Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-11/0-6267-2		

4. Title and Subtitle	5. Report Date
BENEFITS OF PUBLIC ROADSIDE SAFETY REST AREAS IN TEXAS: TECHNICAL REPORT	Published: May 2011
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Jodi L. Carson, Val J. Pezoldt, Nicholas Koncz, and Kwaku Obeng-Boampong	Report 0-6267-2
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135	11. Contract or Grant No. Project 0-6267
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Texas Department of Transportation Research and Technology Implementation Office P. O. Box 5080 Austin, Texas 78763-5080	Technical Report: September 2008–February 2011
	14. Sponsoring Agency Code

15. Supplementary Notes

Project performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.

Project Title: Benefits of Public Roadside Safety Rest Areas in Texas

URL: http://tti.tamu.edu/documents/0-6267-2.pdf

16. Abstract

The objective of this investigation was to develop a benefit-cost analysis methodology for safety rest areas in Texas and to demonstrate its application in select corridors throughout the state. In addition, this project considered novel safety rest area development approaches that could reduce the public cost burden borne by individual public agencies. Based upon the available supporting data for Texas, a benefit-cost ratio relationship was developed that included safety, comfort and convenience, and excess travel and diversion benefits accrued by highway users; direct monetary benefits accrued by highway or other public agencies; economic development/tourism and specific business enterprise benefits accrued by external entities and direct monetary cost accrued by highway or other public agencies. The resulting method utilizes timely and relevant data and national/aggregate unit values, whose sources are carefully documented to ensure defensibility and repeatability of the benefit-cost ratios estimated for Texas. A noted shortcoming of the applied method is that it is heavily assumption-based—minor changes to any of the assumed values will influence the resultant benefit-cost ratios, although it is unclear to what extent these ratios would change. A second shortcoming not unique to this methodology relates to the quality and accessibility of supporting data, which challenged and in some instances prevented estimation of individual benefit and cost components. A high level of variability in individual benefit and cost component estimates—both within and between the three demonstration corridors—suggests limitations to the transferability of these results.

17. Key Words	18. Distribution Statement
Safety Rest Area, Travel Information Center, Benefit, Cost	No restrictions. This document is available to the public through NTIS: National Technical Information Service Alexandria, Virginia 22312 http://www.ntis.gov

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	238	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

BENEFITS OF PUBLIC ROADSIDE SAFETY REST AREAS IN TEXAS: TECHNICAL REPORT

by

Jodi L. Carson, P.E., Ph.D.
Research Engineer
Texas Transportation Institute

Val J. Pezoldt
Research Scientist
Texas Transportation Institute

and

Nicholas Koncz, Ph.D.
Assistant Research Scientist
Texas Transportation Institute

Kwaku Obeng-Boampong, P.E.
Assistant Research Engineer
Texas Transportation Institute

Report 0-6267-2
Project 0-6267
Project Title: Benefits of Public Roadside Safety Rest Areas in Texas

Performed in cooperation with the
Texas Department of Transportation
and the
Federal Highway Administration

Published: May 2011

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Federal Highway Administration (FHWA) or the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation. The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report. The researcher in charge was Dr. Jodi L. Carson, P.E. (Texas Board of Professional Engineers 94536 and Montana Department of Labor and Industries, Board of Professional Engineers and Land Surveyors 16210).

ACKNOWLEDGMENTS

This project was conducted in cooperation with TxDOT and FHWA. The authors would like to thank Mr. Paul G. Campbell—Facilities Management Section, Maintenance Division, TxDOT; Mr. Jim Hollis—Programs Director, Safe Communities, Division Traffic Safety Section, Traffic Operations Division, TxDOT; Ms. Brenda Harper—Director, Travel Services Section, Travel Information Division, TxDOT; and Ms. Martha Martin, Travel Information Division, TxDOT for serving as Project Advisors and Andrew Keith—Supervisor, Safety Rest Area Program, Facilities Management Section, Maintenance Division, TxDOT for overseeing the project as Project Director.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1:
INTRODUCTION

Historically viewed as an integral element of the Interstate and primary highway system, safety rest areas (including travel information centers) generally serve to enhance highway safety; enhance the comfort and convenience of highway travel; and facilitate the transmission of information to highway users. The importance of these facilities is amplified along rural, limited access routes.

The Texas Department of Transportation (TxDOT) currently operates and maintains a system of 80 safety rest areas (SRAs), 12 travel information centers (TICs), and numerous picnic areas statewide (see Figure 1). Despite their popularity with the traveling public—an estimated 50 million travelers visit Texas safety rest areas annually (TxDOT 2008)—increased competition for funding with other highway construction and maintenance programs and concurrent increases in facility construction, operation, and maintenance costs have brought into question the cost-effectiveness of public safety rest areas in Texas.

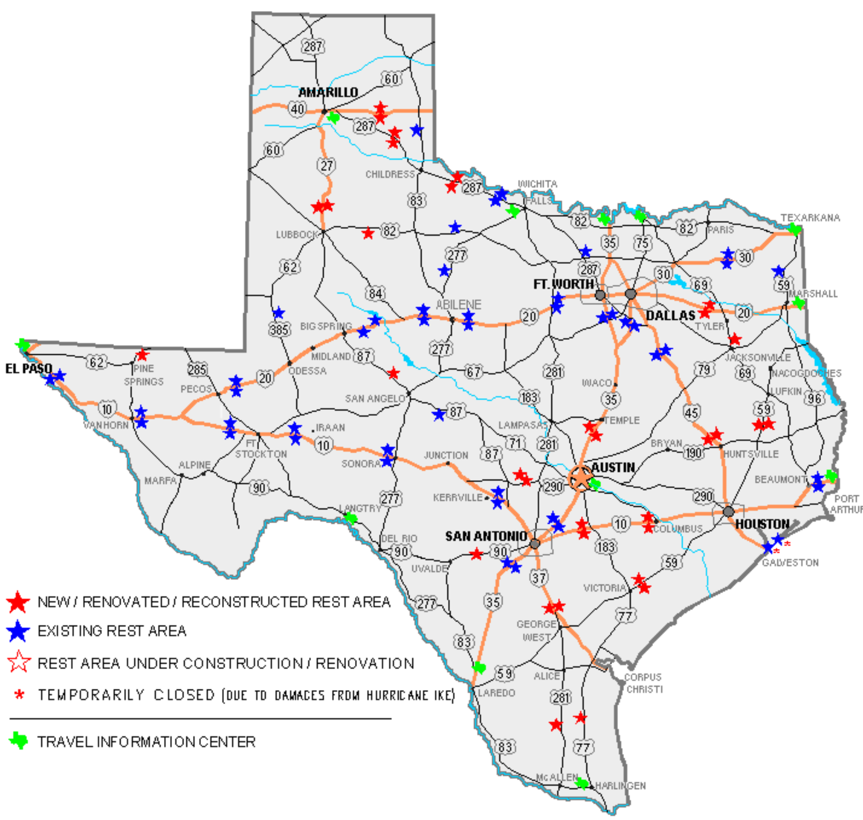


Figure 1. Safety Rest Areas and Travel Information Centers in Texas (TxDOT 2008).

To adequately respond to this question, a reliable and acceptable method for comparing safety rest area benefits with costs is required to guide decision-makers in the allocation of resources to a safety rest area program in competition with other demands. The objective of this project was to develop such a benefit-cost analysis methodology for safety rest areas in Texas and to demonstrate its application in select corridors throughout the state. In addition, this project considered novel safety rest area development approaches that could reduce the public cost burden borne by individual public agencies.

In accomplishing this threefold objective, the approach to this investigation comprised six general tasks:

1. Characterizing available data to support safety rest area benefit-cost analysis.
2. Reviewing existing benefit-cost analysis methods.
3. Developing a methodology for safety rest area benefit-cost analysis in Texas.
4. Selecting demonstration corridors in Texas.
5. Demonstrating the safety rest area benefit-cost analysis methodology in select corridors.
6. Exploring alternate safety rest area development opportunities.

The associated outcomes from Tasks 1 through 6 are described in this research report. More specifically, this report describes the following:

- Commonly recognized safety rest area benefit and cost components, including their respective limitations for measurement (Chapter 2).
- A proposed methodology for safety rest area benefit-cost analysis in Texas based on a review of broader, existing benefit-cost analysis methods and available supporting data (Chapter 3).
- Safety rest area benefit-cost estimates for select demonstration corridors in Texas (Chapter 4).
- Novel safety rest area development approaches that could reduce public agency cost burdens (Chapter 5).
- Conclusions and recommendations to support future safety rest area benefit-cost analyses and long-term decision-making related to the allocation of state and federal resources in Texas (Chapter 6).

CHAPTER 2:
SAFETY REST AREA BENEFIT-COST COMPONENTS AND LIMITATIONS

To adequately and accurately assess roadside safety rest areas, the full breadth of a facility's potential benefits and associated costs should be considered. In some instances, limitations arise in quantifying or "costing" individual benefit and cost components. For example, safety rest areas are presumed to provide travelers with an improved level of comfort during their trip but expressing the level of benefit in monetary terms is difficult.

Early in this investigation, researchers conducted a comprehensive literature and state-of-the-practice review to identify the breadth of potential safety rest area benefits and costs. These component benefits and costs, categorized by beneficiary, are summarized in Table 1. This chapter presents a general description of these components and their respective limitations for inclusion in a benefit-cost analysis methodology.

SAFETY REST AREA BENEFITS

Safety rest areas have been generally observed to benefit three groups with highway users considered to be the primary beneficiary:

- Highway users.
- Highway and other public agencies.
- External entities including tourism boards, local businesses, etc.

Table 1. Potential Safety Rest Area Benefit and Cost Components.

BENEFIT COMPONENTS	COST COMPONENTS
Highway Users	
• Safety • Comfort and convenience • Excess travel and diversion • Commercial motor vehicle scheduling and staging	• Safety
Highway and Other Public Agencies	
• Direct monetary revenue • Highway operations and maintenance	• Direct monetary costs
External Entities	
• Economic development and tourism • Specific business enterprise • Traffic diversion into communities	• Environmental impacts • Socially undesirable behavior • Traffic diversion from communities

Highway Users

For the highway user, safety rest areas typically serve to enhance safety, improve comfort and convenience, reduce excess driving, and accommodate the scheduling and staging of commercial motor vehicles.

Safety Benefits

The determination of safety-related benefits attributable to safety rest areas is challenged by two fundamental factors:

- Safety rest areas must be *used* by motorists to effectively reduce the frequency or severity of crashes—the mere *existence* of a safety rest area does not directly affect safety (except for the potentially adverse effects of additional merging and lane changing near the facility's entrances and exits, which have been anecdotally reported to be minimal).
- Any observed safety effects resulting from the *use* of a safety rest area are not direct—safety rest area use may affect driver performance or actions, which, in turn, are potentially contributing causes to crashes (King 1989).

Note that these challenges do not suggest a *lack* of relationship between safety rest areas and safety outcomes but simply point to the difficulties in *quantifying* the relationship. Supporting data must effectively characterize not only changes in safety outcomes related to the presence and subsequent use of a safety rest area facility, but also any concomitant changes in related factors known to contribute to crashes.

Probable contributing factors are numerous. Rest areas serve to enhance safety by: reducing driver fatigue and other adverse physiological effects; reducing voluntary shoulder stops; providing a safe refuge under hazardous weather, roadway, and visibility conditions; reducing involuntary stops and vehicle-miles of travel by defective vehicles; reducing in-vehicle driver distraction resulting from a restless pet or child; and communicating safety-related information to drivers.

Driver Fatigue. Driver fatigue, as a contributory cause of highway crashes, has been extensively investigated, with seminal studies first occurring in the 1960s. Most researchers agree that adverse fatigue-related effects can be lessened by periodic rest (Drory 1985), exercise, and the moderate use of mild stimulants, such as caffeine. Safety rest areas can potentially meet each of these needs. If safety rest areas are not available, drivers may pursue any of the following options:

- Exit the highway to find required facilities (increasing the trip length, possibility of getting lost, and exposure to crashes or other safety and security risks).
- Defer a necessary rest stop past the start of diminished driving performance (increasing crash potential).
- Stop on a highway shoulder or other unsafe location (increasing crash potential).

Generally less than 3 percent of all crashes annually are reported to be fatigue-related (National Highway Traffic Safety Administration 2009). Given the low proportion of reported fatigue-related crashes, a relationship between fatigue-related crashes and safety rest areas is difficult to discern given the normal variability of crash distributions over time. Fatigue-related crashes are generally presumed to be underreported. "Driver asleep" or "driver fatigued" observations are in most cases self-reported by the involved driver or inferred by the investigating officer.

Shoulder Stops. Vehicles parked on the shoulder, especially on high-speed facilities, pose a hazard to approaching motorists but estimates regarding the extent of hazard vary. In previous investigations, the reported frequency of voluntary or discretionary shoulder stops ranged from one for every 980 vehicle-miles of travel to one for every 2,800 vehicle-miles of travel (Downs and Wallace 1982, Kragh 1983). A study conducted by the Federal Highway Administration (FHWA 1977) reported that 3 percent of all crashes involved vehicles on the shoulder, and that the proximate cause in more than half of these crashes involved a fatigued driver striking the vehicle on the shoulder. A more recent study in California reported 42 fatal crashes resulting from shoulder stops, with approximately half of these crashes involving a truck parked on the shoulder (Howell et al. 1985).

With such small proportions, the effect of any safety rest area facility on crashes is difficult to quantify, given the normal variability of crash distributions. These observations are also presumed to be underreported because they do not include sideswipe or rear-end crashes involving vehicles entering or leaving the shoulder or crashes involving dismounted motorists likely as a result of a shoulder stop (King 1989).

Hazardous Conditions. A safety rest area can serve as a safe refuge whenever weather, visibility, or roadway conditions make further driving hazardous. Drivers who are on the road when these conditions materialize may alternatively leave the highway, make a shoulder stop, or continue driving in unsafe conditions. Drivers may be reluctant to leave the highway in an unknown location, and the normal hazard of a shoulder stop is magnified under adverse weather, visibility, or roadway conditions.

Safety rest areas represent safe and convenient locations to “wait it out” and provide an opportunity for highway authorities to communicate with motorists, advising them of current conditions and recommended actions. Despite the purported benefits, data related to the use and/or benefits of safety rest areas during hazardous conditions are often elusive.

Preventative Maintenance. Although a vehicle may be diagnosed with a minor malfunction (e.g., low tire pressures, engine or exhaust system problems, exterior lighting failures), a driver may continue traveling—especially at night, in an unfamiliar area, or in an apparently hazardous location—in an effort to reach their destination or other safe and convenient location (i.e., a safety rest area) before the vehicle condition deteriorates further. Continuing to drive a defective vehicle—particularly if the defect affects acceleration or braking ability, steering control, driver visibility, or front or rear lighting—creates a hazard and, at a minimum, may result in an involuntary shoulder stop (King 1989).

Safety rest areas may additionally reduce the number of flat tire or mechanical failure stops; the mere act of stopping/starting or entering/exiting a vehicle may often give the first indication of an incipient mechanical or tire failure. Again, data to support determination of preventative maintenance benefits provided by safety rest areas are largely unavailable, despite the purported benefits.

In-Vehicle Distractions. A contributing factor in highway crashes may be driver distraction because of an unruly child or pet in the vehicle or because of driver or passenger discomfort. Such distractions are likely to be reduced by appropriately spaced safety rest areas, but again, insufficient data exists to support this speculation.

Safety-Related Information. Safety rest areas provide a significant interface at which highway and other public agencies can communicate with highway users. It may be reasonable to assume that a driver who is provided with accurate weather, road, and traffic information will select a safer, more convenient route for travel than if this information was not available.

Benefits attributable to the on-site receipt and subsequent use of safety-related information are most often self-reported in safety rest area user surveys. As such, reported benefits may be subjective and qualitative in nature.

Comfort and Convenience Benefits

Apart from improvements to highway safety, enhancing driver comfort and convenience is a principal function of safety rest areas. Comfort and convenience are broad, intangible, and subjective concepts that are difficult to directly quantify or express in monetary terms and vary based on the quality and extent of amenities provided at a safety rest area facility. Typical safety rest area amenities include restrooms, drinking water, vending machines, telephones, picnic areas, and separate truck and passenger parking but may also include wireless Internet access, an air-conditioned lobby, a playground, interpretive displays, handicap access, family/assisted bathrooms, diaper changing stations, etc.

One frequently used method to account for such intangibles is based on a driver's "willingness to pay" as typically self-reported in safety rest area user surveys. These self-reported estimates tend to be lower than observed usage fees, with many respondents reporting a willingness to pay nothing to use safety rest areas. In addition, willingness to pay estimates are typically aggregated to reflect a general willingness to pay "to use a public safety rest area" and do not take into account potentially different pay rates based on differences in the amenities provided (i.e., users may be willing to pay a higher usage fee if the safety rest area facility included interpretive displays, wireless Internet access, etc.). Hence, benefits resulting from upgrading or improving existing safety rest areas are particularly difficult to quantify in terms of comfort and convenience for highway users.

Excess Travel and Diversion Benefits

Excess travel is defined as the arithmetic difference between the actual highway distance traveled and the travel distance that would have resulted under optimum origin-destination route connections (King and Mast 1987). When safety rest areas are not available, drivers are required to access similar services off the highway, increasing both their travel distance and time.

At the microscopic level, estimates for excess travel and diversion can be obtained by comparing existing safety rest area locations with surrogate service (i.e., gas stations, truck stops, etc.) locations. While excess travel distances and associated vehicle operating costs can be readily determined or estimated, the value of wasted time—especially for small time increments—is a controversial aspect of highway economic analysis.

Value of Travel Time Estimates. Value of travel time estimates depends on a number of elements including:

- Type of vehicle.
- Vehicle occupancy.
- Trip purpose.
- Costs included and excluded when developing the estimates.
- Availability of detailed data.
- Underlying assumptions (Whitney 2008).

Most recently, representatives from the Victoria Transport Policy Institute (2009) identified additional factors that tend to affect the value of time and subsequently challenge its accurate estimation:

- There are often substantial differences between objectively measured (clock) travel time and perceived travel time (Li 2003), which tends to increase with congestion, discomfort, and insecurity (Wener et al. 2006, Brundell-Freij 2006).
- The first few minutes of a trip often have minimal value since drivers generally seem to enjoy a certain amount of daily travel. The value of time usually increase if trips exceed 20 minutes in duration or total personal travel exceeds 90 minutes per day (Welch and Williams 1997).
- The value of time tends to increase with variability and arrival uncertainty (Cohan and Southworth 1999) and is particularly high for unexpected delays during activities with strict schedules (Hollander 2006, Small 1999).
- The value of time for recreational travel or errands that involve social activities has a low or positive value because people enjoy the experience (Mokhtarian 2005).

Curiously, research has also shown a noted decline in the value of time from 1987 to 1998; motorists may have become accustomed to being delayed while traveling or desensitized to the severity of delay (Mackie et al. 2003). The availability and use of technologies (i.e., cellular telephones, laptop computers) en route to increase productivity during previously "lost" time may also affect value of time estimates.

Much of the recent literature has focused on refining value of time estimates in the context of urban commuter travel with the intent of defining appropriate tolling or congestion pricing rates and strategies. Because safety rest areas are generally located outside of urban areas and service typically intercity and/or recreational rather than commuter travelers, recent refinements in value of time estimates may not be directly applicable.

Vehicle Operating Costs. Excess travel and diversion in the absence of safety rest areas will also result in additional vehicle operating costs attributable to excess fuel consumption and vehicle wear and tear, subsequent maintenance, and depreciation. Vehicle operating costs, often expressed in terms of cents per mile of travel, vary depending on driving patterns and operating conditions. Fuel consumption per vehicle-mile tends to increase at higher speeds, lower speeds, and under stop-and-go driving conditions. Vehicle operating costs are higher on urban arterials than highways, and costs increase proportional to travel time when congestion dramatically reduces traffic speed. As such, vehicle operating costs are difficult to accurately estimate.

Commercial Motor Vehicle Scheduling and Staging Benefits

In addition to the safety, comfort and convenience, and excess travel and diversion benefits described previously, commercial motor vehicles may gain additional unique benefits from safety rest areas related to vehicle scheduling and staging. A considerable proportion of all goods transports are made by commercial motor vehicles using Interstate and other primary routes. The common use of two-person driving teams allows for extended late-night travel. Comparatively, deliveries—particularly in highly congested urban areas—are usually restricted to normal business hours and may be delayed until after the morning traffic peak period. Safety rest areas often provide convenient staging areas for commercial motor vehicles accommodating restricted delivery/pickup windows in urban areas.

Although this type of behavior has been widely observed, limited quantitative data exists to define its extent (King 1989). Furthermore, the economic benefit or value of this type of scheduling to the individual commercial driver and/or carrier is unknown (King 1989). A significant amount of focus has recently been put toward determining the adequacy of commercial motor vehicle parking at safety rest areas and surrogate facilities (i.e., privately owned and operated truck stops), with particular attention to quantifying and qualifying existing parking space inventories and in measuring and predicting commercial motor vehicle demand.

These studies have largely been conducted with the intent of improving safety (i.e., reducing fatigue-related crashes involving commercial motor vehicles) rather than logistical productivity.

Highway and Other Public Agencies

Highway and other public agencies may accrue many of the same benefits from safety rest areas observed for highway users, but to a lesser extent. For example, a reduction in fatigue or shoulder stop-related crashes attributable to safety rest areas will also result in both direct and indirect benefits to public agencies (i.e., a reduction in crash response costs or a reduction in lost tax revenues due to incapacitating injuries or fatalities). Safety rest area benefits that are unique to highway and other public agencies relate to direct monetary revenue and highway operations and maintenance.

Direct Monetary Revenue Benefits

Highway and other public agencies may realize limited direct monetary revenue benefits from safety rest areas in the form of franchise or lease fees, profit sharing arrangements, and/or shared cost arrangements for maintaining and operating the facilities.

These opportunities are carefully regulated. The *United States Code, Title 23—Highways, §111* currently limits the type of commercial development permitted in safety rest areas on the Interstate system to privately operated telephone, vending, and traveler information services (note that the proliferation of personal cellular telephones has dramatically reduced demand for pay telephone services). Traveler information services generally derive their income from advertisements by businesses that cater to area visitors.

Wireless Internet services are a relatively new feature at safety rest areas, currently offered in several states including Alaska, California, Florida, Iowa, Kansas, Minnesota, Oregon, Texas, and Wisconsin. Washington State recently ceased offering wireless Internet services at safety rest areas because of a lack of subscribers and subsequent revenue. Service providers typically charge an hourly, daily, or monthly subscriber fee and, in some cases, offer between 30 minutes and 2 hours of free initial access.

Regardless of the nature of commercial establishment in safety rest areas, observed monetary benefits accrued by highway or other public agencies are typically directly available through internal financial recordkeeping systems designed to track both income and expenditures of the agency.

Highway Operations and Maintenance Benefits

Safety rest areas, by their intended purpose and design, should result in decreased numbers of shoulder stops, excess travel and diversion, and roadside litter with associated benefits related to extended service lives for shoulder and secondary roadway infrastructure and reduced highway cleanup costs.

A reduction in the frequency of shoulder stops, especially by heavy commercial motor vehicles, will result in less wear on the shoulders and a consequent reduction in shoulder maintenance costs. Similarly, a reduction in excess travel and diversion to seek surrogate services will decrease costs for maintenance on the affected portions of the secondary road system. Associated cost savings may be considerable, especially in areas where shoulders are built to lower design standards than through lanes or if an appreciable number of heavy commercial motor vehicles are deterred from using narrow, flexible pavement, secondary rural roads whose geometry, cross section, and pavement design are inadequate for this vehicle type.

Offering a third source of potential benefit to highway or other public agencies, trash receptacles are an almost universal feature of safety rest areas. A large proportion of the trash deposited at safety rest areas would otherwise be disposed of on or near the highway adding to the already large highway cleanup costs.

Despite the potential for benefit, the subsequent reductions in the extent of highway cleanup and shoulder stops/excess travel made by commercial motor or other types of vehicles attributable to safety rest areas is not often documented by highway or other public agencies. Shoulder stops often only become evident when a resulting crash occurs.

External Entities

In addition to highway user and highway/public agency benefits, safety rest areas may also promote economic development and tourism within the state, benefit various related business enterprises (i.e., vending machine operators, wireless Internet service providers, etc.), and limit undesirable traffic diversion off of the main highway facility into communities.

Economic Development and Tourism Benefits

Safety rest areas are commonly credited with positively impacting a state's economy—and particularly its tourism industry—as a result of traveler information provided at these facilities and subsequent decisions made by travelers to: extend their stay in the state, make future trips to the state, and/or purchase goods or services and visit attractions not previously planned (King 1989). In a survey of national practice conducted by Blomquist and Carson (1998), over 85 percent (85.29 percent) of public agency respondents reported the existence of combined safety rest area facilities and travel information centers in their state.

Despite the prevalence of available traveler information in safety rest areas or combined facilities, purported benefits to economic development and tourism are not well substantiated by quantified data. In a related survey of national practice, King (1989) requested information concerning the impact of safety rest areas on the state's economy and on tourism from all 50 state tourism agencies. Less than half of these agencies responded. Those who did indicated a strong belief that safety rest areas had a definite impact on the state's tourism industry, but few provided monetary estimates. The limited data that do exist are limited to combined facilities and usually consist of inferences drawn from responses to questionnaires distributed in or administered at the travel information centers/safety rest area facilities.

Specific Business Enterprise Benefits

As described previously, highway and other public agencies may realize limited direct monetary benefits from safety rest areas in the form of franchise or lease fees, profit sharing arrangements, and/or shared cost arrangements for maintaining and operating the facilities. Concurrently, participating commercial enterprises are likely to benefit from these same arrangements. For example, vending machine operators providing services through their state's association for the blind under the *Randolph-Sheppard Act (United States Code, Title 20, §107)* or wireless Internet service providers will obtain additional revenue from safety rest area operations. Contract providers of traveler information also expect to profit from these types of enterprises, as do their participating advertisers.

Unlike the revenues accrued by highway or other public agencies as a result of agreements with commercial establishments, private business enterprises may be reluctant to share information related to revenue generation attributable to safety rest areas. While this information is readily quantified, it may be considered proprietary in competitive sectors of the various private industries.

Traffic Diversion into Communities Benefits

As described previously, safety rest areas provide excess travel and diversion benefits to highway users and highway or other public agencies by minimizing excess travel time/distance and preserving secondary route infrastructure, respectively. Safety rest areas also serve to minimize congestion, noise and air pollution, and/or parking demand in adjacent communities when drivers—if safety rest areas are not available—are required to access similar services off the highway. The subsequent impact to local inhabitants—most readily documented in consideration or as a result of a safety rest area closure—is not often documented by highway or other public agencies at the state or local jurisdiction levels.

Comparatively, the need for traffic to divert from the mainline to access services may benefit local business enterprises. These local business benefits may extend beyond the original goods and services sought if diverted travelers are exposed to services and attractions of which they would otherwise not have been aware. Stated alternatively, when safety rest areas are available, local business enterprises may experience a detrimental decline in patronage. As such, the impacts of traffic diversion on local business enterprises reflect a disbenefit or cost to external entities in safety rest area benefit-cost analysis and hence, are described later in this chapter.

SAFETY REST AREA COSTS

While safety rest areas have been generally observed to benefit three groups (i.e., highway users, highway and other public agencies, and external entities including tourism boards, local businesses, etc.), safety rest area costs are almost exclusively borne by highway and other public agencies, with highway users and external entities incurring significantly less associated cost.

Highway Users

Although safety rest areas offer benefits to highway users in a breadth of potential impact areas (i.e., safety, comfort and convenience, reduced travel and diversion, and commercial motor vehicle scheduling and staging), safety rest area costs incurred by highway users relate exclusively to safety.

Safety Costs

As described previously, safety rest areas serve to enhance safety by: reducing driver fatigue and other adverse physiological effects; reducing voluntary shoulder stops; providing a safe refuge under hazardous weather, roadway, and visibility conditions; reducing involuntary stops and vehicle-miles of travel by defective vehicles; reducing in-vehicle driver distraction resulting from a restless pet or child; and communicating safety-related information to drivers. Safety rest areas also offer potentially adverse safety effects attributable to additional merging and lane changing near the facility's entrances and exits.

The extent of adverse safety impacts attributable to safety rest areas can be estimated using observed sideswipe and rear-end crashes that occur proximate to the facility's entrances and exits. State highway agencies have anecdotally reported a low level of crash occurrence at safety rest area entrances and exits (King 1989).

Highway and Other Public Agencies

Safety rest area costs incurred by highway and other public agencies are largely characterized as direct costs to the agencies.

Direct Monetary Costs

Incurring the greatest proportion of costs associated with safety rest areas, highway and other public agencies accrue direct costs associated with providing, maintaining, and operating safety rest area facilities. More specifically, associated direct costs—generally expressed as Equivalent Uniform Annual Costs (EUAC) to accommodate differing life cycles among cost components—typically include initial right-of-way acquisition, design, construction, and ongoing operations and maintenance.

These costs vary widely depending on location and terrain; access to potable water, sewage disposal and utilities; facility size and amount of parking; architecture and the cost of design materials; types of amenities and services offered; amount of use (i.e., demand); use of contracted versus in-house maintenance personnel; and more.

Accurate estimation of safety rest area direct costs is not only challenged by this variability, but supporting data have been historically observed to be incomplete and/or out of date. King (1989) found operations and maintenance costs to be generally current but noted that right-of-way, design, and construction costs—sometimes dating back to the 1960s or prior—were not always updated to reflect current price levels.

External Entities

External costs and disbenefits attributable to safety rest areas—resulting from reductions in environmental impacts, socially undesirable behavior, or traffic diversion from communities and subsequent patronage of local services—are less readily quantified and are presumed to be small relative to overall facility costs.

Environmental Impact Costs

Environmental impacts resulting from safety rest areas may include air or noise pollution, groundwater contamination, interference with surface runoff, destruction of existing vegetation, interference with local animal habitat, removal of arable land from agricultural land use, and adverse aesthetic elements. These impacts are typically avoided or minimized through appropriate facility location, design, and construction. Because of the site- and facility-specific nature of potential environmental impacts and subsequent costs, more generalized environmental impact costs of safety rest areas are often unavailable.

Socially Undesirable Behavior Costs

In some instances, safety rest areas have become the focus for socially undesirable behavior including prostitution, homosexual activities, and drug sales and use. This pattern places an extra burden on already extended police forces (King 1989) but these added costs attributable to the safety rest area facility are often not distinguished by local agencies.

Traffic Diversion from Communities Costs

Safety rest areas are generally credited with reducing traffic diversion by travelers seeking basic services and subsequently benefiting highway users (i.e., by reducing travel distance and time), highway or other public agencies (i.e., by extending infrastructure life), and local inhabitants along the diversion route (i.e., by reducing congestion, noise and air pollution, or parking demand). Comparatively, safety rest areas may compete with demand for services from local business enterprises, resulting in a detrimental decline in commercial patronage.

Existing regulations preclude direct determination of the impact on local sales as a result of existing services offered at safety rest areas. Under existing commercial development limitations imposed by *United States Code, Title 23—Highways,* §*111*, safety rest areas offer few overlapping services that would directly compete with demand for services from local business enterprises.

Restrooms are generally provided free of charge at both safety rest areas and commercial establishments. Vending machine items, drinking water, and other are generally low cost/low profit items for local business enterprises. Only local businesses offer access to fuel, food (other than vending machine items), vehicle repair services, etc.

As such, efforts to relate safety rest areas with a decline in commercial patronage have been speculative; considering the potential impact to local services if a greater extent of commercialization and subsequent services was allowed at safety rest areas (i.e., if current restrictions to safety rest area commercialization were removed).

SUMMARY AND IMPLICATIONS FOR THIS INVESTIGATION

In brief, benefit and cost components that show the most promise for measurement or estimation include safety benefits and costs and excess travel and diversion benefits accrued by highway users; and direct monetary benefits and costs accrued by highway and other public agencies. In addition, some potential exists for measuring or estimating comfort and convenience benefits accrued by highway users; and economic development and tourism and specific business enterprise benefits accrued by external entities.

Comparatively, limited opportunity may exist to quantify scheduling and staging benefits for commercial motor vehicle highway users; highway operations and maintenance benefits accrued by highway and other public agencies; and environmental impact costs, socially undesirable behavior costs, and the benefits and costs associated with traffic diversion into and out of communities accrued by external entities. An underlying limitation in each case is simply a lack of adequate data capture to support analysis.

CHAPTER 3:
PROPOSED SAFETY REST AREA BENEFIT-COST METHODOLOGY IN TEXAS

When developing a unique methodology for determining safety rest area benefits and costs in Texas, researchers first conducted a thorough methodological review and next identified a wide array of potential of local and national/aggregate data sources that could support this effort. The methodological review considered both comprehensive benefit-cost analysis methods—in general and specific to safety rest areas—and more focused efforts that improve upon the estimation of the individual benefit or cost components. Appendices A and B detail the results of these two efforts, respectively.

This chapter details the methods and data sources ultimately used to support determination of the various safety rest area benefits and cost components and the assimilation of these component benefits and costs to reflect the overall economic merit of existing safety rest areas along three demonstration corridors in Texas. For consistency in comparison, each of the component estimates were converted to 2008 dollars using Consumer Price Index (CPI) inflation factors (Bureau of Labor Statistics 2010). Chapter 4 details the results for the three demonstration corridors in Texas.

BENEFIT COMPONENT ANALYSIS METHODS

Considering component benefits first, the proposed methods and potential data sources to support determination of the various safety rest area benefit components for highway users, highway and other public agencies, and various external entities in Texas are summarized in Table 2 and described below.

Note that, in order of preference, estimates for the various benefit components may be directly measured, estimated based on local data, estimated based on national or other aggregate data, or omitted because of an inability to quantify. Whenever possible, a combination of local and national/aggregate data was used to improve upon estimates using national/aggregate data in isolation. Benefit components determined to be immeasurable or inestimable because of a lack of supporting data—including commercial motor vehicle scheduling and staging, highway operations and maintenance, and traffic diversion benefits accrued by select highway users, highway agencies, and external entities, respectively—are not considered further.

Table 2. Proposed Analysis Methods and Data Sources for Safety Rest Area Component Benefits.

BENEFITS	PROPOSED METHODS					SUPPORTING DATA	
	Direct Measurement	Estimates Based on Local Data	Estimates Based on National/Aggregate Data	Not Estimable	METHOD	TYPE	SOURCES
Highway Users							
Safety Benefits		✓	✓		Before/after analysis	SRA Locations	• TxDOT's Safety Rest Area website and database
						Crash Characteristics	• TxDOT's Texas Accident File or CRIS (1978–2009)
					Estimated annual change in crashes by severity level × unit crash costs	Crash Costs	• National Safety Council (2008)
Comfort and Convenience Benefits		✓	✓		Per visitor comfort and convenience benefits by facility type × (annual SRA usage × vehicle occupancy) Per visitor comfort and convenience benefits by facility type = SRA amenity usage × SRA amenity market values	SRA Amenities	• TxDOT's Safety Rest Area website and database
						SRA Amenity Usage	• *Safety Rest Areas and Travel Information Centers in Texas* survey (2010)
						SRA Amenity Market Values	• Various sources (see Table 4)
						SRA Usage	• TxDOT's vehicle classification counts (2002 and 2009–2010)
						Vehicle Occupancy	• *Safety Rest Areas and Travel Information Centers in Texas* survey (2010)
Excess Travel and Diversion Benefits		✓	✓		Excess vehicle operating costs + excess travel time Excess vehicle operating costs = annual SRA usage × diversion rate × roundtrip distance to surrogate service × vehicle operating unit cost Excess travel time = annual SRA usage × diversion rate × (roundtrip distance to surrogate service ÷ off-route travel speed) × value of time unit cost	SRA Location	• TxDOT's Safety Rest Area website and database
						Surrogate Service Locations	• Google Maps™ website
						SRA Usage	• TxDOT's vehicle classification counts (2002 and 2009–2010)
						Diversion Rate	• King (1989)
						Vehicle Operating Cost	• Barns and Langworthy (2004)
						Travel Speed	• Assumed based on local posted speed limits
						Value of Time	• Bureau of Labor Statistics (2009)

Table 2. Proposed Analysis Methods and Data Sources for Safety Rest Area Component Benefits (Continued).

BENEFITS	PROPOSED METHODS					SUPPORTING DATA	
	Direct Measurement	Estimates Based on Local Data	Estimates Based on National/Aggregate Data	Not Estimable	METHOD	TYPE	SOURCES
Highway Users (Continued)							
Commercial Motor Vehicle Scheduling and Staging Benefits				✓	—	—	—
Highway Agencies							
Direct Monetary Revenue Benefits	✓				Direct measurement	Revenue	• TxDOT's wireless Internet services agreement • Texas Department of Assistive/Rehabilitation Services, Business Enterprises of Texas Program
Highway Operations/ Maintenance Benefits				✓	—	—	—
External Entities							
Economic Development and Tourism Benefits		✓	✓		Annual SRA usage × vehicle occupancy × percent of visitors extending their trip × average length of trip extension × average expenditures per day per visitor	SRA Usage	• TxDOT's vehicle classification counts (2002 and 2009–2010)
						Vehicle Occupancy	• *Safety Rest Areas and Travel Information Centers in Texas* survey (2010)
						Percent of Visitors Extending Trip	• *Safety Rest Areas and Travel Information Centers in Texas* survey (2010)
						Length of Trip Extension	• *Safety Rest Areas and Travel Information Centers in Texas* survey (2010)
						Daily Expenditures	• *Texas 2008 Visitor Profile* (Eslinger 2008) • *Safety Rest Areas and Travel Information Centers in Texas* survey (2010)
Specific Business Enterprise Benefits	✓				Direct measurement	Revenue	• TxDOT's wireless Internet services agreement • Texas Department of Assistive/Rehabilitation Services, Business Enterprises of Texas Program
Traffic Diversion into Communities Benefits				✓	—	—	—

Highway Users

Measurable or estimable benefits and costs accrued by highway users relate to safety, comfort and convenience, and excess travel and diversion.

Safety Benefits

The methods, supporting data, and associated assumptions used to estimate safety rest area safety benefits along three demonstration corridors in Texas (detailed later in this document) are described below. Note that various limitations in the nature and extent of supporting data—including a lack of before or after data, a lack of suitable control sections, missing or erroneous data, and an unknown "sphere of influence" for safety rest area facility safety effects—significantly challenged the development of an appropriate analysis methodology and the subsequent quantification of safety benefits attributable to safety rest areas in Texas.

Methods. Direct methods for determining safety benefits accrued by highway users—such as before/after or case/control analyses—are intended to estimate changes in crash frequency by severity level that can be confidently associated with the presence or absence of a safety rest area facility (or series of safety rest area facilities) and expressed in monetary terms. Differences in total crashes, as well as specific crash types most commonly associated with safety rest area benefits (i.e., fatigue-related crashes or crashes occurring on, entering, or exiting the roadway shoulder) may be considered. Appropriate surrogate factors related to time of day (i.e., nighttime) or vehicle involvement (i.e., single vehicle) may be used individually or in combination to reflect possible driver fatigue condition as long as their use can be well justified.

To estimate the change in crash frequency for a given severity level, researchers initially considered use of a combined before/after and case/control analysis to help ensure that any observed change in crash occurrence is attributable to the facility and not confounding factors or systemic changes. Before/after analyses estimate the safety-related benefits of an improvement by most commonly comparing crash occurrence at a location before and after some "treatment," which for this investigation would be the construction/opening of a safety rest area. Simple before/after analyses are susceptible to temporal variations (i.e., adverse weather-related trends, changes in traffic volumes and traffic stream composition, regulatory changes, etc.) and as such may lead to inaccurate or exaggerated inferences regarding safety-related treatment effects. As noted, increase or decrease in crashes may also result from the random nature of crash occurrence independent of any treatment. This phenomenon is particularly problematic when post-treatment data are limited to only a few years.

To overcome the shortcomings of the simple before/after analysis, temporal observations are often combined with observations made across "case" and "control" sites. A group of comparison sites (i.e., control) with geometric and site characteristics similar to the site being studied (i.e., case) is identified. Ideally, the control sites should have roadway geometrics, traffic volumes, and land use characteristics identical to that of the study site. Crash data are collected for the same before/after time period at both the case and control sites. The challenge in conducting case/control analyses is identifying a sufficient number and quality of comparison sites. Given the statewide coverage of existing safety rest area facilities, researchers were unable to identify suitable control corridors. As such, the estimation of the change in crash frequency for a given severity level was limited to before/after analyses, which, in some cases, was also challenged by a lack of before or after supporting data.

Rather than consider crash occurrence directly, researchers considered the occurrence of "casualties" to support determination of benefits in monetary terms. Researchers also limited analysis to the consideration of *total* casualties, given the low observed frequencies and noted variability in reporting of fatigue-related and shoulder stop crashes. Direct casualty frequencies were converted to casualty rates using annual vehicle-miles traveled (VMT) estimates.

The change in casualty rate was considered before and after the construction/opening of a new safety rest area facility and/or the renovation of an existing facility (presuming that a higher number of motorists would be likely to stop and take advantage of the services offered following renovation). Rather than considering potential safety benefits on a site-by-site basis (given the unknown sphere of influence attributable to safety rest area facilities), researchers considered facility characteristics collectively along the entire length of the demonstration corridor to define before and after time periods for analysis.

For older facilities that have not yet been renovated and for new facilities added after 2009, no data were available to support determination of potential safety benefits. This lack of data does not suggest that these facilities offer no benefit but simply that the benefit cannot be quantified as part of this investigation. The following relationship was used to derive corridor-level safety benefits for highway users:

Corridor $SB_{HU\,j}$ =	$\phi_i \times$ *Casualty Frequency* $_i$
Corridor SB_{HU}=	Σ(*Corridor* $SB_{HU\,j} \times$ *Casualty Outcome Unit Costs* $_j$)

Where:

- Corridor $SB_{HU\,j}$ = estimated annual change in casualty frequency for a given severity level j.
- ϕ_i = the casualty reduction factor at site or road segment i.
- Casualty Frequency $_i$ = the annual casualty frequency at site or road segment i.
- Corridor SB_{HU} = the corridor-wide safety benefit accrued by highway users annually.
- Casualty Outcome Unit Costs $_j$ = unit costs for casualty severity level j as determined by the National Safety Council (2008).

If direct analysis methods are challenged because of data limitations, indirect analysis methods modeled after those used by King (1989) that consider estimated reductions in suspected crash causal factors (i.e., fatigue, shoulder stops, etc.) and subsequent reductions in crash occurrence may be used. Appendix A provides a detailed description of these indirect procedures.

Supporting Data. In Texas, safety and crash and casualty data are available from the legacy Texas Accident File and the Crash Records Information System (CRIS) maintained by TxDOT, Traffic Operations Division (formerly maintained by the Texas Department of Public Safety). These databases provide driver, vehicle, roadway, and weather/light condition information, as well as identified contributing factors, for all reportable crashes (i.e., crashes involving fatalities, injuries, and significant property damage) in Texas.

Texas safety and crash/casualty data are available from approximately 1978 through 2001 from the legacy Texas Accident File and from 2003 to 2009 from CRIS. Note that safety and crash data for 2002 are available only on a statewide basis, preventing aggregate or disaggregate analysis at the corridor or site-specific level. Also note that for safety rest areas constructed prior to 1978 or after 2009, the conduct of before/after analyses cannot be directly supported.

Texas safety and casualty data can be specified in terms of the National Safety Council's (NSC) injury severity KABC scale: K = fatality, A = incapacitating injury, B = non-incapacitating injury, C = possible injury, and N = no injury (property damage only, PDO). Consideration of property damage only crashes is challenged, and the threshold for reporting non-injury crashes has changed over time and also varies among different Texas jurisdictions, making comparisons tenuous.

Crashes occurring on Texas highways are located using Control Section/Mile Point (CS/MP) designations. The CS/MP designations also provide the capability to access traffic volume data (Average Annual Daily Traffic [AADT]) and other roadway characteristics (e.g., cross-section design) that may be of interest. Safety rest area facilities are also located using MP designations, providing the means to access and analyze related crash data for specified road segments proximate to safety rest area facilities. Safety rest area location data, including MP and latitude/longitude designations, are available through TxDOT's Safety Rest Area website and database. When MP designations were not directly available for safety rest area facilities of interest in this investigation, latitude/longitude and distance-from-origin data were converted to CS/MP designations using a geographic information systems (GIS) highway network.

