

At times however, the written comments were more specific. For example, in reference to many of the video clips featuring a two-lane highway through a small or medium –sized town (clips 2, 4, 7, 13, and 16) , many participants wrote, “not compelled to pass” or “should not be able to pass”, indicating that they do not feel compelled or expect to pass in these situations. In reference to clip 10, in which the video vehicle was following a vehicle traveling slower than the speed limit, many participants wrote, “would have been frustrated with vehicle going too slow” or “would have passed” or “I would pass if a car was not doing the speed limit.” Comments such as these, when put into the context of the corresponding video clip, served as support to the verbal discussions.

An effort was made to quantitatively analyze the written comments provided on this survey form. A spreadsheet was created in which the comments for each video clip were entered. Irrelevant comments were discarded. The remaining comments were then separated into different categories. Examples of such include: “good visibility,” “pavement quality good,” “posted speed limit is good/adequate,” “not compelled to pass,” and “lane width not good.” The frequency of comments pertaining to a particular category (for each video clip) was then calculated. However, as discussed previously, the frequency in which a particular topic is discussed (or in this case written) does not necessarily reflect its importance. In fact, in this study, the frequency of certain written comments did not always correlate with the topics emphasized most heavily in the discussions. The spreadsheet detailing the frequency of comments is included in appendix H.

Form 2

Unfortunately, much of the results from this form were inconclusive. In many cases the results were inconsistent with the data collected from the focus group discussions and from the written responses on survey form 1. In fact, when analyzing the rankings, it appeared that many of the participants either did not understand what was being asked of them or did not want to take the time to properly fill out the form. Since the form was given to the participants at the end of the focus group session, it is possible that many participants were experiencing fatigue or were simply eager to leave.

In general, participants tended to say that all of the roadway and traffic factors listed on the form were of great importance to their perceived trip quality, rather than indicating the relative importance between them. In some cases, participants recorded 7's (indicating extreme importance) for all of the factors in all of the two-lane highway categories. While it is possible that these individuals felt that all of the roadway and traffic factors were of equal importance on all of the different types of two-lane highways, it is more probable that these individuals were eager to leave and therefore did not take the time to fill out the form in a way that truly represented their opinions.

However, some general trends were observed in the rankings. With respect to the four categories of two-lane highways listed on the form, a general downward shift in the frequency of higher numbered (5's,6's, and 7's) rankings occurred between the high and medium-speed facility categories and the low-speed categories. This indicates that the majority of participants consider the roadway and traffic characteristics listed on the form to factor more heavily in their assessment of trip quality for high and medium-speed facilities, and less heavily for lower-speed facilities such as those through small towns or coastal areas. The results of this form are included in appendix H.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

The objective of this study was to determine what performance measures appear to be most appropriate (i.e., consistent with traveler perceptions and expectations) for assessing LOS on different types of two-lane highways. As it stands, LOS methodologies can be improved by more accurately correlating the roadway performance measures used in analyses to the perceptions and expectations of the roadway users themselves. This will lead to better decision making about the allocation of resources to roadway infrastructure improvements.

Conclusions

Focus Group Implementation and Survey Forms

The recruitment of participants with the newspaper advertisement method was generally effective. The response rate exceeded expectations. Since many more people responded to the advertisement than the number needed for the three focus groups, it was possible to select participants such that each focus group consisted of a reasonably diverse sample of individuals. However, the one limitation with this method was that the majority of respondents were older[1]; thus, almost all of the few younger people (ages 25 – 45) that responded were selected to participate in the focus groups.

All three focus groups ran relatively smoothly and a significant amount of valuable information was obtained. As expected, however, the group discussion w as sometimes

[1] This is expected to be due to a large amount of retirees whose schedules are more often more flexible.

dominated by the more talkative or extroverted individuals, which consequently led to unequal representation in the audio recordings. However, the written survey form was intended to counter this, by giving all participants a forum in which to voice their opinions, although those opinions were limited to the space on the form.

While the written survey form (Form 1) proved useful in some situations, helping to interpret and back-up the data from the focus group discussions, many of the comments were either vague, irrelevant, or sometimes illegible. In many cases, the frequency of certain written comments did not always correlate with the topics emphasized most heavily in the discussions. The use of Form 2 ultimately did not have the desired outcome, in that the results were inconclusive and in some cases inconsistent with the data collected from the focus group discussions. It is suspected that participants either did not understand what was being asked of them or did not want to take the time to properly fill out the form. Therefore, it is felt that the audio data recorded from the focus group discussions is the most reliable set of data.

Focus Group Discussions

The focus group discussions proved to be an effective method of obtaining user perceptions about quality of service on two-lane highways. Based on the focus group discussions in this study, it is apparent that motorists consider several factors in their assessment of trip quality on a two-lane highway. The function and/or development setting of the of two-lane highway facility also appears to dictate what their trip quality expectations are.

In all three focus group sessions, there were many common themes or topics of discussion that arose repeatedly. For many of the study participants, safety was a primary concern, and was discussed heavily. Positive guidance, in the form of appropriate

signage, clear lane markings and striping, reflectors, and in some cases lighting, was considered to be an important factor in their assessment of trip quality on all types of two-lane highways. While this is not necessarily a traffic operations issue, it nevertheless was a popular discussion topic and worthy of noting.

Another popular, but non-traffic operations, issue involved pavement quality. Participants stressed the importance of high quality, well maintained pavement repeatedly throughout the focus group discussions. For example, many participants immediately noticed and responded to the high quality pavement depicted in video clip 1 and the poor quality pavement depicted in video clip 5.

Another heavily repeated theme, that transcended all two-lane highway types, involved the presence or absence of shoulder area (paved or unpaved). While this is partly a safety issue in terms of having an "escape route" or "leeway" in the event of an incident, it can also be an operational issue. Some participants indicated that a lack of shoulder or adequate clearance zone decreases their comfort level and overall perception of trip quality. These participants felt that a lack of shoulder area also influences their choice of travel speed. Others, however, claimed that this had no impact on their travel speed or perceived trip quality.

In relation to shoulders, lane width was also discussed in reference to many video clips, including clips 3, 6, 12 and 14. Like shoulders, lane width appears to have an effect on the choice of travel speed and perceived trip quality for some study participants, but not others.

Speed and following/passing were also themes that arose repeatedly in all of the focus group sessions. The discussions about speed often centered around either an

absolute speed, such as the posted speed of the roadway, or a relative speed, such as the desired travel speed or speed of the vehicles in the video in relation to the posted speed limit. The discussions about following/passing often focused on whether or not the participants felt compelled to pass in a given situation and how they felt about following or being followed by other vehicles. Based on the data collected in this study, motorists have different expectations of speed for different types of two-lane highways, as well as different expectations with regard to passing.

In reference to video clips 1, 5, 10, 14 and 15, most participants agreed that the posted speed limits on the facilities were appropriate given the context of the facilities. All six video clips featured two-lane highways through rural undeveloped areas with 50- to 60-mi/h posted speed limits. Study participants indicated a desire and an expectation to travel at high speeds on these facilities. In most cases this desired or expected travel speed was the speed limit or above by 5-10 mi/h. Most participants agreed that having to travel slower than the posted speed limit on these types of facilities resulted in a lower trip quality. Participants also indicated that passing opportunities were an important aspect of trip quality on a high-speed two-lane highway. However, many participants agreed that they would not feel compelled to pass unless they were following a vehicle going approximately 5-10 mi/h under the speed limit, such as with video clip 10.

Video clips 2, 4, 7, 13 and 16, all feature two-lane highways which travel through small-or medium sized towns. Based on the focus group discussions, many participants agreed that they would not feel compelled or have an expectation to pass in a town area. Participants appeared to feel similarly with respect to passing expectations for the coastal roadway depicted in video clips 8 and 11, which featured moderate surrounding

development and pedestrian activity. Participant also felt this way about the two-lane highway segments depicted in video clips 3 and 12. Video clip 3, featured a scenic tree canopy roadway with narrow lanes and video clip 12 featured a narrow bridge with no shoulder. In all of the above situations, participants agreed that they would not have an expectation to pass, but that having to follow a vehicle traveling slower than the sped limit would negatively affect the trip quality, such as in video clips 13 and 16. Furthermore, participants acknowledged that their preferred travel speed was a speed at or above the speed limit

Video clips 6 and 9, the only two remaining video clips not discussed previously, both depicted two-lane highways with moderate residential development on both sides of the roadway. Both video clips received debate over the appropriate posted speed limit and passing expectations. For video clip 6, some participants felt that the 45 mi/h speed limit was appropriate due to the residences along the roadway. These participants also expressed that they would not feel compelled to pass for this reason. However, others felt that this speed limit was too low and that they would pass if it were safe to do so. For video clip 9, the majority of participants agreed that the posted speed limit of 35 mi/h was too low. Although they recognized the presence of residences, many felt that a speed limit of 45 mi/h would be more appropriate given that very little traffic would be using these private driveways. Again, some participants felt a reasonable expectation to pass in this situation, while others did not.

Based on the data collected from the participants in this study, there appears to be at least three categories of two-lane highways from a motorist's perspective. There are two very definable categories of two-lane highways and the resultant traveler

expectations. However, there were other two-lane highway situations that did not fit into either of those two categories and there was not a clear consensus on the preferred performance measures.

The first category includes high-speed (50 mi/h and above) two-lane highways, in generally rural undeveloped areas, in which motorists expect to travel at high speeds and have frequent passing opportunities. Therefore, the combination of speed- and passing opportunity-based performance measures seems appropriate for this category.

The current HCM service measures for a Class I two-lane highway include ATS and PTSF. The ATS service measure and corresponding thresholds for Class I are intended to reflect the motorist's expectation for high-speed travel. However, the current thresholds for this class are somewhat restrictive given that the threshold for LOS A is 55 mi/h and, based on this study, motorists tend to perceive facilities with 50-60 mi/h speed limits as falling under this classification. Thus, PFFS may be more suitable than ATS in terms of a speed-based performance measure because it references a relative speed rather than an absolute speed. It is felt that the PTSF service measure is reasonable for this class because it accounts for passing opportunities. However, the implication with this measure is that vehicles traveling with headways of 3 seconds or less are compelled to pass, whereas this may not necessarily be the case. Therefore, this category of two-lane highway (high-speed, rural undeveloped) appears to be consistent, in terms of service measures, with the current Class I definition.

The second category consists of two-lane highways in which there is essentially no passing expectation, including roadways through small-or medium-sized towns, developed coastal areas, and certain scenic areas. While these types of facilities are

certainly not Class I facilities, they do not fit under the Class II definition either. These types of two-lane highways therefore should be of a separate class, Class III for example. On these facilities, passing opportunities are not an issue, and in general, neither is the percent time-spent-following. While the participants stated that they would certainly rather be traveling with no other vehicles around them, they acknowledged that following is not much of a concern in these situations. Particularly in low-speed conditions, such as in small towns, following does not tend to be of much concern because there are fewer safety implications. On these two-lane highways, the clear consensus from the focus groups was that the motorist's primary desire is to travel at a speed at or slightly above the posted speed limit. Therefore, a speed-based measure, such as PFFS, appears to be more appropriate for these Class III two-lane highways than a following-based measure such as PTSF.

Based on the focus group results, it is clear that there are additional two-lane highway situations/configurations that do not fall into either of the above described categories. These two-lane highways essentially fall in between the two other categories in that passing expectations on these roadways do not appear to be as definitive. For example, with video clips 6 and 9, participants were essentially divided on the issue of passing. Given the moderate level of residential development depicted in both of the video clips, participants did not expect high-speed travel (such as on a rural undeveloped facility), which in terms of the current HCM classifications, would render this type of highway as Class II. The performance measure for a Class II two-lane highway in the HCM is PTSF, indicating that following is the primary determinant of level of service. However, this does not seem to be consistent with the expectations of some motorists.

Instead, for these types of two-lane highways, speed seemed to be a larger issue. While the participants did not have an expectation for high-speed travel, at the same time they did not feel that low speeds were warranted either (such as in a small town). In reference to video clip 9, most participants expressed frustration with what they perceived was an excessively and unnecessarily low posted speed limit, given the context of the facility. On these types of intermediate two-lane highways, an absolute travel speed appears to be just as important as a relative travel speed. In other words, while most motorists' primary desire is to travel at a speed which is at or above the speed limit, on these types of two-lane highways it is just as important (from the motorist's viewpoint) for the posted speed limit to be set appropriately within the context of the facility. Therefore, for these Class II-type facilities, an absolute-speed-based performance measure such as ATS should be considered. It is possible that, based on the context of the facility and motorist's expectations, a following based performance measure should also be used. However, for these types of two-lane highways, "engineering judgment" will have to dictate.

In summary, it is clear from this focus group effort that some improvements could be made to the current classification scheme and corresponding service measures. To begin with, the manner in which the current HCM classifies two-lane highways does not appear to be comprehensive, and for one of the classifications the chosen service measure is not necessarily appropriate. At this time, classifications are largely based on expectations of travel speed. From this study, it appears that expectations for passing should be considered, in addition to travel speed, when distinguishing among facilities. Also, the current classifications do not address two-lane highways through small towns or through coastal and scenic areas. These types of facilities should receive their own

classification (Class III) and their own specific performance measure, the most logical choice being PFFS.

The current HCM Class I methodology is largely consistent with what was determined in this study. However, the use of PTSF does not account for the possibility that in some situations many people are content to not pass, even if following other vehicles closely. A passing opportunity-based performance measure, rather than a following-based performance measure may be more appropriate for these types of facilities. However, the development of such a measure should perhaps be pursued as part of a more long-term research effort.

The current HCM Class II definition, which includes all roadways in which motorists do not expect to travel at high speeds, is also largely consistent with what was determined in the study, except that two-lane highways in which there is no expectation for passing should be designated as Class III. Unlike the current Class II methodology though, the use of a speed-based performance measure should be considered, as well as a following-based measure. For these types of roadways, it appears that absolute travel speed (e.g., no less than 45 mi/h) is just as important as being able to travel at a certain speed relative to the posted speed limit. Therefore, ATS should be considered as a speed-based measure. Thus, a combination of ATS and PTSF, similar to Class I, should be considered; however, the LOS thresholds would be different than for Class I.

Recommendations for Further Research

For the findings of this study to be adopted on a national level, it is recommended that the scope of the video data collection and participant recruitment be broadened to include regions outside of the University of Florida/north central Florida area. Additionally, a future study should include a larger number of drivers under the age of

26. Future research should also consider the use of more video clips, with a more diverse range of roadway and traffic conditions. Based upon focus group feedback, only two of the video clips featured roadways that fell under Class II (although not done intentionally). In this study, the core of the video clips depicted Class I and Class III two-lane highways. It is recommended that future research include more Class II examples.

While the use of written survey forms provided all participants with an opportunity to provide input, the data collected from the focus group discussions were more reliable and valuable. In a future study, it is recommended that if forms are to be provided for written input, there should be more time allotted for the participants to think about their comments or responses and record them, as well as more time to reiterate the instructions on filling out the forms. Of course, this must be balanced with the overall time requirement for the focus group effort. In this study, the focus group sessions lasted two hours, which may already be pushing the practical limits of what can be expected from recruited participants. It may be more desirable to not require any written input from focus group participants. However, if no written input is to be collected, an attempt should be made to obtain verbal input from each participant.

In the previous section, some suggestions were made for making some improvements to the current LOS methodology for two-lane highways. With regard to two-lane highways that clearly were neither Class I or III, it became evident that there were not enough video data collected with respect to these type of facilities to be able to make definitive recommendations in terms of performance measures. Furthermore, it was made clear that a number of roadway factors (e.g., pavement quality, roadway

striping quality, etc.) are also important to motorists in evaluating trip quality. Thus, the development of a more comprehensive LOS methodology should be considered. The outcome of such research might be a level of service function that could be applied to all categories of two-lane highways. The function could be defined in terms of a series of variables (performance measures) and corresponding coefficients. The variables might include PFFS, ATS, PTSF, Passing Opportunities, % Heavy Vehicles, Pavement Quality, Lane Striping Quality, etc. The coefficients would be defined separately for each category of two-lane highway. Thus, the weighting of the importance of each variable to the overall evaluation of trip quality by a motorist could be different for each class of two-lane highway.

APPENDIX A
LETTERS FROM FLORIDA OFFICIALS REGARDING
HCM 2000 TWO-LANE HIGHWAY ANALYSIS METHODOLOGY

Florida Department of Transportation

JEB BUSH
GOVERNOR

605 Suwannee Street
Tallahassee, Florida 32399-0450

THOMAS F. BARRY, JR.
SECRETARY

November 2, 2001

Dr. Richard Dowling
Principal
Dowling Associates
180 Grand Avenue, Suite 995
Oakland, California 94612

Dear Dr. Dowling:

Subject: HCM2000 Uninterrupted Flow Two-Lane Level of Service Thresholds

Florida Department of Transportation (FDOT) staff has begun working with the new uninterrupted flow two-lane chapter of the HCM2000 and have serious concerns with the new thresholds presented. In some cases service volumes for Class I facilities have dropped approximately 50 percent from those in HCM1997. This change in service volumes will have a significant impact on FDOT actions in determining roadway deficiencies, reporting to legislators on the status of the highway system, and setting priorities. For those states and others who adopt the HCM, requiring the use of these new thresholds may have similar significant impacts.

It is my understanding that there was not a significant amount of discussion on setting the level of service thresholds by the Transportation Research Board Highway Capacity and Quality of Service Committee. Because of the significant change in the thresholds from HCM1997, we strongly request that the Committee revisit the level of service A-E thresholds set for those facilities. As appropriate, additional testing, new research, surveys to users or some other effort appears warranted.

As you are aware, Florida has been one of the leading states implementing and advancing the HCM. On an interim basis until the threshold issue is addressed and resolved, FDOT has made a decision to continue to use the HCM1997 level of service thresholds in rural undeveloped areas and will use a newly developed Class III two-lane class in developed areas. Our lead researchers and staff have submitted a professional paper encompassing these Class III facilities to your committee for its review and expected presentation at the 2002 TRB Annual Meeting.

Dr. Richard Dowling
November 2, 2001
Page Two

If you have any questions or need further information on the FDOT concerns, please contact Doug McLeod, (850) 414-4932, of my staff.

Thank you for consideration of this issue.

Sincerely,

Ysela Llort
State Transportation Planner

YL:bkl

cc: Tom Barry, Chair, AASHTO Standing Committee on Planning
Dwight Bower, Chair, AASHTO Standing Committee on Research
Lily Elefteriadou, Chair, Two-Lane Subcommittee, TRB Highway Capacity and Quality of Service Committee
John Zegeer, Chair, User Liaison Subcommittee, TRB Highway Capacity and Quality of Service Committee
Richard Cunard, Transportation Research Board
Ken Courage, University of Florida
Scott Washburn, University of Florida
Jim St. John, Federal Highway Administration

North Central Florida Regional Planning Council

2009 NW 67 PLACE, SUITE A, GAINESVILLE, FLORIDA 32653-1603
(352)955-2200 SUNCOM 625-2200 FAX (352) 955-2209

October 28, 2002

Mr. Douglas Harwood
Midwest Research Institute
425 Volker Boulevard
Kansas City, MO 64110

SUBJECT: Highway Capacity Manual (HCM) Rural Two-Lane Analysis

Dear Mr. Harwood:

As a member of the Florida Department of Transportation (FDOT) Level of Service Task Team, North Central Florida Regional Planning Council (NCFRPC) staff participated in the October 14-16, 2002 two-lane facility field study in Florida City, Florida. The purpose of this letter is to endorse FDOT's position to modify the HCM 2000 procedures regarding two-lane uninterrupted facility analyses for rural developed areas. This issue is of significant concern to us because the north central Florida region is predominantly rural and has a significant amount of two-lane arterial facilities that provide both intraregional and extraregional access.