Used to assign monetary values to changes in crash/casualty rates or severities observed, unit cost estimates based on the KABC scale are estimated annually by the NSC (National Safety Council 2008). Calculable costs of motor vehicle crashes are wage and productivity losses, medical expenses, administrative expenses, motor vehicle damage, and employers' uninsured costs. The costs of all these items for each death (not each fatal crash), injury (not each injury crash), and property damage crash are designated as "economic costs" in Table 3.

Table 3. Unit Costs for Various Crash Outcome Severity Levels (National Safety Council 2008).

INJURY SEVERITY		ECONOMIC COSTS (2008 Dollars)
K	Fatality	$1,300,000
A	Incapacitating injury	$67,200
B	Non-incapacitating injury	$21,800
C	Possible injury	$12,300
N	No injury (PDO)	$8,300

Given the uncertainties in estimating crash costs, the NSC recommends that any cost estimates be rounded to indicate that they are only approximations, not exact figures. The recommended rule for estimates is as follows:

- Less than $3,000,000, round to the nearest $100,000.
- Between $3,000,000 and $10,000,000, round to the nearest $500,000.

- Between $10,000,000 and $30,000,000, round to the nearest $1,000,000.
- Greater than $30,000,000, round to the nearest $5,000,000.

Assumptions. A number of fundamental assumptions were required when estimating the safety-related benefits attributable to safety rest area facilities along the three demonstration corridors in Texas. First, it was assumed that any observed change in casualty rate was attributable to the safety rest area facility and not confounding factors or systemic changes. With select facilities having a life span of more than 50 years, temporal variations related to traffic volumes and traffic stream composition, roadway and vehicle design principles, enforcement and regulation, adverse weather-related trends, and other factors challenge the validity of this assumption. Efforts to control for each of the potential confounding factors affecting highway user safety would however lead to an investigation that is far too complex and costly to perform.

In an attempt to temper a potential over-estimation of safety rest area facility benefits in light of these confounding factors or systemic changes, casualty data along the three corridors under investigation were compared to statewide data to determine significant differences between corridors with regularly spaced safety rest areas and the remainder of the state roadway system with and without safety rest area facilities. The observed changes in safety for statewide conditions were used to derive a correction factor that was applied to the observed changes in safety along the safety rest area demonstration corridors to more accurately estimate the magnitude of safety improvements attributable to safety rest areas in isolation.

For the U.S. 287 demonstration corridor, the correction factor was based on casualty rates associated with Texas state and U.S. highways. For both Interstate corridors (IH 45 and IH 10), statewide rural Interstate casualty rates were employed to develop the correction factor. While clearly not ideal on either a computational or theoretical basis, the correction factors provide a means for estimating the overall decline in casualty rates that are unrelated to the presence or absence of new or renovated rest areas and travel information centers.

Comfort and Convenience Benefits

The methods, supporting data, and associated assumptions used to estimate safety rest area comfort and convenience benefits along the three demonstration corridors in Texas are described below. Note that the convenience aspects of safety rest area facilities will be largely reflected in the determination of highway user excess travel diversion benefits later in this report.

Methods. Comfort and convenience benefits provided by safety rest areas are most often estimated as a product of safety rest area usage or demand and an associated user-reported "willingness to pay" value intended to characterize the facility's monetary worth to a potential user or beneficiary.

As noted previously, self-reported willingness to pay estimates tend to be lower than observed usage fees, with many respondents reporting a willingness to pay nothing to use safety rest areas. In addition, willingness to pay estimates are typically aggregated to reflect a general willingness to pay "to use a public safety rest area" and do not take into account potentially different pay rates based on differences in the amenities provided (i.e., users may be willing to pay a higher usage fee if the safety rest area facility included interpretive displays, wireless Internet access, etc.).

Safety rest area facilities in Texas offer a wide range of products, services, and amenities. For this investigation, three general classes of facilities were defined: (1) safety rest areas offering basic services, (2) safety rest areas offering extended services, and (3) travel information centers offering specialized services.

To account for this range of facility offerings and to improve upon the accuracy of self-reported willingness to pay estimates, the products, services, and amenities that safety rest area visitors take advantage of at safety rest area facilities were self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010, a copy of the survey instrument and summary of survey results in included in Appendix C), and a market value was externally attached to that product, service, or amenity. For example, if 40 percent of safety rest area users reportedly utilize the WiFi services while stopped, a value for that service can be determined based on market prices in the private sector. Researchers derived similar market values for items such as drinking water, maps, travel assistance, etc.

Specifically, the following two-stage relationship was used to derive corridor-level comfort and convenience benefits for highway users:

$$\textit{Per Visitor } CCB_{HU\,i} = \Sigma(\textit{Percent of Visitors Using Product, Service, Amenity}_j \times \textit{Estimated Market Value}_j)$$

$$\textit{Corridor } CCB_{HU} = \Sigma(\textit{Per Visitor } CCB_{HU\,i} \times \textit{Annual Facility Usage}_i \times \textit{Average Vehicle Occupancy})$$

Where:

- Per Visitor $CCB_{HU\ i}$ = average estimated comfort and convenience benefits accrued by each safety rest area visitor for a given facility type i (e.g., safety rest area offering basic or extended services or a travel information center).
- Percent of Visitors Using Product, Service, Amenity $_j$ = percent of visitors using facility product, service, or amenity j as self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010).
- Estimated Market Value $_j$ = estimated market value of similar product, service, or amenity j offered in the private sector (from various sources, see Table 4).
- Corridor CCB_{HU} = estimated comfort and convenience benefits accrued by highway users corridor-wide.
- Annual Facility Usage $_i$ = estimated number of vehicles entering safety rest area facility i annually, derived from vehicle classification counts (2002, and 2009–2010).
- Average Vehicle Occupancy = number of persons per vehicle estimated as 2.1 persons per passenger car (including motorcycle, pickup truck, van, sport utility vehicle, recreational vehicle, and vehicle with pull-behind camper trailer), 1.2 persons per truck (including semi-truck/tractor trailer), and 1.8 persons per vehicle on average (used when vehicle type was unknown), as self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010).

Table 4 summarizes estimated market values for the various safety rest area products, services, or amenities identified through various sources to support this investigation. Per visitor estimates of comfort and convenience—based on self-reported frequency of use and the available products, services, and amenities offered at safety rest areas offering basic and extended services and travel information centers—are presented in Table 5.

Table 4. Estimated Market Values for Safety Rest Area Products, Services, or Amenities.

PRODUCT, SERVICE, OR AMENITY	SRA		TIC	SOURCE	ESTIMATED MARKET VALUE
	Basic Services	Extended Services			
Attend to pet needs	✓	✓	✓	—	—
Change baby's diaper	✓	✓	✓	—	—
Change drivers	✓	✓	✓	—	—
Check/repair vehicle	✓	✓	✓	—	—
Dispose of trash	✓	✓	✓	—	—
Rest/sleep	✓	✓	✓	—	—
Seek shelter during tornado threat/bad weather	✓	✓	✓	—	—
Stretch/walk	✓	✓	✓	—	—
Use picnic area	✓	✓	✓	—	—
Use restroom	✓	✓	✓	—	—
Allow children to play (playground)		✓		—	—
Take photos at 'Welcome to Texas' photo area			✓	—	—
Purchase vending machine newspaper			✓	—	No cost difference
Purchase vending machine beverages/snacks			✓	—	No cost difference
Purchase motor carrier permit			✓	—	No cost difference
Purchase TxTag toll tag			✓	—	No cost difference
Use pay telephone	✓	✓	✓	—	No cost difference
Get water from drinking fountain	✓	✓	✓	Bottled Water Issues Summary, Worldwatch Institute, 2007	$1.08/bottle ($1.00+0.08 tax)
Access the Internet using free WiFi	✓	✓	✓	Via Internet, TravelPost Airport Wireless Internet Access Guide, http://www.travelpost.com/airport-wireless-internet.aspx, AT&T $3.95/2 hrs, Opt-Fi $2.99/15 min., T-Mobile $6.00/hr, Verizon $7.95/hr Weather/road/ traffic information also available: Via satellite radio, Sirius Traffic, http://www.sirius.com/traffic, $48/year+compatible device Via GPS, GPSReview.net, Traffic, http://www.gpsreview.net/traffic/, $60/year+compatible device	$4.28/2 hrs ($3.95+0.33 tax)
Obtain gas/food/lodging information			✓		
Obtain tourist event/ attraction information			✓		
Obtain weather/road/ traffic information			✓		
Observe interpretive displays		✓	✓	Step Into History-Texas Website, http://www.stepintohistory.com/states/TX/TX_ndx.htm#2, typical fees are donation-based or $1–4 for children/students, $2–9 for adults, $1–8 for seniors	$1.08/person ($1.00+0.08 tax)
Watch videos depicting Texas attractions			✓		
Obtain free Texas map			✓	Texas Map Store Website, http://www.texasmapstore.com/Texas_map_p/texas04.htm	$5.36/map ($4.95+0.41 tax)
Use on-site Travel Counselor services			✓	PayScale Website, http://www.payscale.com/research/U.S./Job=Travel_Counselor/Hourly_Rate/by_State, wages range from $12.73–16.70/hour	$4.24/20 min. ($12.73/hour)

Table 5. Estimated per Visitor Comfort and Convenience Benefits by Facility Type.

PRODUCT, SERVICE, OR AMENITY	SURVEY RESPONDENTS	ESTIMATED MARKET VALUE	PER VISITOR COMFORT AND CONVENIENCE BENEFIT		
			SRA		TIC
			Basic Services	Extended Services	
Get water from drinking fountain	30.9%	$1.08/bottle ($1.00+0.08 tax)	$0.33	$0.33	$0.33
Access the Internet using free WiFi	57.1%	$4.28/2 hrs ($3.95+0.33 tax)	$2.44	$2.44	$2.44
Obtain gas/food/lodging information	14.3%				
Obtain tourist event/ attraction information	11.9%				
Obtain weather/road/ traffic information	25.7%				
Observe interpretive displays	34.1%	$1.08/person ($1.00+0.08 tax)		$0.37	$0.37
Watch videos depicting Texas attractions	6.7%				
Obtain free Texas map	15.3%	$5.36/map ($4.95+0.41 tax)			$0.82
Use on-site Travel Counselor services	5.9%	$4.24/20 min. ($12.73/hour)			$0.25
		TOTAL	**$2.77**	**$3.14**	**$4.21**

Supporting Data. Data to support estimation of corridor-level comfort and convenience benefits for highway users were obtained from the following sources:

- Safety Rest Area Amenities by Facility—Obtained from TxDOT's Safety Rest Areas website and database, http://www.txdot.gov/travel/safety_rest_areas/sralocations.htm.
- Percent of Visitors Using Various Products, Services, or Amenities—Self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010).
- Estimated Private Sector Market Values of Various Products, Services, or Amenities—Various sources, see Table 4.
- Annual Facility Usage—Estimated from vehicle classification counts conducted in 2002 (statewide) and 2009–2010 (San Antonio District/U.S. 287, included in Appendix D); vehicle classification counts were adjusted to reflect 2008 traffic volumes based on observed proximate changes in AADT.
- Average Vehicle Occupancy—Self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010).

Assumptions. Required assumptions when estimating comfort and convenience benefits attributable to safety rest areas relate largely to the estimation of market values of similar products, services, or amenities offered in the private sector. For a number of the amenities offered at safety rest area facilities, such as changing drivers, disposing of trash, using a picnic area, or using the restroom, the estimated market value is assumed to be \$0. These same benefits can be commonly realized outside of public safety rest areas at no cost. For other safety rest area amenities, such as purchasing a vending machine newspaper or beverage or purchasing a motor carrier permit or TxTag toll tag, the product cost is assumed to be the same within and outside of the public safety rest areas.

For select safety rest area amenities, conservative market value estimates for comparable private sector products or services were derived from various sources. For example, a private sector alternative to drinking water from a drinking fountain is likely the purchase of bottled water at a convenience store or gas station. Researchers assumed conservative estimate of \$1.08 (\$1.00 plus a median state and local sales tax totaling 8.25 percent) per bottle of water. Similarly, researchers identified various rates from major Internet Service Providers (ISP) offering temporary Internet access to travelers in airport terminals. A conservative rate of \$4.28 for two hours of access (\$3.95 plus \$0.33 tax) was assumed. Note that free wireless Internet access, similar to that offered at public safety rest areas, is becoming more prevalent in the private sector but these free services are largely concentrated in urban centers.

Access to the Internet can also support attainment of gas, food, or lodging information, tourist event or attraction information, or weather, road condition, or traffic information. Weather, road condition, or traffic information is also available via satellite radio or navigation systems but at a higher cost that includes the initial purchase of a compatible device and annual subscription fees ranging from \$48 to \$60 per year. As such, the more conservative estimate of \$4.28 for two hours of Internet access was assumed to support these information-gathering activities.

To derive a market value for the interpretive displays and videos offered at many of the safety rest areas in Texas, typical fees for comparable local history attractions in the state were identified. Attractions that included displays, self-guided interpretive tours, and videos were thought to be most comparable. Because the extent of the information available at safety rest areas is likely limited in comparison to comparable local history attractions in the state, researchers assumed a conservative estimate of $1.08 ($1.00 plus $0.08 tax) per person. Offered at no cost to public safety rest area visitors, a Texas road map may retail for $4.95 plus tax ($5.36) at a convenience store or gas station.

Last, pay rates for travel counselors in the state of Texas range from $12.73 to $16.70 per hour. The conservative hourly rate of $12.73 was assumed. It was further assumed that the amount of time that travel counselors spend with each assisted visitor approximates 20 minutes. Note that a single per visitor unit estimate was developed for accessing the Internet and obtaining information related to gas, food, or lodging; tourist event or attractions; and weather, road condition, or traffic. It was assumed that any or all of these activities could occur within a single 2-hour Internet session (i.e., the 57.1 percent of survey respondents who indicated accessing the Internet was assumed to be inclusive of the 14.3 percent, 11.9 percent, and 25.7 percent of respondents who indicated seeking specific types of information as part of their session). Similarly, researchers assumed that the percent of survey respondents who indicated observing interpretive displays (34.1 percent) was inclusive of the 6.7 percent of respondents who indicated watching videos depicting Texas attractions at facilities when both activities were available to visitors.

Excess Travel and Diversion Benefits

Largely reflecting the convenience aspects of safety rest area facilities, the methods, supporting data, and associated assumptions used to estimate safety rest area excess travel and diversion benefits along the three demonstration corridors in Texas are described below.

Methods. In the context of safety rest areas, excess travel is defined as the arithmetic difference between the distance traveled (route miles) in the absence or unavailability (i.e., if the facility is closed or at capacity) of safety rest areas if drivers must leave the mainline route to access surrogate services and the reduced distance traveled if safety rest areas could meet the required service needs along the mainline route.

For individual safety rest areas, estimates of excess travel and diversion benefits were obtained by comparing existing safety rest area locations with surrogate service locations and relating this information to vehicle operating costs and value of time measures. For select corridors supported by vehicle classification data, distinct vehicle operating costs and value of time measures were used to distinguish passenger cars from commercial trucks. Unit estimates for excess travel and diversion benefits were extrapolated to reflect safety rest area facility usage. These individual facility estimates were summed along the length of the corridor to determine corridor-wide excess travel and diversion benefits.

More specifically, the following three-stage relationship was used to derive corridor-level excess travel and diversion benefits:

$$\textit{Vehicle Operating Costs}_i = \textit{Annual Facility Usage}_{ij} \times \textit{Diversion Rate} \times \textit{Roundtrip Mileage}_i \times \textit{Vehicle Operating Unit Costs}_j$$

$$\textit{Travel Time Costs}_i = \textit{Annual Facility Usage}_{ij} \times \textit{Diversion Rate} \times (\textit{Roundtrip Mileage}_i \div \textit{Travel Speed}) \times \textit{Travel Time Unit Costs}_j$$

$$\textit{Corridor ETDB}_{HU} = \Sigma(\textit{Vehicle Operating Costs}_i + \textit{Travel Time Costs}_i)$$

Where:

- Vehicle Operating Costs $_i$ = estimated vehicle operating costs accrued by highway users accessing surrogate services if safety rest area i is unavailable.
- Annual Facility Usage $_{ij}$= estimated number of vehicles entering safety rest area facility i annually, by vehicle type j if available, derived from vehicle classification counts (2002 and 2009–2010).
- Diversion Rate= percent of safety rest area users (vehicles) that would seek surrogate services if safety rest area facilities are unavailable, assumed to be 43 percent based on prior research conducted by King (1989).
- Roundtrip Mileage $_i$= estimated roundtrip mileage from nearest mainline intersection to comparable off-route surrogate service location.
- Vehicle Operating Unit Costs $_j$= vehicle operating unit costs, by vehicle type j if available, estimated as $0.23/mile for passenger cars, $0.59/mile for commercial trucks, and $0.37/mile when vehicle type is indistinguishable.
- Travel Speed= average travel speed from nearest mainline intersection to comparable off-route surrogate service location, assumed to be 30 mph.
- Travel Time Unit Costs $_j$= travel time unit costs, by vehicle type j if available, estimated as $29.87/vehicle for passenger cars, $24.38/vehicle for commercial trucks, and $25.60/vehicle when vehicle type is indistinguishable.

- Corridor $ETDB_{HU}$ = the corridor-wide excess travel and diversion benefit accrued by highway users annually.

Supporting Data. Data to support estimation of corridor-level comfort and convenience benefits for highway users were obtained from the following sources:

- Annual Facility Usage—Estimated from vehicle classification counts conducted in 2002 (statewide) and 2009–2010 (San Antonio District/U.S. 287, included in Appendix D); vehicle classification counts were adjusted to reflect 2008 traffic volumes based on observed proximate changes in AADT.
- Diversion Rate—Assumed to be 43 percent based on prior research conducted by King (1989).
- Roundtrip Mileage—Estimated per facility using online mapping capabilities (Google Maps™) to determine the driving distance from the mainline intersection immediately upstream or downstream from the safety rest area to the nearest comparable off-route surrogate service location.
- Vehicle Operating Unit Costs—Estimated by Barns and Langworthy (2004) and adjusted from 2003 to 2008 dollars as $0.23/mile for passenger cars, $0.59/mile for commercial trucks, and $0.37/mile when vehicle type is indistinguishable (calculated as weighted average using self-reported vehicle types in the *Safety Rest Areas and Travel Information Centers in Texas* survey [2010]).
- Travel Speed—Assumed to be 30 mph, reflecting off-route/local travel from the nearest mainline intersection to comparable off-route surrogate service location.
- Travel Time Unit Costs—Estimated as follows:
  - $20.32 × 2.1 persons/car × 0.7 = $29.87 per car
  - $20.32 × 1.2 persons/truck = $24.38 per truck
  - $20.32 × 1.8 persons/vehicle × 0.7 = $25.60 per vehicle

  Where:

  - $20.32 is the average national hourly wage in 2008 as reported by the Bureau of Labor Statistics (2009).
  - Average vehicle occupancies are self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010).

- 0.7 is a reduction factor that reflects a reduced value of time for recreational vs. commuter/work-related travel (AASHTO 2003). To be most conservative in these estimates, the recreational travel reduction factor of 0.7 was used to derive travel time unit costs when vehicle type and subsequent trip purpose was indistinguishable.

Assumptions. When estimating the excess travel and delay benefits attributable to safety rest area facilities along the three demonstration corridors in Texas, various assumptions are required to determine the: (1) percent of safety rest area users (vehicles) that would seek surrogate services if safety rest area facilities are unavailable (assumed to be 43 percent based on prior research conducted by King [1989]) and (2) average travel speed from nearest mainline intersection to comparable off-route surrogate service location (assumed to be 30 mph). In addition, researchers were required to use significant judgment in identifying comparable surrogate services. A minimum criteria used for identifying proximate surrogate services included 24-hour access to restrooms.

Highway and Other Public Agencies

Measurable benefits accrued by highway and other public agencies relate exclusively to the potential for direct monetary revenues generated by safety rest area facilities and amenities.

Direct Monetary Benefits

Regardless of the nature of commercial establishment in safety rest areas, a portion of private revenues generally accrue to highway or other public agencies in the form of franchise or lease fees, profit sharing arrangements, and/or participation in the cost of maintaining and operating the safety rest area facility. In Texas, potential sources of revenue include: (1) profit sharing arrangements for the provision of wireless Internet services (WiFi) at safety rest area facilities accrued by TxDOT's Maintenance Division, (2) select commissions from vending machine operations accrued by the Texas Department of Assistive/Rehabilitation Services, Business Enterprises of Texas (DARS/BET) Program to support equipment purchase, and (3) additional sales tax generated from vending machine operations accrued by the Texas Comptroller of Public Accounts. Only select commissions and additional sales tax resulting from vending machine operations are able to be quantified for this investigation.

Under an initial 2004 agreement for the provision of wireless Internet services at safety rest area facilities, the vendor—Coach Connect—was responsible for providing all equipment, installation, operation, and support service costs at no cost to TxDOT. Safety rest area visitors were offered free WiFi access for up to 2 hours; a usage fee was charged if access was required for longer than 2 hours.

Under this model, TxDOT expected 20 percent of the generated revenues to be returned to the state (Wallace et al. 2009). However, very few users elected to purchase additional time. By 2006, statewide usage had increased significantly and Coach Connect could no longer support the system at no cost to TxDOT. Facilitated under an emergency contract, TxDOT opted to purchase the equipment from Coach Connect and began paying them to maintain and operate the WiFi system. In May 2007, Coach Connect was sold to another company but their parent company agreed to continue providing WiFi services while TxDOT prepared a new Request for Proposal (RFP) to assume WiFi services at the state's safety rest area facilities.

In February 2008, a three-year contract was issued to Zoom Information Systems. Under the current agreement, TxDOT is responsible for paying all WiFi service-related costs including but not limited to the provision of broadband to all safety rest area facilities in the state, an 800 service number, and system maintenance and upgrades (these direct monetary costs are included as safety rest area operating costs accrued by TxDOT and described later in this report). TxDOT supports these activities through its maintenance budget and utilizes the equipment TxDOT purchased from Coach Connect. Future plans include the installation of electronic displays and kiosks at safety rest areas, financed through private advertising and sponsorship. Once initial investment is recouped by Zoom Information Systems, they will begin profit sharing with TxDOT.

Given that few users elected to purchase additional time under the initial WiFi services agreement and that profit-sharing under the existing WiFi agreement has yet to begin, TxDOT's direct monetary benefits resulting from the provision of WiFi services at safety rest area facilities statewide are presumed to be negligible and are not considered further in the context of the three demonstration corridors in Texas. However, once profit-sharing resumes under the current WiFi services agreement, these direct monetary benefits should be included in any efforts to characterize broader safety rest area benefits.

Although not able to be comprehensively quantified as part of this investigation, a brief description of the methods, supporting data, and associated assumptions used to estimate safety rest area direct monetary benefits are described below for each of three identified sources of revenue in Texas.

Methods. The following relationship, representing a summation of the three identified sources of revenue in Texas, was used to derive direct monetary revenue benefits along the three demonstration corridors in Texas:

$$\textit{Corridor } DMB_{HA} = \Sigma(\textit{Wireless Internet Services Profit Sharing}_i + \textit{Vending Commissions}_i + \textit{Vending Sales Tax}_i)$$

Where:

- Corridor DMB_{HA} = the corridor-wide direct monetary revenue benefits accrued by highway and other public agencies annually.
- Wireless Internet Services Profit Sharing $_i$ = annual revenue generated through wireless Internet services profit sharing agreements with TxDOT for safety rest area facility i.
- Vending Commissions $_i$ = annual revenue generated to support DARS/BET equipment purchases through vending commissions for safety rest area facility i.
- Vending Sales Tax $_i$ = annual revenue generated through vending sales for safety rest area facility i, estimated as the product of gross vending sales and a sales tax rate of 8.25 percent.

Supporting Data. Data to support determination of direct monetary revenue benefits accrued by highway or other public agencies are often maintained in internal financial recordkeeping systems designed to track both income and expenditures of the agency and directly available from representatives of the beneficiary agency:

- Revenue benefits resulting from the provision of WiFi services at safety rest area facilities statewide can be obtained from TxDOT's Maintenance Division representatives.
- Revenue benefits resulting from vending machine operations, including select commissions and additional sales tax, can be obtained from DARS/BET

representatives. Participating vendors are required to submit sales and commission reports to DARS/BET on a monthly basis.

Assumptions. Because direct monetary benefits accrued by highway or other public agencies are typically directly available, no associated assumptions are required.

External Entities

Estimable benefits accrued by external entities relate to economic development and tourism and specific business enterprises.

Economic Development and Tourism Benefits

The methods, supporting data, and associated assumptions used to estimate safety rest area economic development and tourism benefits along the three demonstration corridors in Texas are described below.

Methods. While both safety rest areas and travel information centers are presumed to provide economic development and tourism benefits in Texas, the quantification of these benefits are limited to the state's travel information centers. Local usage data are available for both safety rest areas and travel information centers in Texas. However, national or aggregate estimates of the associated economic impacts resulting from these facilities are limited to travel information centers that provide specialized information and services intended to encourage tourism within the state.

The estimation of economic development and tourism benefits in Texas is a function of the: (1) number of visitors who decide to extend their stay as a result of information received at the traveler information center, (2) average length of an extended trip, and (3) average per visitor expenditures.

More specifically, the following relationship was used to derive corridor-level economic development and tourism benefits attributable to travel information centers in Texas:

$$\boxed{\textit{Corridor EDTB}_{EE} = \Sigma(\textit{Annual Facility Usage}_i \times \textit{Average Vehicle Occupancy} \times \textit{Visitors Extending Stay} \times \textit{Average Length of Extended Stay} \times \textit{Average Expenditures})}$$

Where:

- Corridor $EDTB_{EE}$= the corridor-wide economic development and tourism benefits accrued annually.
- Annual Facility Usage $_i$ = estimated number of vehicles entering safety rest area facility i annually, derived from vehicle classification counts (2002 and 2009–2010).
- Average Vehicle Occupancy = number of persons per vehicle estimated as 2.1 persons per passenger car (including motorcycle, pickup truck, van, sport utility vehicle, recreational vehicle, and vehicle with pull-behind camper trailer), 1.2 persons per truck (including semi-truck/tractor trailer), and 1.8 persons per vehicle on average (used when vehicle type was unknown), as self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010).
- Visitors Extending Stay = percent of visitors extending their stay as a result of information received at the travel information center, self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010) as 29.3 percent.
- Average Length of Extended Stay = average length of time that visitors extended or planned to extend their stay as a result of information received at the travel information center, self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010) as 2.5 days.
- Average Expenditures = average expenditures per day per visitor for leisure travelers in the state of Texas, estimated as $58.39 per day per visitor.

Supporting Data. To determine economic impacts of Texas travel information centers, TxDOT has historically relied upon data from outside of the state in the absence of local data. For this investigation, data to support estimation of corridor-level economic development and tourism benefits attributable to travel information centers in Texas was obtained from the following sources:

- Annual Facility Usage—Estimated from vehicle classification counts conducted in 2002 (statewide) and 2009–2010 (San Antonio District/U.S. 287, included in Appendix D); vehicle classification counts were adjusted to reflect 2008 traffic volumes based on observed proximate changes in AADT.
- Average Vehicle Occupancy—Self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010).

- Visitors Extending Stay—Self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010) as 29.3 percent and consistent with similar estimates in Florida (25 percent) and Iowa (33 percent).
- Average Length of Extended Stay—Self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010) as 2.5 days and consistent with similar estimates in Colorado (2.4 days).
- Average Expenditures—Estimated as a weighted average using figures of $97.20 per day per visitor for food and lodging and $25.00 per day per visitor for food only as reported in the *Texas 2008 Visitor Profile* prepared for the Office of The Governor, Economic Development and Tourism Division (Eslinger 2008) and the percentage of visitors extending their stay and assumed to need lodging based on vehicle type as self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010).

Assumptions. When estimating the economic development and tourism benefits attributable to travel information centers along the three demonstration corridors in Texas, a fundamental assumption relates to the percentage of visitors extending their stay, as self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010). It is assumed that only a single visitor per travel party completed the survey. If more than one person in the same travel party completed the survey, the estimates presented in Chapter 4 may be inappropriately inflated.

Additional assumptions were required when estimating the average daily expenditures per visitor. As self-reported in the *Safety Rest Areas and Travel Information Centers in Texas* survey (2010), nearly half (48.75 percent) of visitors extending their stay reported traveling in motorcycles, passenger cars, pickup trucks, vans, or sport utility vehicles and were presumed to need overnight lodging (i.e., food and lodging included in extended daily expenditures). Comparatively, 51.25 percent of visitors extending their stay reported traveling in recreational vehicles, vehicles with pull-behind camper trailers, or semi-trucks/tractor trailers that were presumed to offer in-vehicle sleeping accommodations at no additional cost (i.e., only food included in extended daily expenditures). It was also assumed that visitors extending their stay by up to ½ a day did not require lodging.

Specific Business Enterprise Benefits

Discussed previously in relation to direct monetary revenue benefits for highway and other public agencies, select commercial enterprises additionally benefit from safety rest areas. In Texas, wireless Internet services offered at each of the state's travel information centers and safety rest areas has the potential to provide additional revenue for Internet service providers through service contracts with public agencies, usage fees, and/or advertising sales. In addition, the Texas Department of Assistive and Rehabilitation Services, Business Enterprises of Texas (DARS/BET) Program provides opportunities for revenue generation for the associated businesses/individuals with whom they work through vending machine operation at safety rest area facilities under the *Randolph-Sheppard Act*.

Unlike the revenues accrued by public agencies as a result of agreements with commercial establishments, private business enterprises may be reluctant to share information related to revenue generation attributable to safety rest areas. While this information is readily quantified, it may be considered proprietary in competitive sectors of the various private industries. The methods, supporting data, and associated assumptions used to estimate safety rest area specific business enterprise benefits are described below.

Methods. The following relationship, representing a summation of two identified sources of external entity revenue in Texas—potential revenues generated through the provision of wireless Internet services and vending machine operation—was used to derive specific business enterprise benefits along the three demonstration corridors:

$$\text{Corridor } SBEB_{EE} = \Sigma(\text{Wireless Internet Services Revenue}_i + \text{Vending Services Revenue}_i)$$

Where:

- Corridor $SBEB_{EE}$ = the corridor-wide specific business enterprise benefits accrued by external entities annually.
- Wireless Internet Services Revenue $_i$ = annual reported revenue accrued by Zoom Information Systems as a result of WiFi services offered at safety rest area facility i.
- Vending Services Revenue $_i$ = annual reported revenue accrued by various vendors participating in the Texas DARS/BET Program as a result of vending services offered at safety rest area facility i.

Supporting Data. Data to support determination of specific business enterprise benefits accrued by external entities can be obtained directly from the beneficiary:

- For revenue benefits resulting from the provision of WiFi services at safety rest area facilities statewide, data can be obtained from Zoom Information Systems representatives.
- For revenue benefits resulting from safety rest area vending operations, data can be obtained from representatives of the Texas Department of Assistive and Rehabilitation Services, Business Enterprises of Texas Program.

Assumptions. Requests for revenue-related data from Zoom Information Systems were unanswered. As such, researchers estimated benefits resulting from the provision of wireless Internet services at safety rest area facilities statewide using the TxDOT-reported costs for providing these services (described later in this document). These costs do not include any additional revenue accrued by the vendor through subscription, advertising, or other initiatives.

COST COMPONENT ANALYSIS METHODS

Turning attention to component costs, the proposed methods and potential data sources to support determination of the various safety rest area cost components in Texas related to highway user and highway or other public agency costs are summarized in Table 6 and described below.

Again, note that, in order of preference, estimates for the various cost components may be directly measured, estimated based on local data, estimated based on national or other aggregate data, or omitted because of an inability to quantify. Whenever possible, a combination of local and national/aggregate data was used as to improve upon estimates using national/aggregate data in isolation. Cost components determined to be immeasurable or inestimable because of a lack of supporting data—including costs associated with decreased safety, environmental impacts, socially undesirable behavior, and traffic diversion away from communities—are no longer considered.

Table 6. Proposed Analysis Methods and Data Sources for Safety Rest Area Component Costs.

COSTS	PROPOSED METHODS					SUPPORTING DATA	
	Direct Measurement	Estimates Based on Local Data	Estimates Based on National/Aggregate Data	Not Estimable	METHOD	TYPE	SOURCES
Highway Users							
Safety Costs				✓	—	—	—
Highway and Other Public Agencies							
Direct Monetary Costs	✓				Direct measurement	Construction Cost	• TxDOT's cost-related databases: • DCIS—File 121: Project Information • FIMS—Segment 76: Construction and Maintenance Projects • State Highway/Texas Transportation Commission Minute Orders (1951–1999)
						Operations and Maintenance Cost	• TxDOT's cost-related databases: • FIMS— Segment 78: Routine Maintenance • FIMS—Segment 71: Functional Expenditures • TxDOT's wireless Internet services agreement
External Entities							
Environmental Impacts				✓	—	—	—
Socially Undesirable Behavior				✓	—	—	—
Traffic Diversion from Communities				✓	—	—	—

Note that safety costs attributable to additional merging and lane changing near the facility's entrances and exits and a subsequently higher crash potential were initially presumed to be estimable. However, limitations in the extent of crash data before a safety rest area facility were present, combined with recent changes in available data related to the specific location of the crash in relation to the roadway and a presumed low frequency of crashes challenged efforts to quantify potential safety costs attributable to safety rest area facilities. More than half of the facilities considered in this investigation were originally constructed prior to 1978, and an additional 25 percent were originally constructed between 1978 and 1981 limiting the crash experience to only a few years. In addition, the "Road_Part" variable in CRIS has been redefined such that "Entrance & Exit" crashes are no longer identifiable.

Highway and Other Public Agencies

In Texas, safety rest area costs are accrued by a single agency—TxDOT. Measurable costs typically include initial construction-related costs, including right-of-way acquisition and design, and ongoing operations and maintenance of safety rest areas. Direct monetary costs associated with safety rest areas have been observed to vary widely.

Direct Monetary Costs

The methods, supporting data, and associated assumptions used to estimate safety rest area direct monetary costs along the three demonstration corridors in Texas are described below.

Methods. As noted previously, direct monetary costs resulting from the provision of safety rest area facilities include initial construction-related costs amortized over the estimated design life of the facility and annual, ongoing costs related to the operation and maintenance of the facilities. The following relationship was used to derive corridor-level safety rest area direct monetary costs in Texas:

$$\textit{Corridor } DMC_{HA} = \Sigma(\textit{Amortized Construction Costs}_i + \textit{Annual Operating Costs}_i + \textit{Annual Maintenance Costs}_i)$$

Where:

- Corridor DMC_{HA} = corridor-wide direct monetary cost accrued by TxDOT.

- Amortized Construction Costs $_i$ = estimated right-of-way acquisition, design, and construction costs for safety rest area facility i, amortized (straight-line) over a 50-year facility design life.
- Annual Operations Costs $_i$ = estimated annual operating costs for safety rest area facility i, averaged over the time period for which data are available (variable by facility depending on original construction date).
- Annual Maintenance Costs $_i$ = estimated annual maintenance costs for safety rest area facility i, averaged over the time period for which data are available (variable by facility depending on original construction date).

Note that the availability and accessibility of cost data varied based on the age of the safety rest area facilities. For newer safety rest area facilities constructed after 1999, data to support determination of construction-related, operating, and maintenance costs was generally readily available in electronic format from various financial and activity-based databases maintained by TxDOT (described under Supporting Data below). For facilities constructed prior to 1999, the identification and assimilation of particularly construction-related data required additional effort.

To estimate construction costs for older safety rest area facilities, researchers originally planned to utilize as-built plans to derive construction cost estimates using quantity plan sheets and corresponding unit costs. Though as-built plans and quantity plan sheets existed for older safety rest areas, these sheets did not provide enough detail to derive construction cost estimates.

Instead, researchers reviewed the minutes of the State Highway and Texas Transportation Commission meetings from 1951 to 1999 to identify applicable safety rest area facilities and associated construction costs. The meeting minutes document Commission actions on the Minute Orders reviewed during the meeting. Minute Orders can include authorization to proceed with construction of a facility at an estimated cost, contract award approval at an accepted vendor bid, and contract award cancellation and re-advertisement of the contract.

Researchers searched Commission meeting minutes for Minute Orders involving safety rest area facilities (including travel information centers) using key words such as "comfort station," "rest area," and "travel information." For each facility, researchers then assimilated pertinent data related to the nature of work and cost.

Supporting Data. For recently developed (since 1999) safety rest areas in Texas, cost information is generally well-documented at the detailed project or program level, and needed only to be assimilated to support this investigation. TxDOT's various cost-related electronic information systems (detailed in Appendix B) served as the primary source for direct cost data related to initial construction and ongoing operations and maintenance of safety rest areas in Texas. The project Control Section Job (CSJ) number was used to relate data from these various systems. For older safety rest areas (i.e., constructed in the 1960s and 1970s), cost data are less readily available. Supporting data to determine direct monetary costs resulting from the provision of safety rest area facilities are described below, categorized as construction and operating and maintenance costs.

Construction Costs. For newer safety rest area facilities (constructed after 1999), two primary databases supported estimation of construction-related costs: the Design and Construction Information System (DCIS) and the Financial Information Management System (FIMS).

The DCIS is used by TxDOT to track safety rest area projects during the planning and design phases of the project development process. DCIS provides project identification and evaluation data, project planning and finance data, project estimate data, and contract summary data (Files 121 through 124). Record completeness varies by district and project engineer. DCIS provides a high-level view of project data and does not include project scheduling, task status, document tracking, or project accounting functions. Researchers searched the DCIS File 121 Project Information for records using keywords such as "rest area" and "safety rest area." Researchers then filtered the results by CSJ and county to obtain project cost data for the facilities of interest in this investigation.

The FIMS, managed by TxDOT's Finance Division, is the accounting information system for TxDOT. Access to FIMS is highly restricted but data are available through special request. The FIMS contains financial information for current safety rest area projects in the planning, design, and construction phases, as well as historic data for safety rest areas that have been completed. Within FIMS, Segment 76: Construction and Maintenance Projects includes data for highway construction and other projects managed using TxDOT's construction program procedures. Highway construction projects include preliminary engineering construction, construction engineering, right of way, and beautification. Maintenance jobs contracted through the letting process are also included. Associated costs can originate from outside contractors or state forces and are coded in terms of CSJ numbers, function codes, and expenditure object codes. By combining the DCIS File 121 Project Information data with the FIMS Segment 76 data, researchers were able to identify additional records related to safety rest area construction.

For safety rest areas constructed prior to 1999, researchers extrapolated supporting data from State Highway and Texas Transportation Commission meeting minutes from 1951 to 1999 to identify applicable safety rest area facilities and associated construction costs. As noted previously, the meeting minutes document Commission actions on the Minute Orders reviewed during the meeting. Minute Orders can include authorization to proceed with construction of a facility at an estimated cost, contract award approval at an accepted vendor bid, and contract award cancellation and re-advertisement of the contract.

Operating and Maintenance Costs. Similar to construction costs, data to support determination of safety rest area operating and maintenance costs are more readily available from 1999 to present. The FIMS was the primary database supporting estimation of safety rest area operating and maintenance costs for this investigation. Specifically, within FIMS, Segment 78: Routine Maintenance provided costs for safety rest areas, while Segment 71: Functional Expenditures provided general and administrative costs for travel information centers.

In Segment 78: Routine Maintenance, routine maintenance expenditures are characterized by segment, district, maintenance section, county, highway number, function code, expenditure object code, date, voucher type, voucher number, invoice description, man hours, and amount from 1999 to 2009. Relevant function and expenditure codes for safety rest areas include:

- Rest Area Facility Maintenance (532).
- Rest Area Facility Maintenance through Regional Contracts (533).
- Budget Object 1001: Salaries and Wages.
- Budget Object 1002: Longevity.
- Budget Object 2001: Temporary Personnel.

Note that Segment 78: Routine Maintenance identifies the county and highway for which an expenditure was intended but does not identify a particular safety rest area facility by name. Researchers did not include cost data related to Maintenance of Specialty Facilities (535) or 531 Picnic Area Maintenance (531).

For travel information centers, Segment 71: Functional Expenditures contains attributes for segment, district, CSJ, function code, expenditure object code, date, voucher type, voucher number, invoice description, man hours, and amount for 1999 to 2009. Relevant expenditure codes for travel information centers include:

- Budget Object 1001: Salaries and wages.
- Budget Object 1002: Longevity.
- Budget Object 2001: Temporary personnel.

An additional operating cost that applies to both safety rest area facilities and travel information centers relates to the provision of wireless Internet services at all facilities statewide. TxDOT's Maintenance Division reports these monthly costs to be $29,100 per month. Under the current agreement with Zoom Information Systems, TxDOT is responsible for paying all WiFi service related costs including but not limited to the provision of broadband to all safety rest area facilities in the state, an 800 service number, and system maintenance and upgrades. These monthly costs were assumed to be distributed equally across all safety rest area facilities in the state (80 safety rest areas and 12 travel information centers).

Assumptions. At sites where older safety rest areas were replaced by new facilities, researchers assumed that the older facilities had met or exceeded their service life and as such, considered only direct construction, operations, and maintenance costs for the new facility.

Additional assumptions relate to the determination of initial construction costs for facilities constructed prior to 1999 using State Highway and Texas Transportation Commission meeting minutes and associated Minute Orders from 1951 to 1999. In some instances, the data obtained from the Minute Orders could not be included directly without additional consideration. For example, one would expect to see an initial authorization to proceed with construction of a safety rest area facility at an estimated cost followed by a contract award approval at an accepted vendor bid in a series of Minute Orders. For select facilities, a contract award approval at an accepted vendor bid may be recorded with no preliminary authorization to proceed. Conversely, a preliminary authorization to proceed may be recorded with no subsequent record of a contract award for select facilities. Researchers reviewed these data on a case by case basis to determine which of these construction-related costs were appropriate to include.

In select instances, the costs reported in the Minute Orders included construction of more than one safety rest area facility. Lacking sufficient detail in the data to distinguish per facility construction costs, total construction costs were assumed to be distributed equally across all of the involved safety rest area facilities. Similarly, costs attributable to the construction of safety rest area entry and exit ramps were often included in the broader construction of mainline highways. In these instances, researchers estimated the proportion of costs attributable to the construction of safety rest area entry and exit ramps based on highway and ramp lengths.

COMPREHENSIVE BENEFIT-COST ANALYSIS METHOD

After developing methods to characterize each of the measurable benefit and cost components attributable to safety rest areas, a reliable and acceptable method for comparing safety rest area benefits with costs was required. Benefit-cost ratios (BCR) provide a commonly used and understood method for expressing this relationship. Benefit-cost ratios can be estimated using the following relationship:

$$BCR = \sum_{r=1}^{r} \frac{B_t}{(1+r)^t} \Bigg/ \sum_{r=1}^{r} \frac{C_t}{(1+r)^t}$$

where B_t is the benefit in time t, C_t is the cost in time t, and r is the discount rate that allows for adjustments in monetary worth over time.

Using this fundamental relationship and based upon the available supporting data for Texas, researchers estimated benefit-cost ratios for each of the three demonstration corridors of interest using the following relationship:

$$\boxed{BCR = \frac{SB_{HU} + CCB_{HU} + ETDB_{HU} + DMB_{HA} + EDTB_{EE} + SBEB_{EE}}{DMC_{HA}}}$$

Where:

- SB_{HU} = the safety benefit accrued by highway users.
- CCB_{HU} = the comfort and convenience benefit accrued by highway users.
- $ETDB_{HU}$ = the excess travel and diversion benefit accrued by highway users.
- DMB_{HA} = the direct monetary benefit accrued by highway or other public agencies.
- $EDTB_{EE}$ = the economic development/tourism benefits accrued by external entities.
- $SBEB_{EE}$ = the specific business enterprise benefits accrued by external entities.
- DMC_{HA} = the direct monetary cost accrued by highway or other public agencies.

All component benefits and costs are expressed in 2008 dollars for consistency in comparison.

CHAPTER 4: SAFETY REST AREA BENEFIT-COST ESTIMATES FOR SELECT DEMONSTRATION CORRIDORS IN TEXAS

To prove the application of the safety rest area benefit-cost analysis methodology described in Chapter 3, three corridors in Texas were identified as possible demonstration sites:

- U.S. 287 Corridor-between Ft. Worth and Amarillo (approximately 341 miles).
- IH 45 Corridor-between Houston and Dallas (approximately 240 miles).
- IH 10 Corridor-between San Antonio and Anthony (approximately 574 miles).

Figure 2 shows the location of these corridors in yellow.

For each of these three corridors, researchers assimilated specific data elements that support determination of both benefits and cost from available data sources and analyzed these data using the methodology described in Chapter 3. The resulting benefit-cost estimates for select safety rest areas in Texas are presented here.

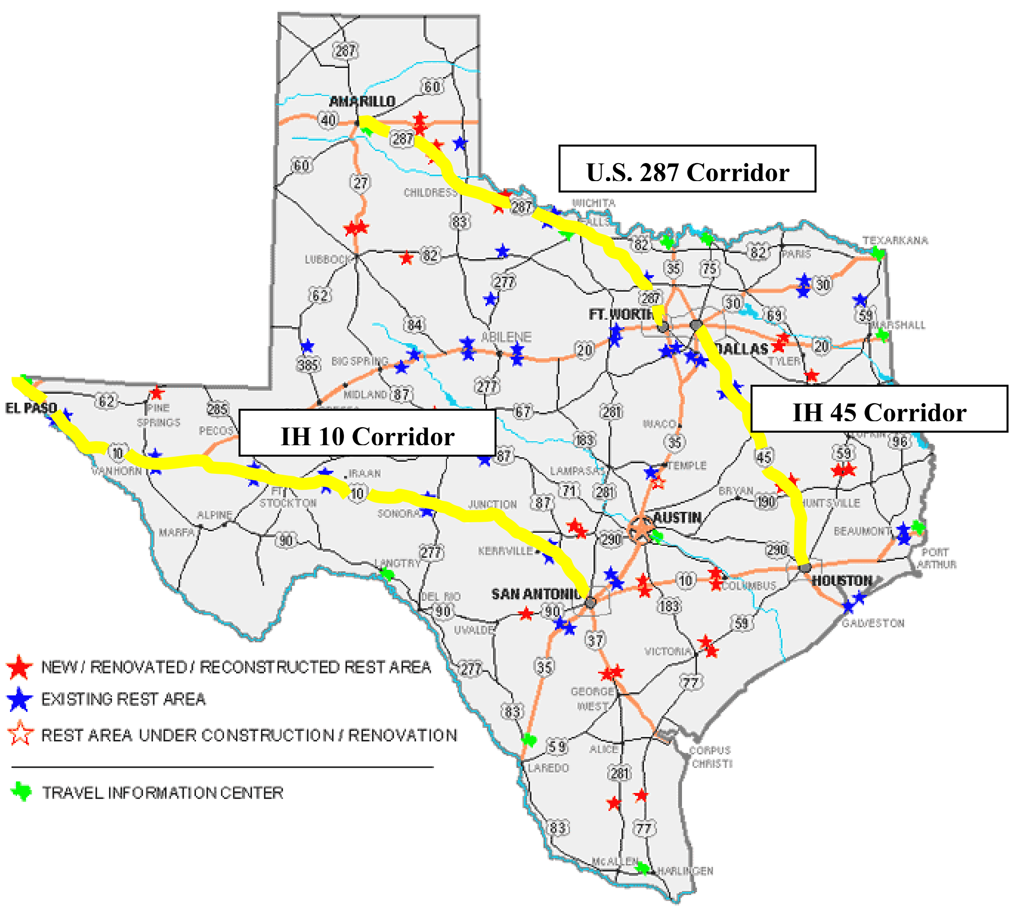


Figure 2. Demonstration Corridor Locations.

DEMONSTRATION CORRIDORS

Demonstration corridors were selected to reflect a range of potential operating conditions in an effort to frame minimum and maximum estimated benefits attributable to safety rest areas and to demonstrate the full breadth of methodology application, including any limitations. More specifically, researchers considered factors such as the crash analysis suitability, the age and amenities of safety rest areas, the presence or absence of travel information centers, the availability of surrogate services, and average traffic volumes along each route.

A general description of the selected demonstration corridors follows. Recall that three general classes of safety rest area facilities were defined to support this investigation: (1) safety rest areas offering basic services, (2) safety rest areas offering extended services, and (3) travel information centers offering specialized services. Researchers describe important advantages and disadvantages of each site with respect to this investigation.

U.S. 287 between Ft. Worth and Amarillo

Table 7 identifies safety rest area facilities available along the U.S. 287 corridor between Ft. Worth and Amarillo. The predominantly rural U.S. 287 corridor between Ft. Worth and Amarillo (approximately 341 miles) has comparatively low traffic volumes yet offers:

- Newer safety rest area facilities—the Hardeman and Donley County safety rest area facilities (northbound and southbound) were newly constructed in 2002 and 2003, respectively.
- Travel information centers at two locations proximate to this corridor—travel information centers, serving the same basic functions as a safety rest area with the additional provision of traveler-related services, are located outside of Wichita Falls and Amarillo.

Alternative convenient stopping points for travelers along this route are limited and are primarily concentrated near Wichita Falls and Amarillo.

IH 45 between Houston and Dallas

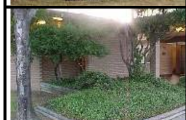
Table 8 identifies safety rest area facilities available along the IH 45 corridor between Houston and Dallas. The IH 45 corridor, connecting the two major urban centers of Dallas and Houston (approximately 240 miles), offers a mix of both newer and older safety rest areas facilities along the route—the Walker County safety rest area facility was reconstructed in 2007 while the Navarro County facility is an older style safety rest area that has not been reconstructed. No travel information centers are present along this corridor.

Surrogate services are evident along this route, primarily concentrated outside of each of the urban centers but available along the length of the corridor as well. And, not surprising given its proximity to two major urban centers, traffic volumes along this corridor are high—annual daily traffic along this corridor, as estimated in 2008, averages 34,000 vehicles per day.

Table 7. Safety Rest Area Facilities along the U.S. 287 Corridor between Ft. Worth and Amarillo.

FACILITY		LOCATION			DATE OPENED	FACILITY TYPE		
						SRA		TIC
		Proximity	Milepost	Control Section		Basic Services	Extended Services	
	Wise County NB	2 miles north of Decatur	47	001307	1970	✓		
	Wichita TIC	IH 44/ U.S. 287/281/277	1	004309	1988			✓
			1	004309	1996			
	Wichita County NB	West of Iowa Park	304	004308	1974	✓		
	Wichita County SB	West of Iowa Park	304	004308	1974	✓		
	Hardeman County NB	East of Quanah	245	004304	2002		✓	
	Hardeman County SB	East of Quanah	245	004304	2002		✓	
	Donley County NB	4 miles east of Hedley	172	004208	2003		✓	
	Donley County SB	4 miles east of Hedley	172	004208	2003		✓	
	Amarillo TIC	East IH 40	75	027501	1969			✓
			76	027501	2003			

Table 8. Safety Rest Area Facilities along the IH 45 Corridor between Houston and Dallas.

FACILITY		LOCATION			DATE OPENED	FACILITY TYPE		
						SRA		TIC
		Proximity	Milepost	Control Section		Basic Services	Extended Services	
	Navarro County NB	South of Corsicana	217	016601	1976	✓		
	Navarro County SB	South of Corsicana	217	016601	1976	✓		
	Walker County NB	North of Huntsville	124	067506	1973 2007		✓	
	Walker County SB	North of Huntsville	125	067506	1973 2007		✓	

IH 10 between San Antonio and Anthony

Table 9 identifies safety rest area facilities available along the IH 10 corridor between San Antonio and Anthony. The IH 10 corridor between San Antonio and Anthony (approximately 574 miles) offers only older safety rest area facilities along the route—none of the 12 safety rest areas (six eastbound and westbound pairs) along this corridor have been newly constructed or reconstructed. A single travel information center exists at the terminus of this corridor—northwest of El Paso in Anthony.

Similar to the IH 45 corridor, surrogate services are evident along this route, primarily concentrated outside of each of the urban centers (San Antonio and El Paso) but available along much of the length of the corridor as well. Traffic volumes along this corridor are comparatively low—annual daily traffic along this corridor, as estimated in 2008, averages between 11,000 and 13,400 vehicles per day near each of the urban centers (San Antonio and El Paso, respectively) but diminishes to 3,700 vehicles per day throughout much of the remaining corridor.

Table 9. Safety Rest Area Facilities along the IH 10 Corridor between San Antonio and Anthony.

FACILITY		LOCATION: Proximity	LOCATION: Milepost	LOCATION: Control Section	DATE OPENED	FACILITY TYPE: SRA: Basic Services	FACILITY TYPE: SRA: Extended Services	FACILITY TYPE: TIC
	Kerr County EB	North of Comfort	514	014214	1980	✓		
	Kerr County WB	North of Comfort	514	014214	1980	✓		
	Sutton County EB	West of Sonora	394	014103	1981	✓		
	Sutton County WB	West of Sonora	394	014103	1981	✓		
	Pecos East County EB	23 miles west of Sheffield	309	014004	1981	✓		
	Pecos East County WB	23 miles west of Sheffield	310	014005	1981	✓		
	Pecos West County EB	26 miles west of Ft. Stockton	233	044107	1968	✓		
	Pecos West County WB	26 miles west of Ft. Stockton	233	044107	1968	✓		
	Culberson County EB	4 miles east of Van Horn	145	000301	1976	✓		
	Culberson County WB	4 miles east of Van Horn	145	000301	1976	✓		
	El Paso County EB	East of Fabens	50	212105	1967	✓		
	El Paso County WB	East of Fabens	51	212105	1967	✓		
	Anthony TIC	Northwest of El Paso	0	212101	1979			✓
			1	212101	2000			

ESTIMATED HIGHWAY USER BENEFITS

Using the methods described in Chapter 3, highway user benefits attributable to safety rest areas and related to enhanced safety, improved comfort and convenience, and reduced excess travel are estimated below for each of the three demonstration corridors in Texas.

Safety Benefits

To estimate safety benefits accrued by highway users and attributable to safety rest areas, researchers performed before-after analyses to detect a change in total casualty rate, as described previously in Chapter 3. Table 10 summarizes the results of these analyses. Recall that safety benefits were considered along the entire length of the demonstration corridors rather than site-by-site to account for the unknown sphere of influence attributable to safety rest areas.

The specified before and after analysis periods represent the only timeframes for which a significant change (e.g., new construction or renovation) to one or more safety rest areas occurred, and adequate casualty data were available before and after that change. Thus, despite the extended period for which casualty data were available (1978–2009), evaluation of corridor safety benefits was limited by the relatively infrequent construction/renovation of facilities.

Along the U.S. 287 corridor, safety benefits were calculable for five years before and after renovation of the Amarillo Travel Information Center. The facility re-opened in January 2003. The direct comparison of casualty rates before and after 2003 indicates a 29 percent reduction in casualties along this corridor.

Table 10. Safety Benefits—U.S. 287, IH 45, and IH 10 Corridors.

CORRIDOR	ANALYSIS PERIOD		CASUALTY COSTS	STATEWIDE CORRECTION FACTOR	CASUALTY REDUCTION FACTOR		TOTAL 2008 SAFETY BENEFIT[1]
			Avg. Annual $/VMT		Unadjusted	Adjusted	SB_{HU}
U.S. 287	Before	1997–2001	$0.029	69.3%	29.3%	9.0%	$1,200,000
	After	2003–2007	$0.021				
IH 45	Before	2005–2006	$0.026	15.8%	39.5%	33.2%	$23,000,000[2]
	After	2008–2009	$0.016				
North Segment	Before	2005–2006	$0.026	NA	49.8%	NA	NA
	After	2008–2009	$0.013				
South Segment	Before	2005–2006	$0.026	NA	36.6%	NA	NA
	After	2008–2009	$0.017				
IH 10	Before	1995–1999	$0.046	47.3%	28.0%	14.8%	$3,500,000
	After	2000–2005	$0.033				

[1] *All cost estimates have been rounded consistent with the recommendations of the National Safety Council (2008).*
[2] *Supporting data may be suspect.*

Because this observed casualty reduction is likely attributable to other factors in addition to the changes occurring at the Amarillo Travel Information Center, researchers reduced the 29 percent unadjusted casualty reduction factor by 69 percent using a statewide correction factor for all Texas and U.S. highways of the same classification that also realized significant casualty reductions unattributable to systematic changes in safety rest area facilities.

Application of the statewide correction factor to this corridor reduces the estimated casualty reduction factor to 9 percent. Expressed in monetary terms, a 9 percent reduction in casualty rates translates to an average annual safety benefit of $1.2 million or the approximate cost equivalent of one less fatality per year.

Researchers performed a similar analysis along the IH 10 corridor. The Anthony Travel Information Center was re-opened in January 2000 following a major renovation. Safety benefits were calculable for five years before and after this renovation. The direct comparison of casualty rates before and after 2000 indicates a 28 percent reduction in casualties along this corridor. Again, to account for significant casualty reductions unattributable to systematic changes in safety rest area facilities, the 28 percent unadjusted casualty reduction factor was reduced by 47.3 percent using a statewide correction factor for all rural Interstate highways.

Adjusted using the statewide correction factor and expressed in monetary terms, a 14.8 percent reduction in casualty rates translates to an average annual safety benefit of $3.5 million or the approximate cost equivalent of two to three less fatalities per year.

Along the IH 45 corridor, a significantly higher safety benefit was estimated. The Walker County safety rest area was re-opened in 2007 following a major renovation. Safety benefits were calculable for only two years before and after this renovation. The direct comparison of casualty rates before and after 2007 indicates a 39.5 percent reduction in casualties along this corridor. The 39.5 percent unadjusted casualty reduction factor was reduced by 15.8 percent using a statewide correction factor but still suggested a greater than 33 percent reduction in casualties and an associated $23 million annual safety benefit.

Researchers caution against placing too great an emphasis on this finding. While no major errors or omissions were discovered, it is conceivable that the casualty data, or more likely the traffic volume data, used in developing the casualty reduction factors and especially the statewide correction factor were in some way incorrect or incomplete. Most suspect are the data for calendar year 2009. Crash data for 2009 are still subject to change. In addition, official 2009

AADTs were not yet available at the time of this investigation. Instead, the AADTs and VMTs used in developing the statewide correction factor are estimates based on prior years.

Comparison of the statewide correction factors derived for each of the two Interstate corridors further suggests the suspect nature of this data. For the IH 10 corridor, the use of five years of before and after data not including 2009 resulted in an estimated statewide correction factor of 47.3 percent. Comparatively, use of only two years of before and after data including 2009 resulted in an estimated statewide correction factor of 15.8 percent along IH 45.

To further investigate the potential of suspect data, researchers conducted an additional analysis for the IH 45 corridor. This corridor—with distinctly different safety rest area characteristics in the northern and southern segments but similar traffic and roadway characteristics along its length—provided an opportunity to identify a case and quasi-control section for comparison. Splitting the corridor roughly in half—with 10 control sections in the four northern-most counties and 10 control sections in the five southern-most counties—unadjusted casualty reduction factors can be calculated independently for the north and south segments. Note that the renovated Walker County safety rest area is located in the south segment of this corridor.

Contrary to expectations, a higher reduction in casualties was estimated when no significant changes to safety rest area facilities occurred. The unadjusted casualty reduction factor for the north segment of IH 45—in which there was no significant safety rest area changes in either the before or after period—was estimated to be 49.8 percent. The unadjusted casualty reduction factor for the south segment of IH 45—in which the Walker County safety rest area renovation occurred—was estimated to be considerably lower at 36.6 percent.

Comparisons across the three demonstration corridors indicate that relatively modest safety benefits may have accrued along the U.S. 287 and IH 10 corridors equivalent to $1.2 million and $3.5 million, respectively. In both cases, these benefits appear to have resulted from the significant renovation of travel information centers along the route.

A more substantial safety benefit was estimated for the IH 45 corridor, along which a basic services safety rest area facility was renovated/replaced with an extended services facility. As discussed above, however, there is reason to believe that the magnitude of safety benefit estimated along the IH 45 corridor is overestimated.

Comfort and Convenience Benefits

Using the methods described in Chapter 3, researchers estimated highway user comfort and convenience benefits attributable to safety rest areas based on the products, services, and amenities that safety rest area visitors use and associated external market values attached to those same products. The results of this analysis are presented in Tables 11, 12, and 13 for the U.S. 287, IH 45, and IH 10 demonstration corridors, respectively.

Table 11. Comfort and Convenience Benefits—U.S. 287 Corridor.

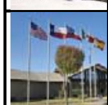
FACILITY		FACILITY TYPE: SRA			PER VISITOR COMFORT/ CONVENIENCE BENEFIT	2008 FACILITY USAGE		2008 VISITORS			TOTAL 2008 COMFORT/ CONVENIENCE BENEFIT
		Basic Services	Extended Services	TIC		Cars	Trucks	Cars (2.1 pers)	Trucks (1.2 pers)	Total	CCB_{HU}
	Wise County NB	✓			$2.77	81,395	32,120	170,930	38,544	209,474	$580,242
	Wichita TIC			✓	$4.21	119,355	6,570	250,646	7,884	258,530	$1,088,409
	Wichita County NB	✓			$2.77	68,985	47,085	144,869	56,502	201,371	$557,796
	Wichita County SB	✓			$2.77	54,750	41,245	114,975	49,494	164,469	$455,579
	Hardeman County NB		✓		$3.14	105,120	55,480	220,752	66,576	287,328	$902,210
	Hardeman County SB		✓		$3.14	135,050	55,480	283,605	66,576	350,181	$1,099,568
	Donley County NB		✓		$3.14	106,580	52,560	223,818	63,072	286,890	$900,835
	Donley County SB		✓		$3.14	77,015	47,085	161,732	56,502	218,234	$685,253
	Amarillo TIC			✓	$4.21	63,510	39,055	133,371	46,866	180,237	$758,798
CORRIDOR TOTAL						**811,760**	**376,680**	**1,704,696**	**452,016**	**2,156,712**	**$7,028,690**

Table 12. Comfort and Convenience Benefits—IH 45 Corridor.

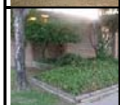
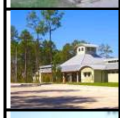
FACILITY		FACILITY TYPE: SRA: Basic Services	FACILITY TYPE: SRA: Extended Services	FACILITY TYPE: TIC	PER VISITOR COMFORT/ CONVENIENCE BENEFIT	2008 FACILITY USAGE	2008 VISITORS (1.8 persons/vehicle)	TOTAL 2008 COMFORT/ CONVENIENCE BENEFIT CCB$_{HU}$
	Navarro County NB	✓			$2.77	334,340	601,812	$1,667,019
	Navarro County SB	✓			$2.77	327,405	589,329	$1,632,441
	Walker County NB		✓		$3.14	304,045	547,281	$1,718,462
	Walker County SB		✓		$3.14	429,605	773,289	$2,428,127
					CORRIDOR TOTAL	1,395,395	2,511,711	$7,466,050

Table 13. Comfort and Convenience Benefits—IH 10 Corridor.

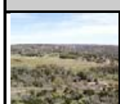
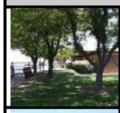
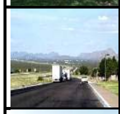
FACILITY		FACILITY TYPE: SRA: Basic Services	FACILITY TYPE: SRA: Extended Services	FACILITY TYPE: TIC	PER VISITOR COMFORT/ CONVENIENCE BENEFIT	2008 FACILITY USAGE	2008 VISITORS (1.8 persons/vehicle)	TOTAL 2008 COMFORT/ CONVENIENCE BENEFIT CCB$_{HU}$
	Kerr County EB	✓			$2.77	225,570	406,026	$624,829
	Kerr County WB	✓			$2.77	228,125	410,625	$631,906
	Sutton County EB	✓			$2.77	177,390	319,302	$491,370
	Sutton County WB	✓			$2.77	175,565	316,017	$486,315
	Pecos East County EB	✓			$2.77	148,920	268,056	$412,508
	Pecos East County WB	✓			$2.77	170,090	306,162	$471,149
	Pecos West County EB	✓			$2.77	156,220	281,196	$432,729

Table 13. Comfort and Convenience Benefits—IH 10 Corridor (Continued).

FACILITY		FACILITY TYPE: SRA Basic Services	FACILITY TYPE: SRA Extended Services	FACILITY TYPE: TIC	PER VISITOR COMFORT/ CONVENIENCE BENEFIT	2008 FACILITY USAGE	2008 VISITORS (1.8 persons/vehicle)	TOTAL 2008 COMFORT/ CONVENIENCE BENEFIT CCB_{HU}
	Pecos West County WB	✓			$2.77	110,595	199,071	$306,348
	Culberson County EB	✓			$2.77	254,405	457,929	$704,702
	Culberson County WB	✓			$2.77	240,900	433,620	$667,293
	El Paso County EB	✓			$2.77	330,325	594,585	$915,000
	El Paso County WB	✓			$2.77	362,810	653,058	$1,004,984
	Anthony TIC			✓	$4.21	223,745	402,741	$941,966
					CORRIDOR TOTAL	2,804,660	5,048,388	$8,091,101

Along the U.S. 287 corridor, estimated annual comfort and convenience benefits range from $455,579 to $1,099,568 at the Wichita County southbound and Hardeman County southbound safety rest areas, respectively. The magnitude of these estimates is largely determined by facility usage and, to a lesser extent, the amenities offered at each site. Note that with few exceptions, annual comfort and convenience benefits and visitation increase concurrently. The Wichita and Amarillo Travel Information Centers provide two exceptions—a higher estimated per visitor comfort and convenience benefit of $4.21 results in higher total comfort and convenience benefits than safety rest areas with comparable or higher facility usage.

Total annual comfort and convenience benefits along this corridor are estimated to be in excess of $7.0 million across nine facilities, or $780,966 per facility on average. Estimated annual comfort and convenience benefits along the IH 45 corridor are higher, ranging from $1,632,441 to $2,428,127 at the Navarro County southbound and Walker County southbound safety rest areas, respectively. Higher traffic volumes and subsequent facility usage along this route help to explain the high magnitude of these benefits. Although the Navarro County safety rest areas offer only basic services (valued at $2.77 per visitor), annual visitation of approximately 600,000 results in sizable estimated comfort and convenience benefits. Total annual comfort and convenience benefits along this corridor are estimated to be nearly $7.5 million across four facilities, or $1,866,513 per facility on average.

Along the IH 10 corridor, estimated annual comfort and convenience benefits range from $306,348 to $1,004,984 at the Pecos West County southbound and Hardeman County southbound safety rest areas, respectively. Again, with few exceptions, the magnitude of annual comfort and convenience benefits and visitation increase concurrently. The Anthony Travel Information Center provides an exception—a higher estimated per visitor comfort and convenience benefit of $4.21 results in higher total comfort and convenience benefits than safety rest areas with comparable or higher facility usage. Total annual comfort and convenience benefits along this corridor are estimated to be in excess of $8.0 million across 13 facilities, or $622,392 per facility on average.

Excess Travel and Diversion Benefits

Using the methods described in Chapter 3, estimated excess travel and diversion benefits accrued by highway users are presented in Tables 14, 15, and 16 for the U.S. 287, IH 45, and IH 10 demonstration corridors, respectively. Excess travel and diversion benefits were defined as the arithmetic difference between the distance traveled if drivers must leave the mainline route to access surrogate services and the reduced distance traveled if safety rest areas could meet the required service needs along the mainline route.

Along the U.S. 287 corridor, estimated annual excess travel and diversion benefits range from $10,742 to $57,024 at the Wichita County southbound safety rest area and the Amarillo Travel Information Center, respectively. The magnitude of these estimates is largely determined by the distance motorists must travel (one-way mileage) to access surrogate services and/or the level of safety rest area facility usage.

For example, the Wichita County southbound safety rest area experiences the lowest levels of facility use (95,995 vehicles per year in 2008) along this corridor and is located within 0.1 miles of comparable alternate services. As such, estimated annual excess travel and diversion benefits are relatively low.

Table 14. Excess Travel and Diversion Benefits—U.S. 287 Corridor.

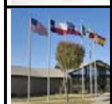
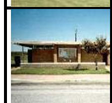
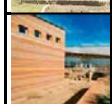
FACILITY	NEAREST SURROGATE SERVICE		2008 FACILITY USAGE		DIVERSION				VEHICLE OPERATING COSTS		TRAVEL TIME				TOTAL 2008 EXCESS TRAVEL/ DIVERSION BENEFIT
					Percent (43%)		Roundtrip Mileage				Time (hrs@30 mph)		Cost		
	Type	One-Way Mileage	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars ($0.23/mi)	Trucks ($0.59/mi)	Cars	Trucks	Cars ($29.87/veh)	Trucks ($24.38/veh)	$ETDB_{EE}$
 Wise County NB	Walmart	0.2	81,395	32,120	35,000	13,812	14,000	5,525	$3,220	$3,260	467	184	$13,949	$4,486	$24,915
 Wichita TIC	Walmart	0.1	119,355	6,570	51,323	2,825	10,265	565	$2,361	$333	342	19	$10,216	$463	$13,373
 Wichita County NB	Walmart	0.1	68,985	47,085	29,664	20,247	5,933	4,049	$1,365	$2,389	198	135	$5,914	$3,291	$12,959
 Wichita County SB	Walmart	0.1	54,750	41,245	23,543	17,735	4,709	3,547	$1,083	$2,093	157	118	$4,690	$2,877	$10,742
 Hardeman County NB	Allsup's Convenience Store	0.1	105,120	55,480	45,202	23,856	9,040	4,771	$2,079	$2,815	301	159	$8,991	$3,876	$17,761
 Hardeman County SB	Allsup's Convenience Store	0.2	135,050	55,480	58,072	23,856	23,229	9,543	$5,343	$5,630	774	318	$23,119	$7,753	$41,845
 Donley County NB	Allsup's Convenience Store	0.1	106,580	52,560	45,829	22,601	9,166	4,520	$2,108	$2,667	306	151	$9,140	$3,681	$17,597
 Donley County SB	Allsup's Convenience Store	0.1	77,015	47,085	33,116	20,247	6,623	4,049	$1,523	$2,389	221	135	$6,601	$3,291	$13,805
 Amarillo TIC	McDonalds	0.5	63,510	39,055	27,309	16,794	27,309	16,794	$6,281	$9,908	910	560	$27,182	$13,653	$57,024
	CORRIDOR TOTAL		**811,760**	**376,680**	**349,058**	**161,973**	**110,274**	**53,363**	**$25,363**	**$31,484**	**3,676**	**1,779**	**$109,802**	**$43,372**	**$210,021**

Table 15. Excess Travel and Diversion Benefits—IH 45 Corridor.

FACILITY		NEAREST SURROGATE SERVICE		2008 FACILITY USAGE	DIVERSION		VEHICLE OPERATING COSTS ($0.37/mi)	TRAVEL TIME		TOTAL 2008 EXCESS TRAVEL/ DIVERSION BENEFIT
		Type	One-Way Mileage		Percent (43%)	Roundtrip Mileage		Time (hrs@30 mph)	Cost ($25.60/hr)	$ETDB_{EE}$
	Navarro County NB	Walmart Supercenter	4.9	334,340	143,766	1,408,909	$521,296	46,964	$1,202,278	$1,723,575
	Navarro County SB	Walmart Supercenter	4.9	327,405	140,784	1,379,685	$510,483	45,989	$1,177,318	$1,687,802
	Walker County NB	Pilot Travel Center	2	304,045	130,739	522,957	$193,494	17,432	$446,259	$639,753
	Walker County SB	Pilot Travel Center	2.3	429,605	184,730	849,759	$314,411	28,325	$725,120	$1,039,531
		CORRIDOR TOTAL		**1,395,395**	**600,019**	**4,161,310**	**$1,539,685**	**138,710**	**$3,550,976**	**$5,090,661**

Table 16. Excess Travel and Diversion Benefits—IH 10 Corridor.

FACILITY		NEAREST SURROGATE SERVICE		2008 FACILITY USAGE	DIVERSION		VEHICLE OPERATING COSTS ($0.37/mi)	TRAVEL TIME		TOTAL 2008 EXCESS TRAVEL/ DIVERSION BENEFIT
		Type	One-Way Mileage		Percent (43%)	Roundtrip Mileage		Time (hrs@30 mph)	Cost ($25.60/hr)	$ETDB_{EE}$
	Kerr County EB	Shell Gas Station	0.9	225,570	96,995	174,591	$64,599	5,820	$148,992	$213,591
	Kerr County WB	Shell Gas Station	0.9	228,125	98,094	176,569	$65,331	5,886	$150,682	$216,012
	Sutton County EB	Town & Country Food Store	1.2	177,390	76,278	183,066	$67,734	6,102	$156,211	$223,946

Table 16. Excess Travel and Diversion Benefits—IH 10 Corridor (Continued).

FACILITY		NEAREST SURROGATE SERVICE		2008 FACILITY USAGE	DIVERSION		VEHICLE OPERATING COSTS ($0.37/mi)	TRAVEL TIME		TOTAL 2008 EXCESS TRAVEL/ DIVERSION BENEFIT
		Type	One-Way Mileage		Percent (43%)	Roundtrip Mileage		Time (hrs@30 mph)	Cost ($25.60/hr)	$ETDB_{EE}$
	Sutton County WB	Town & Country Food Store	1.2	175,565	75,493	181,183	$67,038	6,039	$154,598	$221,636
	Pecos East County EB	Allsup's Convenience Store	14.6	148,920	64,036	1,869,840	$691,841	62,328	$1,595,597	$2,287,438
	Pecos East County WB	Allsup's Convenience Store	14.3	170,090	73,139	2,091,767	$773,954	69,726	$1,784,986	$2,558,939
	Pecos West County EB	Town & Country Food Store	2.6	156,220	67,175	349,308	$129,244	11,644	$298,086	$427,330
	Pecos West County WB	Town & Country Food Store	2.6	110,595	47,556	247,290	$91,497	8,243	$211,021	$302,518
	Culberson County EB	Chevron Food Mart	0.5	254,405	109,394	109,394	$40,476	3,646	$93,338	$133,813
	Culberson County WB	Chevron Food Mart	0.5	240,900	103,587	103,587	$38,327	3,453	$88,397	$126,724
	El Paso County EB	7-Eleven	2.4	330,325	142,040	681,791	$252,263	22,726	$581,786	$834,048
	El Paso County WB	7-Eleven	2.6	362,810	156,008	811,243	$300,160	27,041	$692,250	$992,410
	Anthony TIC	Circle K	2.2	223,745	96,210	423,326	$156,631	14,111	$361,242	$517,872
		CORRIDOR TOTAL		**2,804,660**	**1,206,005**	**7,402,955**	**$2,739,093**	**246,765**	**$6,317,184**	**$9,056,277**

Comparatively, the Amarillo Travel Information Center experiences similar levels of facility use (102,565 vehicles per year in 2008) but the nearest surrogate service is 0.5 miles from the mainline (one-way), resulting in a five-fold increase in estimated annual excess travel and diversion benefits. Total annual excess travel and diversion benefits along this corridor are estimated to be in excess of $210,000 across nine facilities, or $23,336 per facility on average.

Estimated annual excess travel and diversion benefits along the IH 45 corridor are significantly higher, ranging from $639,753 to $1,723,575 at the Walker County northbound and Navarro County northbound safety rest areas, respectively. Longer travel distances to surrogate services and higher traffic volumes and subsequent safety rest area facility use help to explain the high magnitude of these benefits. The nearest surrogate services along this corridor range from 2.0 to 4.9 miles from the mainline (one-way), and annual facility use consistently exceeds 300,000 vehicles per year across all facilities along this route. Total annual excess travel and diversion benefits along this corridor are estimated to be nearly $5.1 million across four facilities, or $1,272,665 per facility on average.

Along the IH 10 corridor, estimated annual excess travel and diversion benefits range from $126,724 to $2,558,939 at the Culberson County westbound and Pecos East County westbound safety rest areas, respectively. Again, with few exceptions, the magnitude of annual excess travel and diversion benefits increase concurrently with the distance motorists must travel (one-way mileage) to access surrogate services and/or the level of safety rest area facility usage. The nearest surrogate services along this corridor range from 0.5 to 14.6 miles from the mainline (one-way) at the Culberson County eastbound/westbound and the Pecos East County westbound safety rest areas, respectively. Annual safety rest area facility use ranges from 110,595 to 362,810 vehicles per year at the Pecos West County westbound and El Paso County westbound safety rest areas, respectively. Total annual excess travel and diversion benefits along this corridor are estimated to be in excess of $9.0 million across 13 facilities, or $696,637 per facility on average.

ESTIMATED HIGHWAY AND OTHER PUBLIC AGENCY BENEFITS

Measurable benefits accrued by highway and other public agencies relate exclusively to the potential for direct monetary revenues generated by safety rest area facilities and amenities.

Direct Monetary Revenue Benefits

In Texas, potential sources of revenue include profit sharing arrangements for the provision of wireless Internet services at safety rest area facilities accrued by TxDOT's Maintenance Division, select commissions from vending machine operations accrued by the Texas Department of Assistive/Rehabilitation Services, Business Enterprises of Texas (DARS/BET) Program to support equipment purchase, and additional sales tax generated from vending machine operations accrued by the Texas Comptroller of Public Accounts.

Given that few users elected to purchase additional time under the initial WiFi services agreement and that profit-sharing under the existing WiFi agreement has yet to begin, only select commissions and additional sales tax resulting from vending machine operations were able to be quantified for this investigation. These estimates are presented in Tables 17, 18, and 19 for the U.S. 287, IH 45, and IH 10 demonstration corridors, respectively. Note that not all facilities offer vending services, and that revenue estimates reported for paired facilities were assumed to be equally allocated to each directional facility.

Along the U.S. 287 corridor, estimated annual direct monetary revenue benefits range from $992 to $8,783 at the Amarillo Travel Information Center and the Donley County northbound safety rest area, respectively. Total annual direct monetary revenue benefits along this corridor are estimated to be nearly $25,000 across nine facilities, or $2,756 per facility on average.

Estimated annual direct monetary revenue benefits along the IH 45 corridor are higher, ranging from $4,465 to $4,619 at the Navarro County northbound/southbound and Walker County northbound/southbound safety rest areas, respectively. Higher traffic volumes and subsequent facility usage along this route are presumed to explain the higher levels of vending sales and associated sales tax accrued by the Texas Comptroller of Public Accounts. Total annual direct monetary revenue benefits along this corridor are estimated to be more than $18,000 across four facilities, or $4,542 per facility on average.

Along the IH 10 corridor, estimated annual direct monetary revenue benefits range from $375 to $1,544 at the Anthony Travel Information Center and Kerr County eastbound/westbound safety rest areas, respectively. Along this corridor, only three of the 13 facilities offer vending services, likely explaining the relatively low level of direct monetary benefits resulting from additional sales tax collected for the state. Total annual direct monetary revenue benefits along this corridor are estimated to be nearly $3,500 across 13 facilities, or $266 per facility on average.

Table 17. Direct Monetary Revenue Benefits—U.S. 287 Corridor.

FACILITY	DIRECT MONETARY REVENUE SOURCE			TOTAL 2008 DIRECT MONETARY REVENUE BENEFIT
	Wireless Internet Services Profit Sharing	Vending Commissions	Vending Sales Tax	
	TxDOT	DARS/BET	TX Comptroller	DMB_{HA}
 Wise County NB	$0	NA	NA	NA
 Wichita TIC	$0	NA	$1,562	$1,562
 Wichita County NB	$0	NA	NA	NA
 Wichita County SB	$0	NA	NA	NA
 Hardeman County NB	$0	NA	$2,343	$2,343
 Hardeman County SB	$0	NA	$2,343	$2,343
 Donley County NB	$0	NA	$8,783	$8,783
 Donley County SB	$0	NA	$8,783	$8,783
 Amarillo TIC	$0	$588	$404	$992
CORRIDOR TOTAL	**$0**	**$588**	**$24,217**	**$24,805**

Table 18. Direct Monetary Revenue Benefits—IH 45 Corridor.

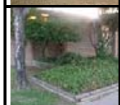
FACILITY		DIRECT MONETARY REVENUE SOURCE			TOTAL 2008 DIRECT MONETARY REVENUE BENEFIT
		Wireless Internet Services Profit Sharing	Vending Commissions	Vending Sales Tax	
		TxDOT	DARS/BET	TX Comptroller	DMB_{HA}
	Navarro County NB	$0	NA	$4,465	$4,465
	Navarro County SB	$0	NA	$4,465	$4,465
	Walker County NB	$0	NA	$4,619	$4,619
	Walker County SB	$0	NA	$4,619	$4,619
CORRIDOR TOTAL		**$0**	**NA**	**$18,169**	**$18,169**

Table 19. Direct Monetary Revenue Benefits—IH 10 Corridor.

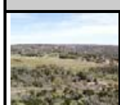
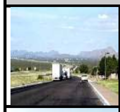
FACILITY		DIRECT MONETARY REVENUE SOURCE			TOTAL 2008 DIRECT MONETARY REVENUE BENEFIT
		Wireless Internet Services Profit Sharing	Vending Commissions	Vending Sales Tax	
		TxDOT	DARS/BET	TX Comptroller	DMB_{HA}
	Kerr County EB	$0	NA	$1,544	$1,544
	Kerr County WB	$0	NA	$1,544	$1,544
	Sutton County EB	$0	NA	NA	NA
	Sutton County WB	$0	NA	NA	NA
	Pecos East County EB	$0	NA	NA	NA
	Pecos East County WB	$0	NA	NA	NA
	Pecos West County EB	$0	NA	NA	NA
	Pecos West County WB	$0	NA	NA	NA

Table 19. Direct Monetary Revenue Benefits—IH 10 Corridor (Continued).

FACILITY	DIRECT MONETARY REVENUE SOURCE			TOTAL 2008 DIRECT MONETARY REVENUE BENEFIT
	Wireless Internet Services Profit Sharing	Vending Commissions	Vending Sales Tax	
	TxDOT	DARS/BET	TX Comptroller	DMB_{HA}
 Culberson County EB	$0	NA	NA	NA
 Culberson County WB	$0	NA	NA	NA
 El Paso County EB	$0	NA	NA	NA
 El Paso County WB	$0	NA	NA	NA
 Anthony TIC	$0	NA	$375	$375
CORRIDOR TOTAL	**$0**	**NA**	**$3,462**	**$3,462**

ESTIMATED EXTERNAL ENTITY BENEFITS

Estimable benefits accrued by external entities relate to economic development and tourism and specific business enterprises.

Economic Development and Tourism Benefits

Estimates of economic development and tourism benefits in Texas—a function of the number of visitors who decide to extend their stay as a result of information received at the traveler information center, the average length of an extended trip, and the average per visitor expenditures—were derived using the methods described in Chapter 3. The results of this analysis are presented in Tables 20, 21, and 22 for the U.S. 287, IH 45, and IH 10 demonstration corridors, respectively.

Recall that although both safety rest areas and travel information centers are presumed to provide economic development and tourism benefits in Texas, the quantification of these benefits is limited to the state's travel information centers. As such, these estimates should be considered to be conservative with respect to the potential economic development and tourism benefits provided by the broader system of safety rest areas in Texas.

Along the U.S. 287 corridor, estimated annual economic development and tourism benefits range from $7,708,858 to $11,057,481 at the Amarillo and Wichita Travel Information

Centers, respectively. The magnitude of these estimates is largely determined by facility usage and the associated number of visitors who decide to extend their stay, the average length of an extended trip, and the average per visitor expenditures.

Total annual economic development and tourism benefits along this corridor are estimated to be nearly $18.8 million across nine facilities (including two travel information centers), or $2,085,149 per facility on average.

Table 20. Economic Development and Tourism Benefits—U.S. 287 Corridor.

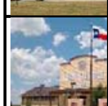
FACILITY	2008 FACILITY USAGE		2008 VISITORS			VISITORS EXTENDING STAY	EXTENDED STAY DURATION	TOTAL 2008 ECONOMIC DEVELOPMENT/ TOURISM BENEFIT EDTB$_{EE}$
	Cars	Trucks	Cars (2.1 pers)	Trucks (1.2 pers)	Total	(29.3%)	Visitor-Days (2.5 days)	($58.39/day/visitor)
 Wise County NB	81,395	32,120	170,930	38,544	209,474	NA	NA	NA
 Wichita TIC	119,355	6,570	250,646	7,884	258,530	75,749	189,373	$11,057,481
 Wichita County NB	68,985	47,085	144,869	56,502	201,371	NA	NA	NA
 Wichita County SB	54,750	41,245	114,975	49,494	164,469	NA	NA	NA
 Hardeman County NB	105,120	55,480	220,752	66,576	287,328	NA	NA	NA
 Hardeman County SB	135,050	55,480	283,605	66,576	350,181	NA	NA	NA
 Donley County NB	106,580	52,560	223,818	63,072	286,890	NA	NA	NA
 Donley County SB	77,015	47,085	161,732	56,502	218,234	NA	NA	NA
 Amarillo TIC	63,510	39,055	133,371	46,866	180,237	52,809	132,024	$7,708,858
CORRIDOR TOTAL	**811,760**	**376,680**	**1,704,696**	**452,016**	**2,156,712**	**128,559**	**321,396**	**18,766,339**

Table 21. Economic Development and Tourism Benefits—IH 45 Corridor.

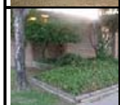
FACILITY		2008 FACILITY USAGE	2008 VISITORS	VISITORS EXTENDING STAY	EXTENDED STAY DURATION	TOTAL 2008 ECONOMIC DEVELOPMENT/ TOURISM BENEFIT
						$EDTB_{EE}$
			(1.8 persons/vehicle)	(29.3%)	Visitor Days (2.5 days)	($58.39/day/visitor)
	Navarro County NB	334,340	601,812	NA	NA	NA
	Navarro County SB	327,405	589,329	NA	NA	NA
	Walker County NB	304,045	547,281	NA	NA	NA
	Walker County SB	429,605	773,289	NA	NA	NA
CORRIDOR TOTAL		**1,395,395**	**2,511,711**	**NA**	**NA**	**NA**

Table 22. Economic Development and Tourism Benefits—IH 10 Corridor.

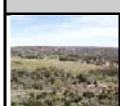
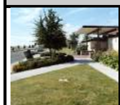
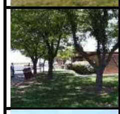
FACILITY		2008 FACILITY USAGE	2008 VISITORS	VISITORS EXTENDING STAY	EXTENDED STAY DURATION	TOTAL 2008 ECONOMIC DEVELOPMENT/ TOURISM BENEFIT
						$EDTB_{EE}$
			(1.8 persons/vehicle)	(29.3%)	Visitor Days (2.5 days)	($58.39/day/visitor)
	Kerr County EB	225,570	406,026	NA	NA	NA
	Kerr County WB	228,125	410,625	NA	NA	NA
	Sutton County EB	177,390	319,302	NA	NA	NA
	Sutton County WB	175,565	316,017	NA	NA	NA
	Pecos East County EB	148,920	268,056	NA	NA	NA
	Pecos East County WB	170,090	306,162	NA	NA	NA

Table 22. Economic Development and Tourism Benefits—IH 10 Corridor (Continued).

FACILITY	2008 FACILITY USAGE	2008 VISITORS	VISITORS EXTENDING STAY	EXTENDED STAY DURATION	TOTAL 2008 ECONOMIC DEVELOPMENT/ TOURISM BENEFIT
					$EDTB_{EE}$
		(1.8 persons/vehicle)	(29.3%)	Visitor Days (2.5 days)	($58.39/day/visitor)
 Pecos West County EB	156,220	281,196	NA	NA	NA
 Pecos West County WB	110,595	199,071	NA	NA	NA
 Culberson County EB	254,405	457,929	NA	NA	NA
 Culberson County WB	240,900	433,620	NA	NA	NA
 El Paso County EB	330,325	594,585	NA	NA	NA
 El Paso County WB	362,810	653,058	NA	NA	NA
 Anthony TIC	223,745	402,741	118,003	295,008	$17,225,488
CORRIDOR TOTAL	**2,804,660**	**5,048,388**	**118,003**	**295,008**	**$17,225,488**

No travel information centers exist along the IH 45 corridor. As such, researchers were unable to estimate annual economic development and tourism benefits along this route. This does not suggest that the safety rest area facilities along IH 45 offer no economic development and tourism benefit but simply that the benefits cannot be quantified as part of this investigation.

Along the IH 10 corridor, annual economic development and tourism benefits are estimated to be $17,225,488 at the Anthony Travel Information Center. The magnitude of this estimate is proportional to the annual facility usage and consistent with the estimates for the Amarillo and Wichita Travel Information Centers.

Total annual economic development and tourism benefits along this corridor are estimated to be in excess of $17.2 million across 13 facilities (including one travel information center), or $1,325,038 per facility on average.

Specific Business Enterprise Benefits

In Texas, additional revenue for private businesses can be accrued by Internet service providers through service contracts with public agencies, usage fees, and/or advertising sales in exchange for the provision of wireless Internet services and businesses/individuals associated with the Texas Department of Assistive and Rehabilitation Services, Business Enterprises of Texas (DARS/BET) Program through the provision of vending services under the *Randolph-Sheppard Act*.