The user's expectation while driving through a rural developed area is different than while driving through a rural undeveloped area. An increase in density of side-access from intersecting roadways and driveways lowers the user's expectation of unimpeded progression through the facility. In many instances, rural developed areas have land use intensity changes that are coincident with lower speed zones. Therefore, the user's expectation is changed. This perception change would indicate higher service volumes than those currently calculated using the HCM 2000 procedures. Exhibit 1 consists of some of the predominantly rural two-lane arterial facilities in north central Florida. It identifies nearly 100 settlements, most without traffic signals, that occur along these facilities.

If you have any questions or need more information, please call me at extension 103.

Sincerely,

Marlie Sanderson, AICP
Director of Transportation Planning

xc: Dr. Lily Elefteriadou, HCM Two-Lane Subcommittee Chair
FDOT Level of Service Task Team

EXHIBIT 1

TWO-LANE ARTERIAL FACILITIES THROUGH RURAL DEVELOPED AREAS OF NORTH CENTRAL FLORIDA

FACILITY	FROM	TO	MILEAGE	SETTLEMENTS
				FEDERAL HIGHWAY SYSTEM
US 27	**Archer**	**Perry**	88	**Archer#**, Half Moon, **Newberry#***, **High Springs#**, **Fort White#**, Hildreth, **Branford**, **Mayo#**, Buckville, Townshend, **Perry#**
US 41	**High Springs**	**Jennings**	67	**High Springs#***, Mikesville, Ellisville, Mason, Myrtis, **Lake City#**, Winfield, Suwannee Valley, **White Springs**, Genoa, Hillcoat, **Jasper#**, **Jennings**
US 90	**Monticello**	**Macclenny**	112	**Monticello#**, **Greenville**, **Madison#***, **Lee**, Ellaville, Falmouth, Dickert, **Live Oak#***, Houston, Wellborn, **Lake City#***, Watertown, Newton, Wilburn, Olustee, Sanderson, **Glen St. Mary#**, **Macclenny#**
US 98	Newport	**Perry**	38	Newport, Nutal Rise, Scanlon, Hampton Springs, **Perry#**
US 129	**Chiefland**	**Jasper**	81	**Chiefland**, **Trenton#**, **Bell**, **Branford**, Obrien, McAlpin, **Live Oak#***, Suwannee Spring, Hillcoat, **Jasper#**
US 221	**Perry**	Ashville	35	**Perry#**, Boyd, Lake Bird, Shady Grove, Ebb, **Greenville**, Ashville
				STATE HIGHWAY SYSTEM
State Road 24	**Cedar Key**	**Gainesville**	53	**Cedar Key**, Lukens, Rosewood, **Otter Creek**, Lennon, **Bronson#**, Meredith, **Archer#***
State Road 26	**Fanning Springs**	Putnam Hall	54	**Fanning Springs**, Wilcox, Lottieville, **Trenton#**, **Newberry#**, Orange Heights, Melrose, Putnam Hall
State Road 47	**Trenton**	**Lake City**	42	**Trenton**, **Fort White#**, Columbia City, **Lake City#**
State Road 51	Steinhatchee	**Live Oak**	53	Steinhatchee, Clara, **Mayo#**, Luraville., **Live Oak#**
State Road 100	**Lake City**	**Palatka**	76	**Lake City#**, Lulu, **Lake Butler#***, **Starke#**, **Keystone Heights**, Lake Geneva, Putnam Hall, Grandin, Florahome, Carraway, Springside, **Palatka#**
State Road 121	**Williston**	**Macclenny**	69	**Williston**, Wacahoota, **La Crosse**, Santa Fe, **Worthington Springs**, Dukes, **Lake Butler#**, Johnstown, **Raiford**, Ellerbee, Sapp, **Macclenny#**

Notes:
1. Settlements in **bold** are incorporated.
2. Pound symbol (#) indicates traffic signal within the settlement.
3. Asterisk (*) indicates greater than two throughlane cross-section within the settlement.
4. Gainesville Metropolitan Area facilities are not included.

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APPENDIX B
TRANSPORTATION RESEARCH BOARD
WORKSHOP PRESENTATIONS
JANUARY 2004

Presentation by Douglas Harwood of MRI

Midwest Research Institute

Level of Service Assessment For Developed Two-Lane Highways

NCHRP Project 20-7(160)

Douglas W. Harwood

Midwest Research Institute

Objective and Scope

OBJECTIVE

- Recommend procedures to assess quality of service for two-lane highways in developed areas

KEY DECISIONS

- What service measure to use?
- Where in HCM does procedure belong?

Existing HCM Chapter 20 Procedure

- Class I highways:
  - motorists expect to travel at relatively high speeds
  - service measures: PTSF and ATS
  - threshold values: Exhibit 20-2
- Class II highways
  - motorists do not expect to travel at relatively high speeds
  - service measure: PTSF only
  - threshold values: Exhibit 20-4

Scenarios Where Existing HCM Chapter 20 Does Not Apply

- two-lane highway through a small town with a reduced speed limit located on a major road with speeds of 55 mph or more
- two-lane highway in a transition area between rural and urban/suburban conditions with reduced speeds and low- to medium-density development

Scenarios Where Existing HCM Chapter 20 Does Not Apply

- two-lane highway with continuous urban/suburban development but no traffic signals or traffic signals spaced at intervals greater than 2 mi
- Are such facilities:
  - "generally uninterrupted flow" ?
  - "partially interrupted flow" ?

Two-Lane Highways with Continuous Development

- Candidate service measures:
  - PTSF
  - ATS
  - PTSF and ATS combined
- Recommended service measure:
  - ATS only
- Threshold values:
  - based on percentage of FFS

LOS Thresholds for HCM Chapter 15

- LOS A/B boundary 90% of FFS
- LOS B/C boundary 70% of FFS
- LOS C/D boundary 50% of FFS
- LOS D/E boundary 40% of FFS
- LOS E/F boundary 30% of FFS

HCM Chapter 15 Procedure for Urban Streets

- At signals:
  - use HCM Chapter 16 to estimate delay
- Between signals:
  - use running time per km from HCM Exhibit 15-3
- Combine segment running time and signal delay to get average running speed
- Apply LOS thresholds

Potential Weaknesses of HCM Chapter 15 Methodology as Applied to Developed Two-Lane Highways

- Running time between signals is based on signal spacing but does not consider:
  - effects of driveways and roadside development on delay
  - effects of unsignalized intersections on delay
- Procedure does not apply to:
  - streets without signals
  - streets with signal spacing over 2 mi

HCM Gaps Between Chapters

- HCM2000 does not address:
  - multilane urban streets without signals or with widely spaced signals
  - two-lane urban streets without signals or with widely spaced signals
  - developed two-lane highways
- HCM Chapter 21 addresses rural and suburban multilane highways
  - service measure: density

Where in HCM to Address Developed Two-Lane Highways

- Same service measures as HCM Chapter 15
- Same threshold values as HCM Chapter 15
- Physical facility like an arterial except for signal spacing
- Would very out of place in HCM Chapter 20
- Recommendation: incorporate in HCM Chapter 15 or a new facilities chapter

Related Questions for Two-Lane and Multilane Arterials

- How to evaluate arterials with no signals or widely spaced signals?
- Why not consider delays between signals when substantial?
- Need a true facilities chapter to combine:
  - multilane and two-lane segments (including driveway and development effects)
  - unsignalized intersections
  - signalized intersections

Alternative Approaches

- Adapt current procedures (combine appropriate elements of existing HCM Chapters 15 and 20)

OR

- Research effort to develop better developed two-lane highways procedure

OR

- Major research effort (new urban arterial facilities procedure)

Combine Existing Procedures

- If developed two-lane highway has no signals:
  - segment length has no effect, so HCM Exhibit 15-3 is not needed
  - determine ATS with HCM Equation 20-15
  - apply LOS thresholds from HCM Chapter 15

Combine Existing Procedures

- If signals are spaced more than 1 mi apart:
  - segment length has no effect, so HCM Exhibit 15-3 is not needed
  - determine ATS between signals with HCM Equation 20-15
  - determine signal delay from HCM Chapter 16
  - use HCM Chapter 15 procedures to combine segment speed and signal delay
  - apply LOS thresholds from HCM Chapter 15

Combine Existing Procedures

- If signals are spaced less than 1 mi apart:
  - determine running speed between signals based on HCM Exhibit 15-3
  - determine running speed between signals based on HCM Equation 20-15
  - use the lower of the two speeds

Combine Existing Procedures

- determine signal delay from HCM Chapter 16
- use HCM Chapter 15 procedures to combine segment speed and signal delay
- apply LOS thresholds from HCM Chapter 15

Small Towns and Transition Areas

- Analysis approach depends on length of area with reduced speeds
- Two-lane highway in an undeveloped area:
  - evaluate as Class I or Class II based on existing criteria in HCM Chapter 20