Using the methods described in Chapter 3, estimates of specific business enterprise benefits accrued by external entities and attributable to safety rest areas are presented in Tables 23, 24, and 25 for the U.S. 287, IH 45, and IH 10 demonstration corridors, respectively.

Table 23. Specific Business Enterprise Benefits—U.S. 287 Corridor.

FACILITY	SPECIFIC BUSINESS ENTERPRISE BENEFIT SOURCE		TOTAL 2008 SPECIFIC BUSINESS ENTERPRISE BENEFIT
	Wireless Internet Services 2008 Revenue	2008 Vending Sales	
	(Zoom Information Systems)	(Various DARS/BET Vendors)	$SBEB_{EE}$
 Wise County NB	$3,796	NA	$3,796
 Wichita TIC	$3,796	$17,369	$21,165
 Wichita County NB	$3,796	NA	$3,796
 Wichita County SB	$3,796	NA	$3,796
 Hardeman County NB	$3,796	$26,054	$29,850
 Hardeman County SB	$3,796	$26,054	$29,850
 Donley County NB	$3,796	$97,673	$101,469
 Donley County SB	$3,796	$97,673	$101,469
 Amarillo TIC	$3,796	$4,497	$8,293
CORRIDOR TOTAL	**$34,164**	**$269,320**	**$303,484**

Table 24. Specific Business Enterprise Benefits—IH 45 Corridor.

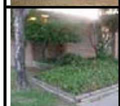
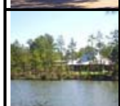
FACILITY		SPECIFIC BUSINESS ENTERPRISE BENEFIT SOURCE		TOTAL 2008 SPECIFIC BUSINESS ENTERPRISE BENEFIT
		Wireless Internet Services 2008 Revenue	2008 Vending Sales	
		(Zoom Information Systems)	(Various DARS/BET Vendors)	$SBEB_{EE}$
	Navarro County NB	$3,796	$49,656	$53,452
	Navarro County SB	$3,796	$49,656	$53,452
	Walker County NB	$3,796	$51,374	$55,170
	Walker County SB	$3,796	$51,374	$55,170
CORRIDOR TOTAL		**$15,184**	**$202,059**	**$217,243**

Table 25. Specific Business Enterprise Benefits—IH 10 Corridor.

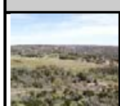
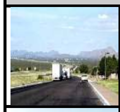
FACILITY		SPECIFIC BUSINESS ENTERPRISE BENEFIT SOURCE		TOTAL 2008 SPECIFIC BUSINESS ENTERPRISE BENEFIT
		Wireless Internet Services 2008 Revenue	2008 Vending Sales	
		(Zoom Information Systems)	(Various DARS/BET Vendors)	$SBEB_{EE}$
	Kerr County EB	$3,796	$17,166	$20,962
	Kerr County WB	$3,796	$17,166	$20,962
	Sutton County EB	$3,796	NA	$3,796
	Sutton County WB	$3,796	NA	$3,796
	Pecos East County EB	$3,796	NA	$3,796
	Pecos East County WB	$3,796	NA	$3,796
	Pecos West County EB	$3,796	NA	$3,796
	Pecos West County WB	$3,796	NA	$3,796

Table 25. Specific Business Enterprise Benefits—IH 10 Corridor (Continued).

FACILITY	SPECIFIC BUSINESS ENTERPRISE BENEFIT SOURCE		TOTAL 2008 SPECIFIC BUSINESS ENTERPRISE BENEFIT
	Wireless Internet Services 2008 Revenue	2008 Vending Sales	
	(Zoom Information Systems)	(Various DARS/BET Vendors)	**$SBEB_{EE}$**
 Culberson County EB	$3,796	NA	$3,796
 Culberson County WB	$3,796	NA	$3,796
 El Paso County EB	$3,796	NA	$3,796
 El Paso County WB	$3,796	NA	$3,796
 Anthony TIC	$3,796	$4,171	$7,967
CORRIDOR TOTAL	**$49,348**	**$38,503**	**$87,851**

Along the U.S. 287 corridor, estimated annual specific business enterprise benefits range from $3,796 to $101,469 at the Wise/Wichita County southbound and Donley County southbound safety rest areas, respectively. Benefits resulting from the provision of wireless Internet services at safety rest area facilities statewide were estimated using the TxDOT-reported costs for providing these services, distributed equally across the state's system of 80 safety rest areas and 12 travel information centers ($3,796 per facility). As such, any differences in specific business enterprise benefits across the various safety rest area facilities is attributable to the availability of vending services and associated facility usage and subsequent vending sales. Total annual specific business enterprise benefits along this corridor are estimated to be in excess of $303,000 across nine facilities, or $33,720 per facility on average.

Estimated annual specific business enterprise benefits along the IH 45 corridor range from $53,452 to $55,170 at the Navarro County northbound/southbound and Walker County northbound/southbound safety rest areas, respectively. Total annual specific business enterprise benefits along this corridor are estimated to be more than $217,000 across four facilities, or $54,311 per facility on average.

Along the IH 10 corridor, only three of the 13 facilities offer vending services. Considering only those that do, estimated annual specific business enterprise benefits range from

$7,967 to $20,962 at the Anthony Travel Information Center and Kerr County eastbound/westbound safety rest areas, respectively. Annual specific business enterprise benefits at all other sites along this corridor are estimated to be $3,796 per facility, resulting from the provision of wireless Internet services statewide. Total annual specific business enterprise benefits along this corridor are estimated to be nearly $88,000 across 13 facilities, or $6,758 per facility on average.

ESTIMATED HIGHWAY AND OTHER PUBLIC AGENCY COSTS

In Texas, safety rest area costs are accrued by a single agency—TxDOT—and include only direct monetary costs.

Direct Monetary Costs

Direct monetary costs associated with safety rest area facilities include initial construction-related costs amortized over the estimated design life of the facility and annual, ongoing costs related to the operation and maintenance of the facilities. Using the methods described in Chapter 3, Tables 26, 27, and 28 present the direct monetary costs for the U.S. 287, IH 45, and IH 10 demonstration corridors, respectively. Note that direct monetary cost estimates reported for paired facilities were assumed to be equally allocated to each directional facility, and initial construction costs were amortized over a 50-year service life.

Along the U.S. 287 corridor, estimated annual direct monetary costs range from $176,573 to $621,058 at the Wichita County northbound/southbound safety rest areas and the Amarillo Travel Information Center, respectively. The range of direct monetary costs may be better explained by considering the individual cost components for each of the facilities. Initial construction costs, expressed in 2008 dollars, range from $422,761 to $6,542,993 ($8,455 to $130,860 per service life year) at the Wichita County northbound and Donley County northbound/southbound safety rest areas, respectively. The magnitude of these estimates is largely determined by the level of service offered—basic, extended, or specialized services.

Average annual operation costs vary widely between safety rest areas and travel information centers. Annual estimated operating costs for safety rest areas along the U.S. 287 corridor range from $3,959 to $11,828 at the Donley County northbound/southbound and Wichita County northbound safety rest areas, respectively. Comparatively, annual estimated operating costs for the Wichita and Amarillo Travel Information Centers are $185,669 and

$202,776, respectively. The increased operating costs at travel information centers are largely attributable to the on-site staffing requirements.

Average annual maintenance costs along this corridor range from $66,870 to $365,195 at the Wichita Travel Information Center and Donley County northbound/southbound safety rest areas, respectively. Contrary to expectations, newer facilities along this corridor generally incur higher annual average maintenance costs than those approaching the end of their service life. Total annual direct monetary costs along this corridor are estimated to be in excess of $3.1 million across nine facilities, or $351,970 per facility on average.

Table 26. Direct Monetary Costs—U.S. 287 Corridor.

FACILITY		CONSTRUCTION			OPERATIONS/MAINTENANCE			TOTAL 2008 DIRECT MONETARY COSTS
		Date Opened	2008 Construction Costs	Average Amortized Costs (50 year life)	Data Time Period	Average 2008 Operations Costs	Average 2008 Maintenance Costs	DMC_{HA}
	Wise County NB	Jul-71	$422,761	$8,455	FY99-09	$11,828	$161,802	$182,085
	Wichita TIC	Jul-96	$767,112	$15,342	FY99-09	$185,669	$66,870	$267,881
	Wichita County NB	Dec-75	$900,317	$18,006	FY99-09	$4,593	$153,974	$176,573
	Wichita County SB	Dec-75	$900,317	$18,006	FY99-09	$4,593	$153,974	$176,573
	Hardeman County NB	Nov-02	$5,790,788	$115,816	FY03-09	$4,580	$251,371	$371,767
	Hardeman County SB	Nov-02	$5,790,788	$115,816	FY03-09	$4,580	$251,371	$371,767
	Donley County NB	Nov-03	$6,542,993	$130,860	FY04-09	$3,959	$365,195	$500,014
	Donley County SB	Nov-03	$6,542,993	$130,860	FY04-09	$3,959	$365,195	$500,014
	Amarillo TIC	Jan-03	$6,443,196	$128,864	FY03-09	$202,776	$289,418	$621,058
CORRIDOR TOTAL			**$34,101,263**	**$682,025**		**$426,537**	**$2,059,169**	**$3,167,731**

Table 27. Direct Monetary Costs—IH 45 Corridor.

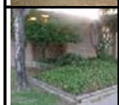
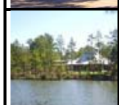
FACILITY		CONSTRUCTION			OPERATIONS/MAINTENANCE			TOTAL 2008 DIRECT MONETARY COSTS
		Date Opened	2008 Construction Costs	Average Amortized Costs (50 year life)	Data Time Period	Average 2008 Operations Costs	Average 2008 Maintenance Costs	DMC_{HA}
	Navarro County NB	1976	$1,422,101	$28,442	FY99-09	$23,270	$266,171	$317,883
	Navarro County SB	1976	$1,422,101	$28,442	FY99-09	$23,270	$266,171	$317,883
	Walker County NB	2007	$10,174,379	$203,488	FY07-09	$3,813	$80,436	$287,737
	Walker County SB	2007	$10,174,379	$203,488	FY07-09	$3,813	$80,436	$287,737
CORRIDOR TOTAL			**$23,192,960**	**$463,859**		**$54,166**	**$693,215**	**$1,211,240**

Table 28. Direct Monetary Costs—IH 10 Corridor.

FACILITY		CONSTRUCTION			OPERATIONS/MAINTENANCE			TOTAL 2008 DIRECT MONETARY COSTS
		Date Opened	2008 Construction Costs	Average Amortized Costs (50 year life)	Data Time Period	Average 2008 Operations Costs	Average 2008 Maintenance Costs	DMC_{HA}
	Kerr County EB	1980	$1,024,655	$20,493	FY99-09	$8,967	$203,753	$233,213
	Kerr County WB	1980	$1,024,655	$20,493	FY99-09	$8,967	$203,753	$233,213
	Sutton County EB	May-81	$1,488,463	$29,769	FY99-09	$12,796	$197,844	$240,409
	Sutton County WB	May-81	$1,488,463	$29,769	FY99-09	$12,796	$197,844	$240,409
	Pecos East County EB	1981	$1,722,053	$34,441	FY99-09	$9,703	$187,060	$231,204
	Pecos East County WB	1981	$1,722,053	$34,441	FY99-09	$9,703	$187,060	$231,204
	Pecos West County EB	1968	$808,840	$16,177	FY99-09	$16,468	$183,085	$215,730

Table 28. Direct Monetary Costs—IH 10 Corridor (continued).

FACILITY	CONSTRUCTION			OPERATIONS/MAINTENANCE			TOTAL 2008 DIRECT MONETARY COSTS
	Date Opened	2008 Construction Costs	Average Amortized Costs (50 year life)	Data Time Period	Average 2008 Operations Costs	Average 2008 Maintenance Costs	DMC_{HA}
 Pecos West County WB	1968	$808,840	$16,177	FY99-09	$16,468	$183,085	$215,730
 Culberson County EB	1976	$1,382,324	$27,646	FY99-09	$7,186	$177,917	$212,749
 Culberson County WB	1976	$1,382,324	$27,646	FY99-09	$7,186	$177,917	$212,749
 El Paso County EB	Dec-67	$1,181,811	$23,636	FY99-09	$8,502	$151,121	$183,259
 El Paso County WB	Dec-67	$1,181,811	$23,636	FY99-09	$8,502	$151,121	$183,259
 Anthony TIC	Jan-00	$4,837,294	$96,746	FY99-09	$202,619	$302,314	$601,679
CORRIDOR TOTAL		**$20,053,585**	**$401,070**		**$329,863**	**$2,503,874**	**$3,234,807**

Estimated annual direct monetary costs along the IH 45 corridor are lower, ranging from $287,737 to $317,883 at the Walker County northbound/southbound and Navarro County northbound/southbound safety rest areas, respectively. Note that the estimated annual direct monetary costs for the Walker County northbound/southbound are low despite a relatively high initial construction cost of $10,174,379 ($203,488 per service life year). Low average annual operating and maintenance costs help to offset the initial cost of construction at this facility. Total annual direct monetary costs along this corridor are estimated to be approximately $1.2 million across four facilities, or $302,810 per facility on average.

Along the IH 10 corridor, estimated annual direct monetary costs range from $183,259 to $601,679 at the El Paso County eastbound/westbound safety rest areas and the Anthony Travel Information Center, respectively. Considering the individual cost components for each of the facilities along this corridor, initial construction costs range from $808,840 ($16,177 per service life year) to $4,837,294 ($96,746 per service life year) at the Pecos West County eastbound/westbound safety rest areas and the Anthony Travel Information Center, respectively.

The magnitude of these estimates is again largely determined by the level of services offered—basic, extended, or specialized services.

Annual estimated operating costs for safety rest areas along the IH 10 corridor range from $7,186 to $12,796 at the Culberson County eastbound/westbound and Sutton County eastbound/westbound safety rest areas, respectively. Comparatively, annual estimated operating costs for the Anthony Travel Information Center is $202,619, largely attributable to the on-site staffing requirements.

Average annual maintenance costs along this corridor range from $151,121 to $302,314 at the El Paso County eastbound/westbound safety rest areas and the Anthony Travel Information Center, respectively. Again, the estimated average annual maintenance costs do not suggest an increasing trend in magnitude with the age of the facility as expected. Instead, the oldest facilities along the corridor—the El Paso County eastbound/westbound safety rest areas—have the lowest average annual maintenance costs while the newest facility along the corridor; the Anthony Travel Information Center has the highest average annual maintenance costs. Other facility characteristics, including building size, building design, water/energy sources, water/energy efficiency, landscaping, and other affect average annual maintenance costs irrespective of facility age. Total annual direct monetary costs along this corridor are estimated to be in excess of $3.2 million across 13 facilities, or $248,831 per facility on average.

ESTIMATED COMPREHENSIVE BENEFITS AND COSTS

Based upon the available supporting data for Texas, researchers estimated benefit-cost ratios along the three demonstration corridors using the following relationship:

$$BCR = \frac{SB_{HU} + CCB_{HU} + ETDB_{HU} + DMB_{HA} + EDTB_{EE} + SBEB_{EE}}{DMC_{HA}}$$

Where:

- SB_{HU} = the safety benefit accrued by highway users.
- CCB_{HU} = the comfort and convenience benefit accrued by highway users.
- $ETDB_{HU}$ = the excess travel and diversion benefit accrued by highway users.
- DMB_{HA} = the direct monetary benefit accrued by highway or other public agencies.
- $EDTB_{EE}$ = the economic development/tourism benefits accrued by external entities.

- $SBEB_{EE}$ = the specific business enterprise benefits accrued by external entities.
- DMC_{HA} = the direct monetary cost accrued by highway or other public agencies.

Results are presented in Tables 29, 30, and 31 for the U.S. 287, IH 45, and IH 10 demonstration corridors, respectively.

Note that because safety benefits were estimated on a corridor-wide basis rather than for individual facilities, comprehensive benefit-cost ratios per facility were inestimable. Instead, a single comprehensive benefit-cost ratio was estimated for each of the three demonstration corridors. Considering estimable benefits and costs for individual facilities—exclusive of safety benefits—would provide a conservative or minimum expected benefit to cost ratio per facility.

Along the U.S. 287 corridor, total annual benefits for 2008 are estimated to be \$27,533,339 (\$3,059,260 per facility on average), and total annual costs for the same year are estimated to be \$3,167,731 (\$351,970 per facility on average), resulting in an estimated annual benefit-cost ratio of 8.7:1. The magnitude of this estimate is largely determined by the potential for increased economic development and tourism, comfort and convenience, and, to a lesser extent, safety along this corridor. These three component benefits comprise more than 98 percent of the total benefits. Benefits resulting from increased economic development and tourism comprise more than 68 percent of the total benefits.

Along the IH 45 corridor, total annual benefits for 2008 are estimated to be \$35,792,123 (\$8,948,031 per facility on average), and total annual costs for the same year are estimated to be \$1,211,240 (\$302,810 per facility on average), resulting in an estimated annual benefit-cost ratio of 29.5:1. The magnitude of this estimate is largely determined by the potential for increased safety and, to a lesser extent, increased comfort and convenience and decreased excess travel and diversion along this corridor. These three component benefits comprise more than 99 percent of the total benefits. Benefits resulting from increased safety comprise more than 64 percent of the total benefits.

Both the safety-related benefits and the resultant benefit-cost ratio along this corridor may be overestimated. As noted previously, while no major errors or omissions were discovered, the casualty and/or traffic volume data used in developing the casualty reduction and statewide correction factors may be incorrect or incomplete, particularly for the 2009 data. As such, researchers caution against placing too great an emphasis on this finding.

Table 29. Estimated Comprehensive Benefits and Costs—U.S. 287 Corridor.

FACILITY		2008 ESTIMATED BENEFITS						2008 ESTIMATED COSTS	BENEFIT-COST RATIO
		Increased Safety	Comfort/ Convenience	Excess Travel/ Diversion	Direct Monetary Revenue	Economic Development/ Tourism	Specific Business Enterprise	Direct Monetary Costs (2008 Dollars)	
		SB_{HU}	CCB_{HU}	$ETDB_{HU}$	DMB_{HA}	$EDTB_{EE}$	$SBEB_{EE}$	DMC_{HA}	BCR
	Wise County NB	NA	$580,242	$24,915	NA	NA	$3,796	$182,085	NA
	Wichita TIC	NA	$1,088,409	$13,373	$1,562	$11,057,481	$21,165	$267,881	NA
	Wichita County NB	NA	$557,796	$12,959	NA	NA	$3,796	$176,573	NA
	Wichita County SB	NA	$455,579	$10,742	NA	NA	$3,796	$176,573	NA
	Hardeman County NB	NA	$902,210	$17,761	$2,343	NA	$29,850	$371,767	NA
	Hardeman County SB	NA	$1,099,568	$41,845	$2,343	NA	$29,850	$371,767	NA
	Donley County NB	NA	$900,835	$17,597	$8,783	NA	$101,469	$500,014	NA
	Donley County SB	NA	$685,253	$13,805	$8,783	NA	$101,469	$500,014	NA
	Amarillo TIC	NA	$758,798	$57,024	$992	$7,708,858	$8,293	$621,058	NA
CORRIDOR		**$1,200,000**[1]	**$7,028,690**	**$210,021**	**$24,805**	**$18,766,339**	**$303,484**	**$3,167,731**	**8.7:1**

[1] *All cost estimates have been rounded consistent with the recommendations of the National Safety Council (2008).*

Table 30. Estimated Comprehensive Benefits and Costs—IH 45 Corridor.

FACILITY		2008 ESTIMATED BENEFITS						2008 ESTIMATED COSTS	BENEFIT-COST RATIO
		Increased Safety	Comfort/ Convenience	Excess Travel/ Diversion	Direct Monetary Revenue	Economic Development/ Tourism	Specific Business Enterprise	Direct Monetary Costs (2008 Dollars)	
		SB_{HU}	CCB_{HU}	$ETDB_{HU}$	DMB_{HA}	$EDTB_{EE}$	$SBEB_{EE}$	DMC_{HA}	BCR
	Navarro County NB	NA	$1,667,019	$1,723,575	$4,465	NA	$53,452	$317,883	NA
	Navarro County SB	NA	$1,632,441	$1,687,802	$4,465	NA	$53,452	$317,883	NA
	Walker County NB	NA	$1,718,462	$639,753	$4,619	NA	$55,170	$287,737	NA
	Walker County SB	NA	$2,428,127	$1,039,531	$4,619	NA	$55,170	$287,737	NA
CORRIDOR		**$23,000,000**[1,2]	**$7,466,050**	**$5,090,661**	**$18,169**	**NA**	**$217,243**	**$1,211,240**	**29.5:1**[2]

[1] *All cost estimates have been rounded consistent with the recommendations of the National Safety Council (2008).*
[2] *Supporting data may be suspect.*

Table 31. Estimated Comprehensive Benefits and Costs—IH 10 Corridor.

FACILITY		2008 ESTIMATED BENEFITS						2008 ESTIMATED COSTS	BENEFIT-COST RATIO
		Increased Safety	Comfort/ Convenience	Excess Travel/ Diversion	Direct Monetary Revenue	Economic Development/ Tourism	Specific Business Enterprise	Direct Monetary Costs (2008 Dollars)	
		SB_{HU}	CCB_{HU}	$ETDB_{HU}$	DMB_{HA}	$EDTB_{EE}$	$SBEB_{EE}$	DMC_{HA}	BCR
	Kerr County EB	NA	$624,829	$213,591	$1,544	NA	$20,962	$233,213	NA
	Kerr County WB	NA	$631,906	$216,012	$1,544	NA	$20,962	$233,213	NA
	Sutton County EB	NA	$491,370	$223,946	NA	NA	$3,796	$240,409	NA

Table 31. Estimated Comprehensive Benefits and Costs—IH 10 Corridor (Continued).

FACILITY		2008 ESTIMATED BENEFITS						2008 ESTIMATED COSTS	BENEFIT-COST RATIO
		Increased Safety	Comfort/ Convenience	Excess Travel/ Diversion	Direct Monetary Revenue	Economic Development/ Tourism	Specific Business Enterprise	Direct Monetary Costs (2008 Dollars)	
		SB_{HU}	CCB_{HU}	$ETDB_{HU}$	DMB_{HA}	$EDTB_{EE}$	$SBEB_{EE}$	DMC_{HA}	BCR
	Sutton County WB	NA	$486,315	$221,636	NA	NA	$3,796	$240,409	NA
	Pecos East County EB	NA	$412,508	$2,287,438	NA	NA	$3,796	$231,204	NA
	Pecos East County WB	NA	$471,149	$2,558,939	NA	NA	$3,796	$231,204	NA
	Pecos West County EB	NA	$432,729	$427,330	NA	NA	$3,796	$215,730	NA
	Pecos West County WB	NA	$306,348	$302,518	NA	NA	$3,796	$215,730	NA
	Culberson County EB	NA	$704,702	$133,813	NA	NA	$3,796	$212,749	NA
	Culberson County WB	NA	$667,293	$126,724	NA	NA	$3,796	$212,749	NA
	El Paso County EB	NA	$915,000	$834,048	NA	NA	$3,796	$183,259	NA
	El Paso County WB	NA	$1,004,984	$992,410	NA	NA	$3,796	$183,259	NA
	Anthony TIC	NA	$941,966	$517,872	$375	$17,225,488	$7,967	$601,679	NA
CORRIDOR		**$3,500,000**[1]	**$8,091,101**	**$9,056,277**	**$3,462**	**$17,225,488**	**$87,851**	**$3,234,807**	**11.7:1**

[1] *All cost estimates have been rounded consistent with the recommendations of the National Safety Council (2008).*

Along the IH 10 corridor, total annual benefits for 2008 are estimated to be $37,964,179 ($2,920,321 per facility on average), and total annual costs for the same year are estimated to be $3,234,807 ($248,831 per facility on average), resulting in an estimated annual benefit-cost ratio of 11.7:1. The magnitude of this estimate is largely determined by the potential for increased economic development and tourism, decreased excess travel and diversion, increased comfort and convenience, and, to a lesser extent, increased safety along this corridor. These four component benefits comprise more than 99 percent of the total benefits. Benefits resulting from increased economic development and tourism comprise more than 45 percent of the total benefits.

CHAPTER 5: ALTERNATIVE SAFETY REST AREA DEVELOPMENT OPPORTUNITIES

The *Federal Beautification Act of 1965* spurred construction of the initial system of roadside safety rest areas along Interstate Highways in most states. The subsequent operation, maintenance, and reconstruction costs to support these facilities commonly originates from state highway funds—comprised of revenue from the state fuel tax and vehicle license tax. Challenged to adequately quantify safety rest area benefits and facing increased competition for funding with other highway construction and maintenance programs, a number of states have investigated alternative opportunities to support safety rest area construction, operation, and maintenance.

These strategies can be generally categorized as:

- Commercialization/public-private partnerships.
- Non-traditional funding sources.
- Joint public development.
- Targeted cost savings.

Each of these alternative opportunities is described more fully below. Because safety rest area facilities have been in existence for more than 50 years, and earlier efforts to identify alternative funding opportunities may have limited application, this literature and state-of-the-practice review is limited to more recent findings and experiences.

COMMERCIALIZATION/PUBLIC-PRIVATE PARTNERSHIPS

The commercialization of safety rest areas has been an ongoing focus of investigation and debate for almost as long as safety rest areas have been in existence. Two types of commercial services in safety rest areas have been generally defined:

(1) Primary commercial services that offer high revenue-generating potential and may include food, beverage, retail merchandise, or fuel sales.

(2) Secondary commercial services that offer lower revenue-generating potential and may include charges for advertising, Internet access, automatic teller machines (ATMs), or RV dump station use.

For the purposes of this investigation, a third category—emerging commercial services—that relates to anticipated demand for alternative energies and the associated requirements for supporting infrastructure is described.

At present, federal statutes prohibit commercial or private enterprise within Federal Interstate rights-of-way, except in the form of vending machines operated under the *Randolph-Sheppard Act*. Specifically, *U.S. Code, Title 23, §111* states that "…the State will not permit automotive service stations or other commercial establishments for serving motor vehicle users to be constructed or located on the rights-of-way of the Interstate System." Vending machines are allowed at safety rest areas but operation and/or profits must be offered to qualified Randolph-Sheppard agencies (i.e., state associations for the blind). The *Code of Federal Regulations, Title 23*, reiterates many of the stipulations expressed in the *U.S. Code* regarding the placement and operation of vending machines. Namely, it specifies that the state can operate vending machines directly or contract for their installation, operation, and maintenance. States are required to give a preference to the operation of vending machines under the guidelines of the *Randolph-Sheppard Act*. Charges for goods and services are not allowed, except for the use of telephones and vending machines. Commercial facilities established prior to the enactment of the *Federal Aid Highway Act of 1956* and accompanying *Revenue Act*, which established the Highway Trust Fund with the purpose of constructing the Interstate Highway System, are exempt from these restrictions. Despite current restrictions along Federal Interstate corridors, the commercialization or privatization of safety rest areas continues to be promoted as a viable means for revenue generation (Eggers 1993, Clary et al. 2001, Dornbush Associates 2008).

Despite the predicted potential for benefit and subsequent support of many state and federal transportation agencies—including the National Transportation Safety Board (NTSB) and the American Association of State Highway and Transportation Officials (AASHTO)—ongoing and recent efforts to allow commercialization of safety rest areas, even as limited pilot or demonstration projects, have failed. Several organizations oppose safety rest area commercialization or privatization including the National Association of Truck Stop Operators (NATSO), Society of Independent Gasoline Marketers of America (SIGMA), and the National Association of Convenience Stores (NACS). Opponents often cite various studies (Corsi et al. 1999, University of Maryland 2003) that predict a negative economic impact from the commercialization or privatization of safety rest areas on private industry.

In anticipation of a change in federal regulations that has yet to come, the AASHTO Task Force on the Commercialization of Interstate Highway Rest Areas developed a series of recommendations related to legal requirements, services provided, access options, overnight truck parking, truck inspection/weighing, utilities, maintenance, vending machine programs, state-operated welcome centers, local involvement, and financial considerations (AASHTO 1990). On a more limited basis, Gattis and Tooley (1997) considered desirable facility attributes and effective contractual terms for safety rest area commercialization/privatization. More recently, an ad hoc task force under the AASHTO Subcommittee on Highways has worked to update and develop various guidelines and recommendations for specific aspects of safety rest area commercialization or privatization (AASHTO 2003).

In addition to these generalized guidelines and recommendations, a number of state-level transportation agencies have conducted their own investigations to determine the feasibility and impact of safety rest area commercialization in their respective states (Beling Consultants, Inc. 1991, Euritt et al. 1992, Phillips and Perfater 1991). Offering a unique perspective, select states such as Connecticut, Florida, Maryland, Ohio, and Pennsylvania have reported their direct experiences with commercialized safety rest area facilities along non-federal toll facilities. Select state-level experiences with commercialization and public-private partnerships involving safety rest areas are described below, categorized by the nature of commercial services considered including primary, secondary, and emerging commercial services.

Primary Commercial Services

Working within the existing statutory framework that restricts private enterprise within Federal Interstate rights-of-way, states are pursuing commercialization of safety rest areas along privately funded toll roads and non-Interstate routes, and at locations proximate to but outside of Federal Interstate rights-of-way (near Interstate interchanges). Safety rest area facilities operating along privately funded toll roads provide the longest history of experiences and potential impacts from commercialization. Table 32 summarizes the reported revenue potential from safety rest area commercialization reported along the Connecticut Turnpike (now IH 95 but allowed to continue commercial operation under grandfathered agreements), the Florida Turnpike, and the Pennsylvania Turnpike. Sales from food and beverages, convenience store items, and gasoline and diesel fuel are estimated separately as per entering vehicle unit expenditures.

Table 32. Revenue Potential from Safety Rest Area Commercialization Reported along Various Toll Roads (Dornbush Associates 2008).

<table>
<tr><th rowspan="3">REVENUE SOURCE</th><th colspan="2">CONNECTICUT TURNPIKE (IH 95)</th><th colspan="2">FLORIDA TURNPIKE</th><th colspan="2">PENNSYLVANIA TURNPIKE</th></tr>
<tr><th colspan="2">Per Entering Vehicle</th><th colspan="2">Per Entering Vehicle</th><th colspan="2">Per Entering Vehicle</th></tr>
<tr><th>Range</th><th>Median</th><th>Range</th><th>Median</th><th>Range</th><th>Median</th></tr>
<tr><td>Food and Beverage Sales</td><td>$2.25–$3.34</td><td>$3.09</td><td>$3.34–$5.43</td><td>$3.90</td><td>$2.03–$2.85[1]</td><td>$2.28[1]</td></tr>
<tr><td>Convenience Store Sales</td><td>$1.40–$1.80</td><td>$1.59</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Gasoline and Diesel Fuel Sales</td><td>1.6–3.2 gal. gasoline (car)

2.4–4.2 gal. diesel (truck)</td><td>2.2 gal. gasoline (car)

2.8 gal. diesel (truck)</td><td>2.8–6.0 gal. gasoline (car)

6.3–18.2 gal. diesel (truck)</td><td>3.6 gal. of gasoline (car)

14.1 gal. diesel (truck)</td><td>1.2–2.4 gal. of gasoline (car)[1]

3.3–33.8 gal. diesel (truck)[1]</td><td>1.9 gal. of gasoline (car)[1]

9.5 gal. diesel (truck)[1]</td></tr>
</table>

[1] Values may underestimate revenue potential since several of the Pennsylvania Turnpikes' busiest service plazas were temporarily closed in 2007 for remodeling.

States are also beginning to pursue the development of safety rest areas and subsequent commercialization opportunities along non-Interstate routes and at locations proximate to but outside of Federal Interstate rights-of-way (near Interstate interchanges). Facilities that are accessible along non-Interstate routes or from an interchange—not from dedicated on/off ramps—and outside the Federal Interstate right-of-way are candidates for commercialization. In addition, no specific federal laws or regulations address safety rest areas on non-Interstate, federally-funded highways. The *Code of Federal Regulations, Chapter 23, §1.23* states that any right-of-way purchased with Federal Title 23 participation must be used exclusively for a highway purpose. However, the regulation also states that certain non-highway uses—such as the limited over-the-counter sales of goods—may be allowed by agreement with the FHWA Division Office. Sales must not interfere with the facility's primary purpose. Select examples of state efforts to introduce primary commercial services to safety rest area facilities in compliance with existing statutes and along non-Interstate routes or at locations proximate to but outside of Federal Interstate rights-of-way are provided below.

California

The California Department of Transportation (Caltrans) has been pursuing efforts to commercialize safety rest areas for more than 50 years. In the 1990s, Caltrans promoted development of a series of six travel services rest areas (TSRA). Under initial development plans, Caltrans would provide land outside of the Interstate right-of-way but near a roadway interchange and $500,000 to a private partner who would build the safety rest area facility and assume operation and maintenance responsibilities for a period of 35 years. After that time, the safety rest area would become the property of the state of California. Caltrans estimated receiving a total of approximately $9 million from rent and a percentage of commercial sales (Kress and Dornbusch 1991).

In November 1990, Caltrans signed an agreement with the winning private partnership to develop and operate the first safety rest area in the state to include private commercial services. The new TSRA was to be located on 14 acres of land entirely owned by Caltrans in the northwest quadrant of the IH 15 and Route 395 intersection. Architects designed the facility to include a 16,400 square foot restaurant, convenience store, and information center. It was also to include a fuel service facility (selling both gasoline and diesel fuel), as well as public rest rooms, landscaped areas for picnics and relaxation, parking areas for 275 cars, trucks and buses, and drinking fountains. A uniformed security guard was to patrol the picnic area, and call buttons located throughout the site would allow motorists to summon emergency help. The state also agreed to erect standard highway signs along IH 15 and Route 395 to indicate the location of the TSRA. The design of the signs was to conform to safety rest area signs used elsewhere in the state, including the symbols to indicate the sale of food and fuel.

The project progressed through completion of construction plans, acquisition of building permits, and ground breaking. However, the project stalled when the developer reported having difficulty obtaining construction financing. The developer sought to renegotiate the contract but was unsuccessful in reaching a new agreement with Caltrans. Caltrans abandoned the project in February 1994. In 1996, the original developer contacted Caltrans, expressing renewed interest in the project but the project never advanced.

Despite a series of similar implementation setbacks at various locations throughout the state, Caltrans continues to pursue efforts to commercialize safety rest areas. As recently as 2008, Caltrans commissioned Dornbush Associates to develop a strategic action plan and business plan for Caltrans to contract with private partners who would maintain and participate in, or fully fund, development of new safety rest areas in exchange for the rights to sell goods and services on-site. The strategic action plan recommends limiting implementation exclusively to locations outside of Interstate rights-of-way, as close as possible to existing interchanges. Public/private commercial partnership projects provided a distinct financial advantage to Caltrans compared to the cost to develop, operate, and maintain entirely public safety rest areas.

Iowa

Iowa has also experimented with commercializing safety rest areas. The Top of Iowa Welcome Center and Rest Area, located at an interchange along IH 35 in north central Iowa, opened in 1998 and includes the welcome center/safety rest area facility and retail stores located behind the parking lot, just outside of the limits of the site. The welcome center/safety rest area facility was jointly developed by the Iowa Department of Transportation (Iowa DOT) and the Iowa Department of Economic Development (the Tourism Division leases room and has a gift shop). A private consortium of business leaders from the community developed the retail stores and funded installation of a sewage disposal pond.

Even before the Top of Iowa facility was opened, the Iowa legislature prohibited the DOT from seeking proposals from private entities for any new partnerships at roadside safety rest areas. The law stated that "…private persons, firms, or corporations entering into an agreement with the department under this section shall not develop, establish, or own any commercial business located on land adjacent to the rest area which is subject to the agreement." The Iowa law continued that, "…an interstate rest area shall be located entirely on the interstate right-of-way, including, but not limited to, all entrance and exit ramps, all rest area buildings including information centers, and all parking facilities." Under current Iowa law, Iowa DOT is only allowed to partner with a private entity to provide informational centers within safety rest areas. An information center is defined as a "site, either with or without structures or buildings, established and maintained at a rest area for the purpose of providing information of specific interest to the traveling public" (Dornbush Associates 2008). Despite the restrictive legislation, Iowa DOT is still interested in pursuing the commercialization of safety rest areas, considering the potential for facility redevelopment at interchange locations outside of Interstate rights-of-way and supported through the Federal Interstate Oasis Program (described later in this chapter).

New Mexico

Comparatively, New Mexico passed legislation in 2005 that stated: "Commercial enterprises or activities may be conducted, permitted or authorized on department-owned land or land leased to or from the department, not including interstate highway rights of way, but including controlled-access facilities; or land owned or leased to or from the state, a county, city, town or village highway authority or by any other governmental agency for the purpose of providing goods and services to the public, including gasoline service stations or other commercial establishments that may be built on department-owned land or the property acquired for or in connection with the controlled-access facilities" (Dornbush Associates 2008). Briefly, the intent of the legislation was to allow the state to lease land to private entities for development. The land might be near an existing safety rest area or land that was outside Interstate right-of-way but still easily accessible from the highway.

It would also allow primary commercialization to take place along highway rights-of-way that were not federally funded. Currently there are six safety rest areas on non-Interstate controlled-access highways. Initial efforts to introduce private enterprise included the sale of books about New Mexico, Native American crafts, and other New Mexico themed souvenirs at safety rest areas along U.S. highways (non-Interstates). This narrow commercial objective was approved by regional New Mexico FHWA officials, but it was later rejected by FHWA's legal department, since New Mexico received federal funds to build and maintain the U.S. highways on which the identified safety rest areas were located. Remaining eligible highways in the state have very little traffic, no existing safety rest areas, and no plans for future safety rest area development that might qualify for commercialization (Dornbush Associates 2008).

Massachusetts

In Massachusetts and the broader New England region, several safety rest areas are located outside of Interstate rights-of-way. One of these, located adjacent to Massachusetts IH 91, sells souvenirs and crafts made by the local businesses. Space constraints at interchanges frequently limit the number of parking spaces and accessibility.

Idaho

The latest focus on the adequacy of commercial vehicle parking has introduced alternatives that encourage public partnership to construct, modernize, or expand privately owned truck stops as surrogate safety rest area facilities (FHWA 1999, Trombly 2003). Dornbush Associates (2008) recommends that if a partnership project seeks to adapt an existing primary commercial services site, and maintaining the site indefinitely as a safety rest area is considered critical, long-term control might be sought through lease provisions or permanent easement. However, such indefinite or long-term site control might be sacrificed for shorter-term financial benefits, if such control is not otherwise achievable.

In 2006, the Idaho Transportation Department (ITD) signed an agreement with the Flying J Corporation, a truck stop operator, to provide a commercialized safety rest area near the IH 15 and U.S. 30 interchange. Flying J owns all of the land and structures. The ITD contributed about $380,000 to develop the site to meet construction specifications and provided signing. Construction of the truck stop/safety rest area began shortly thereafter and opened to the public on July 3, 2007. Services provided include a convenience store, gas, restaurant, free restrooms, and separate parking areas for autos/RVs and for trucks. The ITD does not incur any operating or maintenance costs associated with the site (Russell 2008).

This facility represents the ITD's first public/private safety rest area partnership. This initiative was a favored alternative to extensively rehabilitating a nearby safety rest area at an estimated cost of about $12 million (Russell 2008). This safety rest area was closed following construction of the commercialized safety rest area. The ITD encountered almost no significant external opposition (or support for that matter) to implementing the safety rest area, and it entailed minimal legal or departmental restrictions. The ITD expects to develop more safety rest areas using this approach and is currently drafting department policies and guidelines for such development, but no additional projects are currently planned. This effort received funding from the Federal Oasis Program (described later in this chapter) that allows state transportation departments to enter into agreements with a private partner to provide safety rest area facilities that are accessible at all times to travelers.

Utah

The Utah Department of Transportation (UDOT) has developed a successful model for commercializing safety rest areas by partnering with existing private services offering gas, food, and beverages at interchange locations and subsequently converting these facilities to official state safety rest areas. Five safety rest areas outside of the IH 15 right-of-way are currently being privately operated:

- State Route 77 Interchange. Operated by Flying J Truck Stop, the site includes safety rest area facilities, a convenience store, fueling stations, and visitor information (provided by the Utah Department of Tourism). No picnic facilities or trails are provided. The UDOT installed a traffic light at the intersection and signing (Dornbush Associates 2008).

- U.S. 50 Interchange. Developed as a new facility and operated by Chevron, the site includes safety rest area facilities, a convenience store, and fueling stations. Initial resistance provided by two local gas stations was insufficient to prevent development. Chevron supported site grading and landscaping, and UDOT installed signing (Dornbush Associates 2008).
- IH 70 Interchange (3 miles north). Operated cooperatively by Sinclair Oil Corporation and Subway, the site includes safety rest area facilities (including picnic area/tables and a lawn area), a convenience store, a Subway sandwich shop, and fueling stations. The UDOT installed a left-hand turn lane and signing (Dornbush Associates 2008).
- U.S. 50 Interchange (13 miles south). Operated by Texaco, the site includes safety rest area facilities (including picnic area/tables and a lawn area), a convenience store, and fueling stations. Little opposition was raised by the eight competing gas stations in nearby Fillmore during development. The UDOT installed signing (Dornbush Associates 2008).
- State Route 153 (3 miles south). Operated by Shell, the site includes safety rest area facilities (including picnic area/tables and a lawn area), a convenience store, and fueling stations. As with the other sites, little opposition was raised by the eight competing gas stations in nearby Beaver during development. The UDOT funded the paint striping, concrete curbs, and signing (Dornbush Associates 2008).

All of the sites are located on private land, at interchanges, and 0.25 miles or less from the highway right-of-way. The safety rest area at the U.S. 50 interchange was constructed as a new facility; all other developments involved pre-existing gas stations or truck stops. The UDOT does not incur any operating or maintenance costs for these facilities and is currently considering several additional sites for potential development. Although little opposition was raised from competing local gas stations, blind vendors operating under the *Randolph-Sheppard Act* expressed some opposition to these developments. However, because these sites are privately owned and located outside of the Interstate right-of-way, the preferential obligations under the *Randolph-Sheppard Act* do not apply (Dornbush Associates 2008).

To support these public-private partnerships, UDOT does not currently participate in the Federal Interstate Oasis Program (described later in this chapter). Instead, it operates under a state program that mirrors the federal program yet with a greater ability to impose restrictions on the private operator. The only sacrifice in not participating in the Federal Interstate Oasis Program, and following the federal criteria, is that the federal program would allow use of highway signs designating the site as an official National Interstate Oasis.

Secondary Commercial Services

In addition to pursuing commercial services related to food, beverage, retail merchandise, or fuel sales, a number of states are engaging in public-private partnerships that offer lower revenue-generating potential through advertising, sponsorships, or Internet use charges, with lesser focus on ATM or RV dump station use charges. Considering the potential for revenue generation through advertising at safety rest areas, early investigations showed limited potential. Potential revenues generated through the use of interactive kiosks are constrained because of hardware and software development costs, physically constrained maximum likely “readership” for an individual kiosk, and the rapid emergence of the Internet as a major potential competing marketplace for information distribution.

Researchers determined that kiosk-based advertising revenues were inadequate to support the total cost for the development, implementation, and operation of the system. Advertising revenues may cover the cost of operating and maintaining the system, but not system development or hardware (David M. Dornbush & Company 1996). Despite these predicted limitations for revenue generation, a number of states have focused on advertising at safety rest area facilities. Select examples of state efforts are provided below.

California

Caltrans has included advertising in its safety rest areas for the past 20 years. Much of the advertising activity is managed under their Adopt-A-Rest Area Program, which offers the right to operate informational kiosks in the safety rest areas on a first-come, first-served basis, with preference given to local Chambers of Commerce.

As a participant of the Adopt-A-Rest Area Program, adopters are responsible for the cost of constructing or refurbishing these kiosks, as well as any associated utilities and maintenance. In addition, adopters must adhere to specifications regarding the type and extent of allowable advertisements. For example, 40 percent of the information presented at kiosks must include public service messages, including travel maps. The type of advertising that is used in the kiosks includes backlit sign boxes, direct phone lines, and computers that can print advertisements. Advertising must not be visible from the traveled roadway.

The advertising profits from the kiosks are shared between Caltrans and the adopter, based on a sliding revenue sharing formula. For a typical "adopted" safety rest area, Caltrans will defer all of the facility's maintenance to the adopter and will receive a portion of the advertising profits, resulting in a net benefit to Caltrans of between $25,000 and $100,000 annually (British Columbia Ministry of Transport 1995).