Small Town or Transition Area

- Two-lane highway in a small town or transition area on a Class I highway:
  - evaluate as Class II highway if developed area with reduced speeds extends for less than 2 mi and most traffic is through traffic
  - if developed area with reduced speeds extends for more than 2 mi or there is substantial local circulating traffic, evaluate with developed two-lane highway procedure

Research Needed

- Desirable, but not comprehensive:
  - HCM procedures for developed two-lane highways
- Long-term, more comprehensive:
  - urban arterial facilities procedure for any combination of:
    - segments (including driveways and development)
    - unsignalized intersections
    - signalized intersections

Presentation by Doug McLeod of FDOT

FDOT's Major Recommendations in Contrast to NCHRP 20-7

(focus of this workshop)

- There should be **one class (Class III)** of uninterrupted flow two-lane segments that applies in all developed areas
- **Percent free flow speed** is the best service measure for these segments in developed areas, not percent time spent following or average travel speed
- **Practical** level of service **thresholds** should be established for these segments, not untested thresholds
- Because these segments are uninterrupted flow, they should be addressed consistently in an **uninterrupted flow chapter**, not interspersed with an interrupted flow chapter

Class III for All Developed Areas (1)

Recommendation 1

- Current HCM classes apply to undeveloped areas
  - Class I – high speed segments
  - Class II – not high speed segments
- **Class III** Typical developed areas
  - Small towns/communities (most typical situation)
  - Roads with development along them (e.g., beach roads)
  - In urbanized areas (e.g., fringe areas)

Class III for All Developed Areas (2)

Recommendation 1

- Class III should apply to all developed areas
- Conceptually it makes sense to
  - Group developed areas into one category of roads
  - HCM users would probably appreciate
    - Simply first making a choice of "developed" or "undeveloped"
    - Not having to go to different chapters and use different performance measures for comparable situations

Class III for All Developed Areas (3)

Recommendation 1

- Current NCHRP 20-7 Recommendations
  - Does not recommend a Class III
  - Small towns
    - Should be treated like other Class II segments
    - Should use percent time spent following as the service measure
  - Other developed situations (greater than 2 miles)
    - Should be treated in the urban streets interrupted flow chapters
    - Should use average travel speed as the service measure

Use Percent Free Flow Speed as the Service Measure (1)

Recommendation 2

- In small towns/communities what are through drivers primarily concerned with?
  - **Percent time spent following** (largely reflecting the desire to pass)
  - **Average travel speed** (largely reflecting the desire to maintain a set speed)
  - **Percent free flow speed** (largely reflecting the desire to maintain a speed reflective of specific roadway/area circumstances
  - Other

Use Percent Free Flow Speed as the Service Measure (2)

Recommendation 2

- FDOT's position - in small towns posted (e.g.,) 30 mph with no stop conditions drivers would:
  - Probably like to average about 35 mph
  - Probably not expect to be able to pass vehicles
  - Probably not expect to average a set speed (e.g., 45 mph)

- FDOT's position - in small towns or along developed roadways posted (e.g.,) 50 mph with no stop conditions drivers would:
  - Probably like to average about 55 mph
  - Probably not expect to be able to pass vehicles
  - Probably not expect to average a set speed (e.g., 45 mph)

Recommendation 2

Use Percent Free Flow Speed as the Service Measure (3)

- Current NCHRP 20-7 Recommendations
  - Small towns
    - Percent time spent following as the service measure
    - Implied - drivers in these areas are most concerned about trying to pass
  - Other developed situations (greater than 2 miles)
    - Average travel speed as the service measure
    - Implied - drivers expect to go the same speed regardless of the roadway/surrounding conditions

Recommendation 2

Use Percent Free Flow Speed as the Service Measure (4)

- **Percent Free Flow Speed** is the best service measure for these segments in developed areas, not Percent Time Spent Following or Average Travel Speed

Recommendation 3

Practical LOS Thresholds Should Be Established (1)

- Practical level of service thresholds should be established for these segments, not untested thresholds

Recommendation 3

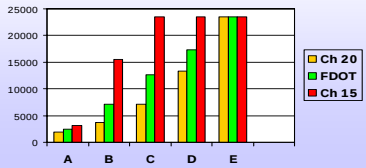
EXAMPLE

~ Service Volumes (using 20-7 Chapter 20 Class II approach for small towns)	~ Service Volumes (using FDOT's approach with Exhibit 20-2 as a base)	~ Service Volumes (using 20-7 Chapter 15 approach in other developed areas)
A = 1,900	A = 2,500	A = 3,100
B = 3,700	B = 7,200	B = 15,500
C = 7,100	C = 12,700	C = 23,500
D = 13,300	D = 17,300	D = N/A
E = 23,500	E = 23,500	E = N/A

Recommendation 3

EXAMPLE

~ Service Volumes (using 20-7 Chapter 20 Class II approach for small towns)	~ Service Volumes (using FDOT's approach with Exhibit 20-2 as a base)	~ Service Volumes (using 20-7 Chapter 15 approach in other developed areas)
A = 1,900	A = 2,500	A = 3,100
B = 3,700	B = 7,200	B = 15,500
C = 7,100	C = 12,700	C = 23,500
D = 13,300	D = 17,300	D = N/A
E = 23,500	E = 23,500	E = N/A



Recommendation 3

Practical LOS Thresholds Should Be Established (1)

- FDOT's position – LOS thresholds need to make sense when applied in the real world
  - HCM practitioners would probably appreciate LOS thresholds that can **be applied consistently** for these roads in developed areas
  - Resulting LOS calculations and service volumes for these roadways **need to make sense** in relation to those in undeveloped areas and those that are signalized

Recommendation 3

Practical LOS Thresholds Should Be Established (2)

- FDOT has provided LOS percent free flow speed thresholds directly linked to HCM Exhibit 20-2 (on average travel speed) that work reasonably well
- FDOT has provided closely related alternative percent free flow speed thresholds that may work even better in the field

Recommendation 3

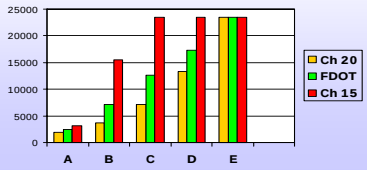
Practical LOS Thresholds Should Be Established (3)

- Current NCHRP 20-7 Recommendations
  - Different service measures in different areas
  - Small towns
    - Use of Class II percent time spent following thresholds result in abnormally low LOS service volumes
      - Northern California case – (Local perceptions)
      - Georgia case – (FHWA requiring LOS C for design)
  - Other developed situations (greater than 2 miles)
    - Use of HCM's interrupted flow average travel speed criteria
      - The related percent free flow speeds have a heavy dependence on control delay
      - Essentially LOS D & E would never exist

Recommendation 3

Practical LOS Thresholds Should Be Established (4)

- Practical level of service thresholds should be established for these segments, not untested thresholds



Recommendation 4

These Roadways Should Be Addressed in the HCM Uninterrupted Flow Two-Lane Segment Chapter (1)

- FDOT's position - Uninterrupted flow highway segments should be treated in the same chapter of the HCM
  - They should not be split between the current two-lane segment chapter and the interrupted flow urban streets chapter

Recommendation 4

These Roadways Should Be Addressed in the HCM Uninterrupted Flow Two-Lane Segment Chapter (2)

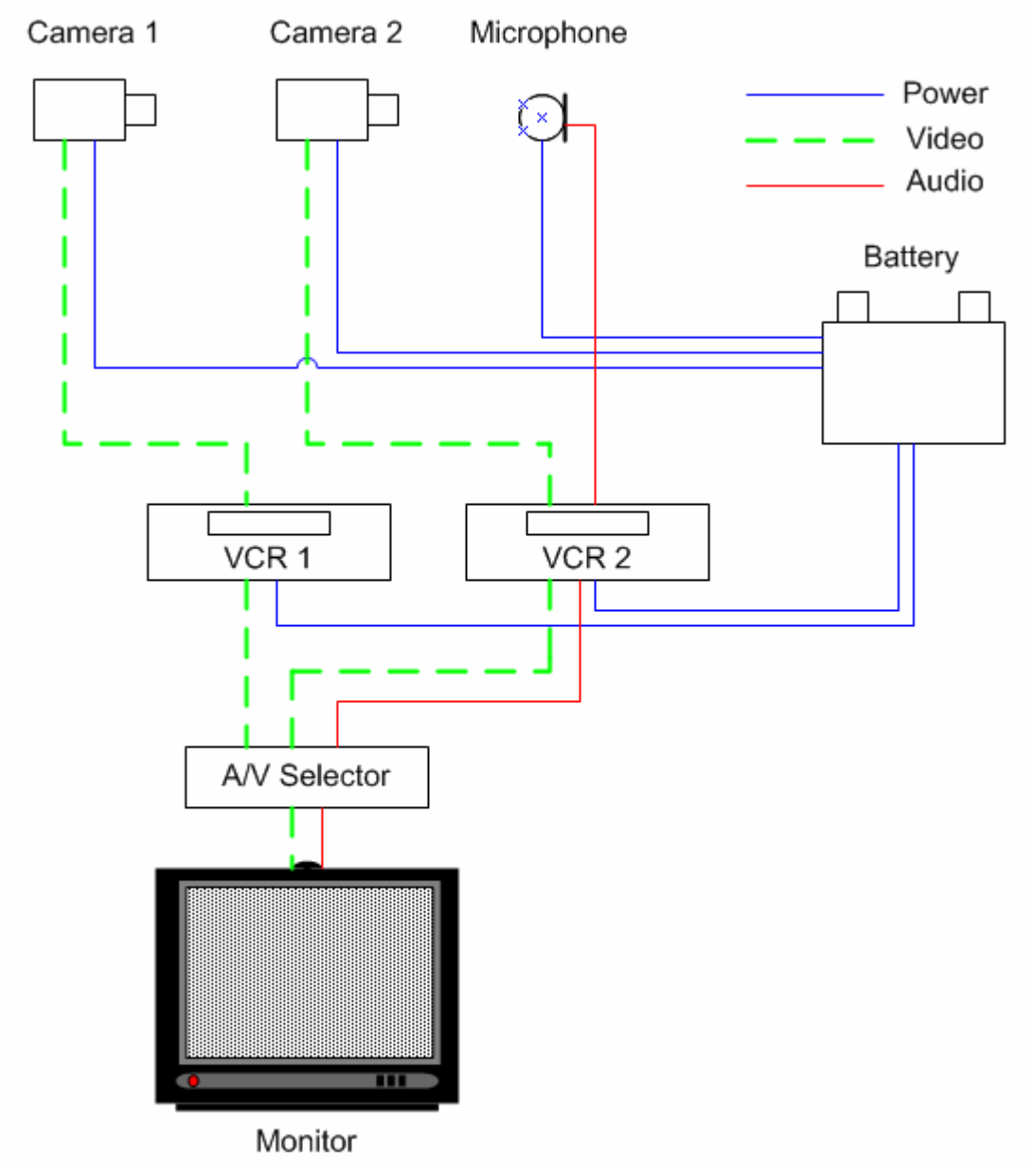
- Current NCHRP 20-7 Recommendations
  - Small towns – evaluate in the current uninterrupted two-lane chapter (20)
  - Other areas – evaluate in the current interrupted flow urban streets chapter (15), even though they are uninterrupted
    - Is this logical to the HCM practitioner?

FDOT Side Issues

(not the focus of this workshop)

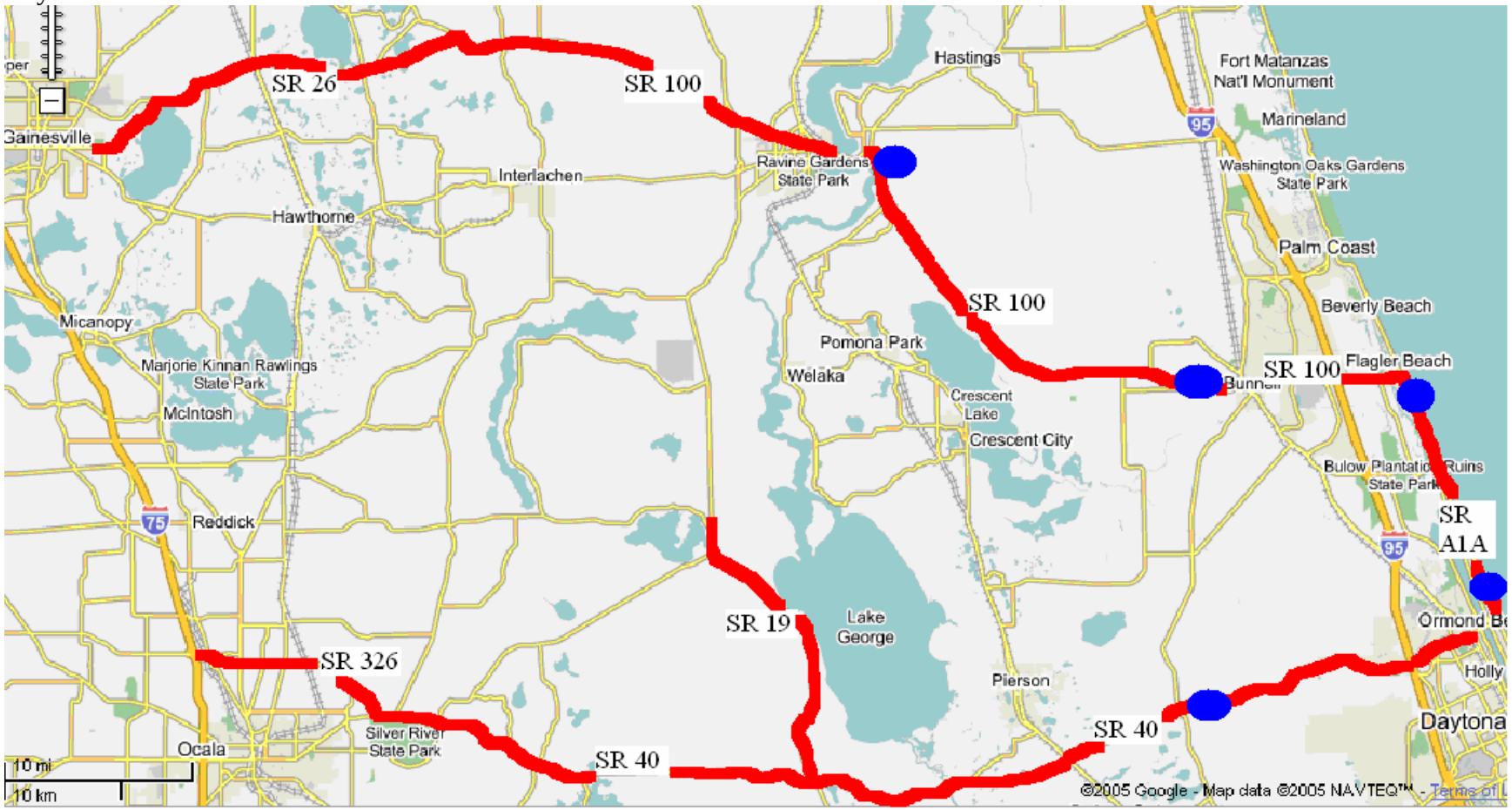
- Quality of service research should be conducted as to what drivers actually believe is most important
- Research is needed to develop an HCM **facility** chapter on generally uninterrupted flow facilities combining uninterrupted flow two-lane and multilane segments and isolated stop control conditions (FDOT has funded in-state research and has submitted a research proposal as a future NCHRP project)
- Concerns about the current service measures for Class I and II
- These roadways should be multimodal in approach (i.e., bike LOS analysis should be included)