Washington

In Washington, a number of safety rest areas include informational kiosks that provide opportunities for commercial advertising. Select kiosks include direct dial telephones and brochure racks that distribute free pamphlets for advertisers. The Washington State Department of Transportation (WSDOT) employs a private contractor to administer and maintain the advertising program. The WSDOT determines which facilities will support advertising, as well as the nature and content of advertisements—advertisements should be travel-related and advertisements related to alcohol, tobacco, or political or religious messages are prohibited.

Advertising revenue approximates $25,000 per year (British Columbia Ministry of Transport 1995). Payments are received under the *Revised Code of Washington (RCW) 47.12.125 – Lease of Unused Highway Land or Airspace* and are deposited into WSDOT's Advance Right-of-Way Revolving Fund. Under current statutory regulations, the safety rest area program has no direct access to this revenue.

Oregon

In Oregon, the quasi-governmental Travel Information Council operates informational kiosks in safety rest areas along IH 90. The Council does not administer its own advertising in safety rest areas. Instead, it contracts the administration and maintenance of the advertising program out to a private firm. With an alternate focus, approximately 18 states are currently or have provided wireless Internet services at safety rest areas (Wallace et al. 2009). The business models for providing wireless Internet services vary widely but can generally be categorized as costs that are: paid by the WiFi provider, paid by a third party, paid by the state, or shared between the state and private sector WiFi provider.

Under the first business model, the wireless Internet services provider pays for the equipment, installation, and operating costs. Revenues are obtained by the provider through the sale of advertisements or by charging user fees for the service. Several states, including Michigan and Washington have opted for this type of model. Although this model has been successful in Michigan and service is still available, it was not successful in Washington and has been discontinued. Other states pursuing this business model include Kansas, Kentucky, Minnesota, and Nevada. North Carolina has also attempted to offer wireless Internet access using this type of business model. In December 2007, the North Carolina Department of Transportation issued a request for proposals (RFP) for a private partner to provide WiFi services at no cost to the state but received no bids (Wallace et al. 2009).

Under the second type of business model—where costs are paid by a third party—revenues to the provider are typically not sufficient to cover costs, so wireless Internet services are provided along with other revenue-generating endeavors. This model has been successful in Illinois—the private partner responsible for providing WiFi service also provides food services, retail services, and other driver conveniences at their toll road pavilions and service plazas (Wallace et al. 2009). The WiFi service is offered at no cost to users and is offered as an additional service to draw in customers to the existing services.

The third type of business model is where all costs are paid by the state. If the service generates any revenues—either from the sale of advertisement or user fees—these revenues are retained by the state. Florida, North Dakota, Oregon, Texas, and Vermont prescribe to this business model in the interest of safety—the provision of free wireless Internet services encourages drivers to take breaks more frequently and provides a convenient medium for disseminating traffic information (Wallace et al. 2009). Although it is difficult to determine exactly how successful these programs are in meeting the states' goals, these programs remain operational. For both Oregon and Texas, the current business model reflects a departure from their original plans that involved shared costs and exclusive costs borne by the private provider, respectively.

The last type of business model involves shared costs between the public and private sector. Revenues generated through this type of partnership may be shared between the provider and the state, or the provider may retain all revenues generated from ad sales or user fees. Several states, including California and Iowa, are providing wireless Internet services under this business model.

As part of a 2008 National Safety Rest Area Conference panel discussion, members suggested that business models in which the private wireless Internet service provider is wholly responsible for the costs (no costs incurred by the state) are no longer effective because of a lack of accountability and/or perceived benefit by private partners. In addition, business models that include usage fees may also be unsuccessful given the varied connectivity options available through other mechanisms. Instead, business models that involve state-owned hardware, support contracts for operation and maintenance, and share revenues between the state and private partners appear to be most sustainable (National Safety Rest Area Conference Panel Discussion 2008).

Taking a comprehensive approach, the Minnesota Department of Transportation (MnDOT) recently hired a marketing firm to engage private enterprise support for sponsorship, advertising, and wireless Internet access at public safety rest areas:

- Sponsorship fees provide sponsors with an acknowledgment on four signs: an advance highway sign visible to approaching traffic; a welcome sign within the facility; a sign on the acceleration ramp visible to exiting traffic; and a sign, plaque, or other means of acknowledgment within the main building of the sponsored facility. State law limits facility sponsors to transportation and tourism-related entities.
- Advertising is displayed using equipment and furnishings provided and maintained by the contractor, although MnDOT permits the use of some existing state-owned backlit display cases. Up to 40 percent of display space must be provided free of charge to MnDOT for public service announcements. Advertisements are limited to automotive services, food, camping/lodging, tourist attractions, or as otherwise approved by MnDOT.
- Through wireless Internet service access, the contributing entity is acknowledged on the opening screen viewed by motorists. Free-standing or wall kiosks announce the availability of wireless Internet access, as well as display information on traffic and road conditions, tourism, government regulations or announcements, special alerts

and travel tools such as weather conditions, mapping, routing and business services such as gas, food, lodging, attractions, and other travel-related commerce.

Under the intended agreement, limited to a maximum of five years, the selected contractor pays marketing service fees, and the marketing firm subsequently pays MnDOT a percentage of revenues. MnDOT's intent is to utilize these revenues to offset safety rest area maintenance costs (Dornbush Associates 2008).

Emerging Commercial Services

In addition to the primary and secondary commercial service described above, a number of states are pursuing commercial services related to emerging alternative energy markets, including alternative fuel services, recharge facilities for electric vehicles, and solar power generation facilities. Select examples of state efforts to introduce emerging commercial services to safety rest area facilities are provided below.

New York

The New York State Thruway Authority has been actively investing in the state's alternative energy vehicle infrastructure. In November 2006, the Thruway Authority opened the first E-85 (85 percent ethanol/15 percent gasoline) fueling facility at Thruway travel plazas. Similar E-85 facilities were planned for installation at each of the 26 remaining safety rest areas along the Thruway (New York Office of General Services 2008).

Washington

With a similar focus on alternative energy vehicle infrastructure, the WSDOT and the Washington State Department of Commerce plan to implement electric vehicle (EV) charging stations along IH 5 between British Columbia and Oregon as part of the West Coast Green Highway Project. The "electric highway" will support mass-produced plug-in electric vehicles such as the Nissan Leaf, Ford Focus, and Chevrolet Volt.

The state will partner with private companies to install fast charging infrastructure in critical charging zones in under-served locations along major interstates. Electric vehicle charging every 40 to 60 miles will provide a safety net for EV drivers traveling long distances. As an initial step, "medium-speed" chargers will be installed at Washington's gateway safety rest areas for public education and outreach. The public will be able to charge at these locations starting in early 2011. Next, "fast charge" stations will be developed through public/private partnerships and located proximate to the private partner's retail location. Funding for this effort originates from the Federal *American Recovery and Reinvestment Act of 2009* ($1.32 million) with an additional $1 million in Federal Transportation funds pending congressional approval (WSDOT 2010).

Oregon

Taking a different approach, the Oregon Department of Transportation (ODOT) recently completed a demonstration project focused on solar power generation using a third-party financing model. The concept of generating solar electricity in the highway operating right-of-way is of interest to solar industry providers, state and federal elected officials, FHWA, the Oregon Department of Energy, and the U.S. Department of Energy. While "roadside solar" has operated successfully for almost 20 years in Europe, it had not previously been attempted in the United States.

Following the success of Oregon's Solar Highway Demonstration Project—which currently supplies about 128,000 kWh per year—the Oregon Transportation Commission recently approved investigating additional opportunities for solar highway projects. One such opportunity includes installing solar power generation systems (1.3 Megawatts) at the IH 5 northbound Baldock safety rest area south of Wilsonville in partnership with PGE and PacifiCorp—Oregon's investor-owned utility companies.

Under such a partnership, the utility companies would contract with solar developers to design, build, and install solar arrays. Once developed, the utility companies or limited liability companies involving the utilities would own, operate, and maintain the arrays (including any damage due to vandalism or crashes). Development of such systems contributes toward meeting statutory requirements to develop renewable energy resources. ODOT would purchase all electricity generated by the systems under a 25-year Solar Power Purchase Agreement, with options to renew for up to three five-year extensions (ODOT 2010).

NON-TRADITIONAL FUNDING SOURCES

Historically, various sections under the *United States Code, Title 23*—including but not limited to *§103: National Highway System, §118: Interstate Maintenance Discretionary (IMD) Program, §133: Surface Transportation Program, §164: National Scenic Byways Program and*

§204: Federal Lands Highway Program—provide funds for safety rest area construction and rehabilitation along eligible roadways. In addition, *§120 of the United States Code, Title 23* was revised to allow an increased Federal funding share (up to 100 percent) for approved safety projects, including the construction or rehabilitation of safety rest areas.

At the state level, safety rest area construction, operation, and maintenance must typically compete for funding with other state transportation needs supported by the General Fund. While many states struggle to find adequate support for their safety rest area facilities, select states have proven successful in identifying non-traditional sources of funding to support safety rest area construction, operation, and maintenance. Such sources include but are not limited to the following:

- Transportation Enhancement (TE) Funds—FHWA.
- Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grants—U.S. Department of Transportation (USDOT).
- Interstate Oasis Program (*§1310, Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users [SAFETEA-LU]*)—FHWA.
- Truck Parking Facilities *(§1305, SAFETEA-LU)*—FHWA.
- Corridors of the Future Program—FHWA.
- Green Highways Partnership—FHWA/Environmental Protection Agency (EPA).

Transportation Enhancement (TE) Funds—FHWA

While many states struggle to find adequate support to redevelop their safety rest area systems, select states have identified a non-traditional source of federal funding—Federal Transportation Enhancement (TE) Funds—that has led to the construction of new or renovated safety rest area facilities in the state.

Texas

Since 1999, TxDOT has constructed or renovated safety rest area facilities in 21 locations—18 of these facilities were supported by nearly $70 million dollars in Federal TE Funds (Wallace et al. 2009). Additional safety rest areas are currently under construction, with several additional facilities planned. Federal TE Funds cannot be used to maintain or build new roads. To be eligible for Federal TE Funds, a project must relate to surface transportation and involve at least one of the 12 following features or design concepts:

1. Pedestrian and bicycle facilities.
2. Safety and educational activities for pedestrians and bicyclists.
3. Acquisition of scenic easements and scenic or historic sites.
4. Scenic or historic highway programs.
5. Landscaping or other scenic beautification.
6. Historic preservation.
7. Rehabilitation/operation of historic transportation buildings, structures, or facilities.
8. Preservation of abandoned railway corridors.
9. Control and removal of outdoor advertising.
10. Archaeological planning and research.
11. Environmental mitigation.
12. Establishment of transportation museums (FHWA 2010).

With these 12 features and activities in mind, TxDOT strives to incorporate the following seven characteristics in each new facility designed and constructed:

- Scenic locations.
- Pedestrian features.
- Landscaping.
- Historical preservation.
- Context sensitivity.
- Environmental features.
- Safety and educational activities.

Local area assessment and close collaboration with TxDOT districts and local authorities provide valuable insights during the initial facility design stage.

These features and design concepts—including playground equipment, hiking trails, and interactive exhibits—are intended to encourage motorists to stop, spend time away from the wheel, reduce fatigue, and prevent crashes. Proving effective in attracting motorists to stop, daily traffic counts at new facilities have increased between 52 and 116 percent compared to the facilities that they replaced (Wallace et al. 2009).

Demonstrated to be an effective use of Federal TE Funds, state FHWA officials have issued programmatic approval that allows TxDOT to skip the initial call for projects and instead advance to the preliminary design stage. Schematic drawings are submitted to FHWA as they are developed along with design descriptions. Demonstrating commitment at the state level, TxDOT has allocated 25 percent of the State's Federal TE Fund allocation to make improvements to its safety rest area system.

Minnesota

MnDOT has also successfully utilized Federal TE funds to incorporate context-sensitive features and interpretive sites along state corridors (Venner et al. 2007).

Washington

The WSDOT has expressed an interest in utilizing Federal TE funds to support safety rest area development but has encountered some challenges in doing so. In Washington State, Federal TE funds have traditionally been directed to local communities. To redirect a portion of Federal TE funds to safety rest area development, WSDOT must work with local planning community leaders to prioritize safety rest area facility needs with other local community needs.

TIGER Discretionary Grants—USDOT

A number of states were successful in garnering funds to support safety rest area construction or improvement through the *American Recovery and Reinvestment Act (ARRA) of 2009*. For example, TxDOT secured more than $30 million to support construction of safety rest areas along IH 45 and IH 10. Departments of transportation in California, North Carolina, Oregon, Wyoming, and other states were also successful in securing *ARRA* funds to support similar safety rest area construction or improvement projects. In Wyoming, *ARRA* funds were used to fully construct one facility and improve facilities at seven other locations in the state.

As part of the *ARRA*, the USDOT initiated the Transportation Investment Generating Economic Recovery (TIGER) discretionary grant program, which awarded funds on a competitive basis for projects that were determined to have a significant impact on the nation, a metropolitan area, or a region. Given the observed success of the original TIGER program, the USDOT introduced the TIGER II discretionary grant program pursuant to *Title I* of the *FY 2010 Appropriations Act* with a funding allocation of $600 million. The TIGER II program was similar but not identical in program structure and objectives to the original TIGER discretionary grant program introduced under the *ARRA*. Projects eligible for TIGER II discretionary grants under included, but were not limited to:

- Highway or bridge projects eligible under *United States Code, Title 23*.
- Public transportation projects eligible under *United States Code, Title 49, Chapter 53*.
- Passenger and freight rail projects.
- Port infrastructure investments (USDOT 2010).

The *FY 2010 Appropriations Act* required that not less than $140 million of the funds provided for TIGER II discretionary grants be used for projects in rural areas. For projects located in rural areas, no matching funds were required (USDOT 2010).

TIGER II discretionary grants were awarded based on two categories of selection criteria: primary and secondary. Primary selection criteria included the following:

- Long-term outcomes including the following:
  - State of Good Repair: Improving the condition of existing transportation facilities and systems, with particular emphasis on projects that minimize life-cycle costs.
  - Economic Competitiveness: Contributing to the economic competitiveness of the United States over the medium to long term.
  - Livability: Fostering livable communities through place-based policies and investments that increase transportation choices and access to transportation services for people in communities across the United States.
  - Environmental Sustainability: Improving energy efficiency, reducing dependence on oil, reducing greenhouse gas emissions, and benefitting the environment.
  - Safety: Improving the safety of U.S. transportation facilities and systems.
- Job creation and economic stimulus.

Secondary selection criteria include the following:

- Innovation in pursuit of long-term outcomes outlined above.
- Partnership among a broad range of participants and/or integration of transportation with other public service efforts (USDOT 2010).

Requested amounts under the TIGER II discretionary grant program could range from $10 million to $200 million, and no more than 25 percent of the funds made available for the TIGER II program (or $150 million) could be awarded to projects in a single state. A number of states pursued opportunities for safety rest area development through the TIGER and TIGER II discretionary grant programs (USDOT 2010).

New York

The New York State Department of Transportation (NYSDOT) submitted a grant application that included construction of a new Rest Area and Tourist Information Center (RATIC) along U.S. Route 15 as part of a broader rural highway improvement project. The RATIC would be considered part of the statewide rest area system, and the proposed location was consistent with department spacing intervals. Representatives from the NYSDOT also noted that the RATIC is consistent with the overall project needs and purpose of the U.S. Route 15 Improvement Project—that being increasing motorist safety (NYSDOT 2009).

Ohio

The Ohio Turnpike Commission (OTC) pursued a similar bid for safety rest area funding. In their grant application, OTC representatives noted that driving long distances can lead to fatigue-related crashes and suggested that providing a safety rest area would reduce crashes due to fatigue (Ohio Turnpike Commission 2009).

In both of these cases, the funding applications were unsuccessful. To date, the number of grant applications from states has far exceeded available funds, making the program highly competitive. The opportunities are anticipated to continue however. The House Appropriations Subcommittee on Transportation, in its efforts to develop the draft appropriations bill for FY 2011, has included a provision to create a TIGER III discretionary grant program with a funding allocation of $400 million ($200 million less than FY 2010).

Interstate Oasis Program—FHWA

Established under *§1310* of *SAFETEA-LU*, the Interstate Oasis Program supports the designation of facilities near, but not within, the Interstate right-of-way as "Interstate Oases" and in doing so, supports public/private partnerships. State departments of transportation can enter to enter into an agreement with a private partner for use of safety rest area facilities that are accessible at all times to travelers. More specifically, facilities designated as "Interstate Oases" must:

- Be located within 3 miles of an interchange.
- Be safely and conveniently accessible (as determined by an engineering study).

- Have physical site geometry to safely and efficiently accommodate all vehicles, including heavy trucks of an anticipated size and weight (as determined by an engineering study).
- Provide a public telephone, food (vending, snacks, fast food, and/or full service), and fuel, oil, and water for automobiles and trucks.
- Provide public restrooms accessible 24 hours per day, 365 days per year and drinking water at no charge or obligation.
- Provide public parking spaces for automobiles and heavy trucks that are well lit, available for durations of up to 10 hours or more at no charge or obligation, and in sufficient numbers to meet anticipated demand.
- Staffed by at least one person 24 hours per day, 365 days per year.
- Allow participating states flexibility to consider products and services of a combination of two or more businesses at an interchange when all the criteria cannot be met by any one business at that interchange.
- Preclude states from imposing any additional eligibility criteria.
- Adhere to specified signing policies and restrictions (FHWA 2006).

Recall that examples of public/private partnerships in Idaho and Iowa, presented earlier in this chapter, have pursued or plan to pursue safety rest area development under the FHWA Interstate Oasis Program. Utah does not currently participate in the Federal Interstate Oasis Program. Instead, it operates under a state program that mirrors the federal program yet with a greater ability to impose restrictions on the private operator. The only sacrifice in not participating in the Federal Interstate Oasis Program, and following the federal criteria, is that the federal program would allow use of highway signs designating the site as an official National "Interstate Oasis."

Organizations typically opposed to safety rest area commercialization or privatization—including NATSO, SIGMA, and NACS—are generally supportive of the FHWA Interstate Oasis Program. Instead, some resistance may be expressed by blind vendor advocates who perceive such projects to compete with and therefore reduce the financial benefits from vending machines by blind licensees. Therefore, concurrent expansion of vending machine operations at traditional Interstate safety rest area facilities with the development of Interstate Oasis facilities has been recommended (Dornbush Associates 2008).

Truck Parking Facilities—FHWA

Established under *§1305* of *SAFETEA-LU*, a three-year Truck Parking Facilities pilot program provides funding to address the shortage of long-term parking for commercial vehicles on the National Highway System. States, metropolitan planning organizations (MPOs), and local governments are eligible recipients of program funds. Funding priority is given to applicants that:

- Demonstrate a severe shortage of commercial vehicle parking in the corridor.
- Have consulted with affected state and local governments, community groups, commercial vehicle parking providers, and motorist and trucking organizations.
- Demonstrate that their proposed projects are likely to have positive effects on highway safety, traffic congestion, or air quality (FHWA 2010b).

Eligible activities funded under this program include the following:

- Constructing safety rest areas that include commercial vehicle parking.
- Constructing commercial vehicle parking facilities adjacent to commercial truck stops and travel plazas.
- Opening existing facilities to commercial vehicles.
- Promoting the availability of publicly or privately provided commercial vehicle parking on the National Highway System using Intelligent Transportation Systems and other means.
- Constructing turnouts for commercial vehicles.
- Making capital improvements to public commercial vehicle parking facilities to allow year-round use.
- Redesigning interchanges to improve access to parking facilities (FHWA 2010b).

The California iPark project and the IH 95 Corridor Coalition truck parking project were the first two initiatives funded in 2008. Funds made available in FY 2009 have supported five additional projects: IH 15 in Utah, IH 10 in Mississippi, IH 5 in Oregon, a statewide project in Tennessee, and IH 81 in Pennsylvania. Funding for FY 2010 has been received, and awards are expected to be made in FY 2011.

Although the funds for this initial three-year pilot program have been obligated, it is likely that additional funds focused on addressing the shortage of long-term parking for commercial vehicles on the National Highway System will be allocated, either through a continuation of the Truck Parking Facilities pilot program or a similar program.

Corridors of the Future Program—FHWA

In September 2007, the USDOT selected six Interstate routes as the first to participate in a new federal initiative—the "Corridors of the Future" program:

- IH 5 in California, Oregon, and Washington.
- IH 10 from California to Florida.
- IH 15 in Arizona, Utah, Nevada, and California.
- IH 69 from Texas to Michigan.
- IH 70 in Missouri, Illinois, Indiana, and Ohio.
- IH 95 from Florida to the Canadian border (FHWA 2008).

The program's intent is to use public and private resources to reduce traffic congestion within these corridors and across the country. Strategies may include building new roads and adding lanes to existing roads, building truck-only lanes and bypasses, and integrating real-time traffic technology like lane management that can match available capacity on roads to changing traffic demands.

Safety rest areas may also play an important role in the USDOT Corridors of the Future Program. The FHWA has indicated that future awards under the Corridors of the Future Program must include truck parking strategies to be considered for funding (WSDOT 2008). Safety rest area construction or reconstruction could address this need.

Green Highways Partnership—FHWA/EPA

The Green Highways Partnership (GHP) is a joint effort between the FHWA and EPA that is intended to make highway-related construction, preservation, and maintenance more environmentally friendly. The GHP provides funding to state departments of transportation, private foundations, and other organizations that will help achieve the goals for a "green highway." Strategies may include the use of recycled materials in construction, storm water management, and the application of cutting edge technologies to protect critical habitats and ecosystems (Green Highways Partnership 2010). Under the GHP, the Department of Ecology

(DOE) is interested in providing truck electrified parking at truck stops and safety rest areas to reduce idle emissions (WSDOT 2008).

JOINT PUBLIC DEVELOPMENT

While much of the historic focus has been on public-private development opportunities, safety rest area construction, operation, and maintenance can also be supported through public-public partnerships at federal, state, or local levels. The development of joint facilities can include the construction or redevelopment of safety rest areas in conjunction with:

- Travel information centers.
- State or local parks.
- Tribal nation facilities.
- Public agency offices (including transportation and law enforcement agencies).
- Truck weigh or inspection stations.
- Public trucking interest facilities.

Each of these facilities requires unique public-public partnerships and special allowances for site location and development.

Travel Information Centers

Combined safety rest areas and travel information centers are the most common example of joint public development, with facilities in nearly every state. Texas is no exception, offering 12 such travel information centers statewide (Texas Department of Transportation 2008). In addition to the opportunities to make a positive impression on visitors and foster state tourism and commerce through these joint facilities, the Maine Department of Transportation has reported a decrease in crime and loitering since travel information staff is generally present. Safety rest areas in Maine also sell fishing and hunting licenses to tourists. A combined safety rest area/travel information center in Connecticut includes a trout fishery that is open year-round.

State or Local Parks

Safety rest areas can also be developed jointly with state or local parks. Combined park/safety rest area facilities are most appropriate along 2-lane highways as long as (1) a suitable community lies within the designated corridor, (2) the site is responsive to the recommended rest area spacing criteria (i.e., in areas where the maximum rest area spacing criteria is exceeded), and (3) an existing park is available and can be accessed directly from the highway (Blomquist et al. 1999).

Oregon

Several state parks serve as safety rest areas under an agreement with the Oregon Department of Transportation (ODOT). In exchange for managing a system of safety rest areas along the highways and freeways within the state, the Oregon State Department of Parks and Recreation Department (OPRD) receives funds from ODOT to supplement its other sources of revenue that include the Oregon Lottery, state park user fees, and recreation vehicle license fees. The Oregon Transportation Commission also recently approved two OPRD requests totaling $1.72 million and supported through the *ARRA* to improve safety rest areas in eastern and western Oregon.

Arizona

Providing a more limited example, the Arizona Department of Transportation (ADOT) used federal funds to construct a building near a safety rest area on Highway 89A near Page, Arizona. Under a unique agreement, ADOT turned operation of the building over to the National Park Service (NPS), who then allowed a concessioner to sell natural history books and related products while assuming all of the safety rest area's operating and maintenance expenses.

Montana

Comparatively, the Montana Department of Transportation (MDT) operates a City Park Rest Area (CPRA) Program as a low-cost way to help address rest area needs on Montana's Primary and Non-Interstate National Highways. Initially supported by distinct legislative appropriations in 1991 and 1995, 13 facilities were constructed under agreement with participating communities. These agreements allowed MDT to authorize a monetary contribution up to $100,000 to each participating community to improve local facilities and make them suitable for use as a safety rest area. MDT also committed to install and maintain signing on the serviced highway(s). In return, each participating community agreed to coordinate and oversee construction, provide any funding that was needed above the state's contribution, and operate and maintain the safety rest area for the agreement period (Blomquist et al. 1999).

More specifically, MDT's City Park Rest Area Policy is excerpted below:

City Park Rest Area Policy. *MDT will offer additional funding assistance based on availability to participating local governments to maintain or improve City Park Rest Area facilities that are older than 10 years and that MDT determines are still serviceable. The parameters of this funding assistance, which will be formalized in amendments to the original funding agreements, will include the following basic requirements:*

- *MDT will provide funding, based on availability, for maintenance following MDT inspection of the facilities. MDT will periodically inspect each facility to ensure that the facility has been maintained and an inspection report will be completed. The reimbursement agreement can be discontinued at the discretion of MDT should the facility not be maintained in a satisfactory manner.*
- *Although maintenance can be performed by other entities through local agreements, MDT will only reimburse local governments. Although the local agreements may include other facilities, MDT reimbursements will be limited to costs directly related to maintenance of the rest areas.*
- *Proposals for funding assistance for improvements to rest area facilities must he reviewed and approved by MDT's facilities manager, and the improvements must directly benefit the traveling public.*
- *Eligible maintenance costs include janitorial supplies, labor, garbage disposal, grounds maintenance, and utilities necessary to provide a safe and clean rest area facility. Additional items will be considered on a case-by-case basis*.

Tribal Nation Facilities

The potential for joint safety rest area development includes partnerships with various tribal nations. A number of states provide successful examples of such ventures.

Washington

In western Washington, a unique partnership between WSDOT, the Colville Confederated Tribes, and the town of Nespelem (located approximately 2½ miles north of the tribal headquarters) resulted in the development of the new Chief Joseph Safety Rest Area. The facility is located along State Route 155 at Nespelem, where the renowned Chief Joseph of the Nez Perce is buried. The nearest roadside safety rest area is 56 miles away on U.S. 2.

The WSDOT originally approved $377,000 to support facility development. In 2008, when the funds were made available, high fuel prices had driven up the cost of construction materials. Local residents raised an additional $112,000 for the facility when state funds proved inadequate. Tribal officials, who administered the grant on behalf of the town, used local resources to provide paving, curbing, an interpretive sign, boulder monuments for each of the Colville Reservation's 12 tribes, and steel sculptures. The tribal Telecommunications Program donated a security system. The Chief Joseph Safety Rest Area is owned and operated by the town of Nespelem (Craig 2010).

Similar development efforts are under way in other states. The Idaho Department of Transportation is continuing partnership efforts with the Nez Perce Tribe to develop a safety rest area along the U.S. 95 corridor. The Tribe has developed a site plan that will be reviewed for feasibility. The Montana Department of Transportation (MDT) is considering a broader range of partners for a proposed safety rest area facility along the IH 90 corridor. The facility would be located near the Garryowen Historical Marker in Crow Agency, Montana, and offers partnership opportunities between MDT, the National Park Service, the Crow Tribe, and Travel Montana.

Public Agency Offices

With continued resource limitations, select states have looked to safety rest area facilities to support a combination of public agency functions.

Connecticut

In Connecticut, for example, the Willington safety rest area, located along eastbound IH 84, includes a department of transportation maintenance shed and personnel offices.

New York

Combined public agency functions are not limited to a single agency. In 1997, the New York State Department of Transportation expanded the Clifton Park safety rest area facility along IH 87 to include a state police station in addition to traditional safety rest area amenities such as parking lots for cars and trucks, picnic areas, restrooms, vending machines, and a tourist information pavilion. Currently, nearly one-fourth of New York's safety rest area system includes satellite state police stations that have been integrated into the facilities' design. Office space is provided for the State Police Interstate Highway Patrol that is dedicated to patrolling the adjacent Interstate routes. Co-locating law enforcement personnel at the safety rest areas has been demonstrated to be a successful strategy in reducing crime at the safety rest area, providing a faster response to calls for service by the motoring public, and removing unsafe commercial vehicles from Interstate highways (if safety rest areas are concurrently used to support commercial motor vehicle weighing/inspections as described below).

Truck Weigh or Inspection Stations

As noted above, joint safety rest area facilities can also be used to support commercial motor vehicle size and weight enforcement in addition to broader transportation and law enforcement functions.

New York

The safety rest area building contains offices for the New York State Police Commercial Vehicle Enforcement Unit (CVEU) that enforces state and federal laws pertaining to commercial motor vehicles and—in conjunction with department of transportation inspectors—performs commercial motor vehicle safety inspections. At select locations, weigh-in-motion technology installed in the Interstate mainline is used to identify potentially overweight vehicles from the traffic stream. If the vehicle is suspected to be overweight, the driver of the vehicle is directed to enter the safety rest area for further weight measurement using portable scales. No permanent weigh scales are installed at any of the state's safety rest areas. Further safety inspections are performed as necessary. Any commercial driver who is placed out-of-service, as a result of hours-of-service or safety violations, is not allowed to leave the safety rest area until the violations are corrected. A number of additional states use their safety rest areas to support commercial motor vehicle weighing and inspection but not all provide on-site office space for enforcement personnel.

Public Trucking Interest Facilities

Washington

In Washington State, the Ports of Seattle and Tacoma have a vested interest in ensuring adequate truck parking along highways for their customers and may partner with WSDOT to ensure that parking demand is met. Several under-developed safety rest area facilities have been identified for potential joint development (WSDOT 2008). The WSDOT intends to further evaluate the sites, locations, and additional potential partners to determine feasibility of providing expanded truck parking. The WSDOT Public Private Partnership Office, WSDOT Real Estate Services, and FHWA will be consulted on these opportunities.

TARGETED COST SAVINGS

Concurrent with efforts to identify additional funding sources or partnership strategies to support safety rest area development, states have also pursued cost-saving measures to reduce their overall budgetary impact. Efforts to reduce safety rest area costs have generally focused on maintenance labor and utilities.

Maintenance Labor

Opportunities to reduce the labor costs associated with safety rest area maintenance have been a subject of study for more than three decades (Public Works Journal Corporation 1981, FHWA 1981, Tatman 1986, Garcia-Diaz and Cediel-Franco 1988, Garcia-Diaz et al. 1988, Wilmot et al. 2003, Chapman and Wiczkowski 2009). Most often, researchers conducted these studies to support decision making regarding the outsourcing of all or some safety rest area maintenance functions.

A number of states currently outsource all or a portion of safety rest area maintenance functions. In 2003, the Louisiana Department of Transportation and Development (LaDOTD) sponsored a study that resulted in development of a software model to assist public agency managers in decision making about outsourcing broader agency functions and activities. Results of a pilot application test showed that both qualitative and cost assessment of the rest area maintenance activity favored outsourcing (Wilmot et al. 2003). Other state departments of transportation, including the Minnesota Department of Transportation, are planning to investigate the use of this same software tool to assist the department in determining whether outsourcing safety rest area maintenance is reasonable for MnDOT.

Outsourced labor can extend beyond the traditional model using private contractors. In a number of states, non-violent offenders in the Department of Corrections (DOC) system are successfully assigned to roadside clean-up work crews. Partnerships with local sheriffs, community corrections officers, or state DOCs can facilitate the performance of safety rest area maintenance functions (e.g., landscaping, clean-up) by those currently sentenced to community service or eligible for work release programs. Most recently, state departments of transportation have been looking to expand the traditional Adopt-a-Highway program for litter control to include safety rest area maintenance as part of an "Adopt-a-Rest Area" program.

Virginia

With the impending closure of 18 safety rest areas and one welcome center statewide, and in the midst of a state election, Virginia's Governor-elect announced his support for prompt, proactive, and creative measures to keep safety rest area facilities open. He pledged to re-open closed facilities within 90 days of taking office in January 2010 (Gray Television, Inc. 2010). As part of his action plan, the Governor ordered the immediate creation of an "Adopt-a-Safety Rest Stop" program with Virginia businesses, community, and civic organizations helping to keep the safety rest areas open in the near term, without providing commercial services. Leaders of the Virginia Business Council indicated their willingness to participate.

Oregon

The Oregon Department of Transportation (ODOT) is also considering implementation of an Adopt-A-Rest Area program. Under such a program, firms would bid on the right to adopt certain safety rest areas. Once awarded, the adoptee would maintain the facilities, and in exchange, can sell or display advertising under certain limitations.

Minnesota

The Minnesota Department of Transportation (MnDOT) currently operates an Adopt-A-Rest Area Program and plans to increase marketing efforts to encourage program participation. Additionally, MnDOT is exploring opportunities to expand the types of services provided by volunteers to include landscape maintenance and minor repairs in addition to the customary litter pickup. As with the Adopt-A-Highway program, adopting groups are acknowledged with the blue and white "Adopt-A" sign on the mainline route (MnDOT 2004).

Utilities

A second significant area of focus to reduce safety rest area costs relates to utilities. More specifically, strategies that states have focused on:

- Increased system efficiency to reduce overall energy consumption.
- The use of alternative energy sources—including wind or solar powered electrical systems (Rock and Vliet 1986, Woodham 1986, Vollo 1988, Chapman and Wiczkowski 2009).
- Efforts to reduce overall waste (wastewater, litter) generated by safety rest area facilities—including low-volume flush systems (AASHTO 1992 and 1993, Farrell et al. 2000, Griffin and Yan 2003).

A number of recently constructed or redesigned safety rest areas provide examples of these utility-related strategies applied collectively. Select state-level experiences are described below.

Virginia

Completed in 2007, the New Kent safety rest area along westbound IH 64 is the first state-owned facility to obtain a Gold Certification from the U.S. Green Building Council. The $5 million, 9,000-square-foot building uses 42 percent less energy than a standard building of its size, is 75 percent more efficient in energy consumption than its predecessor, is estimated to save more than 1 million gallons of water, and was constructed using 20 percent recycled building materials. The safety rest area also features a system to collect more than 250,000 gallons rainwater from the roof annually used for flushing the restrooms (Virginia Department of Transportation 2007).

North Carolina

The North Carolina Department of Transportation (NCDOT), in cooperation with Wilkes County and the towns of North Wilkesboro and Wilkesboro, committed to build a "green" safety rest area U.S. 421. The Northwest North Carolina Visitor Center/Rest Area—which opened to the public in 2010—is the state's first environmentally friendly safety rest area. The 10,030-

square-foot building is designed to be energy efficient, conserve water, and reduce greenhouse gases. The safety rest area's "green" features include the following:

- Small building footprint surrounded by open space.
- Storm water management through bio-retention basin, hazardous spill basins, and bio-swales.
- Xeriscape landscape (no irrigation needed).
- Light pollution reduction.
- 0.8 mile green trail.
- 4.5 acres of reforestation.
- Preferred parking for low emitting and fuel efficient vehicles and van pools.
- Reduced parking capacity to appropriate amounts.
- Reclaimed site vegetation for landscape mulch and site furniture.
- Photovoltaic system.
- Domestic solar water heating for restroom sinks.
- Increased daylighting.
- Rainwater harvesting.
- Building shell constructed of an Energy star rated membrane.

In addition, 90 percent of waste was diverted from the landfill during the construction process (Wilkes Chamber of Commerce 2010).

Ohio

Currently underway, the Ohio Department of Transportation recently secured $1,662,500 in *ARRA* funds for the state's "America's Energy Gateway" initiative, which showcases Ohio's leadership and opportunities to further develop advanced energy industries. The project includes the installation of renewable energy and energy efficiency technologies at the following locations:

- The IH 90 Gateway Rest Areas in Ashtabula and Wood Counties includes truck electrification systems at each safety rest area to provide "on-board" power to trucks to reduce the amount of trucks idling at the facility, light-emitting diode (LED) and induction lighting for each tourist information center, a 250-kilowatt wind turbine and

15-kilowatt solar system that both provide on-site electricity, a power management system, and an educational kiosk for visitors to learn about advanced energy.

- The IH 70 Gateway Rest Areas in Belmont County includes LED and induction lighting for each tourist information center, a 30-kilowatt solar electric system, electric vehicle charging equipment, and an educational kiosk for visitors to learn about advanced energy (Ohio Department of Development 2010).

SUMMARY AND IMPLICATIONS FOR THIS INVESTIGATION

TxDOT has historically pursued a number of alternative safety rest area development strategies in the state including but not limited to the provision of secondary commercial services such as wireless Internet access, the use of non-traditional funding sources such as FHWA's Transportation Enhancement funds, joint public development in partnership with TxDOT's Travel Information Division, and pursuit of targeted cost savings related to maintenance labor and utilities (water/energy).

Based on recent experiences in other states, additional safety rest area development opportunities that TxDOT may wish to consider include the construction/renovation of new or existing facilities along privately funded toll roads, along non-Interstate routes, or Interstate interchange locations outside of the federal right-of-way that can subsequently support the provision of primary commercial services (e.g., food and beverage sales, fuel sales, etc.). A number of states are pursuing these efforts under FHWA's Interstate Oasis Program.

An increased national focus on alternative energy provides additional opportunities for safety rest area development. Several states are looking to supplement existing safety rest areas with infrastructure to support the use of electric vehicles and generate power using solar or wind technologies. These efforts are supported through various non-traditional funding sources and through public-private partnerships.

A second area of national focus relates to the adequacy of truck parking. Select states have partnered with private truck stop owners—under FHWA's Interstate Oasis Program or other similar state-level programs—to cooperatively meet the needs of general safety rest area patrons and commercial motor vehicle operators. The inclusion of truck parking strategies has also been recently introduced as a criterion for funding under FHWA's Corridors of the Future

Program (recall that IH 69 in Texas was one of the first corridors selected for participation under this initiative).

Last, TxDOT may be able to take advantage of additional joint development opportunities through pursuit of public-public partnerships involving state or local park agencies, Tribal Nations, or state or local law enforcement agencies. Law enforcement agencies in other states utilize safety rest areas for personnel office space as well as the conduct of commercial motor vehicle size and weight inspections. To ensure sustainability of existing facilities and continued development and expansion of additional safety rest area facilities, TxDOT should continue to pursue a wide range of strategies related to commercialization/public-private partnerships, non-traditional funding sources, joint public development, and targeted cost savings.

In addition, TxDOT may want to consider opportunities to "multi-purpose" safety rest area facilities to broaden their real or perceived value. Other states have successfully involved additional public or private sector partners and increased facility functions to include commercial service activity, law enforcement activity, power generation, etc. as a means to ensure safety rest area sustainability. In pursuit of these opportunities, it is important to maintain the basic function of safety rest areas, which is to encourage motorists to take a break from the driving task and subsequent increase traffic safety.

CHAPTER 6:
CONCLUSIONS AND RECOMMENDATIONS

Recall that the objective of this investigation was to develop a benefit-cost analysis methodology for safety rest areas in Texas and to demonstrate its application in select corridors throughout the state. In addition, this project considered novel safety rest area development approaches that could reduce the public cost burden borne by individual public agencies. Conclusions and recommendations related to each of these efforts are provided below.

BENEFIT-COST ANALYSIS METHODOLOGY

Based upon the available supporting data, the following relationship was derived to estimate benefit-cost ratios along three demonstration corridors in Texas:

$$\boxed{BCR = \frac{SB_{HU} + CCB_{HU} + ETDB_{HU} + DMB_{HA} + EDTB_{EE} + SBEB_{EE}}{DMC_{HA}}}$$

Where:

- SB_{HU} = the safety benefit accrued by highway users.
- CCB_{HU} = the comfort and convenience benefit accrued by highway users.
- $ETDB_{HU}$ = the excess travel and diversion benefit accrued by highway users.
- DMB_{HA} = the direct monetary benefit accrued by highway or other public agencies.
- $EDTB_{EE}$ = the economic development/tourism benefits accrued by external entities.
- $SBEB_{EE}$ = the specific business enterprise benefits accrued by external entities.
- DMC_{HA} = the direct monetary cost accrued by highway or other public agencies.

For each of the component benefits and costs listed above, estimates were either—in order of preference—directly measured, estimated based on local data, estimated based on national or other aggregate data, or omitted because of an inability to quantify.

Benefit components determined to be immeasurable or inestimable because of a lack of supporting data included benefits associated with commercial motor vehicle scheduling and staging, highway operations and maintenance, and traffic diversion benefits accrued by select highway users, highway agencies, and external entities, respectively. Immeasurable or inestimable cost components included costs associated with decreased safety for highway users, and environmental impacts, socially undesirable behavior, and traffic diversion away from communities accrued by external entities.

Resulting benefit-cost ratios along each of the three corridors were estimated to be 8.7:1 along the U.S. 287 corridor, 29.5:1 along the IH 45 corridor, and 11.7:1 along the IH 10 corridor. As previously noted, the data used to develop the safety-related benefits and the resultant benefit-cost ratio along the IH 45 corridor may be suspect. As such, researchers caution against placing too great an emphasis on this particular finding.

Although varying in magnitude across the three corridors, benefits related to increased comfort and convenience, decreased excess travel and diversion, increased economic development and tourism, and to a lesser extent, increased safety, generally comprised the majority of total estimated benefits. Estimated benefits related to direct monetary revenue and specific business enterprise were smaller in magnitude.

Regarding the validity of this overall approach for comparing safety rest area benefits with costs, a number of strengths and shortcomings can be identified. First, this method utilizes data and national/aggregate unit values that are more timely and relevant than those used in prior comprehensive safety rest area studies conducted more than 20 years ago (e.g., King 1989). Second, researchers were careful to document specific sources for each of the individual national/aggregate unit values used in this investigation to ensure defensibility and repeatability of the benefit-cost ratios estimated for Texas. Third, researchers framed required assumptions to produce the most conservative estimates of safety rest area benefits and costs.

A key shortcoming of the applied method is that it is heavily assumption-based. Required assumptions when determining each of the individual benefit and cost components are well documented in this document. Minor changes to any of these assumed values will influence the resultant benefit-cost ratios, although it is unclear to what extent these ratios would change.

A second shortcoming not unique to this methodology relates to the quality and accessibility of supporting data. It was previously noted that several perceived benefit and cost components attributable to safety rest areas were simply inestimable due to a lack of supporting data and were not considered further. For select benefit and cost components included in this methodology, both data quality and accessibility proved challenging. For example, available crash data to support determination of potential safety benefits (and costs) attributable to safety rest areas suffered from incomplete or erroneous entries, inconsistent data elements/definitions over time, and aggregation that limited data utility in 2002. Associated traffic volume data for the most recent analysis year (2009) is also thought to be incomplete or erroneous resulting in inconsistent safety benefit estimates along the IH 45 corridor. The availability and accessibility of select cost data was also limited. For safety rest area facilities constructed before 1999, researchers reviewed the minutes of the State Highway and Texas Transportation Commission meetings from 1951 to 1999 to identify applicable safety rest area facilities and associated construction costs. Incomplete and sometimes inconsistent information contained in the Minute Orders required researchers to review these data on a case by case basis to determine which of these construction-related costs were appropriate to include.

A final observation in regard to the safety rest area benefit-cost methodology presented here relates to the transferability of the results. A high level of variability in aggregate benefit-cost ratio estimates was observed across the three demonstration corridors in Texas. Given that these three corridors were selected for that purpose—to demonstrate application of this methodology across a wide range of traffic, roadway, and facility conditions—this may not be surprising. The high level of variability in individual benefit and cost component estimates—both within and between the three demonstration corridors—does, however, suggest limitations to the transferability of these results. The observed variability in individual benefit and cost component estimates is not readily explained by the age of the facility, the level of services offered, or other explanatory factor but instead appears to be influenced by collective site-specific characteristics.

Given the site-specific nature of these results, TxDOT should limit the practice of simply applying or transferring these results to other "similar" facilities and/or corridors. Instead, TxDOT should use the guidance provided in this document to apply the benefit-cost methodology directly to those facilities or corridors of interest. The added effort in assimilating and processing data specific to the facilities or corridors of interest will significantly enhance the accuracy of the results.

ALTERNATIVE SAFETY REST AREA DEVELOPMENT OPPORTUNITIES

TxDOT has historically pursued a number of alternative safety rest area development strategies in the state including but not limited to the provision of secondary commercial services such as wireless Internet access, the use of non-traditional funding sources such as FHWA's

Transportation Enhancement funds, joint public development in partnership with TxDOT's Travel Information Division, and pursuit of targeted cost savings related to maintenance labor and utilities (water/energy).

To ensure sustainability of existing facilities and continued development and expansion of additional safety rest area facilities, TxDOT should continue to pursue a wide range of strategies related to commercialization/public-private partnerships, non-traditional funding sources, joint public development, and targeted cost savings. Based on recent experiences in other states, promising opportunities may include the following:

- Constructing/renovating new or existing facilities along privately funded toll roads, along non-Interstate routes, or Interstate interchange locations outside of the federal right-of-way that can subsequently support the provision of primary commercial services (e.g., food and beverage sales, fuel sales, etc.). Such efforts may be supported under FHWA's Interstate Oasis Program.
- Supplementing existing safety rest areas with infrastructure to support the use of electric vehicles and generate power using solar or wind technologies. Such efforts may be supported through various non-traditional funding sources or public-private partnerships.
- Partnering with private truck stop owners to cooperatively meet the commercial motor vehicle parking demand while concurrently meeting the needs of general safety rest area patrons. Such efforts may be supported under FHWA's Interstate Oasis Program, FHWA's Corridors of the Future Program, or other.
- Expanding public-public partnerships to include state or local park agencies, Tribal Nations, or state or local law enforcement agencies.

Although a focus on securing funding is key to sustainability and growth, TxDOT may also want to consider opportunities to "multi-purpose" safety rest area facilities to broaden their real or perceived value. Other states have successfully involved additional public or private sector partners and increased facility functions to include commercial service activity, law enforcement activity, power generation, etc. as a means to ensure safety rest area sustainability. In pursuit of these opportunities, it is important to maintain the basic function of safety rest areas, which is to encourage motorists to take a break from the driving task and subsequent increase traffic safety.

REFERENCES

American Association of State Highway and Transportation Officials (AASHTO). A Look at What Some States Are Doing: Penndot Initiates 'Adopt-A-Rest Area' Recycling Program. *AASHTO Quarterly Magazine,* Vol. 71 No. 1. 1992.

American Association of State Highway and Transportation Officials (AASHTO). A Look at What Some States Are Doing: Rest Area Recycling Program in Wisconsin. *AASHTO Quarterly Magazine,* Vol. 72 No. 2. 1993.

American Association of State Highway and Transportation Officials (AASHTO). *A Manual on User Benefit Analysis of Highway Improvements*. 1977 and 2003.

American Association of State Highway and Transportation Officials (AASHTO). *Final Report of the AASHTO Standing Committee on Highways–Task Force on Commercialization of Interstate Highway Rest Areas*. Washington D.C., July 1990.

American Association of State Highway and Transportation Officials (AASHTO). Subcommittee on Traffic Engineering Annual Meeting. Savannah, Georgia, June 11, 2003. http://www.transportation.org/sites/scote/docs/2003Meeting/Commercialization.pdf.

American Automobile Association. *Travel Data*. 1984.

American Automobile Association. *Your Driving Costs 2008*. 2008. www.aaaexchange.com/Assets/Files/20084141552360.DrivingCosts2008.pdf.

American Trucking Associations; Apogee Research, Incorporated; Smith (Wilbur) and Associates; and Federal Highway Administration. *Commercial Driver Rest and Parking Requirements: Making Space for Safety.* 1996.

Barnes, G. and P. Langworthy. Per Mile Costs of Operating Automobiles and Trucks. *Transportation Research Record 1864*, Transportation Research Board, Washington D.C., 2004.

Beling Consultants, Inc. *Interstate Rest Area Privatization Feasibility Study: Final Report.* Illinois Department of Transportation. Springfield, Illinois, March 1991.

Blomquist, D. and J. Carson. *Rest Area User Survey*. Montana Department of Transportation, December 1998.

Blomquist, D., D. Johnson, and J. Carson. *Montana Rest Area Plan*. Montana Department of Transportation, December 1999.

British Columbia Ministry of Transport. *Investigation of Commercial Advertising on Kiosks at Safety Rest Areas*. 1995. http://www.th.gov.bc.ca/publications/eng_publications/environment/references/Commercialization_of_Rest_Areas.pdf.

Bronzini, M., R. Gomez, and A. Choudhary. *Using Remote Sensing To Monitor Truck Rest Areas*. International Truck and Bus Safety Research and Policy Symposium, University of Tennessee, Knoxville, National Safety Council, 2002.

Brundell-Freij, K. *User Benefits and Time in Road Investment and Maintenance: The Role of Speed Choice and Driving Comfort*. Transportation Research Board's 85th Annual Meeting, Washington, D.C., 2006.

Bureau of Labor Statistics. *Consumer Price Index* Webpage. 2010. http://www.bls.gov/cpi/.

Bureau of Labor Statistics. *May 2008 National Occupational Employment and Wage Estimates*. 2009. http://www.bls.gov/oes/2008/may/oes_nat.htm#b23-0000.

Bureau of Labor Statistics. *National Occupational Employment and Wage Estimates*. 2001.

Chapman, P. and P. Wiczkowski. *Wind-powered Electrical Systems: Highway Rest Areas, Weigh Stations, and Team Section Buildings*. Illinois Department of Transportation, 2009.

Chen, K. J., K. K. Pecheux, J. Farbry, and S. A. Fleger. *Commercial Vehicle Driver Survey: Assessment of Parking Needs and Preferences.* Science Applications International Corporation and Federal Highway Administration, 2002. http://www.tfhrc.gov/safety/pubs/01160/index.htm.

Clary, L., C. Hand, R. Creamer, and G. Branagan. *Alternative Transportation Revenue Sources.* Second National Conference on Transportation Finance, Transportation Research Board Conference Proceedings No. 24, Transportation Research Board, 2001.

Cohan, H. and F. Southworth. On the Measurement and Valuation of Travel Time Variability Due to Incidents on Freeways. *Journal of Transportation and Statistics*, Bureau of Transportation Statistics, 1999. www.gcu.pdx.edu/download/2cohen.pdf.

Connecticut Department of Transportation. *Truck Stop and Rest Area Parking Study*. 2001. http://ntl.bts.gov/lib/24000/24300/24353/RestAreaReport.pdf

Corsi, T. M., R. J. Windle, and A. M. Knemeyer. *Evaluating the Potential Impact of Interstate Highway Rights-of-Way Commercialization on Economic Activity at Interchanges*. *Transportation Journal* 39(2):16-25, 1999. http://www.entrepreneur.com/tradejournals/article/print/62528217.html.

Craig, J. Rest Area Offers Dose of History. *The Spokesman Review.* March 26, 2010. http://www.spokesman.com/stories/2010/mar/26/rest-area-offers-dose-history/.

David M. Dornbusch & Company. *Feasibility of Financing Public Information in Rest Area Interactive Kiosks through Private Advertising*. Federal Highway Administration, 1996. http://ntl.bts.gov/lib/16000/16000/16006/PB2000102000.pdf.

Dornbush Associates. *Caltrans Commercial Partnership Rest Areas: Financial Analysis*. California Department of Transportation, November 2008.

Downs, M. G. and D. W. Wallace. *Shoulder Geometrics and Use Guidelines*. Report 254. National Cooperative Highway Research Program, Transportation Research Board, Washington, D.C., 1982.

Drory, A. *The Effects of Rest and Secondary Task on Simulated Truck Driving Task Performance*. Human Factors, 27(2), 1985.

Economic Impact of Michigan Welcome Centers. 1989.

Eger, R. J. and A. L. Wilsker. *Cost-Effective Analysis and Governmental Outsourcing: Everything You Need to Know but No One Said.* 85th Transportation Research Board Annual Meeting, Washington, D.C., 2006.

Eggers, W. D. *Privatization Opportunities for States*. Reason Foundation, 1993.

Eslinger, J. *Texas 2008 Visitor Profile*. Office of the Governor, Economic Development and Tourism Division, 2008.

Euritt, M. A., R. Harrison, and S. Grant. *Feasibility of Safety Rest Area Commercialization in Texas*. Report No. 1269-1F, Texas Department of Transportation, Austin, Texas, November 1992.

Farrell, M., L. Van der Hoven, and T. Olsen. *Vermont Rest Area Uses Green Wastewater Treatment System*. Public Roads, Vol. 63, No. 6, 2000. http://www.tfhrc.gov/pubrds/mayjun00/vermont.htm.

Federal Highway Administration (FHWA). *Commercial Vehicles in Collisions Involving Vehicles Parked or Stopped on Highway Shoulders*. Bureau of Motor Carrier Services, 1977.

Federal Highway Administration (FHWA). *Corridors of the Future* Website. 2008. http://www.corridors.dot.gov/.

Federal Highway Administration (FHWA). *Highway Economic Requirements System—State Version*. Technical Report, U.S. Department of Transportation, 2002.

Federal Highway Administration (FHWA). Interstate Oasis Program. *Federal Register,* Vol. 71, No. 201, October 18, 2006.

Federal Highway Administration (FHWA). *Optimizing Maintenance Activities—Rest Area Maintenance*. FHWA TS-80-210, Ninth Report, U.S. Department of Transportation, 1981.

Federal Highway Administration (FHWA). *Rest Area Forum: Summary of Proceedings*. FHWA-RD-00-034, U.S. Department of Transportation, Washington, D.C., December 1999. http://www.tfhrc.gov/safety/00034.pdf.

Federal Highway Administration (FHWA). SAFETEA-LU Section §1305. May 2010 (b). http://www.ops.fhwa.dot.gov/freight/freight_analysis/sec_1305.htm.

Federal Highway Administration (FHWA). *Transportation Enhancement Activities* Website. November 2010. http://www.fhwa.dot.gov/environment/te/index.htm.

Fleger, S. A., R. P. Haas, J. W. Trombley, R. H. Cross III, J. E. Noltenius, K. K. Pecheux, and K. J. Chen. *Study of Adequacy of Commercial Truck Parking Facilities*. Technical Report. FHWA-RD-01-158, Federal Highway Administration, U.S. Department of Transportation, March 2002.

Garber, N. J. and H. Wang. *Estimation of the Demand for Commercial Truck Parking on Interstate Highways in Virginia.* Virginia Transportation Research Council, Virginia Department of Transportation, Federal Highway Administration, 2004. http://www.Virginiadot.Org/Vtrc/Main/online_Reports/Pdf/04-R10.Pdf.

Garcia-Diaz, A. and F. Cediel-Franco. *Evaluation of In-House Maintenance Contract Costs for Guardrail, Rest Areas, Pavement Marker, Striping and Seal Coats*. Final Report, Revised Edition, Volume I, Texas Department of Transportation, 1988.

Garcia-Diaz, A., J. Buffington, and F. Cediel-Franco. *Cost Evaluation Procedures Concerning the Use of Contractors and State Forces in Routine Maintenance and Mowing Projects.* Summary Report, Texas Transportation Institute, Texas State Department of Highways and Public Transportation, Federal Highway Administration, 1988.

Gattis, J. L. and M. S. Tooley. *Rural Rest Area Privatization Conditions*. Mack-Blackwell Transportation Center, University of Arkansas and the Federal Highway Administration, 1997.

Gray Television, Inc. *Plan to Reduce Costs of Reopened Rest Areas*. WHSV.com. Website. July 6, 2010. http://www.whsv.com/home/headlines/97876699.html.

Green Highways Partnership. Green Highways Partnership Website. 2010. http://www.greenhighwayspartnership.org/index.php.

Greene, W. H. *Econometric Analysis*. Prentice-Hall, Inc., 1997.

Griffin Jr., D. M., and X. Yan. *Water Use, Waste Generation, and Traffic Counts at Interstate Rest Areas in Louisiana*. Louisiana Tech University; Louisiana Transportation Research Center, 2003.

Hauer, E. On the Estimation of the Expected Number of Accidents. *Accident Analysis and Prevention,* Vol. 18, No. 1, February 1986.

Hauer, E. and J. Lovell. *Safety Measures Aimed at Reducing Accidents Occasioned by Vehicles Stopped on Freeway Shoulders*. Department of Civil Engineering, University of Toronto, 1984.

Hicks, Byron. *Wireless Internet at Texas Safety Rest Areas*. Presentation, National Safety Rest Area Conference, 2004. http://maintenance.transportation.org/sites/maintenance/docs/WirelessInternetByronHicks.ppt.

Hollander, Y. Direct Versus Indirect Models for the Effects of Unreliability. *Transportation Research A,* Vol. 40, Issue 9, 2006.

Howell, D. W., R. N. Smith, and E. J. Tye. *Freeway Fatal Accidents—1984*. Report CALTRANS-TE-85-2. California Department of Transportation, Sacramento, California, July 1985.

Intellichoice. 2001. www.intellichoice.com.

King, G. F. and T. M. Mast. Excess Travel: Causes, Extent, and Consequences. *Transportation Research Record, No. 1111*, 1987.

King, G. F. *Evaluation of Safety Roadside Rest Areas*. Report 324, National Cooperative Highway Research Program, Transportation Research Board, Washington D.C., December 1989.

Kragh, B. C., Stopped Vehicles on Freeway Shoulders. *Public Roads*, Vol. 74, No. 3, December 1983.

Kress, E. N. and D. M. Dornbusch. Commercialization of Rest Areas in California. *Transportation Research Record No. 1326,* Transportation Research Board, Washington, D.C., 1991.

Li, Yuen-wah. Evaluating the Urban Commute Experience: A Time Perception Approach. *Journal of Public Transportation,* Vol. 6, No. 4, 2003. www.nctr.usf.edu/jpt/pdf/JPT%206-4%20Li.pdf.

Mackie, P. J., A. S. Fowkes, M. Wardman, G. Whelan, J. Nellthorp, and J. Bates. *Values of Travel Time Savings in the UK.* 2003. www.dft.gov.uk/pgr/economics/rdg/valueoftraveltimesavingsinth3130.

Minnesota Department of Transportation (MnDOT). *Report to the Legislature on the Minnesota Department of Transportation Rest Area Program*. January 30, 2004.

Mokhtarian, P. L. (Editor). *Transportation Research—Special Issue: The Positive Utility of Travel*. Vol. 39A, Issues 2-3, February/March 2005.

Morris, P. and K. O'Brien. *Safety Rest Area Spacing and Vehicle Crash Rates: Is There a Minnesota Connection*? Presentation, National Safety Rest Area Conference, Minneapolis, Minnesota, 2007.

Morris, S. M., A. L. Erera, and C. C. White. *Impact of Using Designated Secure Rest Facilities on Single Lane Truck Dispatching Productivity*. 86th Transportation Research Board Annual Meeting. Washington, D.C., 2007.

National Highway Traffic Safety Administration. Fatal Accident Reporting System. 2009. http://www-fars.nhtsa.dot.gov/Main/index.aspx.

National Restaurant Association. *Restaurant Industry Operations Report*. 1995 Edition, Washington, D.C., 1995.

National Safety Council. *Crash Facts—1988*. Chicago, IL, 1988. 3. U.S. Department of Transportation, Federal Highway Administration, "Highway Statistics—1987," USGPO, 1988.

National Safety Council. *Estimating the Costs of Unintentional Injuries*, 2007. http://www.nsc.org/resources/issues/estcost.aspx.

National Safety Council. *Estimating the Costs of Unintentional Injuries*, 2008. http://www.nsc.org/resources/issues/estcost.aspx.

National Safety Rest Area Conference Panel Discussion. *Internet Access and Sponsorship Programs at SRAs and Travel Plazas*. National Safety Rest Area Conference, Seattle, Washington, October 2008.

Neumann, L. A. and J. Dresser. New Approach for Analyzing Highway Program Choices and Trade-offs. *Transportation Research Record, No. 742,* Transportation Research Board, 1980.

New York Office of General Services. *New York State: A Leader in Alternative Fueled Vehicles*. http://www.ogs.state.ny.us/supportservices/vehicles/cleanfuel/epactInfrastructureUpdate.pdf. January 2008.

New York State Department of Transportation (NYSDOT). *Last Link on the Multi-State Appalachian Development Highway System Corridor U/U1*. TIGER Grant Application, 2009.

Ohio Department of Development. *American Recovery and Reinvestment Act Energy Efficiency and Conservation Block Grant Program Awards* Website. 2010. http://development.ohio.gov/recovery/EECBGAwards.htm.

Ohio Turnpike Commission. *Supporting Documentation—Benefit Cost Analysis Methodology*. TIGER Grant Application. http://www.ohioturnpike.org/business/TIGER/. 2009

Oregon Department of Transportation. *Innovative Partnerships Program* Website. http://www.oregon.gov/ODOT/HWY/OIPP/inn_solarhighway.shtml. March 2010.

Patterson, O. *Safety Aspects of Roadside Rest Program*. University of California–Los Angeles, 1969.

Phillips, A. W. M. and M. A. Perfater. *Opportunities for the Privatization of Virginia's Rest Areas and Welcome Centers.* Final Report, Virginia Transportation Research Council, Virginia Department of Transportation, 1991. http://www.bts.gov/NTL/DOCS/phil.html.

Pogust, F., A. Kiprejanaw, and H. Forster. *Means of Locating and Communicating with Disabled Vehicles*. Interim Report 6, National Cooperative Highway Research Program, 1964.

Porter, T. M. *Trends in the Procurement Models for Highway Maintenance*. 80th Transportation Research Board Annual Meeting, Washington, D.C., 2001.

Prouty, D. *Privatization of Rest Area Maintenance*. Iowa Legislative Fiscal Bureau, 1993.

Public Works Journal Corporation. *Cost Reduction in Roadside Rest Area Maintenance*. Public Works, Vol. 112, No. 3, 1981.

Reed, A. *WiFi on the Highway: Rest Stops Go High-Tech*. http://www.roadtripamerica.com/dashboarding/WiFi-On-The-Highway.htm. January 18, 2008.

Rich, M. M. *Study of Rest Area Truck Parking*. Final Report, Smith (Wilbur) and Associates, Ohio Department of Transportation and Federal Highway Administration, 1990.

Rock, B. A. and G. C. Vliet. *Evaluation of Energy Sources for Roadside Rest Areas*. Interim Report, Texas Department of Transportation and Federal Highway Administration, 1986.

Rollins, J. B. and W. F. McFarland. *Costs of Motor Vehicle Accidents and Injuries*. Transportation Research Record, No. 1068, 1986.

Russell, B. Z. Idaho Transportation Looking at Lean Times. *Spokesman Review,* February 13, 2008. http://www.spokesmanreview.com/breaking/story.asp?ID=13645.

Small, K. *Valuation of Travel Time Savings and Predictability in Congested Conditions for Highway User–Cost Estimation*. NCHRP 431, Transportation Research Board, 1999.

Southeast Wyoming Welcome Center, Rest Area and Division of Tourism Offices. *Supplemental Budget Request, Priority #1: SE Wyoming Welcome Center; Division of Tourism Offices 2007.* www.wyomingbusiness.org/pdf/tourism/2008_1126_SE_WY_Welcome_Center.pdf.

Stynes, D. *Spending and Economic Impacts Associated with State Welcome Centers.* 1998. https://www.msu.edu/course/prr/840/econimpact/michigan/wc98b.htm.

Tatman, R. E. *Ohio's Contract Maintenance Program for Rest Areas*. Transportation Research Circular No. 307, Transportation Research Board, 1986.

Taylor, W. and N. Sung. *A Study of Highway Rest Areas and Fatigue-Related Truck Crashes*. 78th Transportation Research Board Annual Meeting, Washington, D.C., January 1999.

Texas Department of Transportation. *Maintenance Operations Manual*. 2005.

Texas Department of Transportation. *Safety Rest Area* Website. 2008. http://www.dot.state.tx.us/services/maintenance/rest_areas.htm.

Texas Department of Transportation. *Traffic Data and Analysis Manual*. September 2001.

Tolliver, D. D. and A. Dybing. *Highway User Costs at 2008 Prices.* Transportation Research Board 88th Annual Meeting, Washington, D.C., January 2009.

Trombly, J. W. *Dealing with Truck Parking Demands*. NCHRP Synthesis of Highway Practice No. 317, Transportation Research Board, Washington, D.C., 2003. http://www.trb.org/trbnet/ProjectDisplay.asp?ProjectID=33.

United States Department of Transportation (USDOT). *Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis*. Office of the Secretary of Transportation, U.S. Department of Transportation, 2003. http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2-11-03.pdf.

United States Department of Transportation (USDOT). *The Economic Impact of Motor Vehicle Crashes*. 2000a.

United States Department of Transportation (USDOT). *Revision of Departmental Guidance on Treatment of the Value of Life and Injuries*. 2000b.

United States Department of Transportation (USDOT). *TIGER II* Webpage. 2010. http://www.dot.gov/recovery/ost/tigerii/.

University of Maryland. *Fueling American Prosperity: How Rest Area Commercialization Will Devastate the Economic Contributions of Interstate Business*. 2003.

Venner, M., S. Ostria, J. D'Ignazio, and J. Ang-Olson. *Context Sensitive Solutions, Value Engineering and Asset Management: Creating and Maintaining Value, Improving Accountability, Reaching for Sustainability*. Transportation Research Board Annual Meeting, Washington, D.C., January 2007.

Victoria Transport Policy Institute. *Transportation Cost and Benefit Analysis II—Travel Time Costs*. January 2009. www.vtpi.org/tca/tca0502.pdf.

Virginia Department of Transportation. *VDOT Goes Green as it Reopens I-64 West New Kent Safety Rest Area*. Press Release, April 26, 2007. http://www.virginiadot.org/newsroom/statewide/2007/vdot_goes_green_as14733.asp.

Vollo, S. D. *Solar Energy for Utilization in a Georgia Rest Area (Space & Domestic Water Heating)*. Final Report, Georgia Department of Transportation and Federal Highway Administration, 1988.

Wallace, C. Y., J. R. Walton, and J. D. Crabtree. *Best Practices for Providing Traveler Information Services to Motorists at Rest Areas and Welcome Centers*. Kentucky Transportation Cabinet, June 2009.

Washington State Department of Transportation (WSDOT). *Electric Highways Project* Website. 2010. http://westcoastgreenhighway.com/electrichighways.htm.

Washington State Department of Transportation (WSDOT). *Safety Rest Area Program Strategic Plan*. November 2008. http://www.wsdot.wa.gov/NR/rdonlyres/6CEBB99E-B6AE-48A6-AF31-86382985044B/0/SRAStrategicPlan.pdf.

Weisbrod, G. and B. Weisbrod. *Assessing the Economic Impact of Transportation Projects: How to Choose the Appropriate Technique for Your Project*. Transportation Research Circular, No. 477, Transportation Research Board, National Research Council, Washington, D.C., October 1997.

Welch, M. and H. Williams. Sensitivity of Transport Investment Benefits to the Evaluation of Small Travel Time Savings. *Journal of Transport Economics and Policy,* Vol. 31, No. 3, September 1997.

Wener, R., G. W. Evans, and J. Lutin. *Leave the Driving to Them: Comparing Stress of Car and Train Commuters*. American Public Transportation Association, 2006. www.apta.com/passenger_transport/thisweek/documents/driving_stress.pdf.

Whitney, D. *The Value of Travel Time: Estimates of the Hourly Value of Time for Vehicles in Oregon 2007*. Oregon Department of Transportation, June 2008.

Wilkes Chamber of Commerce. *Northwest North Carolina Sustainable Rest Area and Visitor Center* Website. 2010. http://www.nwncvisitorcenter.com/About.html.

Wilmot, C. G., D. R. Deis, and R. Xu. *Assessing Outsourcing Potential in a State DOT*. 82nd Transportation Research Board Annual Meeting, Washington, D.C., January 2003.

Woodham, D. B. *Vail Pass Solar Heated Rest Area*. Final Report. Colorado Department of Highways and Federal Highway Administration, 1986.

APPENDIX A:
A REVIEW OF BENEFIT-COST ANALYSIS METHODS

Early in this investigation, researchers conducted a comprehensive literature and state-of-the-practice review to identify and assess existing benefit-cost analysis methods that may have applicability for safety rest area analysis in Texas. Researchers considered both comprehensive benefit-cost analysis methods (general and specific to safety rest areas) and more focused efforts that improve upon the estimation of the individual benefit or cost components.

Findings from the literature/state-of-the-practice review were intended to:

- Guide the selection/development of appropriate safety rest area benefit-cost analysis methods in Texas.
- Gauge the reasonableness of component benefit and cost estimates in Texas, based on order of magnitude estimates previously reported.

In addition to identifying observed methods and reported benefit-cost outcomes, researchers documented key reported assumptions that supported previous findings. Similar assumptions were anticipated when estimating the benefits and costs of safety rest areas in Texas.

BENEFIT COMPONENT ANALYSIS METHODS

When reviewing the related literature and state-of-the-practice, researchers considered component estimation alternatives and attempted to identify and document both methods to support direct measurement and local estimation, as well as available national or aggregate data. Considering the estimation of component benefits first, findings from the literature and state-of-the-practice review related to highway user, highway or other public agency, and external entity benefits are described below. Observed analysis methods across the range of component benefits are summarized in Table 33.

Highway Users

Potential highway user benefits relate to safety, comfort and convenience, excess travel and diversion, and commercial motor vehicle scheduling and staging.

Table 33. Safety Rest Area Component Benefit Observed Analysis Methods.

BENEFITS	OBSERVED ANALYSIS METHODS					
	Direct Measurement	Indirect/ Parametric Analysis	Hazard-Based Regression	Simple Linear Regression	User Surveys	Not Estimable
Highway Users						
Safety Benefits		✓	✓	✓		
Comfort and Convenience Benefits					✓	
Excess Travel and Diversion Benefits					✓	
Commercial Motor Vehicle Scheduling and Staging Benefits						✓
Highway and Other Public Agencies						
Highway Operations and Maintenance Benefits						✓
Direct Monetary Benefits	✓					
External Entities						
Economic Development and Tourism Benefits					✓	
Specific Business Enterprise Benefits	✓					
Excess Travel and Diversion Benefits						✓

Safety Benefits

With a focus on broader safety treatments, a brief methodological review suggests four predominant methods used in practice to evaluate safety-related benefits:

1. Before/after analyses.
2. Case/control analyses.
3. Regression methods.
4. The Empirical Bayes method.

In some instances, a combination of methods is applied to overcome individual methodological shortcomings.

Simple before/after analyses estimate the safety-related benefits of an improvement by most commonly comparing crash occurrence at a location before and after some "treatment." The comparison can best be expressed with a reduction factor, ϕ_i, which provides the percentage of the original crashes that is prevented by the treatment:

$$\phi_i = \frac{(N_{B_i}/V_{B_i}) - (N_{A_i}/V_{A_i})}{(N_{B_i}/V_{B_i})}$$

Where ϕ_i denotes the crash reduction factor at site i, N_{Bi} and N_{Ai} are the number of crashes at site i before and after the improvement, respectively and V_{Bi} and V_{Ai} represent the traffic volumes at site i for the before and after period, respectively.

Simple before/after analyses are susceptible to temporal variations (i.e., adverse weather-related trends, changes in traffic volumes and traffic stream composition, regulatory changes, etc.) and as such may lead to inaccurate or exaggerated inferences regarding safety-related treatment effects. A noted increase or decrease in crashes may also result from the random nature of crash occurrence independent of any treatment. This phenomenon is particularly problematic when post-treatment data are limited to only a few years.

To overcome the shortcomings of the simple before/after analysis, temporal observations are often combined with observations made across "case" and "control" sites. A group of comparison sites (i.e., control) with geometric and site characteristics similar to the site being studied (i.e., case) is identified. Ideally, the control sites should have roadway geometrics, traffic volumes, and land use characteristics identical to that of the study site. Crash data are collected for the same before/after time period at both the case and control sites.

The inclusion of control sites in before/after analyses helps to ensure that any observed change in crash occurrence is attributable to the treatment and not confounding factors or systemic changes (i.e., if the same reduction in crashes was noted before and after at the control site without any treatment and the case site with the treatment, the treatment can be presumed ineffective). The challenge in conducting combined before/after, case/control analyses is identifying a sufficient number and quality of comparison sites. Oftentimes, either a smaller number of highly-similar sites or a larger number of less similar sites is the resulting compromise.

Rather than trying to control for the varying roadway geometrics, traffic volumes, and land use characteristics through control site selection, regression methods can be used to directly account for these factors and their affect on safety. Most widely applied and easily understood, the multiple linear regression equation assumes the following form:

$$Y = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + ...\beta_{p-1} X_{i,p-1} + \varepsilon_i$$

where Y denotes the dependent variable (e.g., crashes per year), X_{i1} through $X_{i,p-1}$ denote independent, explanatory variables (e.g., lane width, degree of horizontal curvature, average annual daily traffic, percent trucks in the traffic stream, etc.), β_0 through β_{p-1} denote estimable parameters, β_0 represents the y-intercept value, and ε_i is the unexplainable, random error not accounted for in the model.

Simplistic linear regression models that consider only crash exposure as an explanatory variable have been employed; however, a significant body of research now points to the appropriate use of more sophisticated regression techniques including Poisson, hazard, negative binomial, and zero-inflated regression models to estimate crash occurrence and logistic and ordered probit regression to estimate crash severity (see Greene [1997] for a complete description of these model forms). Application of these advanced modeling techniques is limited in practice because of the large amount of data required and the complexity of the analysis. Further, since regression methods cannot take into account every factor that influences the occurrence or severity of a crash, estimates of resulting safety benefits may suffer similar accuracy problems as other methods.

Recently integrated into the USDOT's *Interactive, Highway Safety Design Model (IHSDM)* and *SafetyAnalyst* software, the Empirical Bayes (EB) method uses data from a group of similar control sites as well as pre-treatment data from the case site to estimate how many crashes would have occurred at the study site had no improvements (i.e., treatment) been made. This approach allows for the comparison of the "after treatment" crash occurrence at the site to the estimated or expected crash occurrence at the site in the absence of treatment during the same time period.

The EB method increases the precision (i.e., reduces the variability) of estimates beyond what is possible using any of the above methods, particularly when limited to by a two- to three-year crash history. A second benefit of the EB method is its ability to account for regression-to-the-mean bias (i.e., when treatment sites have been selected because of a high crash occurrence and this "before" rate is used to estimate the reduction in crash occurrence, the random variation in crashes will lead to exaggerated estimates of the treatment's effectiveness [Hauer 1986]). While the EB method has been determined to be more accurate, the accuracy of the results depends upon the quality of the underlying crash data and the goodness-of-fit of the estimated model to the data. Limited variability in the model's explanatory variables (e.g., lane widths, shoulder widths, horizontal and vertical curvature, average annual daily traffic, etc.), as may be observed across Interstate roadway segments, may inhibit useful results.

The evaluation of safety rest areas under any of these traditional safety analysis methods is challenged by two fundamental factors previously identified: any effect on safety (1) depends upon the use rather than the mere existence of a safety rest area and (2) is indirect (i.e., safety rest area use may affect driver performance or actions, which, in turn, are potentially contributing causes to crashes). Hence, although there is general agreement that the establishment of a safety rest area has a beneficial effect on highway safety, little supporting empirical evidence was found in the literature.

Of the studies identified that attempted to relate highway safety and safety rest areas, two general approaches were observed:

- Direct analyses intended to correlate crash locations to safety rest area locations (microscopic level) or crash frequencies to safety rest area spacing (macroscopic level).
- Indirect analyses that consider estimated reductions in suspected crash causal factors (i.e., fatigue, shoulder stops, etc.) and subsequent reductions in crash occurrence.

Specific methodologies employed under each of the general approaches are described below, along with any relevant reported outcomes that can be used to gauge the reasonableness of subsequent component benefit and cost estimates in Texas.

Direct Safety Benefit Analyses. Many researchers have tried to derive quantitative relationships between highway safety, expressed in terms crash occurrence, type, or severity, and the existence, use pattern, or other attributes of safety rest areas. These efforts have been challenged by: (1) inaccurate reports of driver fatigue and shoulder stop crash causes (i.e., often self-reported by the involved driver or subjective inferences by the investigating officer) and (2) the general associated infrequency of crashes reportedly attributable to driver fatigue and shoulder stops.

Microscopic. Despite these limitations, King (1989) devoted considerable effort to microscopic analyses of crash data drawn from the records of a number of cooperating states. King (1989) attempted to correlate distances to the nearest upstream and downstream safety rest areas with crash frequency by coding individual crashes. No significant relationship could be developed using this approach.

More recently, a similar approach was taken by Taylor and Sung (1999), with a focus on the effects of safety rest areas on fatigue-related large truck crashes. Taylor and Sung (1999) developed a hazard function to measure the probability of a crash occurring in a predetermined distance interval (i.e., every 10 miles) from the previous rest area, while controlling for various confounding traffic and roadway factors. The generalized hazard function is defined as:

$$h(t) = \frac{f(t)}{1 - F(t)}$$

where h(t) is the conditional probability that an event (i.e., a crash) will occur between time t and t + dt, given that the event has not occurred up to time t. Results from this effort indicated that the probability of a nighttime (i.e., 10:00 PM to 6:00 AM), single-vehicle crash occurring on a rural freeway segment was predicted to increase when the distance to the last rest area exceeded 30 miles. This phenomenon continues for a distance of at least up to 50 miles.

With a broader focus on vehicle involvement for all vehicle types and potentially confounding factors (i.e., weather and road conditions, interchanges, safety rest area occupancy), Morris and O'Brien (2007) considered the effects of safety rest area spacing on crashes along key Interstates in Minnesota. Unlike the work by Taylor and Sung (1999), descriptive rather than statistical findings were largely reported. For example, Morris and O'Brien (2007) graphically depicted single-vehicle truck crashes in relation to both upstream rest area distances and geographic location (see Figure 3) but provided no statistical correlation or confirmation of the relationship. Using simple linear regression methods, the authors did develop statistical relationships between single-vehicle truck crashes and safety rest area occupancy:

Single-vehicle truck crashes =
2.9968 (rest area percent occupancy) + 1.9642
$R^2 = 0.3413$

Single-vehicle, "asleep" truck crashes =
2.5129 (rest area percent occupancy) + 0.0113
$R^2 = 0.3413$

Although the relatively low R^2 values suggest limited explanatory power (an R^2 value of 1.00 suggests a perfect model).

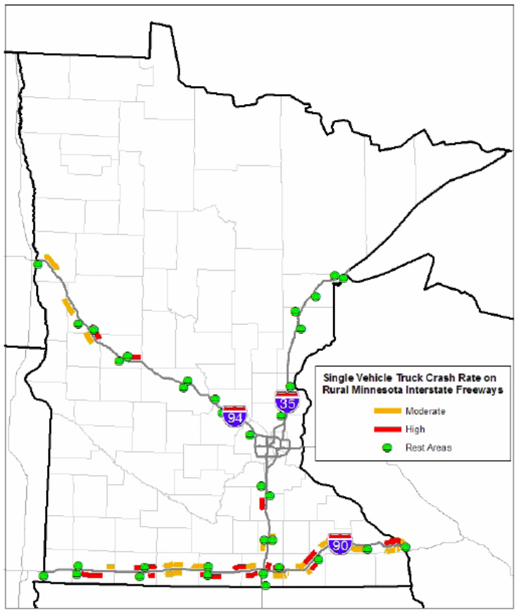


Figure 3. Moderate and High Crash Rates and Safety Rest Areas by Location (Morris and O'Brien 2007).

Macroscopic. As a companion effort to his earlier reported work, King (1989) also attempted to confirm a correlation between crash frequencies and average safety rest area spacing along rural highway segments 100 miles or more in length. This macroscopic approach was challenged by:

- Infrequent 100-mile sections that did not contain an urban aggregation or major freeway to freeway interchange.
- Limited traffic volume, traffic stream composition, and topographic data for most of the highway sections of interest.

Non-statistical results from this effort suggested that crash frequency may decrease with decreased safety rest area spacing down to approximately 50 miles; shorter spacing had no apparent effect. No statistically valid, quantifiable safety benefit of safety rest areas could be demonstrated.

Indirect Safety Benefit Analyses. Using indirect analysis methods and with a focus on fatigue and shoulder stops, King (1989) estimated the safety benefits resulting from a reduction in fatigue-related and shoulder stop crashes attributable to safety rest areas using a four-step procedure:

1. Define a functional relationship between driver performance attributes and the occurrence of highway crashes.
2. Quantify the "base" levels of the pertinent driver performance attributes.
3. Quantify the change in these attributes as a result of the existence and use of safety rest areas.
4. Apply the functional relationship of (1) to the quantitative information of (2) and (3) using appropriate mathematical techniques to quantify the effect of safety rest areas on crash occurrence.

Fatigue. The opportunity for rest afforded by safety rest areas should contribute significantly to the alleviation of fatigue in the driving population and, therefore, to a reduction in fatigue-related highway crashes. The quantification of this effect is challenged, however. No database currently exists that defines the distribution of fatigue in the driving population. Further, there is no general agreement on a metric for defining or delineating fatigue.

In response to these challenges, King (1989) developed a parametric approach to determine an order of magnitude of the effect. Initially, King (1989) defined the following relationships:

Crash rate with no safety rest areas = Af × Pf + Anf × (1 – Pf)

Crash rate with safety rest areas = Af × (Pf – Cfe) + Anf × (1 – Pf + Cfe)

Change in crash rate = Cfe × (Af – Anf)

where Af and Anf = fatigued and non-fatigued driver crash rates; Pf = the proportion of all drivers who are fatigued, and Cfe = the change in the proportion of fatigued drivers attributable to the safety rest area.

The total crash rate cannot be disaggregated into a fatigued and non-fatigued component because the relative size of these two populations is not known. However, if the proportion of all crashes involving fatigue can be ascertained from crash data files and per person vehicle-miles traveled are assumed to be equal for the two populations:

$$\mathrm{Af} = \frac{\mathrm{AC\ x\ Paf}}{\mathrm{Pop\ x\ Pf}} = \frac{\text{Crashes involving fatigue}}{\text{Fatigued driver population}}$$

$$\mathrm{Anf} = \frac{\mathrm{AC\ x\ (1 - Paf)}}{\mathrm{Pop\ x\ (1 - Pf)}} = \frac{\text{Crashes not involving fatigue}}{\text{Non - fatigued driver population}}$$

$$\text{Reduction in crash rate} = \frac{\text{Cfe x (Paf - Pf)}}{\text{Pf x (1 - Pf)}} \text{ x } \frac{\text{AC}}{\text{Pop}}$$

where AC = the total number of crashes, Pop = the driving population, Paf = the proportion of all crashes involving fatigue, all other variables are as previously defined.

Dividing this latter equation by the overall crash rate, AC/Pop:

$$\text{Percent reduction in crash rate} = 100 \text{ x } \frac{\text{Cfe x (Paf - Pf)}}{\text{Pf x (1 - Pf)}}$$

An estimate for the change in the proportion of fatigued drivers attributable to the safety rest area (Cfe) was derived based on the following information:

- Safety rest area interview responses indicated that almost 28 percent of persons interviewed at rest areas indicated that they felt fatigued before entering the rest area.
- An in-depth analysis of rest area interview responses—concentrating on such items as somatic complaints associated with fatigue, boredom and monotony, and the time elapsed since the last stop—indicated an additional 4 percent feeling fatigued.
- Data shown in Figure 4 indicate that, given the national average rest area spacing of 44 miles, 14 percent of all passing traffic will enter a rest area based on the following relationships for Interstates:

  FHWA: P = 0.0024 DSL

  1: P = 0.020 + 0.0029 DSL (King 1989)

  2: P = 0.035 DSL (King 1989)

  3: P = 0.0070 DSL $^{0.81}$ (King 1989)

  where P = is the proportion of mainline traffic entering the rest area and DSL = the actual distance between safety rest areas in miles.

Using a Cfe estimate of approximately 5 percent for drivers who are fatigued and who enter a rest area (Cfe = (0.28+0.04) × 0.14), King (1989) developed a graphical representation of these results (see Figure 5). Note that the potential for safety rest areas to provide a reduction in crash rate increases as the influence of fatigue on crash causation (i.e., Paf – Pf) increases.

King (1989) demonstrated the economic significance of this estimated reduction in crash rates by example. If it is assumed that half of all fatigued drivers will enter a rest area, the population fatigue level, Pf, will be given as two times the number of drivers who are fatigued and who enter a rest area (2 × Cfe) or [2 × (0.28+0.04) × 0.14] = 0.09. If it is now assumed that the true proportion of all crashes which involve fatigue is 0.15 (approximately 50 percent higher than the 9 percent fatigue-related crashes reported in the 1982 National Accident Sampling System (NASS) file and considered to be the lower bound), the reduction in crash rates due to the rest area is as follows:

$$\text{Percent reduction in crash rate} = 100 \text{ x } \frac{\text{Cfe x (Paf - Pf)}}{\text{Pf x (1 - Pf)}} = \frac{0.05 \text{ x } (0.15 - 0.09)}{0.09 \text{ x } (1 - 0.09)} = 3.7\%$$

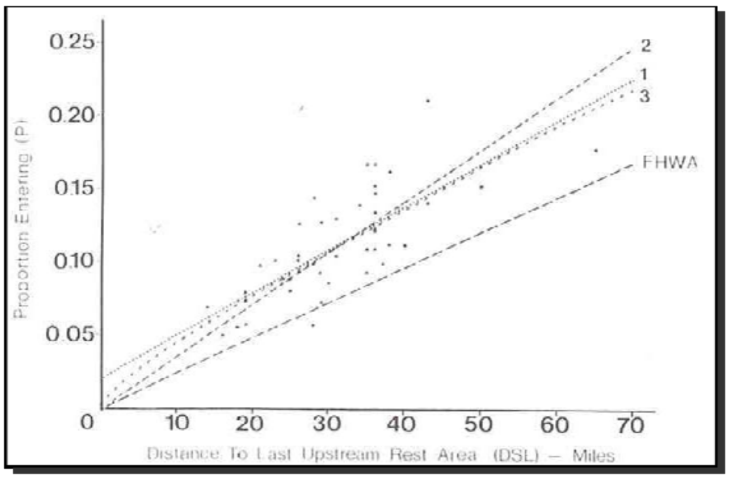


Figure 4. Rest Area Use as a Function of Rest Area Spacing (King 1989).

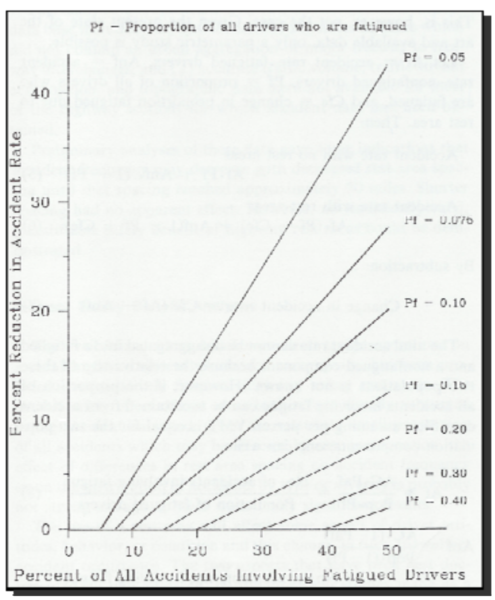


Figure 5. Possible Reduction in Crash Rates (King 1989).

At the time of his investigation, the total economic loss due to crashes on the rural Interstate System had been estimated to exceed $4 billion annually (King 1989). A reduction in crash rates by 3.7 percent because of the existence of safety rest areas would thus represent a benefit to society of $148 million per year under the conservative assumption that the severity distribution of crashes involving fatigue is the same as that for all crashes. This amount represents approximately 50 percent of the annualized cost of U.S. Interstate safety rest areas.

The procedure used to derive the estimated reduction in crashes implies that these costs are insensitive to distance between rest areas if the FHWA formula (see Figure 3 provided previously), or any other formula specifying a straight line through the origin, is used. This assumption may not be realistic; as the distance between safety rest areas increases, motorists will seek other stopping opportunities resulting in an increasing proportion of shoulder stops or travel to off-route facilities.

Shoulder Stops. Drivers will stop on the shoulders of a highway for a number of both voluntary and involuntary reasons. Involuntary reasons may involve police action, crash involvement, an impairment of the vehicle or driver, or highway surface or visibility conditions that make further progress impossible or excessively hazardous. Voluntary or discretionary shoulder stops are typically more frequent and made for any number of reasons. The frequency of discretionary shoulder stops has been estimated to range from one for every 980 vehicle-miles of travel to one for every 2,800 vehicle-miles of travel (Pogust et al. 1964, Downs and Wallace 1982).