APPENDIX C
SCHEMATIC OF IN-VEHICLE EQUIPMENT



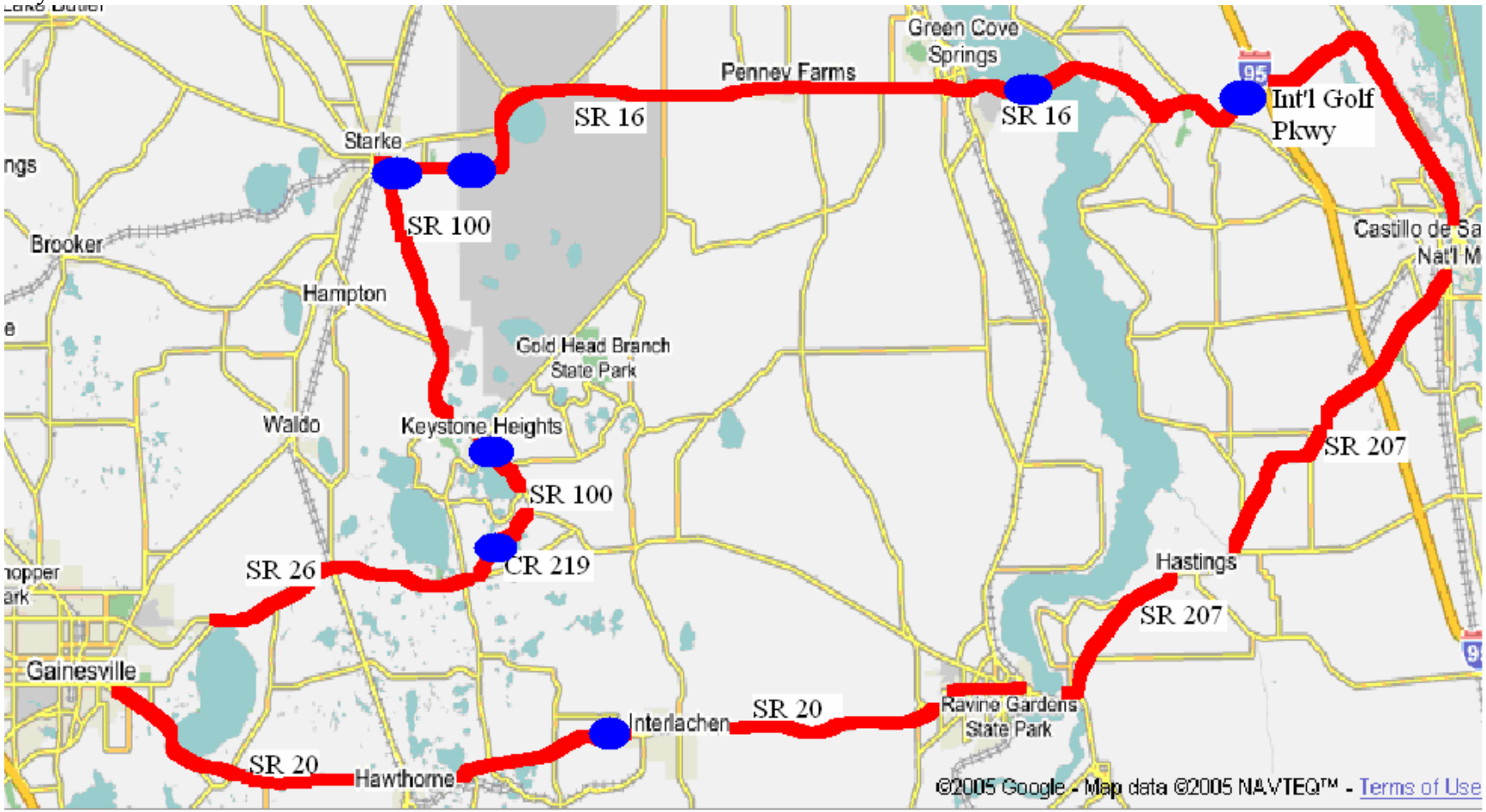
APPENDIX D
MAPS OF DRIVING ROUTES

Day 1



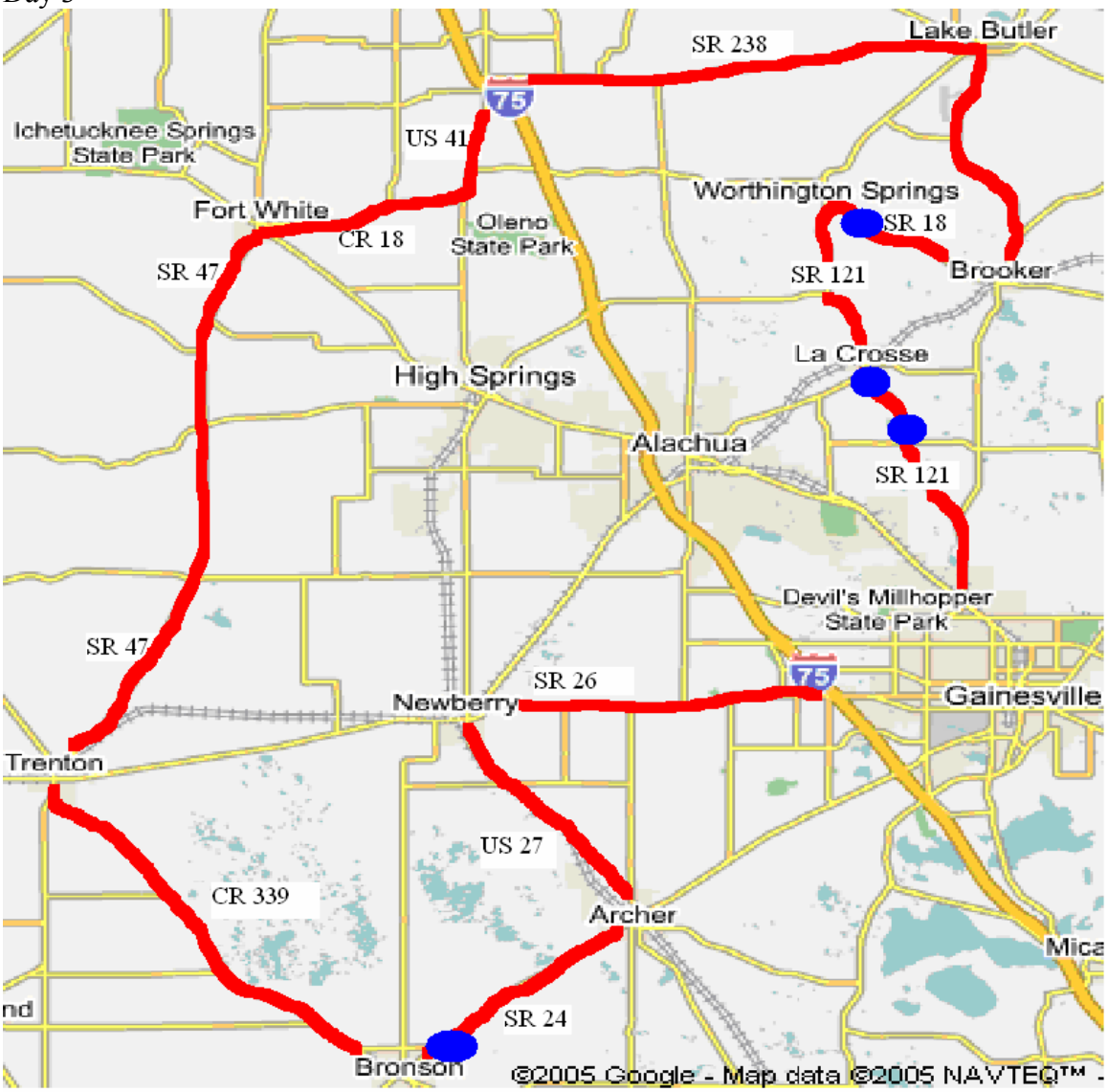
*Blue dot indicates approximate location of video clip footage

Day 2



*Blue dot indicates approximate location of video clip footage

Day 3



*Blue dot indicates approximate location of video clip footage

APPENDIX E
GAINESVILLE SUN NEWSPAPER ADVERTISEMENT

FOCUS GROUP PARTICIPANTS
Needed for a UF Transportation Study
If you are: A licensed driver at least 25 years of age and have experience driving on two-lane roadways
If you are willing to: Complete a short survey about your driving experience, participate in a 2 hour focus group session
Then you are eligible to participate In this study. You will be paid $50 for competing the study.
Please call 392-9537 ex. 1537 Leave a message with your name and contact phone #.

APPENDIX F
PRELIMINARY SURVEY FORM

CONTACT PHONE #: _____

2-Lane Highway Preliminary Questionnaire

Opening: Hi, this is Jessica calling from the University of Florida Transportation Research Center with the Civil Engineering Department. We received your message about your interest in participating in a focus group session.

Do you have a few minutes now so I can tell you a little bit about the research project?

If yes:

These focus groups are being conducted to find out about people's opinions and perceptions of travel on 2-lane highways. Focus group participants will be shown several short video clips and then will participate in a group discussion. Participants will then be asked to complete a short survey. It will take about 2 hrs. and afterward you will receive $50 for your participation.

Are you still interested in being considered for participation in one of these focus groups?

If yes:

We are planning to hold the focus group sessions either on Saturday April 16th or Saturday April 23? Are you available for either or both of these dates?

Can you tell me about what time would you prefer to meet. Morning, mid-day or afternoon?

Now, I'd like to ask you a few demographic questions so that we can be sure that participants are a representative sample.

2. Number of years of driving experience: _____

3. Do you have experience driving on 2-lane highways?

Yes No if no, thank and end call.

4. How frequently do you drive on 2-lane highways?

Frequently Somewhat Frequently Not Frequently

5. Gender: Male Female don't ask, just record.

6. Age:

☐ 25 to 34 yrs ☐ 35 to 44 yrs ☐ 45 to 54 yrs ☐ Over 54 years

7. Marital Status:

☐ Single ☐ Married ☐ Other

8. # of Kids: _____

9. Highest level of education:

☐ High School ☐ College degree ☐ Some college

10. Is your family's total yearly income before taxes $35,000 or less, or more than $35,000?

☐ Less than $35,000 ☐ More than $35,000 ☐ Not Sure

11. Would you please tell me your race?

☐ Black/African American ☐ White ☐ Asian ☐ Hispanic ☐ Other

Closing:

Thank you very much for participating in our preliminary selection process. I'll be in touch with you within 7 days to let you know if you've been chosen to participate in the next phase of the study.

To facilitate that follow-up, can you please tell me:

12. Your first name:
13. Your last name:
14. Can I confirm that your telephone # is:_____
15. Can I get your mailing address:

16. Do you have an email address where we can send you information?

Thank you, that completes the first part of the process. If you are selected to participate, we will contact you within 7 days Have a nice evening (day).

APPENDIX G
FOCUS GROUP INSTRUCTION SHEET AND SURVEY FORMS

Instruction Sheet

UNIVERSITY OF FLORIDA

TRC

Transportation Research Center

Two-Lane Trip Quality Survey

In the exercise you are about to participate in, you will be watching a series of 11 short video segments of various roadway and traffic conditions on two-lane highways. A two-lane highway is defined as a roadway that consists of one lane of travel in each direction. Two-lane highways make up a significant portion of our roadway network. While many two-lane highways can be used for regional or inter-city travel, they can also be used for local travel, providing access between other major roadways.

There are two objectives for this focus group exercise:

1. Identify the factors (e.g., traffic and/or roadway) that are most important to you in your assessment of the trip quality provided on a two-lane highway, and
2. Identify the relative differences, if any, between the importance of these factors on your assessment of trip quality for different types of two-lane highways.

The format of the focus group session will be as follows:

- Watch a video clip (each clip is approximately 1.5 to 2 minutes in length).
- Immediately following the conclusion of the video clip, the session moderator will facilitate group discussion about the conditions observed in the clip and what the important factors are for the assessment of trip quality for that roadway. Approximately 5 minutes will be allotted for the discussion of each clip.
- After the group discussion, you will write down your opinions on the survey form for the specific video clip.
- Repeat the above for each of the 11 video clips.
- Upon conclusion of the individual video clip viewings and discussions, the session moderator will facilitate a group discussion about the different types of two-lane highway classifications you observed and the relative importance of the various factors previously identified for the assessment of trip quality for each. After this discussion, you will fill out a final survey page relative to this issue.

Points to keep in mind:

- You should view each video clip from the perspective of the overall traffic stream and roadway conditions—do not focus on just the behavior of any one vehicle, either within the field of view, or the vehicle from which the video was recorded.
- The focus in the group discussion should be on the important factors to assessing trip quality, not about specific complaints with the conditions observed.
- Remember to be as specific as possible when discussing the reasons/factors that helped in forming your opinions.
- Do not consider the impacts of weather. While the weather conditions observed may vary from one clip to another, the effects of weather are beyond the scope of this study.
- Although the lighting conditions may vary somewhat, please do not factor in the environmental conditions unless you feel very strongly about a certain condition.

Thank you for your cooperation and participation.

Form 1 Section 1

UNIVERSITY OF FLORIDA

TRC
Transportation Research Center

About Yourself

Gender: ☐ Male ☐ Female

Age: ☐ 16 to 25 years ☐ 26 to 45 years ☐ 46 to 65 years ☐ Over 65 years

Marital Status: ☐ Single ☐ Married ☐ Separated/Divorced ☐ Widowed

Highest level of education:

☐ Some or no high school ☐ High school diploma or equivalent
☐ Technical college degree (A.A.) ☐ College degree ☐ Post-graduate degree

Approximate annual household income:

☐ No income ☐ Under $25,000 ☐ $25,000 – 49,999 ☐ $50,000 – 74,999
☐ $75,000 – 99,999 ☐ $100,000 – 149,999 ☐ $150,000 or more

Number of years possessing a driver's license: _____

About Your Two-Lane Highway Driving

Typical number of two-lane highway round trips made during a month?

☐ 1 to 2 ☐ 3 to 4 ☐ 5 to 6 ☐ 7 to 8 ☐ 9 to 10 ☐ 11 to 12 ☐ Over 12

Typical percentage of these trips made as a driver _____, as a passenger _____ (should sum to 100)

Typical one-way length of trip made on a two-lane highway (in miles)?

☐ less than 5 miles ☐ 6 to 10 ☐ 11 to 20 ☐ 21 to 40 ☐ 41 to 60 ☐ Over 60

Vehicle type most often used for two-lane highway trips:

☐ Sedan ☐ Sports car ☐ Pickup truck ☐ SUV ☐ Minivan
☐ Full-size van ☐ RV/Motorhome ☐ Motorcycle ☐ Other _____

When making a trip on two-lane highway, what is your most common trip purpose?

☐ Business ☐ School ☐ Recreation ☐ Social ☐ Personal (e.g., grocery shopping)
☐ Other _____

Typical number of passengers in vehicle for two-lane highway trips?

☐ 0 – Driver only ☐ 1 ☐ 2 ☐ 3 ☐ 4 or more

Typical driving style on two-lane highways (on a scale from 1-5, with 1 being 'Very Conservative' and 5 being 'Very Aggressive'): _____

Form 1 Section 2

Your Opinions

In the spaces provided below, please describe what you consider to be the primary indicators of the trip quality for each of the two-lane highway video clips. Please be as specific as possible when describing what you feel are the important factors used in your assessment of trip quality. Factors you should consider include traffic conditions and/or characteristics of the roadway itself.

Video Clip	Important Factors (Traffic and/or Roadway Characteristics)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

Form 2

From the list of items below, rate each item on a scale of 1 to 7 (1-not at all important, 7-extremely important) as to how that item affects the quality of your trip on a *two-lane highway*.

Item	High Speed Roadways (generally used for travel **between** cities)	Medium to Lower Speed Roadways (generally connect to higher speed roadways or are used for travel **within** cities)	Lower Speed Roadways that go through small towns (possibly with a traffic signal)	Lower Speed Roadways that ar scenic (could be coastal, or with a tree-canopy, etc.)
Ability to consistently maintain your desired travel speed				
Ability to travel at a speed no less than the posted speed limit				
Frequent passing zones (i.e., dashed yellow line)				
Frequent passing lanes				
Infrequent steep grades and/or sharp curves				
Small percentage of large commercial trucks in traffic stream				
Small percentage of large personal vehicles (pickups, vans, SUV's) in traffic stream				
Wide, paved shoulders				
Wide travel lanes				
Other (describe)				
Other (describe)				

APPENDIX H
WRITTEN SURVEY FORM RESULTS

Form 1 Results

Clip #	Comment Type	Frequency	Percentage of Comments
1	Good trip quality	2	3.4
	Good visibility, sight distance	6	10.3
	Low traffic volume, density	2	3.4
	Good passing opportunities	3	5.2
	Lane width good	2	3.4
	Shoulder and/or clearance space good	13	22.4
	Pavement quality good	5	8.6
	Positive guidance (signage, lane markings, reflectors,etc.) good	12	20.7
	Needs more positive guidance (signage, lane markings, reflectors,etc.)	6	10.3
	Posted speed limit good/appropriate	7	12.1
2	Mentioning of on-steet parking	6	15.4
	Good trip quality	1	2.6
	Shoulder and/or clearance space inadequate	5	12.8
	Positive guidance (signage, lane markings, reflectors,etc.) good	3	7.7
	Speed limit reduction warning signs needed	8	20.5
	Speed reduction as roadway approaches town too abrupt	4	10.3
	Posted speed limit in town was good/acceptable	8	20.5
	Posted speed limit should have resumed more quickly outside of town	4	10.3
3	Good trip quality	2	4.2
	Visibility not good	3	6.3
	Should be allowed to pass	4	8.3
	Should not be allowed to pass/not compelled to pass	4	8.3
	Should have designated passing lanes	2	4.2
	Lane width good/sufficient	1	2.1
	Lane width not good	3	6.3
	Shoulder and/or clearance space not good/inadequate	14	29.2
	Positive guidance (signage, lane markings, reflectors,etc.) good	2	4.2
	Wildlife crossing signs needed	3	6.3
	Posted speed limit good/appropriate	9	18.8
	Posted speed limit too high	1	2.1

Form 1 Results Continued

4	High level of activity/surrounding development	2	5.7
	No problem with having to stop for traffic signals	4	11.4
	Did not like having to stop for traffic signals	2	5.7
	Bad or poor trip quality	2	5.7
	Visibility not good	2	5.7
	Not compelled to pass	2	5.7
	Shoulder and/or clearance space not good/inadequate	3	8.6
	Did not like following larger vehicle	1	2.9
	Pavement quality good	1	2.9
	Positive guidance (signage, lane markings, reflectors,etc.) insufficient	2	5.7
	Posted speed limit in town was good/acceptable	7	20.0
	Posted speed limit in town was too slow or low	4	11.4
	Posted speed limit in town was too high	3	8.6
5	Liked safety aspect of guardrail	6	18.8
	Bad or poor trip quality	1	3.1
	Mediocre trip quality	1	3.1
	Good visibility, sight distance	2	6.3
	Following negatively affects trip quality-tailgater	3	9.4
	Good passing opportunities	3	9.4
	Shoulder and/or clearance space not good/inadequate	4	12.5
	Pavement quality bad	10	31.3
	Posted speed limit is good/adequate	2	6.3
6	Hills/terrain influence more cautious driving	1	2.3
	Negative comments about overhanging tree limbs	2	4.5
	Positive comments about the tree limbs - enhance driving quality	1	2.3
	Bad or poor trip quality	1	2.3
	Good trip quality	2	4.5
	Visibility, sight distance not good	1	2.3
	Good visibility, sight distance	1	2.3
	Lanes too narrow	3	6.8
	Shoulder and/or clearance space not good/inadequate	8	18.2
	Needs more positive guidance (signage, lane markings, reflectors,etc.)	12	27.3
	Posted speed limit is good/adequate	4	9.1
	Posted speed limit is too slow or low	6	13.6
	Posted speed limit too high	2	4.5

Form 1 Results Continued

7	Liked exclusive turn lanes at traffic signal	3	7.7
	Mediocre trip quality	1	2.6
	Good trip quality	3	7.7
	Should not be allowed to pass/not compelled to pass	3	7.7
	Lane width good/sufficient	1	2.6
	Shoulder and/or clearance space not good/inadequate	6	15.4
	Positive guidance (signage, lane markings, reflectors,etc.) good	4	10.3
	Pavement quality good	2	5.1
	Posted speed limit in town/developed area was good/acceptable	16	41.0
8	High level of activity/surrounding development/pedestrians	2	4.9
	Positive comments about scenic nature of roadway	3	7.3
	Negative comments about scenic nature of roadway - too distracting	1	2.4
	Mediocre trip quality	2	4.9
	Not compelled to pass	1	2.4
	Following negatively affects trip quality	4	9.8
	Shoulder and/or clearance space not good/inadequate	9	22.0
	Positive guidance (signage, lane markings, reflectors,etc.) good	3	7.3
	Posted speed limit is good/adequate	13	31.7
	Posted speed limit is too slow or low	1	2.4
	Posted speed limit is too high	2	4.9
9	Good visibility, sight distance	3	7.0
	Lanes too narrow	1	2.3
	Shoulder and/or clearance space not good/inadequate	8	18.6
	Shoulder and/or clearance space good	2	4.7
	Positive guidance (signage, lane markings, reflectors,etc.) good	7	16.3
	Needs more positive guidance (signage, lane markings, reflectors,etc.)	2	4.7
	Posted speed limit is good/appropriate	3	7.0
	Posted speed limit is too slow or low	17	39.5

Form 1 Results Continued

10	Good visibility, sight distance	1	2.9
	Good passing opportunities	3	8.8
	Would pass slower vehicle-does not like following at reduced speed	9	26.5
	Shoulder and/or clearance space not good/inadequate - not paved	6	17.6
	Shoulder and/or clearance space good	1	2.9
	Posted speed limit is good/adequate	11	32.4
	Posted speed limit is too high	3	8.8
11	Need for more pedestrian crossing/saftey zones and pedestrian crossing signs	10	23.8
	Does not like parking on side of roadway	4	9.5
	Mediocre trip quality	1	2.4
	Not compelled to pass	2	4.8
	Does not like vehicle following behind	1	2.4
	Shoulder and/or clearance space inadequate	2	4.8
	Positive guidance (signage, lane markings, reflectors,etc.) good	2	4.8
	Positive guidance (signage, lane markings, reflectors,etc.) insufficient	3	7.1
	Posted speed limit too high for high pedestrian activity and development	12	28.6
	Posted speed limit is good/adequate	5	11.9
12	Good trip quality	1	3.1
	Good visibility, sight distance	1	3.1
	Should not be allowed to pass/not compelled to pass	2	6.3
	Lane width not good	4	12.5
	Shoulder and/or clearance space not adequate	8	25.0
	Positive guidance (signage, lane markings, reflectors,etc.) good	1	3.1
	Pavement quality good	1	3.1
	Posted speed limit is good/adequate	8	25.0
	Posted speed limit is too high	6	18.8