Vehicles parked on shoulders, regardless of purpose, create a crash hazard, especially on high-speed facilities. A study conducted by the FHWA (1977) reported that 3 percent of all crashes involved vehicles on the shoulder and that the proximate cause in more than half of these crashes involved a fatigued driver striking the vehicle on the shoulder. A more recent study in California reported 42 fatal crashes resulting from shoulder stops, with approximately half of these crashes involving a truck parked on the shoulder (Howell et al. 1985). Both the frequency and severity of shoulder stop crashes may be underestimated. Crashes involving dismounted motorists were likely preceded by a shoulder stop but are not classified as such. Further, some proportion of sideswipe or rear-end crashes is likely a result of vehicles entering or leaving the highway shoulder.

Using the same general four-step procedure for estimating safety benefits resulting from a reduction in fatigue-related crashes, King (1989) considered the potential for reductions in shoulder stop crashes based on:

- Data on the frequency of shoulder stops and the rate of crashes involving vehicles stopped on the shoulder assembled by Hauer and Lovell (1984).
- Estimates of the number of shoulder stops prevented by safety rest areas and safety rest area usage derived from the surveys conducted by King (1989).
- Estimates of safety rest area use.
- Disaggregate vehicle-miles traveled data provided by FHWA.

Using indirect analysis methods, King (1989) defined a relationship to estimate the potential increase in discretionary shoulder stops if safety rest areas were not available:

$$\text{Percent increase in discretionary shoulder stops} = 100 \text{ x} \left[\frac{\left(\text{P x Pss x } 10^6 / \text{DSL}\right)}{\text{SSl}} \right]$$

where P = the proportion of mainline traffic entering the safety rest area, Pss = the proportion of drivers who would make a shoulder stop if the rest area were not available, DSL = the distance between safety rest areas in miles, and SSl = the estimated shoulder stop frequency per million vehicle miles of leisure travel.

Based on public responses, King (1989) estimated the proportion of drivers who would make a shoulder stop if the rest area were not available as 12.5 percent for passenger cars (estimated as 11.2 percent by Hauer and Lovell [1984] and 14.7 percent by King [1989]) and 22.9 percent for trucks and RVs (estimated by Hauer and Lovell [1984]). Somewhat greater weight was given to the rest area surveys conducted by Hauer and Lovell (1984) because respondents had recently been exposed to signing to the effect that shoulder stops are only permitted in emergencies.

Relating this information to vehicle miles traveled, Hauer and Lovell (1984) noted considerable spread in the estimates for shoulder stop frequencies (see Table 34). King (1989) supported these findings related to voluntary stops for passenger cars. Based on the 100-mile median distance between discretionary stops and the proportion of respondents who prefer a shoulder stop to other alternatives (5.4 percent) as reported in a telephone survey, King (1989) estimated that a discretionary shoulder stop will be made approximately every 1,850 miles resulting in 541 voluntary shoulder stops per million vehicle miles.

Table 34. Stops per Million Vehicle Miles (Hauer and Lovell 1984).

VEHICLE TYPE	EMERGENCY	LEISURE	TOTAL
Passenger Cars	74	555	629
Trucks	192	1000	1192

King (1989) estimated, without explicitly specifying the source of this data, the average proportions of the total mainline traffic stream that will enter a safety rest area as 10 percent for passenger cars and 15 percent for trucks and RVs. The proportion of the traffic stream that will *not* voluntarily stop on the shoulder is given by the proportion entering a safety rest area × the proportion that would stop on the shoulder:

Passenger Cars $0.1 \times 0.125 = 0.0125$

Trucks and RVs: $0.15 \times 0.229 = 0.0344$

Based on these proportions and using the national average Interstate safety rest area spacing of 44 miles (it was assumed that the potential shoulder stops prevented by the safety rest area would, presumably, occur at some point between the safety rest area and the next downstream facility), the rate for prevented shoulder stops estimated by King (1989) was:

Passenger Cars: $(0.0125 \times 10^6)/44 = 284$ per million vehicle miles

Trucks and RVs: $(0.0344 \times 10^6)/44 = 782$ per million vehicle miles

If safety rest areas were not available, King (1989) estimates that discretionary shoulder stops could increase by the following percentages:

Passenger Cars: $100 \times (284/555^{\dagger}) = 51$ percent

Trucks and RVs: $100 \times (782/1000^{\dagger}) = 78$ percent

† *Total voluntary shoulder stops estimated by Hauer and Lovell (1984)*

King (1989) derived a similar relationship to estimate the potential increase in involuntary shoulder stops if safety rest areas were not available:

$$Percent\ increase\ in\ involuntary\ shoulder\ stops = 100\ x \left[\frac{\left(P\ x\ Pvc\ x\ Pvs\ x\ 10^6 / DSL \right)}{SSe} \right]$$

where Pvc = the proportion of drivers who would stop at a safety rest area to perform vehicle or load checks, Pvs = the proportion of drivers who avoided a subsequent emergency stop as a result of checking their vehicle or load, and SSe = the estimated involuntary shoulder stop frequency per million vehicle miles of travel, and all other variables are as previously defined.

It has been postulated that safety rest areas may also prevent involuntary (emergency) shoulder stops (most of which are due to vehicle failure) by offering an opportunity to detect incipient vehicle failure. In King's (1989) investigation, it was assumed that at least 10 percent of all rest area users who checked their vehicle, or its load, during a rest area stop thereby avoided a subsequent emergency stop. Based on safety rest area survey responses, King (1989) estimated the percentages of passenger cars and trucks/RVs whose drivers reported stopping for car services, load checks, etc. as 8.9 percent and 18.0 percent, respectively.

Using the same procedures as before, the proportion of the traffic stream that will *not* involuntarily stop on the shoulder is given by the proportion entering a rest area × the proportion checking vehicle or load × the proportion of prevented emergency stops:

Passenger Cars: $0.1 \times 0.089 \times 0.1 = 0.00089$

Trucks and RVs: $0.15 \times 0.18 \times 0.1 = 0.0027$

Based on these proportions and using the national average Interstate rest area spacing of 44 miles, the rate for prevented involuntary shoulder stops estimated by King (1989) was:

Passenger Cars: $(0.00089 \times 10^6)/44 = 20$ per million vehicle miles

Trucks and RVs: $(0.0027 \times 10^6)/44 = 61$ per million vehicle miles

If safety rest areas were not available, King (1989) estimates that discretionary shoulder stops could increase by the following percentages:

Passenger Cars: $100 \times (20/74^{\dagger}) = 27$ percent

Trucks and RVs: $100 \times (61/192^{\dagger}) = 32$ percent

† *Total involuntary (emergency) shoulder stops estimated by Hauer and Lovell (1984)*

To determine the total percentage increase in shoulder stops (voluntary and involuntary) that would occur if safety rest areas were not available, King (1989) utilized a weighted average based on vehicle type and associated vehicle miles of travel for passengers cars (80.9 percent) and trucks and RVs (19.1 percent) on the rural Interstate System:

Passenger Cars: $100 \times ((0.51 \times 555) + (0.27 \times 74))/(555 + 74) = 48$ percent

Trucks and RVs: $100 \times ((0.78 \times 1000) + (0.32 \times 192))/(1000 + 192) = 71$ percent

Total: $(48 \times 0.809) + (71 \times 0.191) = 52$ percent

The same procedure can be used for individual state safety rest area systems and possibly for individual facilities by using local traffic volume and proportion entering data and only considering the segment of road to the next downstream safety rest area. The use of nationwide data on shoulder stop frequency for individual, specific locations may, however, be questionable; the factors affecting shoulder stop frequency are not fully understood, and there may be considerable regional differences in that frequency.

In his investigation, King (1989) assumed that a 52 percent increase in shoulder stops frequency would produce a 52 percent increase in crashes involving vehicles on shoulders. Using crash rates determined by Hauer and Lovell (1984) for crashes involving vehicles stopped on the shoulder on the rural Interstate System (see Table 35) and a total vehicle miles traveled estimate of 171,370, King (1989) provided a disaggregate estimate of shoulder stop crashes prevented by safety rest areas as follows:

Fatal: $2.22 \times 10^{-3} \times 171{,}370 \times 0.52 = 198$

Non-Fatal Injury: $3.53 \times 10^{-2} \times 171{,}370 \times 0.52 = 3{,}146$

Property Damage Only: $5.00 \times 10^{-2} \times 171{,}370 \times 0.52 = 4{,}456$

Total: $8.75 \times 10^{-2} \times 171{,}370 \times 0.52 = 7{,}797$

Note that evidence suggests that the crash severity of shoulder stop crashes may differ from that of other types of crashes or total crashes combined and may differ by environment (i.e., urban or rural). Hauer and Lovell (1984) estimated a ratio for fatality, non-fatal injury, and property damage only crashes of 1:16:22. Comparably, the National Safety Council (1988) reported a 1:28:453 ratio for all crashes and a 1:8:182 ratio for rural Interstate System crashes.

Table 35. Crashes Involving Vehicles Stopped on the Shoulder on the Rural Interstate System (Hauer and Lovell 1984).

CRASH SEVERITY	NUMBER	RATE (million vehicle-miles)
Fatal	309	2.22×10^{-3}
Non-Fatal, Injury	4,898	3.53×10^{-2}
Property Damage Only	6,938	5.00×10^{-2}
Total	12,145	8.75×10^{-2}

These data are not directly comparable since non-disabling injuries are designated as property damage only crashes. An examination of disaggregate crash data from select states produced the following severity ratios for rural Interstate crashes:

Illinois	1:26:57	Oregon	1:22:21
Nebraska	1:27:51	South Carolina	1:11:72
North Carolina	1:20:27	Wisconsin	1:46:126
North Dakota	1:24:65	Wisconsin	1:46:126
		Seven State Average	1:21:53

The differences in the proportion of crashes recorded as property damage only is likely explained by differences in crash reporting thresholds between the states. Hauer's data are corroborated by data from Virginia, which reports a 1:16:24 ratio for crashes involving parked vehicles on Interstates as compared with 1:48:83 for all (rural and urban) crashes on these routes.

Using unit crash cost data for rural crashes developed by Rollins and McFarland (1986), updated to 1987 dollars by applying appropriate economic indices, King (1989) estimated the total cost of preventable crashes to be approximately $297 million. The average cost for each of these prevented crashes is almost $38,000 because of their high average severity; 44 percent higher than the average cost of rural crashes computed by Rollins and McFarland (1986).

With the total annual maintenance cost of the entire U.S. Interstate safety rest area/welcome center system estimated to be approximately $309 million (EAUC based on $93.4 million annual maintenance costs, $2.4 billion replacement costs, 25-year facility life, and a 7.5 percent tax free bond interest rate), the estimated total costs of shoulder stop crashes prevented by safety rest areas is almost equal to the total cost of the safety rest area system.

Other Causal Factors. The preceding information has suggested potential safety benefits attributable to safety rest areas as a result of reductions in driver fatigue, voluntary shoulder stops, and to a lesser extent, involuntary shoulder stops.

A number of other causal mechanisms that relate safety rest area use to highway safety improvements have been postulated. Rest areas serve to enhance safety by: providing a safe refuge under hazardous weather, roadway, and visibility conditions; reducing in-vehicle driver distraction resulting from a restless pet or child; or communicating safety-related information to drivers. With few exceptions, these items are not able to be verified empirically or quantified.

Monetary Valuation of Safety Benefits. Contemporary guidance to assign monetary values to changes in crash rates or severities observed is available through a number of different sources including *The Economic Impact of Motor Vehicle Crashes* (USDOT 2000a), *Revision of Departmental Guidance on Treatment of the Value of Life and Injuries* (USDOT 2000b), and *Estimating the Costs of Unintentional Injuries, 2007* (National Safety Council 2007).

The first two sources listed above define crash costs based on the Maximum Abbreviated Injury Scale (MAIS), which categorizes injury severity in eight distinct levels: property damage only, six levels of injury, and fatality. The NSC describes injury severity in five distinct categories using the KABC scale: K=fatality, A=incapacitating injury, B=non-incapacitating injury, C=possible injury, and N=no injury (property damage only). These two scales do not directly relate. For this investigation, the nature of severity data available from the Texas Accident File or CRIS best aligns with the KABC injury severity scale.

Calculable costs of motor vehicle crashes are wage and productivity losses, medical expenses, administrative expenses, motor vehicle damage, and employers' uninsured costs. The costs of all these items for each death (not each fatal crash), injury (not each injury crash), and property damage crash are designated as "economic costs" in Table 36. In addition to the economic cost components listed, comprehensive costs include a measure of the value of lost quality of life, which was obtained through empirical studies of what people actually pay to reduce their safety and health risks. The average comprehensive costs on a per injured person basis are also listed in Table 36. The unit costs listed in Table 36 are expressed in terms of 2007 dollars.

Given the uncertainties in estimating crash costs, the NSC recommends that any cost estimates be rounded to indicate that they are only approximations, not exact figures. The recommended rule is as follows for estimates:

- Less than $3,000,000, round to the nearest $100,000.
- Between $3,000,000 and $10,000,000, round to the nearest $500,000.
- Between $10,000,000 and $30,000,000, round to the nearest $1,000,000.
- Greater than $30,000,000, round to the nearest $5,000,000.

Table 36. Unit Costs for Various Crash Outcome Severity Levels (National Safety Council 2007).

INJURY SEVERITY		2007 DOLLARS
ECONOMIC COSTS		
K	Fatality	$1,130,000
A	Incapacitating injury	$65,000
B	Non-incapacitating injury	$21,000
C	Possible injury	$11,900
N	No injury (PDO)	$7,500
COMPREHENSIVE COSTS		
K	Fatality	$4,100,000
A	Incapacitating injury	$208,500
B	Non-incapacitating injury	$53,200
C	Possible injury	$25,300
N	No injury (PDO)	$2,300

Comfort and Convenience Benefits

There is general agreement that, apart from improvements in highway safety, enhancement of the comfort and convenience of the motoring public is the principal reason for the existence of safety rest areas. Comfort and convenience are broad, intangible, and subjective concepts incapable of being directly quantified or expressed in monetary terms.

The need to develop an appropriate methodology to account for such intangibles (non-economic goods) in decisions concerning the expenditure of public funds has received considerable recent attention, often in relation to providing support for cultural or recreational facilities. One of the frequently advocated methods—if an equivalent economic good with a known price cannot be identified—is willingness to pay. This method, essentially, consists of asking the potential user or beneficiary "What is it worth to you?"

Safety rest area and telephone surveys conducted by King (1989) included a series of questions that explored "willingness to pay" in terms of both amount and modality. Depending on how these data are interpreted, the perceived value of comfort and convenience is estimated to be between $0.40 and $1.00 per entering vehicle, with travelers with children and truckers indicating a higher willingness to pay. Relating these willingness to pay estimates to the national annual rest area usage of 600 million vehicles (concurrently estimated in his investigation), King (1989) estimated the total "comfort and convenience" benefit attributable to safety rest areas to be between $240 and $600 million with a midpoint of $420 million.

King (1989) used a hypothetical example to demonstrate this same relationship on an individual facility scale. In this example, King (1989) assumed a local average daily traffic (ADT) of 7,500 (the 1987 average unidirectional ADT per mile for the U.S. Interstate System), that 10 percent of all passenger cars and 15 percent of all trucks on the mainline enter the safety rest area, and that trucks constitute 14 percent of the traffic stream. Ignoring weekday-weekend differentials, the annual mainline volume approximates 2.7 million vehicles (7,500 vehicles per day × 365 days per year). Annual safety rest area use would thus consist of 219,000 passenger cars and 77,000 trucks. King (1989) further assumed that passenger car drivers would pay $0.76 and truck drivers $0.82 per visit (these estimates assume that half of all respondents who indicated that they would not pay a fee to use a safety rest area would change their mind if a fee were actually imposed). Using these estimates and under these assumptions, comfort and convenience benefits attributable to a single safety rest area would be valued at approximately $230,000. This amount is approximately equal to the estimated EUAC of constructing, operating, and maintaining a single safety rest area according to AASHTO.

Similar willingness to pay estimates was obtained in a safety rest area survey conducted for the Montana Department of Transportation (Blomquist and Carson 1998). When asked whether or not they would be willing to pay a use fee to finance rest area improvements, 36.26 percent statewide responded affirmatively. When presented a range of monetary values and asked how much they would be willing to pay per safety rest area visit, the highest percentage of respondents reported a willingness to pay somewhere between $0.25 to $1.00 (17.43 percent statewide). Many respondents chose not to respond to this question.

Excess Travel and Diversion Benefits

Excess travel is defined as the arithmetic difference between the actual highway distance traveled and the travel distance that would have resulted under optimum origin-destination route connections. In the context of route finding, a synthesis of available data conducted by King and Mast (1987) indicates that excess travel contributes 4 percent of all vehicle miles of travel and 7 percent of all travel time for work-related trips. Corresponding figures for non-work-related trips are 20 and 40 percent, respectively. Applying these proportions to all U.S. travel, excess travel accounts for 83.5 billion miles and 914,000 person-years annually, with a total estimated cost of more than $45 billion. Reductions in excess travel concurrently reduce crash exposure.

As part of the same investigation, King and Mast (1987) estimated that excess driving is responsible for crashes with a total economic loss of $4.4 billion nationwide.

Based again on responses from safety rest area and telephone surveys, King (1989) applied these same estimation principles to determine the degree of excess travel that results in the absence of available safety rest areas. In this investigation, approximately 30 percent of all drivers reported that they would leave the highway if a safety rest area were not available. If there were *no* rest areas available, this percentage would increase to 43 percent because a proportion of those drivers who would travel to the *next* rest area would also divert off the route.

If it is assumed that the services required (e.g., toilet, telephone, safe stopping place, etc.) are available within 5 miles of the next interchange and the return can be made using that same interchange, every such detour would involve an extra 10 miles. Applying this figure to the total annual safety rest area usage estimate of 600 million vehicles, excess driving is estimated to account for 2.5 billion miles. This excess mileage results in costs associated with both the operation of the vehicle and the driver's wasted time.

For individual safety rest areas, the analysis can be made more precisely because both the location of the alternate stopping places in relation to the nearest interchange and the excess distances generated are known or can be ascertained in the field. Other required input data, such as expected safety rest area use, can also be determined more accurately.

At the time of King's study, variable, out-of-pocket driving costs for passenger cars were estimated to be 7.6 cents per mile. Operating costs for trucks—because of higher fuel consumption, higher tire costs, and mileage based taxes—are much higher but exact figures were not readily available. King (1989) assumed a conservative composite rate of 10 cents per mile for the entire traffic stream. At this rate, the estimated excess driving distance would result in extra costs to the public exceeding $250 million for the entire Interstate safety rest area system.

In addition to these excess operating costs, the detour will also consume time. If an average detour speed of 30 mph is assumed, this extra time will be 20 minutes for each detour or a total of about 85 million hours. Average value of time estimates for passenger cars of $8.50 per hour for work trips and $6.50 per hour for other trips were derived in his earlier study (King and Mast 1987). Using data from the Nationwide Personal Transportation Survey (NPTS, now the National Household Travel Survey, NHTS) and highway statistics from FHWA, King (1989) estimated the extent of personal business travel to be 7.5 percent of vehicle miles traveled

(VMT) for trips over 150 miles and truck business travel to be 24 percent of all VMT (if it is assumed that 50 percent of all VMT by 2-axle, 4-tire trucks (e.g., vans, pick-ups and other small trucks) are non-business related). King (1989) further assumed that vehicle occupancy was 1.4 for business travel and 2.1 (adults) for other travel. Using these estimates and under these assumptions, the total cost of this excess time equates to more than $1 billion. The authors noted that the value of time, especially small increments of time, is an extremely controversial aspect of highway economic analysis. This estimate should therefore be considered with caution.

Monetary Valuation of Travel Time. Efforts to accurately estimating the value of travel time, particularly as it applies to safety rest area users, are challenged. The USDOT, in their *Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis* (2003), provides general guidance on the valuation of time for broader transportation-related economic analysis. Using this methodology, an hour of travel associated with a business trip or commerce is usually valued at the average traveler's wages, fringe benefits (i.e., insurance, vacation, holidays, sick leave, other paid leave, etc.) and legally required benefits (i.e., unemployment insurance, Social Security, workers' compensation, etc.), representing the cost to the traveler's employer. Current and regional wage and employment data can be obtained from the Bureau of Labor Statistics website (http://www.bls.gov/bls/blswage.htm).

Personal travel time (either for commuting or leisure) is usually valued as a percentage of average traveler wage and reflects the opportunity cost of time spent traveling vs. time that could be spent doing something else. The USDOT recommends valuing local and intercity personal travel time at 50 percent (ranging from 35 to 60 percent) and 70 percent (ranging from 60 to 90 percent) of average wage, respectively. Comparatively, the USDOT recommends valuing travel time for truck drivers and business travelers at 100 percent, with a range of 80 to 120 percent for the latter category of traveler. The USDOT (2003) suggests using a range of plausible values to test the sensitivity of economic evaluations and conclusions.

Mean hourly values of travel time savings by trip type and purpose, as well as plausible ranges of values, are provided in Table 37. Monetary values are expressed in terms of 2000 dollars and adjusted appropriately for inflation.

Table 37. Recommended Hourly Values of Travel Time Savings by Trip Type and Purpose (USDOT 2003).

TRIP TYPE/PURPOSE	2000 DOLLARS			2008 DOLLARS		
	Mean	Range		Mean	Range	
		Low	High		Low	High
LOCAL						
Personal	$10.60	$7.40	$12.70	$13.13	$9.17	$15.73
Business-Truck Driver	$18.10	-	-	$22.42	-	-
Business-Other	$21.20	$17.00	$25.40	$26.26	$21.05	$31.46
All Purposes[1]	$11.20	$7.90	$13.40	$13.87	$9.78	$16.60
INTERCITY						
Personal	$14.80	$12.70	$19.00	$18.33	$15.73	$23.53
Business-Truck Driver	$18.10	-	-	$22.42	-	-
Business-Other	$21.20	$17.00	$25.40	$26.26	$21.05	$31.46
All Purposes[1]	$15.60	$13.20	$19.80	$19.32	$16.35	$24.52

[1] Weighted averages using distributions of travel by trip purpose on various modes (*1995 NPTS,* http://www-cta.ornl.gov/npts/1995/Doc/index.shtml). Local travel: 94.4% personal, 5.6% business. Intercity travel: 86.9% personal, 13.1% business.

Based on average hourly earnings rates in 2000 for local and intercity personal travel by surface modes (U.S. Census Bureau median household income of $42,148 divided by 2,000 hours per year) and local and intercity business travel by surface modes (total compensation cost per hour worked reported by the Bureau of Labor Statistics [2001]), recommended hourly values of travel time savings were derived ranging from $10.60 to $21.20.

Average hourly rates for truck drivers in local and intercity travel are based on the median weekly earnings of full-time truck drivers for 2000 (reported by the Bureau of Labor Statistics [2001] as $564) divided by average weekly hours for full-time operators in transportation and material moving occupations (45.7 hours per week) plus total benefits (reported by the Bureau of Labor Statistics [2001] as $5.80). The recommended hourly values of travel time savings for truck drivers engaged in local or intercity travel is $18.10.

Utilizing the national guidance provided by the USDOT and state-level wage and compensation data, the Oregon Department of Transportation's Long Range Planning Unit recently updated it estimates of the hourly value of time at the state level (Whitney 2008). Table 37 provides the final estimated values of travel time for autos (including private passenger trucks), light trucks (including single-unit, two-axle, four-tire trucks in commercial use; other single-unit trucks; and single trailer trucks with four axles or less), and heavy trucks and summarizes the various supporting estimates used to derive the value of time. Three types of data were considered: (1) wages and total compensation data, (2) on-the-job trip characteristics (not including commute trips), and (3) off-the-job trip characteristics. Specific data sources supporting ODOT's value of time estimates are provided as footnotes to Table 38.

Whitney (2008) considered the sensitivity of these estimates to different underlying assumptions. Table 39 summarizes these results. For example, the estimated value of travel time for a person driving an auto alone changes the value of travel time estimate from $17.58 to $12.65. Doubling the assumed miles on-the-job for autos increases the value of travel time estimate from $17.58 to $19.09. Removing benefits from the total compensation calculation reduces the heavy truck estimate from $30.93 to $21.35. Increasing the assumed wage for light truck drivers by 10 percent increases the value of travel time estimate from $21.32 to $22.74. When applied at the state level, this sensitivity analysis exercise can point to specific underlying assumptions that should be refined through additional research or data collection to enhance the accuracy of estimates.

Monetary Valuation of Vehicle Operating Costs. Excess travel and diversion in the absence of safety rest areas will also result in additional vehicle operating costs attributable to excess fuel consumption, vehicle wear and tear, subsequent vehicle maintenance, and vehicle depreciation. Vehicle operating costs that can be expressed in terms of cents per mile of travel vary depending on driving patterns and operating conditions. Fuel consumption per vehicle-mile tends to increase at higher speeds, lower speeds, and under stop-and-go driving conditions. Vehicle operating costs are higher on urban arterials than highways, and costs increase proportional to travel time when congestion dramatically reduces traffic speed. As such, vehicle operating costs are difficult to estimate accurately.

The *Highway Economic Requirements System (HERS)-State Version* (FHWA 2002) and other roadway investment models provide detailed vehicle cost estimates for various vehicle classes and road conditions but require significant input data. Recent vehicle operating cost estimates reported by Tolliver and Dybing (2009) using HERS considered both urban and rural environments, at volume/capacity (v/c) ratios ranging from 0.40 to 1.0, and for percentages of trucks ranging from 15 to 50 percent. Table 40 presents typical average vehicle operating costs estimated by Tolliver and Dybing (2009), aggregated across all vehicle types.

Table 38. Estimated Hourly Travel Time Values by Vehicle Class in Oregon (Whitney 2008).

CATEGORY		VEHICLE CLASS		
		Auto	Light Trucks	Heavy Trucks
1	2007 Oregon Average Wage	$18.71	$13.80	$17.16
2	2007 Value of Fringe Benefits	$8.08	$6.88	$8.56
3	Total Compensation	$26.79	$20.68	$25.72
On-the-Job Trips				
4	Average Vehicle Occupancy	1.22	1.03	1.12
5	2007 Cost of Employees	$32.57	$21.32	$28.80
6	2007 Freight Inventory Value	$0.00	$0.00	$2.13
7	Total "On-the-Job" Value	$32.57	$21.32	$30.93
8	Miles "On-the-Job" %	9.1%	100.0%	100.0%
9	Weighted Value	$2.98	$21.32	$30.93
Off-the-Job Trips				
10	Average Vehicle Occupancy	1.58	N/A	N/A
11	Total "Off-the-Job" Value	$16.07	$0.00	$0.00
12	Miles "Off-the-Job" %	90.9%	0.0%	0.0%
13	Weighted Value	$14.60	$0.00	$0.00
14	**Total Weighted Average**	**$17.58**	**$21.32**	**$30.93**

1 Oregon Employment Department, Oregon Covered Employment data (autos) and Oregon Wage Information 2007 (light and heavy trucks)

2 Bureau of Labor Statistics, National Compensation Survey for (a) all civilian workers and (b) transportation and material moving occupations: 30.1% (autos) and 33.3% (light and heavy trucks) of total compensation.

3 2007 Oregon Average Wage (#1) + 2007 Value of Fringe Benefits (#2)

4 2001 National Household Travel Survey (NHTS) (autos); weighted average vehicle occupancy based on FHWA HERS-ST (average occupancy of 1.05 persons for six-tire vehicles and 1.00 for heavier single-unit trucks) and Oregon State highway system ADT data for each truck type (light trucks); and FHWA HERS-ST (heavy trucks)

5 Total Compensation (#3) × Average Vehicle Occupancy (#4)

6 NCHRP *Guidebook for Assessing the Social and Economic Effects of Transportation Projects*, combination truck inventory values of $1.78 per hour (2000 dollars) adjusted to 2007 dollars, excludes costs for spoilage and/or depreciation and assumes inventory values for vehicles other than heavy trucks are negligible.

7 2007 Cost of Employees (#5) + 2007 Freight Inventory Value (#6)

8 Bureau of Transportation Statistics, National Transportation Statistics 2008 and 2001 NHTS

9 Total "On-the-Job" Value (#7) × Miles "On-the-Job" % (#8)

10 2001 NHTS

11 FHWA HERS-ST (60% (drivers) and 45% passenger) of the average wage rate exclusive of benefits) and Average Vehicle Occupancy (#10): (0.60 × 1 driver) + (0.45 × 0.58 passengers) × $18.71.

12 100% - Miles "On-the-Job" % (#8)

13 Total "Off-the-Job" Value (#11) × Miles "Off-the-Job" % (#12)

14 Weighted Value (#9) of On-the-Job Trips + Weighted Value (#13) of Off-the-Job Trips

Table 39. Sensitivity Analysis Results for Estimated Hourly Travel Time Values in Oregon (Whitney 2008).

SENSITIVITY ANALYSIS MODIFICATIONS	VEHICLE CLASS		
	Auto	Light Trucks	Heavy Trucks
Total Weighted Average	**$17.58**	**$21.32**	**$30.93**
Vehicle Occupancy Rate of 1.0	$12.65	$20.68	$25.72
Miles On-the-Job Doubled	$19.09	N/A	N/A
Miles On-the-Job Halved	$16.83	N/A	N/A
Value of Benefits Excluded	$16.68	$14.22	$21.35
Wage Reduction of 10%	$15.91	$19.89	$29.01
Wage Increase of 10%	$19.25	$22.74	$32.85

Table 40. Unit Vehicle Operating Cost Values Estimated Using HERS in 2008 Cents per Mile (Tolliver and Dybing 2009).

ENVIRONMENT	V/C RATIO	PERCENT TRUCKS	TERRAIN	VEHICLE OPERATING COSTS
Urban	0.75	15%		76
		35%		97
Rural	0.70	15%	Flat	106
		50%	Mountainous	156

A number of other sources—including *The Complete Car Cost Guide* and *Complete Small Truck Guide* (Intellichoice 2001), *Your Driving Costs* (American Automobile Association 2008), *A Manual on User Benefit Analysis of Highway Improvements* (AASHTO 2003), *Per Mile Costs of Operating Automobiles and Trucks* (Barns and Langworthy 2004), and others—provide average unit vehicle operating cost estimates, distinguished primarily by vehicle type. Table 41 provides a summary of typical estimates for various private and commercial motor vehicles. Note that these estimates are not directly comparable because of differences in derivation. For example, estimates derived by the American Automobile Association (2008) reflect costs only during the first five years of a vehicle's life and as such, include relatively high depreciation and insurance costs, and almost no repair costs.

The Victoria Transport Policy Institute (2009) recently calculated vehicle operating costs using these and other published vehicle operating cost estimates, adjusted to represent life cycle costs for urban peak, urban off-peak and rural travel (see Table 42). Although vehicle operating costs were considered for a number of different transportation modes (e.g., diesel bus, bicycle, walk), only a limited number of private automobile types were applicable for this investigation.

Table 41. Unit Vehicle Operating Cost Values by Vehicle Type in 2008 Cents per Mile.

<table>
<tr><th rowspan="3">VEHICLE TYPE</th><th colspan="8">SOURCE</th></tr>
<tr><th rowspan="2">Intellichoice (2001)</th><th colspan="3">AAA (2008)</th><th colspan="3">AASHTO (2003)</th><th rowspan="2">Barns and Langworthy (2004)</th></tr>
<tr><th>10,000 mi/yr</th><th>15,000 mi/yr</th><th>20,000 mi/yr</th><th>20mph</th><th>55 mph</th><th>65 mph</th></tr>
<tr><td colspan="9">PRIVATE MOTOR VEHICLES</td></tr>
<tr><td>Subcompact</td><td>38.7</td><td></td><td></td><td></td><td rowspan="4">26.1</td><td rowspan="4">28.1</td><td rowspan="4">30.2</td><td rowspan="4">17.8</td></tr>
<tr><td>Compact</td><td>50.9</td><td>56.6</td><td>43.3</td><td>36.7</td></tr>
<tr><td>Intermediate</td><td>56.4</td><td>73.9</td><td>56.7</td><td>48.2</td></tr>
<tr><td>Full-Sized Vehicle</td><td>61.5</td><td>88.2</td><td>66.9</td><td>56.3</td></tr>
<tr><td>Compact Pickup</td><td>48.4</td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="7">22.3</td></tr>
<tr><td>Full-Sized Pickup</td><td>57.4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Compact Utility</td><td>54.9</td><td rowspan="3">93.5</td><td rowspan="3">71.6</td><td rowspan="3">60.7</td><td></td><td></td><td></td></tr>
<tr><td>Intermediate Utility</td><td>61.9</td><td></td><td></td><td></td></tr>
<tr><td>Full-Sized Utility</td><td>63.7</td><td></td><td></td><td></td></tr>
<tr><td>Mini-Van</td><td>61.0</td><td>77.0</td><td>59.2</td><td>50.5</td><td></td><td></td><td></td></tr>
<tr><td>Full-Sized Van</td><td>62.6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">COMMERCIAL MOTOR VEHICLES</td></tr>
<tr><td>Single Unit Truck</td><td></td><td></td><td></td><td></td><td>64.0</td><td>70.2</td><td>76.8</td><td rowspan="2">50.4</td></tr>
<tr><td>Tractor Trailer Truck</td><td></td><td></td><td></td><td></td><td>65.9</td><td>89.0</td><td>95.1</td></tr>
</table>

Table 42. Unit Vehicle Operating Cost Values by Environment in 2008 Cents per Mile (Victoria Transport Policy Institute 2009).

VEHICLE TYPE	URBAN PEAK	URBAN OFF-PEAK	RURAL	AVERAGE
Average Car	48.39	45.79	43.19	45.24
Compact Car	39.48	36.53	35.65	37.15
Van/Light Truck	65.13	61.43	57.74	60.75
Motorcycle	43.07	41.98	41.43	41.98

Commercial Motor Vehicle Scheduling and Staging Benefits

Motivated primarily by a desire to reduce the occurrence of fatigue-related crashes involving large trucks, a substantial body of literature exists that considers commercial motor vehicle driver needs and preferences (Chen et al. 2002), the adequacy of safety rest area parking for commercial motor vehicles (Rich 1990, American Trucking Associations et al. 1996, Connecticut Department of Transportation 2001, Trombly 2003, Garber and Wang 2004), and the use of remote sensing technology to monitor safety rest area parking capacity in real time (Bronzini et al. 2002).

With a focus on industry productivity rather than safety, Morris et al. (2007) developed an approach for analyzing how restricted rest (sleep) locations for long-haul truckers—including safety rest areas and/or private facilities—may affect operational productivity, given hours-of-service regulations. When drivers may stop for rest at any location, they should be able to maximize utilization under regulated driving hours. When drivers may stop for rest only at certain discrete locations, drivers may suffer decreased utilization. The analysis considers the simplest case, in which all loads to be transported move along a single lane and utilizes an optimal tree search algorithm for determining the minimum number of drivers required to cover a set of loads given a set of allowed rest locations.

Although not directly applicable to practice, analysis of a sample data set indicated that the productivity impact of restricting rest to a small number of discrete locations is likely to be minimal. In other words, the availability of rest (sleep) locations, including safety rest areas and/or private facilities, is predicted to have little impact on commercial motor vehicle logistics and productivity.

Highway and Other Public Agencies

Highway or other public agency benefits relate to highway operations and maintenance and direct monetary revenue.

Highway Operations and Maintenance Benefits

Safety rest areas, by their intended purpose and design, should result in decreased numbers of shoulder stops, excess travel and diversion, and roadside litter with associated benefits related to extended lives for shoulder and secondary roadway infrastructure and reduced highway cleanup costs. No prior efforts to quantify cost savings accrued by highway or other public agencies attributable to reduced highway operations and maintenance were uncovered as part of this investigation. Despite the potential for benefit, reductions in the extent of highway cleanup and shoulder stops/excess travel made by commercial motor or other types of vehicles attributable to safety rest areas is not often documented by highway or other public agencies.

Direct Monetary Benefits

Regardless of the nature of commercial establishment in safety rest areas, a portion of private revenues generally accrue to highway or other public agencies in the form of franchise or lease fees, profit sharing arrangements, and/or participation in the cost of maintaining and operating the safety rest area facility. Where such arrangements exist, observed monetary benefits accrued by highway or other public agencies are typically directly available.

External Entities

External entity benefits relate to economic development and tourism, specific business enterprises, and excess travel and diversion.

Economic Development and Tourism Benefits

The area in which external benefits are most often mentioned is the positive impact of safety rest areas on the state's economy, primarily on its tourism industry. These purported benefits are not well substantiated by quantified data and are instead inferred responses to questionnaires distributed in or administered at combined safety rest area/travel information centers. As a result, reported benefits related to economic development and tourism are highly variable (see Table 43).

More recent data collected from Michigan's welcome centers indicated that, on average, visitors who obtained and used travel information spent \$574 in Michigan during their trip; about \$200 more per trip than those who stopped but didn't obtain information (\$371) (Stynes 1998). Sixty-three percent of vehicles stopping at the welcome centers during open hours in July and August reported using the information provided changing their behavior: 10 out of every 100 vehicles spent more time in Michigan, 27 percent visited more attractions, 10 percent visited more restaurants, 18 percent traveled to more areas of Michigan than planned, and 19 percent spent more money in the state than planned. Visitors who reported spending more money than planned averaged an additional \$128 in spending on their trip: \$34 for recreation, \$30 for lodging, \$29 for food, \$11 in additional transportation expenses, and \$24 on other items. Factoring in those who do not receive information or make spending changes, the expected change in spending from welcome center information is \$23 per vehicle during open hours. Assuming that the information programs have a similar effect per vehicle throughout the year, the annual impact is \$32 million.

Table 43. Estimated Economic Development and Tourism Benefits Attributable to Safety Rest Areas (King 1989).

STATE	REPORTED BENEFITS
Colorado	Based on the observed economic impacts of Tourist Information Centers (TICs) in other states, the estimated revenue generated from the Grand Junction and Burlington TICs is $5,014,347 based on the following assumptions: • 15% of the Directional Average Daily Traffic (DADT) stop at the TIC. • 9% of this 15% (1.4%) extend their stay by 2.4 days based on information received. • Average daily expenditures (meals and lodging only) for two adults is $111/day (American Automobile Association 1984).
Florida	Four out of five visitors to the Welcome Centers read, saw, or picked up information about attractions, activities, and/or destinations. Due to the information obtained at the Welcome Centers, one out of four added one or more days to their trip.
Iowa	Based on average party expenditures and length of stay, the estimated economic impact of Welcome Centers totaled $38,117,346 in 1984 and $46,054,970 in 1985.
Kentucky	Four welcome centers were responsible for a $59.1 million infusion into the Kentucky economy in 1983. $7.4 million originated from tourists whose travel decisions were influenced by information obtained at these information centers: • Nearly $364,000 was spent on Kentucky's state parks. • Over $514,000 in tax revenues was generated. • Total revenues received by state government totaled over $778,000. The cost to the agency of operating the four welcome centers was $195,000 (net benefit of $583,000).
Michigan	Personnel at 11 travel information centers counseled 1,800,000 people: • 9 percent of travelers decided to stay an additional 4.02 days in Michigan. • The direct economic impact to the state was $41,679,360. • $6,083,519 was tax generated (assuming a 1.78 multiplier [dollars generating additional dollars] and 8.2 percent of tourism dollars resulting in tax revenue) (*Economic Impact of Michigan Welcome Centers* 1989).
Utah	At the St. George Visitor Center, nearly 20 percent of visitors said they would stay longer in Utah, and 15 percent would visit unplanned attractions. Assuming that this 35% spent at least an extra one-half night in Utah, the St. George Visitor Center may have accounted for an additional expenditure of $650,000.
Vermont	Welcome centers could generate some $100 million in additional traveler spending and upward of $10 million in state and local tax revenues.

This figure only captures the immediate effect of welcome center information programs on the current trip. Half of welcome center visitors obtaining information reported that they were "very" or "extremely likely" to use the information on future trips. If the information caused just 12 percent of these visitors to make one additional future trip, an additional $32 million in spending impacts would result.

In similar studies conducted in Rhode Island, research concludes that the welcome center generates approximately $35 in new tourism expenditures for every dollar of operating budget (Southeast Wyoming Welcome Center 2007).

To better support determination of economic development and tourism benefits, Table 44 characterizes this information in terms of the:

1. Number of visitors who decide to extend their stay or otherwise change their travel behavior as a result of information received at the traveler information center.
2. Average length of an extended trip.
3. Average size of travel party.
4. Average travel party expenditures.

Table 44. National/Aggregate Estimates to Support Determination of Economic Development and Tourism Benefits.

SOURCE	VISITORS WHO EXTEND STAY/CHANGE TRAVEL BEHAVIOR	AVERAGE LENGTH OF EXTENDED TRIP	AVERAGE TRAVEL PARTY SIZE	AVERAGE TRAVEL PARTY EXPENDITURE
Colorado	1.4% of Directional ADT	2.4 days		
Florida	25% of travelers	one or more days		
Iowa	33% of travelers	60% by 2 hrs 40% by 2 days		
Michigan	63% of vehicles 10% extended stay 27% visited attractions 10% visited restaurants 18% visited more areas 19% spent more money	9% by 4.02 days		$371/trip, no information $574/trip, information $23/vehicle
Texas			3	$117/day
Utah	20% extend stay 15% visit attractions			

Specific Business Enterprise Benefits

Discussed previously in relation to direct revenue benefits for public agencies, some specific commercial enterprises will likely benefit from safety rest areas. For example, telephone companies and vending machine operators may obtain additional revenue from safety rest area operations. Contract operators of computerized or on-site tourist information systems also expect to profit from this type of enterprise as do the participating advertisers. Operators of tourist attraction and travelers' services can be expected to obtain additional revenues from the distribution of promotional literature in safety rest area information centers.

Unlike the revenues accrued by public agencies as a result of agreements with commercial establishments, private business enterprises may be reluctant to share information related to revenue generation attributable to safety rest areas. While this information is readily quantified, it may be considered proprietary in competitive sectors of the various private industries.

Excess Travel and Diversion Benefits

Safety rest areas provide excess travel and diversion benefits to highway users by minimizing excess travel time/distance, highway or other public agencies by preserving secondary route infrastructure, and adjacent communities by minimizing congestion, noise and air pollution, and/or parking demand when drivers—if safety rest areas are not available—are required to access similar services off the highway. The subsequent impact to local inhabitants—most readily documented in consideration or as a result of a safety rest area closure—is not often documented by highway or other public agencies at the state or local jurisdiction levels. No prior efforts to quantify monetary benefits accrued by external entities attributable to reduced local congestion, noise and air pollution, and/or parking demand were uncovered as part of this investigation.

COST COMPONENT ANALYSIS METHODS

Unlike the estimation of component benefits, the estimation of cost components to support benefit-cost analyses typically involves much less uncertainty and can, in many cases, be measured directly. Component findings from the literature and state-of-the-practice review related to highway user, highway or other public agency, and external entity costs are described below. Table 45 summarizes observed analysis methods across the range of component costs.

Again, researchers attempted to identify and document both methods to support direct measurement and local estimation, as well as available national or aggregate data although the variability and site-specific nature of safety rest area costs limits the applicability of national or aggregate data in Texas.

Table 45. Safety Rest Area Component Cost Observed Analysis Methods.

COSTS	OBSERVED ANALYSIS METHODS					
	Direct Measurement	Indirect/ Parametric Analysis	Hazard-based Regression	Simple Linear Regression	User Surveys	Not Estimable
Highway Users						
Safety Costs						
Highway and Other Public Agencies						
Direct Monetary Costs	✓					
External Entities						
Excess Travel and Diversion Costs						✓
Environmental Impact Costs						✓
Socially Undesirable Behavior Costs						✓

Highway Users

Highway users potentially experience adverse safety impacts (i.e., safety cost) attributable to safety rest areas as a result of sideswipe and rear-end crashes that occur proximate to the facility's entrances and exits.

Safety Costs

Although not explicitly described in his work, the same four-step procedure used by King (1989) to estimate a reduction in fatigue-related and shoulder stop crashes (i.e., safety benefit) attributable to safety rest areas can be used to estimate the potential increase in sideswipe and rear-end crashes proximate to the facility's entrances and exits:

1. Define a functional relationship between driver performance attributes and the occurrence of highway crashes.
2. Quantify the "base" levels of the pertinent driver performance attributes.

3. Quantify the change in these attributes as a result of the existence and use of safety rest areas.
4. Apply the functional relationship of (1) to the quantitative information of (2) and (3) using appropriate mathematical techniques to quantify the effect of safety rest areas on crash occurrence.

State highway agencies have anecdotally reported a low level of crash occurrence at safety rest area entrances and exits (King 1989).

Highway and Other Public Agencies

Safety rest area costs accrued by highway and other public agencies typically include initial right-of-way acquisition, design, construction, and ongoing operations and maintenance costs that can be determined directly. These types of costs are generally well documented for existing facilities or can be accurately estimated for planned safety rest areas using data from comparable facilities.