Form 1 Results Continued

13	Liked exclusive turn lanes at traffic signal	2	6.3
	No problem with having to stop for traffic signals	2	6.3
	Good trip quality	1	3.1
	Should not be allowed to pass/not compelled to pass	1	3.1
	Does not like following at reduced speed	1	3.1
	Positive guidance (signage, lane markings, reflectors,etc.) good	6	18.8
	Positive guidance (signage, lane markings, reflectors,etc.) insufficient	2	6.3
	Speed reduction unclear	1	3.1
	Posted speed limit is good/adequate	14	43.8
	Posted speed limit is too high	2	6.3
14	Good trip quality	3	6.5
	Good visibility, sight distance	1	2.2
	Good passing opportunities	3	6.5
	Lane width not good	4	8.7
	Shoulder and/or clearance space inadequate	9	19.6
	No need for shoulder	1	2.2
	Pavement quality good	2	4.3
	Positive guidance (signage, lane markings, reflectors,etc.) insufficient	4	8.7
	Positive guidance (signage, lane markings, reflectors,etc.) good	2	4.3
	Posted speed limit is good/adequate	9	19.6
	Posted speed limit is too slow or low	8	17.4
15	Would like there to be exclusive turn lanes for vehicles turning off of roadway	4	9.1
	Good trip quality	6	13.6
	Good visibility, sight distance	5	11.4
	Lane width good	1	2.3
	Shoulder and/or clearance space inadequate	1	2.3
	Shoulder and/or clearance space good	3	6.8
	Positive guidance (signage, lane markings, reflectors,etc.) good	3	6.8
	Positive guidance (signage, lane markings, reflectors,etc.) insufficient	4	9.1
	Posted speed limit is good/adequate	14	31.8
	Posted speed limit is too high near the more developed area and driveways	3	6.8

Form 1 Results Continued

16	Good trip quality	1	2.5
	Did not like presence of side-parking	1	2.5
	No problem with having to stop for traffic signals	1	2.5
	High traffic volume negatively affects trip quality	4	10.0
	Does not like following at reduced speed	3	7.5
	Should not be allowed to pass/not compelled to pass	11	27.5
	Shoulder and/or clearance space good	1	2.5
	Shoulder and/or clearance space inadequate	1	2.5
	Positive guidance (signage, lane markings, reflectors,etc.) good	2	5.0
	Pavement quality good	2	5.0
	Posted speed limit is good/adequate	13	32.5

Form 2 Results

Two-Lane Highway Category or Type	Min	Max	Mean	Mode	St. Dev.	Frequency							
						1	2	3	4	5	6	7	Sum
High-Speed Roadways (generally used for travel between cities)													
Ability to consistently maintain your desired travel speed	3	7	6.1	7	1.21	0	0	2	3	1	10	18	**34**
Ability to travel at a speed no less than the posted speed limit	1	7	5.9	7	1.45	1	0	1	4	4	8	16	**34**
Frequent passing zones (i.e., dashed yellow line)	1	7	6.0	7	1.29	1	0	1	0	6	11	15	**34**
Frequent passing lanes	1	7	5.3	7	1.85	2	1	4	2	6	6	13	**34**
Infrequent steep grades and/or sharp curves	1	7	5.4	7	1.88	3	0	2	4	4	7	14	**34**
Small % of large commercial trucks in traffic stream	1	7	5.1	7	2.01	3	2	3	3	6	5	12	**34**
Small % of large personal veh. (pickups, vans,SUV's) in traffic stream	1	7	4.2	5	2.13	5	5	3	3	8	3	7	**34**
Wide, paved shoulders	1	7	5.9	7	1.77	2	0	3	0	4	4	20	**33**
Wide travel lanes	1	7	6.1	7	1.32	1	0	0	2	5	7	18	**33**
Medium to Lower-Speed Roadways (w/i cities or connects to HS)													
Ability to consistently maintain your desired travel speed	3	7	5.6	7	1.21	0	0	1	7	6	10	10	**34**
Ability to travel at a speed no less than the posted speed limit	2	7	5.5	5	1.28	0	1	2	3	10	10	8	**34**
Frequent passing zones (i.e., dashed yellow line)	2	7	5.5	7	1.31	0	1	1	5	9	8	10	**34**
Frequent passing lanes	1	7	4.9	5	1.54	1	1	5	4	9	9	5	**34**
Infrequent steep grades and/or sharp curves	1	7	4.9	7	1.91	3	2	2	6	7	5	9	**34**
Small % of large commercial trucks in traffic stream	1	7	5.1	7	1.85	2	1	5	2	9	3	12	**34**
Small % of large personal veh. (pickups, vans,SUV's) in traffic stream	1	7	4.5	5	1.96	3	4	4	2	10	4	7	**34**
Wide, paved shoulders	1	7	5.3	7	1.99	3	1	3	2	4	7	13	**33**
Wide travel lanes	1	7	5.7	7	1.55	1	1	1	3	5	9	13	**33**
Lower-Speed Roadway through Small Town (maybe w/ signal)													
Ability to consistently maintain your desired travel speed	2	7	4.91	5	1.54	0	3	4	4	12	4	7	**34**
Ability to travel at a speed no less than the posted speed limit	1	7	4.88	5	1.43	1	1	2	8	13	3	6	**34**
Frequent passing zones (i.e., dashed yellow line)	1	7	4.53	7	1.93	3	2	6	5	7	3	8	**34**
Frequent passing lanes	1	7	4.00	3	1.79	5	0	10	4	8	4	3	**34**
Infrequent steep grades and/or sharp curves	1	7	4.12	3	1.74	3	2	8	8	5	4	4	**34**
Small % of large commercial trucks in traffic stream	1	7	4.97	7	1.80	2	1	4	6	7	4	10	**34**
Small % of large personal veh. (pickups, vans,SUV's) in traffic stream	1	7	4.03	5	1.87	5	3	4	6	10	2	4	**34**
Wide, paved shoulders	1	7	4.64	7	2.03	4	2	3	5	6	5	8	**33**
Wide travel lanes	2	7	5.24	7	1.56	0	2	3	5	8	5	10	**33**
Lower-Speed Roadway that Scenic (coastal, tree canopy)													
Ability to consistently maintain your desired travel speed	2	7	4.53	4	1.58	0	4	5	9	6	5	5	**34**
Ability to travel at a speed no less than the posted speed limit	1	7	4.47	5	1.78	2	3	6	5	7	6	5	**34**
Frequent passing zones (i.e., dashed yellow line)	1	7	4.18	3	1.99	3	3	11	3	3	4	7	**34**
Frequent passing lanes	1	7	3.62	3	1.84	5	4	10	5	3	4	3	**34**
Infrequent steep grades and/or sharp curves	1	7	3.94	2	1.86	3	6	6	6	5	4	4	**34**
Small % of large commercial trucks in traffic stream	1	7	5.00	5	1.84	3	0	5	2	9	6	9	**34**
Small % of large personal veh. (pickups, vans,SUV's) in traffic stream	1	7	4.44	5	2.03	5	1	6	2	9	4	7	**34**
Wide, paved shoulders	1	7	4.42	7	2.21	5	2	7	1	5	4	9	**33**
Wide travel lanes	1	7	4.76	5	1.90	2	3	5	2	8	5	8	**33**

LIST OF REFERENCES

1. Transportation Research Board. *Highway Capacity Manual*. National Research Council, Washington D.C., 2000.

2. Harwood, Douglas W., May, Adolf D., Anderson, Ingrid B., Leiman, Lannon, Archilla, A. Ricardo. "Capacity and Quality of Service of Two-Lane Highways: Final Report of NCHRP Project 3-55 Task 3." Midwest Research Institute. Berkeley, California, 1999.

3. Transportation Research Board. *Highway Capacity Manual*. National Research Council, Washington D.C., 1985.

4. De Arazoza, Rafael E. and McLeod, Douglas S. "Methodology to Assess Level of Service on US-1 in the Florida Keys." *Transportation Research Record*: Journal of the Transportation Research Board, No. 1398. TRB, National Research Council. Washington D.C., 1993.

5. Botha, Jan L., Sullivan, Edward C., Zeng, Xiaohong. "Level of Service of Two-Lane Rural Highways with Low Design Speeds." *Transportation Research Record*: Journal of the Transportation Research Board, No. 1457. TRB, National Research Council. Washington D.C., 1994.

6. Washburn, Scott S., McLeod, Douglas S., Courage, Kennth G. "Adaptation of *Highway Capacity Manual* 2000 for Planning-Level Analysis of Two-Lane and Multilane Highways in Florida." *Transportation Research Record*: Journal of the Transportation Research Board, No. 1802. TRB, National Research Council. Washington D.C., 2002.

7. Florida Highway Data 2003 CD-ROM. Florida Department of Transportation. Tallahassee, Florida, 2003.

8. Florida Traffic Information 2003 CD-ROM. Florida Department of Transportation. Tallahassee, Florida, 2003.

9. Roadway Characteristics Inventory Field Handbook. Florida Department of Transportation. Tallahassee, Florida, 2004.

BIOGRAPHICAL SKETCH

Jessica Lora Morriss is a 24 year old graduate student at the University of Florida. She is currently pursuing her Master of Engineering degree, specializing in transportation engineering. Jessica was born and raised in Tampa, Florida, and graduated from Paul R. Wharton High School in 1999. She received her Bachelor of Science degree in civil engineering from the University of Florida in May 2004.