Direct Monetary Costs

Direct monetary costs associated with safety rest areas have been observed to vary widely depending on location and terrain; access to potable water, sewage disposal and utilities; facility size and amount of parking; architecture and the cost of design materials; types of amenities and services offered; amount of use (i.e., demand); use of contracted versus in-house maintenance personnel; and more. For safety rest areas offering a high, average, and low level of service respectively, King (1989) observed high to low cost ratios from 240.0:1, 150.0:1, and 50.0:1 for right-of-way; from 20.0:1, 53.3:1, and 60.0:1 for design and construction; and from 9.1:1, 24.1:1, and 15.2:1 for maintenance and operations. Operations and maintenance costs were consistently observed to comprise approximately 35 percent of total annual safety rest area costs (King 1989).

Not surprising given the site- and facility-specific nature of safety rest area cost components and the subsequent observed national variability, little published literature related to safety rest area direct costs was uncovered to support this investigation. Anecdotal information provided for various state safety rest area facilities contained insufficient detail to adequately characterize and interpret reported costs (e.g., researchers could not determine whether reported development costs included preliminary survey and design or right-of-way-acquisition or whether annual reported cost savings resulting from closed facilities included personnel reductions).

Instead, much of the related literature focused on the routine maintenance of safety rest areas (and other roadside features), and in particular, how to reduce associated costs. A number of broad-based strategies for reducing ongoing safety rest area maintenance costs were presented in FHWA's *Optimizing Maintenance Activities–Rest Area Maintenance* report (1981). Such strategies include a review of current staffing levels, low-volume flush systems, a review of trash and litter pickup operations, and so on. A larger body of literature has more narrowly focused on the potential for private contracting of safety rest area maintenance services (Garcia-Diaz et al. 1988, Prouty 1993, Porter 2001, Wilmot et al. 2003, Eger and Wilsker 2006). Most findings suggest a realized cost savings with the use of contracted services for safety rest area maintenance. Garcia-Diaz et al. (1988) estimated that the use of contracted safety rest area maintenance services is more cost effective, resulting in an average 34.7 percent annual reduction in costs when compared to in-house services. In Iowa, Prouty (1993) estimated a total annual cost savings of $221,000 (1993 dollars) resulting from contracted safety rest area maintenance services and an additional one-time savings of $376,000 resulting from liquidated maintenance equipment no longer needed by state workforces.

External Entities

External costs and disbenefits attributable to safety rest areas—resulting from excess travel and diversion, environmental impacts or socially undesirable behavior—are less readily quantified but, as noted by King (1989), should have no significant effect on decision-making related to the establishment or continuance of a safety rest area as long as the facilities are properly located, designed, operated, and policed.

Excess Travel and Diversion Costs

The presence of a safety rest area reduces the need to depart from the route and search for desired services in a nearby locality. Subsequently, local business enterprises may experience a decline in revenue generated from a traveler's need for goods and services.

No related studies were uncovered that directly considered the negative impact on local sales as a result of existing services offered at safety rest areas. Corsi et al. (1999), however, considered the potential impact to local services if a greater extent of commercialization and subsequent services was allowed at safety rest areas (i.e., if current restrictions to safety rest area commercialization were removed). The results of the study indicated that commercialization of

Interstate rights-of-way would have a negative impact on highway-oriented services located at nearby interchanges. Specifically, the study suggests that gasoline station, food, and truck service activity sales at interchanges would be substantially reduced by commercialization of Interstate rights-of-way.

Researchers utilized data from the 1996 American Trucker EXIT GUIDE database, which included information on 7,626 interchanges where at least one of these types of establishments was present. The amount of economic activity at each establishment was estimated for a typical facility for each of the service categories under examination. Supporting economic data for each type of establishment was obtained through:

- A nationwide survey of truck stop operators who were members of the National Association of Truck Stop Operators (NATSO) (for full service truck stops and truck repair services).
- A nationwide survey of members of the Society of Independent Gas Marketers of America (SIGMA) (for gasoline stations and truck fuel stops).
- Secondary research provided by the National Restaurant Association (1995) (for food establishments).

Econometric models were developed to estimate the change in economic activity at an Interstate interchange. Potential explanatory variables included proximity population (city or county), traffic, income (average personal income per capita in the city or county), distances to nearest city, extent of access to the highway, and the existence of facilities along the rights-of-way. In the final model forms, significant explanatory variables related to traffic, demographic variables, and the level of competition along Interstate rights-of-way:

Truck Service Activity Sales at Interchanges within a County = $\beta_0 + \beta_1$ Traffic + β_2 Presence of Interstate Fuel Stop

Gasoline Station Sales at Interchanges within a County = $\beta_0 + \beta_1$ Traffic + β_2 Population + β_3 Presence of Interstate Gasoline Station

Food Establishment Sales at Interchanges within a County = $\beta_0 + \beta_1$ Traffic + β_2 Population + β_3 Presence of Interstate Food Establishment

Model results indicate that commercialization along Interstate rights-of-way on a per county basis would result in an average loss of:

- $17.3 million in truck service activity annual sales (53 percent reduction).
- $18.7 million in gasoline station annual sales (71 percent reduction).
- $12.6 million in food establishment annual sales (78 percent reduction).

Corresponding reductions in employment and tax receipts can be expected.

While these estimates do not directly reflect the current revenue loss (i.e., costs) accrued by local businesses under existing safety rest area commercialization limits, they do provide a valuable order of magnitude estimate for comparison and consideration.

Environmental Impact Costs

Environmental impacts resulting from safety rest areas may include air or noise pollution, groundwater contamination, interference with surface runoff, destruction of existing vegetation, interference with local animal habitat, removal of arable land from agricultural land use, and adverse aesthetic elements. These impacts are typically avoided or minimized through appropriate rest area location, design, and construction policies (King 1989).

Not surprising, again because of the site- and facility-specific nature of potential costs associated with environmental impacts, no cost-related information was uncovered through the published literature or state-of-the-practice search that would support determination of these costs in Texas.

Socially Undesirable Behavior

In some instances, safety rest areas have become the focus for socially undesirable behavior including prostitution, homosexual activities, and drug sales and use. This pattern places an extra burden on already extended police forces (King 1989) but these added costs attributable to the safety rest area facility are often not distinguished by local agencies. No prior efforts to quantify costs associated with socially undesirable behavior at safety rest areas were uncovered through the published literature or state-of-the-practice search conducted as part of this investigation.

COMPREHENSIVE BENEFIT-COST ANALYSIS METHODS

In addition to considering focused efforts that improve upon the estimation of the individual benefit or cost components, researchers also considered comprehensive benefit-cost analysis methodologies that assimilate the individual benefit and cost component findings.

A variety of indices can be used to describe benefit-cost relationships as follows:

- Net Present Value (NPV) is the sum of benefits minus costs, adjusted for changes in monetary worth over time using a discount rate:

$$NPV = \sum_{t=1}^{T} \frac{\left(Benefit_t - Cost_t\right)}{(1+r)^t}$$

  The NPV should be greater than zero. Depending on their nature, individual costs (or benefits) may be expressed as Equivalent Uniform Annual Costs (EUAC) to accommodate differing life cycles among cost components.

- Benefit-Cost Ratio (BCR) is calculated as the NPV of benefits divided by the NPV of costs:

$$BCR = \frac{\sum_{t=1}^{T} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{T} \frac{C_t}{(1+r)^t}}$$

  where B_t is the benefit in time t and C_t is the cost in time t. The BCR should be greater than 1.

- Internal Rate of Return (IRR) is the discount rate for which the present value of total benefits equals the present value of total costs (i.e., the maximum interest that could be paid for a project which would still allow the investor to break even):

  PV(Benefits) − PV(Costs) = 0

  In general, the IRR should be greater than the discount rate.

Utilizing one or more of these indices, comprehensive benefit-cost analysis methods are generally designed to support ranking and selection among a set of alternatives and have, to date, been focused on capital improvement projects. Recent efforts have focused on developing selection methods and criteria that support comparison of operations and maintenance projects concurrently with capital improvement projects. Under these methodologies, less emphasis has been placed on demonstrating the economic merit of an existing project, program, or facility (i.e., safety rest areas), as was the intent of this investigation.

Detailed benefit-cost analysis methodologies for the roadway environment were originally published by AASHTO in 1977, and updated most recently in 2003 in *A Manual on User Benefit Analysis of Highway Improvements* (i.e., the AASHTO Red Book) to assist decision-makers in evaluating benefits and costs associated with highway improvement projects. Highway improvement benefits are generally described in terms of time savings and reduced vehicle operating costs, crashes, and harmful emissions. Associated costs include life-cycle and annual operating and maintenance costs. Similar, less extensive benefit-cost analysis methods were concurrently developed (Neumann and Dresser 1980, Weisbrod and Weisbrod 1997) but none have been implemented as extensively as the methodologies presented in the AASHTO Red Book (2003).

The AASHTO Red Book (2003) presents an 11-step process to determine the relative benefits and costs of a "base case" and one or more project alternatives:

1. Define the base case and the project alternative including the network elements affected (i.e., what portion of the total road system is affected), engineering characteristics, project build-out schedule, project capital cost schedule, and project operating cost schedule.
2. Determine the level of detail required, including vehicle classes to be studied, types of benefits and costs, and hourly/daily/seasonal detail.
3. Develop basic user cost factors including value of time (based on the average wage rate prevailing among users of the facility), vehicle occupancy rates, vehicle unit operating costs (based on the prevailing vehicle types), and crash rate and cost parameters.
4. Select economic factors to support crash analysis including discount rate (if benefits and costs measured in constant (inflation removed) dollars, use a discount rate of 3 percent; if benefits and costs measured in nominal (inflation included) dollars, use a discount rate of 3 percent plus the annual future inflation rate used in the analysis), analysis period, evaluation date, inflation rates, and value of life/morbidity.
5. Obtain traffic performance data for both the base case and the project alternative for explicitly modeled periods including volumes, speeds/travel times, and occupancy before and after improvement (usually requires travel demand and traffic assignment models).
6. Measure user costs for both the base case and the project alternative for affected links or corridors including hourly/daily/seasonal traffic volumes, link/corridor travel time

costs, vehicle operating costs, intersection delay costs, crash costs, and factors in steps 3 and 4.

7. Calculate user benefits including data from step 5 and user benefit formula (often based on user's willingness to pay).
8. Extrapolate/interpolate benefits to all project years unless time periods are explicitly modeled including traffic growth rate factors, volume-delay function factors, and peak spreading assumptions.
9. Estimate terminal value including assumptions about facility life and salvage opportunities (often ignored because present value calculations significantly discount its value).
10. Determine present value of benefits and costs including data from steps 1, 4, 7, and 8 and analysis of project management alternatives.
11. Make project selection decision including data from step 9, data from other project alternatives, and budget constraint conditions.

This 11-step process reduces a complex assembly of numbers to a single, tractable number, reported as net present value of benefits and benefit-cost ratios.

Prior to developing extensive information for the various alternatives under consideration, AASHTO (2003) identifies several key aspects that should be considered initially:

- *Evaluation year*. All costs forward of the evaluation year must be discounted and all non-sunk costs incurred prior to this year must be compounded by the appropriate discount rate.
- *Calendar vs. project year*. Project years are measured relative to the date of project evaluation forward and backward in time.
- *Units of measurement*. Analyses may consider road-segments or corridors, segment or corridor/O-D pair volumes, vehicles or individuals, etc. Per-vehicle-based user costs should be used with vehicle measured volumes, per-trip-based user costs should be used with trip-measured volumes, etc.
- *User class definitions*. Multiple classes of users may differ by type of vehicle, value of time, or other behavioral features of interest.

- *Vehicle class definitions*. The engineering performance of highway facilities can vary with vehicle type, as can the travel time experienced by the user classes occupying those vehicles.
- *Treatment of inflation*. It is convenient to think of future costs and benefits in current (evaluation year) dollars. Costs and benefits have a history or prospect of inflating, in unit cost terms, some at a rate greater or less than other goods and services in the economy.
- *Modeling grain*. A project can affect the highway system's performance differently at different times of the day, months of the year, for different classes of users or vehicles, and for various years into the future.

In each case, the AASHTO Red Book (2003) recommends striving for simplicity in analysis and adding complexity and detail only when it will significantly enhance the accuracy of the outcomes.

While this methodology supports estimation of user benefits primarily in the context of capital improvement projects, the same methodology can be extended to maintenance and other project types. To facilitate ease of application, the methodologies presented in the AASHTO Red Book (2003) were integrated, in the early 1990s, into a personal computing software application, *MicroBENCOST*. Subsequently, a variety of state-level and mode-specific (e.g., the Federal Railroad Administration's *Gradedec* software is specific to the benefit-cost evaluation of upgrades, separations, and closures of highway-rail grade crossings) benefit-cost analysis models have been developed. In 2000, FHWA released a state-level version of its *Highway Economic Requirements System* (*HERS-ST*) to support benefit-cost analysis for capital improvements directed at correcting broader pavement, geometric, or capacity deficiencies. Each of these software applications enhance the ease and consistency with which benefit-cost analyses are performed but none explicitly consider the unique benefits and costs attributable to safety rest areas.

Benefit-Cost Analysis Methods Specific to Safety Rest Areas

When both benefits and costs can be expressed in monetary terms, the application of standard benefit-cost or cost-effectiveness analysis methods, as detailed above, is appropriate. Most decisions concerning safety rest areas are based on benefits and costs that cannot be expressed in monetary terms; aspects of highway safety; user comfort and convenience; and community, environmental, and institutional consequences cannot readily be quantified. Perhaps as a direct result of these quantification challenges, few studies have focused on the application of benefit-cost analysis methods to safety rest areas. Only two studies that comprehensively considered the benefits and costs of safety rest areas were uncovered.

In 1969, Patterson conducted an evaluation of the safety aspects of the California Department of Transportation's roadside rest area program. In this early study, researchers developed and applied criteria for a benefit-cost analysis using data from published literature, the state's computerized crash records, and trip questionnaires administered at rest areas along routes normally used for long distance travel. The dated nature of this study limits its utility to support the current investigation's efforts, given changes in travel behavior and expectations; safety rest area designs and amenities; and analytic methods for determining benefits and costs.

More recently, King (1989) developed an alternative methodology when the classical approach provided in the first-edition AASHTO Red Book (1977) proved infeasible. Specific limitations cited included the following:

- Detailed analyses of historical crash records have shown that the safety effect of an individual rest area (i.e., the crash reduction due to the presence of a specific rest area) cannot be completely quantified given the accuracy and resolution of currently available crash data. The stochastic nature of crash occurrence further challenges quantification.
- Other highway user benefits are not supported by reliable data to quantify them. Data on how much rest area users are willing to pay—a standard economic method to estimate the monetary value of intangibles—present methodological problems when transforming these data into a quantitative benefit for a specific rest area alternative.
- Uncertainty exists when considering the assignment of anticipated costs—both initial and recurring—to the alternatives to be considered.

For these reasons, King (1989) developed an alternative analysis methodology based on the general principles of decision theory. The methodology follows a utility-based approach with the following conceptual framework and basic principles:

1. The decision maker can identify and must choose between a number of alternatives, which may generally include rehabilitate, reconstruct, relocate, close, or do nothing.

Initial alternatives are preliminarily screened based on a qualitative assessment of technical feasibility and cost, as well as impacts to safety, the driver, the environment, the economy, public agency operations, and other safety rest areas in the system.

2. Associated with each alternative decision is a set of "consequences" that reflect user-specified criteria and affect different groups. Possible consequences relate to:
   - Cost including annual capital, operating and maintenance costs, service life, funding sources and limitations, and participation.
   - Safety including the highway crash occurrence, facility entrance/exit crashes, and crashes within the facility.
   - Drivers including comfort and convenience and excess driving.
   - Public agency operations.
   - The environment including air and noise pollution, groundwater and surface runoff, and aesthetics.
   - The economy including overall and tourism impacts and land use and community effects.
   - Implementation including lead time for land acquisition, preliminary survey and evaluation, approval, and construction; opposition probability; and effectiveness and availability during construction.
   - The system including overall and specific facility effects.
3. The relative magnitude and importance of most of these consequences depend on one or more external future factors such as rest area usage.
4. The relative importance of each consequence must be defined by the decision-maker in terms of weighting factors.
5. The individual consequences may be expressed on a continuous scale expressed directly or transformed into dollar values, on a continuous scale in terms of a measurement system, which cannot accurately and reliably be transformed into dollar values, or in terms of a series of qualitative descriptors.
6. Each consequence can be assigned a definite level with an associated probability of occurrence, and each consequence level can be assigned a specific utility value.

7. The total utility of each alternative can be obtained by summing the utilities of the individual consequences. In mathematical terms the total utility, U, of alternate i, can be expressed as:

$$U_i = \sum_j W_j \sum_k P_{jk} U(S_{ijk})$$

where S_{ijk} is the level of consequence j for alternative i under future conditions k; $U(S_{ijk})$ is the utility associated with that consequence level; P_{jk} is the probability of condition k for consequence j; and W_j is the relative weight of consequence j.

This procedure again provides a rank ordering of all alternatives in terms of the totality of the consequences included in the analysis and in accordance with the weighting and value assignment structure adopted. King (1989) purports that this procedure can be applied to all safety rest area related decisions.

APPENDIX B: POTENTIAL DATA SOURCES TO SUPPORT SAFETY REST AREA BENEFIT-COST ANALYSIS IN TEXAS

After considering various potential safety rest area benefit and cost components, researchers began investigating the availability of data available to support development of a unique methodology for determining safety rest area benefits and costs in Texas.

SAFETY REST AREA BENEFITS

Potential data identified to support component safety rest area benefit measurement or estimation in Texas mimics that observed in the literature and state-of-the-practice review related to highway user, highway and other public agency, and external entity benefits. Table 46 summarizes specific data sources.

Highway Users

Benefit components accrued by highway users that show the most promise for measurement or estimation in Texas include safety, excess travel and diversion, and, to a lesser extent, comfort and convenience benefits.

Safety Benefits

In Texas, safety and crash data are available from the legacy Texas Accident File or Crash Records Information System (CRIS) maintained by the Texas Department of Transportation (TxDOT), Traffic Operations Division (formerly maintained by the Texas Department of Public Safety). These databases provide driver, vehicle, roadway, and weather/light condition information, as well as identified contributing factors, for all reportable crashes (i.e., crashes involving fatalities, injuries, and significant property damage) occurring in Texas. Examples of available data of interest include but are not limited to the following:

- Crash date and time.
- Vehicle type and body style.
- Collision type (e.g., two vehicles/both going straight/sideswipe, etc.).
- Road alignment (e.g., straight level, straight grade, straight hillcrest, curve level, etc.).
- Roadway relationship (e.g., on roadway, off roadway, shoulder, median).
- Surface condition (e.g., dry, wet, snowy/icy, sand/mud/dirt).
- Weather condition (e.g., clear/cloudy, rain, fog, sleet/hail, severe crosswind).
- Light condition (e.g., daylight, dark not lighted, dark lighted, dawn, dusk).

Table 46. Safety Rest Area Benefits: Potential Data Sources.

BENEFITS	DATA TYPE	DATA SOURCES
Highway Users		
Safety Benefits	Crashes	• TxDOT's Texas Accident File or CRIS, 1978–2009 • NHTSA's FARS, limited to fatal crashes • FMCSA's MCMIS Crash File, limited to motor carrier involved crashes
	Crash Costs	• National estimates from National Safety Council (2007)
Comfort and Convenience Benefits	SRA Usage	• TxDOT's vehicle classification counts, 2002 (adjusted for traffic growth) and 2009–2010
	Willingness to Pay	• TxDOT's user survey, 2010 • National estimates (King 1989, Blomquist and Carson 1998)
	SRA Amenities	• TxDOT's Safety Rest Areas website and database
Excess Travel and Diversion Benefits	SRA Location	• TxDOT's Safety Rest Areas website and database • TxDOT's TPP Division GIS database • Texas Natural Resources Information System's NAIP
	SRA Usage	• TxDOT's vehicle classification counts, 2002 (adjusted for traffic growth) and 2009–2010
	SRA Capacity	• TxDOT's cost-related databases: DCIS, ROWIS, BAMS/DSS and SiteManager, CMCS, MMIS, FIMS • TxDOT's original construction details • Texas Natural Resources Information System's NAIP • SRA site visits
	Permanent SRA Closures	• TxDOT's MMIS, Form 1125
	Surrogate Services	• Business location and Dun & Bradstreet/ReferenceUSA classification • National Association of Truck Stop Organizations and Truck Stop Directory
	Value of Time	• National estimates from the *Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis* (USDOT 2003) • Bureau of Labor Statistics website, www.bls.gov/bls/blswage.htm
	Vehicle Operating Costs	• National estimates (various)
Highway and Other Public Agencies		
Direct Monetary Benefits	Revenue	• TxDOT's wireless Internet services contract
External Entities		
Economic Development and Tourism Benefits	Travel characteristics for TICs	• TxDOT's Travel Services Section estimates • National estimates (various)
Specific Business Enterprise Benefits	Revenue	• TxDOT's wireless Internet services contract • Texas Department of Assistive and Rehabilitation Services

- Driver defect (e.g., fatigued/asleep, mentally defective, road rage, etc.).
- Contributing factors to the crash (see Table 47).

Texas safety and crash data are available from approximately 1978 through 2001 from the legacy Texas Accident File and from 2003 to 2009 from CRIS. Note that safety and crash data for 2002 are available only on a statewide basis, preventing aggregate or disaggregate analysis at the corridor or site-specific level.

Crashes occurring on Texas highways are located using Control Section/Mile Point (CS/MP) designations. Each safety rest area can be assigned a corresponding CS/MP for its entry gore point, exit gore point, and midpoint between its entry and exit. Specification of these CS/MPs for safety rest area facilities provides the means for accessing and analyzing related crash data for specified road segments of predetermined lengths when safety rest areas are accessible to highway users and when they are not (i.e., either before and after development of a given safety rest area or during normal operating hours and temporary closures) and/or contemporaneously for comparable roadway segments with and without safety rest area facilities. The CS/MP data also provide the capability to access traffic volume data (Average Annual Daily Traffic [AADT]) and other roadway characteristics (e.g., cross-section design) that may be of interest in this investigation.

Texas safety and crash data can be specified in terms of the NSC's injury severity KABC scale: K=fatality, A=incapacitating injury, B=non-incapacitating injury, C=possible injury, and N=no injury (property damage only [PDO]). Consideration of property damage only crashes is challenged; the threshold for reporting non-injury crashes has changed over time and also varies among different Texas jurisdictions, making comparisons tenuous.

Table 47. Potential Contributing Factors for Crashes.

CONTRIBUTING FACTORS		
Speeding - unsafe (under limit)	Backed without safety	Distraction in vehicle
Animal on road - wild	Changed lane when unsafe	Failed to give half of roadway
Failed to control speed	Failed to drive in single lane	Failed to yield row - yield sign
Fatigued or asleep	Fleeing or evading police	Failed to yield row - private drive
Faulty evasive action	Load not secured	Followed too closely
Driver inattention	Animal on road - domestic	Parked in traffic lane
Failed to yield row - stop sign	Disregard stop sign or light	Turned improperly - wide right
Defective or slick tires	Ill (explain in narrative)	Under influence - drug
Other factor (written in)	Road rage	Impaired visibility
Under influence - alcohol	Defective trailer hitch	Passed in no passing lane

Secondary sources of safety and crash information include the following:

- The Fatality Analysis Reporting System (FARS)—available through the National Highway Traffic Safety Administration—provides driver condition (i.e., drowsy/sleepy/asleep/fatigued), roadway location (i.e., shoulder), and weather/road surface condition information among other data for reportable crashes that involve a fatality. FARS includes crash site location coordinate data to support Geographic Information Systems (GIS) mapping capabilities.
- The Motor Carrier Management Information System (MCMIS) Crash File—available through the Federal Motor Carrier Safety Administration—provides safety and crash data for commercial motor vehicles exclusively and presents a more limited set of data elements for consideration.

A preliminary comparison of these data sources with TxDOT's CRIS for the same time period suggests some inconsistencies. For example, TxDOT's CRIS reports a higher number of *fatal crashes* than there are *fatalities* reported in FARS involving a "drowsy/sleepy/asleep/ fatigued" driver; one would expect a higher number of fatalities than fatal crashes. Researchers considered and addressed these and other data quality issues as part of this investigation. In addition, the appropriate use of surrogate factors related to time of day and vehicle involvement (i.e., nighttime, single vehicle) to reflect possible driver fatigue conditions, were investigated.

Comfort and Convenience Benefits

In Texas, representatives of TxDOT's Maintenance Division reported no known historic public opinion/customer satisfaction surveys focused on safety rest areas, or more specifically, a user's willingness to pay for safety rest area services. Highway user opinions regarding safety rest areas have been shared informally (i.e., through an Internet blog regarding the safety rest area near Guadalupe, Texas) but the utility of this anecdotal information was limited for this investigation. Customer satisfaction surveys are routinely (every two years) conducted at the state's travel information centers but these surveys do not include willingness to pay estimates.

In lieu of direct local data, national willingness to pay estimates can be combined with information related to specific rest area usage and amenities for safety rest areas in Texas to derive more localized comfort and convenience benefit estimates. Concerns over the dated nature of national willingness to pay estimates and their indiscriminant consideration of facility amenities led researchers to develop new data as part of this investigation.

Safety Rest Area Usage. Aggregate annual safety rest area usage data were available (i.e., an estimated 50 million travelers visit Texas safety rest areas annually) from TxDOT. In addition, vehicle classification counts conducted at all travel information centers and safety rest areas in the state in 2002 provided disaggregate usage data for individual safety rest areas of interest. Counts were conducted at two different times during the year for 24-hour intervals over 7 days. Tube counters were installed at either facility entrances or exits, depending on the layout. Vehicles were classified according to the standard scheme listed in Table 48.

As a supplement to this 2002 data, new vehicle classification data were collected as part of this investigation. Two (weekday and weekend) 24-hour period vehicle classification counts from 2009 were captured at each of the various safety rest areas in the San Antonio District as part of a distinct TxDOT project. Similar counts were conducted for safety rest area facilities considered in this investigation but constructed after 2002.

Table 48. Texas Vehicle Classification Scheme (TxDOT 2001).

Classification Code	Vehicle Type
1	Motorcycles, passenger vehicles, and small or short-wheel-based pickups
2	2 axles, 4-tire single-unit trucks (full-sized pickup trucks)
3	Buses (2 and 3 axles)
4	2-D, 6-tire single-unit vehicles (includes handicapped equipped and mini school buses)
5	3 axles, single-unit vehicles
6	4 or more axles, single-unit vehicles
7	3 axles, single trailer (2S1)
8	4 axles, single trailer (2S2 or 3S1)
9	5 axles, single trailer (3S2, 3S2 split, or 2S3)
10	6 or more axles, single trailer (3S3, 3S4, etc.)
11	5 or less axles, multi-trailers (2S1-2)
12	6 axles, multi-trailers (2S2-2 or 3S1-2)
13	7 or more axles, trailers (3S2-2)
14	Unclassified (AVC and WIM)

In addition to overall safety rest area facility usage, TxDOT also monitors usage for certain on-site amenities. The TxDOT Maintenance Division receives daily wireless Internet login reports containing the number of logins per facility and total usage in minutes as well as TexTreks reports (TexTreks provides access to information on road conditions, weather, events, accommodations, etc.) that describe the web portal's page visits and 24-hour activity provided graphically. The visitor's domain/country of origin is also reported. Between 2003 and 2005 and predating the availability of wireless Internet and TexTreks services, TxDOT offered a network of free-standing kiosks and virtual portals (TexBox) capable of capturing information about the traveling public including their activities, preferences, and feedback. Data from the TexBox pilot project are not readily available. Despite its availability, the utility of wireless Internet or web portal access usage data is uncertain in estimating overall comfort and convenience benefits attributable to safety rest areas.

Safety Rest Area Amenities. Information regarding safety rest area amenities, which in turn affects the perceived comfort and convenience offered to highway users, is available through TxDOT's Safety Rest Areas website and maintained separately in a comprehensive database (see Figure 6) by TxDOT's Maintenance Division—Facilities Management Section. Typical amenities include separate restrooms for men and women, family/assisted bathrooms, diaper changing stations, drinking water, vending machines, air-conditioned lobby, telephones, picnic areas, playground, trash receptacles, wireless Internet access, interpretive displays, handicap access, separate truck and passenger parking, security surveillance, and more.

Quantity inventories of select safety rest area amenities are indirectly developed under TxDOT's *Special Specification 7284: Rest Area Total Maintenance, Operation, and Repair*. This specification is intended to ensure a high level of customer satisfaction based on safety rest area condition. During routine safety rest area inspections, maintenance personnel indicate whether an item needs no maintenance, minor cleaning, minor repairs, or major repairs and maintenance. For select amenities, personnel are instructed to count and record the number of items falling under each condition category (i.e., the number of picnic tables needing no maintenance, minor cleaning, minor repairs, or major repairs and maintenance).

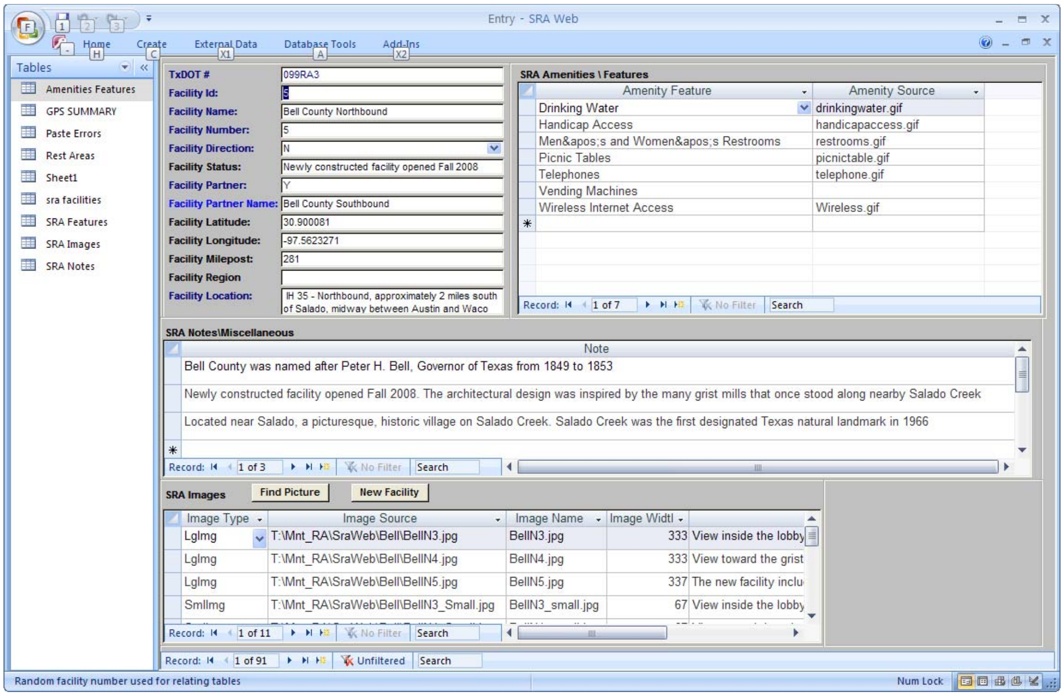


Figure 6. TxDOT's Safety Rest Area Database Screen Capture.

Despite the availability of amenity data for safety rest areas in Texas, willingness to pay estimates are typically aggregated to reflect an individual facility or system facilities and do not take into account potentially different fee rates based on differences in the amenities provided. Hence, estimated benefits for safety rest areas that offer a low (providing only basic amenities) or high (providing full service amenities) level of service may be indistinguishable if usage rates are comparable. Benefits resulting from upgrading or improving existing safety rest areas are particularly difficult to quantify in terms of comfort and convenience for highway users. New willingness to pay data collection efforts conducted as part of this investigation attempted to address this shortcoming.

Excess Travel and Diversion Benefits

Estimates of excess travel and diversion benefits can be obtained by comparing existing safety rest area locations with surrogate service locations and relating this information to vehicle operating costs and value of time measures.

Safety Rest Area Locations. In Texas, safety rest area location data are provided through the previously referenced Safety Rest Area website and database maintained by TxDOT. Locations are provided in terms of latitude/longitude and distance from origin (DFO), with the latitude/longitude locations generally reflecting the midpoint between the facility entrance and exit ramps offset from the highway and the DFO values rounded to the nearest mile. In addition, TxDOT's Transportation Planning and Programming (TPP) Division maintains a broader spatial database that includes district and area offices, maintenance facilities, vehicle title registration offices, travel information centers, and safety rest areas. Attributes in this dataset include general land office site number, TxDOT site number, facility name, TxDOT district, county, street address, zip code, latitude, longitude, and record date.

In a preliminary investigation, the traveler information center and safety rest area facility data in the TPP database were extracted and compared with the data from TxDOT's Safety Rest Areas website. Overall, the TPP database was more accurate, although several safety rest area facilities were missing from the database. The TPP database includes safety rest areas that have been closed as well as those facilities where the operational status is unclear.

As a supplemental source of safety rest area location data, the Texas Natural Resources Information System, part of the Texas Water Development Board, stores imagery collected by the National Agriculture Imagery Program (NAIP). The 2004 NAIP imagery dataset has a 1 meter resolution; the 2005 and 2006 NAIP imagery datasets have a 2 meter resolution. NAIP imagery datasets for all safety rest areas in Texas are available. Figure 7 depicts a sample NAIP image for the Colorado County safety rest area along IH 10 outside Columbus, Texas. The red and yellow symbols on the image reflect original and adjusted (i.e., midpoint between the entrance and exit gore points) facility locations to support crash data retrieval and subsequent safety analyses.

Safety Rest Area Status. In addition to its location, it is important to simultaneously consider safety rest area capacity relative to user demand and facility closure status. Safety rest area capacity can be compared to user demand to determine how often highway users are required to seek surrogate services or forego services because the safety rest area is full. Reductions in excess travel attributable to safety rest areas are impacted if a facility is often closed or has reached its usable capacity.

With respect to safety rest area capacity, data of primary interest relate to parking space for both passenger cars and commercial motor vehicles. In 2002, Fleger et al. considered the adequacy of commercial motor vehicle parking facilities nationwide. In Texas, the peak hour parking demand for safety rest areas along Interstate and other National Highway System routes carrying more than 1,000 trucks per day was estimated to be 8,305, with an estimated annual increase in demand of 2.7 percent. Based on a reported 654 parking spaces at 105 safety rest area facilities, commercial motor vehicle parking demand was estimated to exceed supply at safety rest areas in Texas by a ratio of 12.70 to 1 (Fleger et al. 2002).

Outside of special studies and for select safety rest areas of interest, safety rest area capacity information may be obtained from a variety of sources including cost-related databases maintained by TxDOT (described later in this document); original construction details, or safety rest area site visits. The NAIP imagery described previously may also be used to obtain approximate estimates of safety rest area capacities in lieu of direct data. Vehicle classification counts conducted in 2002 provide supplemental disaggregate demand or usage data for individual safety rest areas of interest.

Figure 7. 2004 NAIP Image of the Colorado County Safety Rest Area.

Regarding safety rest area closures, TxDOT documents current and historical safety rest area closures of a permanent nature. A request to close a rest area, for highway expansion, continual abuse, lack of use, or other reasons, includes the following information:

- Location including county, highway, reference marker, and class code.
- Existence and description of any historical markers or dedication markers.
- Approximate size and description of features.
- Primary reason(s) for the closing.
- If known, support or opposition by:
    - Law enforcement officials.
    - County or city officials.
    - General public.
- Any deed restrictions (TxDOT 2005).

Once a rest area is closed, the responsible district must file Form 1125 Notice of Change of Roadway Maintenance File and distribute copies to TxDOT's Finance, Planning, and Maintenance Divisions. According to TxDOT Maintenance Division representatives, temporary safety rest area closures are not consistently documented.

Surrogate Service Locations. To determine the availability of surrogate services in the presumed absence of public safety rest areas, business location and Dun & Bradstreet/ ReferenceUSA™ classification (i.e., gas stations, fast food restaurants, etc.) data can be utilized. Supplemental information regarding the location of private truck stops is available through the National Association of Truck Stop Organizations (NATSO) and the National Truck Stop Directory (www.truckstops.com).

The ReferenceUSA™ web-based search engine allows retrieval of business-related data using Standard Industrial Classification (SIC) codes (four digit numerical codes assigned by the U.S. government to identify the primary business of an establishment). The SIC codes of primary interest for this investigation include 5541 Gasoline Service Stations (including truck stops and plazas) and 5812 Eating Places. Each of these general business categories is further disaggregated into multiple subcategories to better reflect specific amenities offered.

For each of these business categories, ReferenceUSA™ provides the following types of information available for download:

- Address information.
- Corporate information (e.g., employees, estimated annual sales, metro area, latitude/longitude, years in business, hours of operation).
- Management directory (e.g., owner, president).

- Company description (line of business, SIC number).
- Business expenditures by spending category (e.g., accounting, insurance, technology).
- Competitors' reports.
- Nearby businesses.

As a supplemental source of commercial motor vehicle related services, a review of the NATSO database revealed 86 privately owned truck stops in Texas. Comparatively, a general Internet search uncovered 181 privately owned Texas truck stops; 124 of which are part of national chains or associations including:

- Love's Travel Stops (32).
- Petro Stopping Centers (6).
- Pilot Travel Centers (18).
- Texas Travel Centers of America (13).
- Flying J Travel Plazas (19).
- Roady's Truck Stops (27).
- AMBEST Truck Stops (9).

The number in parentheses indicated their frequency in Texas.

Each of these national truck stop chains maintains a website that provides the location of each of their facilities and the respective amenities offered. Locations are reported in address and latitude/longitude format and are often available for download. Truck stop amenities often include restroom and shower facilities, laundry service, banking and mail services, telephones, Internet access, travel/convenience store, air/water, express oil/lube lane service, truck wash, truck repair shop, overnight parking, and more.

Value of Travel Time. The USDOT (2003) provides general guidance on the valuation of time for broader transportation-related economic analysis. Using this methodology, an hour of travel associated with a business trip or commerce is usually valued at the average traveler's wages, fringe benefits (i.e., insurance, vacation, holidays, sick leave, other paid leave, etc.), and legally required benefits (i.e., unemployment insurance, Social Security, workers' compensation, etc.) representing the cost to the traveler's employer. Personal travel time (either for commuting or leisure) is usually valued as a percentage of average traveler wage and reflects the opportunity cost of time spent traveling vs. time that could be spent doing something else. Wage and employment data can be obtained from the Bureau of Labor Statistics website, http://www.bls.gov/bls/blswage.htm.

Vehicle Operating Costs. Excess travel and diversion in the absence of safety rest areas will also result in additional vehicle operating costs attributable to excess fuel consumption and wear and tear. Unlike the value of travel time, the USDOT does not provide official guidance on estimating vehicle occupancy costs. Some guidance is provided in the *Highway Economic Requirements System (HERS)-State Version* (FHWA 2002).

Highway and Other Public Agencies

Benefit components accrued by highway and other public agencies that show the most promise for measurement or estimation in Texas include direct monetary benefits resulting from lease fees, profit sharing arrangements, and/or shared cost arrangements for maintaining and operating its facilities.

Direct Monetary Benefits

In Texas, following a brief pilot program, TxDOT began offering wireless Internet services at the state's travel information centers and safety rest areas in 2004. Under an initial agreement with Coach Connect Corporation, TxDOT received revenue and/or in-kind services under the following contract terms:

- All equipment, maintenance, and technical support were provided by Coach Connect Corporation.
- Coach Connect Corporation installed and maintained Internet kiosks in TxDOT's lobbied facilities for those users not possessing a wireless computing device.
- TxDOT received 25 percent of any Texas safety rest area originated Coach Connect subscriptions (Internet access was free for the first two hours, subscription rates for Internet use after the first two hours was $1.99/20 minutes, $3.99/day, $7.99/week or $29.99/month) (Hicks 2004).

Under this initial arrangement, low subscription rates resulted in a program cost incurred by TxDOT of approximately $38,000 per month (Reed 2008).

In 2008, TxDOT updated their wireless Internet services agreement, changing both the vendor and funding/revenue generation mechanism. Following the lead of other states, including Kansas, TxDOT's wireless Internet services at the state's travel information centers and safety rest areas will rely upon advertising rather than user subscriptions to fund the program. Some initial resistance from FHWA has been encountered but states appear confident that concerns related to advertising restrictions along Interstate rights-of-way can be adequately addressed. Representatives from TxDOT's Maintenance Division did not identify any additional sources of revenue as a result of franchise or lease fees, profit sharing arrangements, and/or shared cost arrangements for maintaining and operating its facilities.

External Entities

Benefit components accrued by external entities are less directly and/or readily quantified in Texas. Only limited local data exist to support measurement or estimation of economic development and tourism and specific business enterprise benefits accrued by external entities.

Economic Development and Tourism Benefits

At the state's travel information centers, personnel from TxDOT's Travel Services Section monitor limited information regarding travelers (i.e., whether they reside in the state or outside of the state) and travel information dissemination (i.e., how many and what type of brochures are provided to travelers). To determine economic impacts of Texas travel information centers, TxDOT relies upon data from Iowa in the absence of local data. Recent data from Iowa suggests that approximately one-third of travelers who visit a traveler information center and receive travel information decide to extend their stay in the state. Of these travelers, 60 percent extend their stay by an additional 2 hours while 40 percent extend their stay by two days. In Texas, an average travel party size is assumed to be three, and an average travel party expenditure is assumed to be $117 per day. Complete estimates of the economic impacts of Texas travel information centers are currently under development by TxDOT's Travel Services Section personnel.

Traveler-related data and subsequent economic impact estimates for safety rest area facilities (distinct from travel information centers) are not available. The Texas Economic Development and Tourism Office provides detailed profiles of pleasure and business travelers to Texas, including the number of travelers and day trip characteristics. This information is not, however, related to safety rest areas (or travel information centers) in the state.

Specific Business Enterprise Benefits

In Texas, as noted previously, wireless Internet services offered at each of the state's travel information centers and safety rest areas has the potential to provide additional revenue for: (1) Internet service providers under the original contracting terms (Coach Connect received additional revenue from Texas safety rest area originated subscriptions) or (2) Internet service providers and participating advertisers (i.e., local hotels, restaurants, etc.) under the current contract, where Internet service providers generate revenue through advertising sales rather than subscription or use fees. Both Internet service providers and participating advertisers may view revenue data related to their wireless Internet services as proprietary. Additional business enterprise data—related primarily to vending machine operation at safety rest area facilities—may be available from the Texas Department of Assistive and Rehabilitation Services and the associated businesses/individuals with whom they work.

SAFETY REST AREA COSTS

Potential data identified to support component safety rest area cost measurement or estimation in Texas mimics that observed in the literature and state-of-the-practice review related to highway user, highway and other public agency, and external entity costs. Hence, while researchers may have to derive some cost estimates based on local or on national/aggregate data or may have to omit certain costs because of an inability to quantify, it is anticipated that many of the cost components will be successfully measured directly for safety rest areas in Texas. Table 49 summarizes specific data sources.

Highway Users

Safety rest area costs incurred by highway users relate exclusively to safety, attributable to potentially adverse effects of merging/lane changing near facility entrances and exits.

Safety Costs

The same data sources described previously to characterize safety rest area safety benefits will support determination of safety rest area safety costs. In Texas, safety and crash data are available from TxDOT's Texas Accident File or CRIS. Secondary sources of safety and crash information include NHTSA's FARS and the FMCSA MCMIS Crash File.

Table 49. Safety Rest Area Costs: Potential Data Sources.

COSTS	DATA TYPE	DATA SOURCES
Highway Users		
Safety Costs	Crashes	• TxDOT's Texas Accident File or CRIS, 1978–2008 • NHTSA's FARS, limited to fatal crashes • FMCSA's MCMIS Crash File, limited to motor carrier involved crashes
	Crash Costs	• National estimates from National Safety Council (2007)
Highway and Other Public Agencies		
Direct Monetary Costs	Right-of-way acquisition, design, construction, and ongoing operations and maintenance costs for recent SRAs	• TxDOT's cost-related databases: DCIS, ROWIS, BAMS/DSS and SiteManager, CMCS, MMIS, FIMS
	Construction costs for older SRAs	• TxDOT's as-built plans

Highway and Other Public Agencies

Safety rest area costs incurred by highway and other public agencies are largely characterized as direct costs to the agencies.

Direct Monetary Costs

The Federal Beautification Act of 1965 supported development of TxDOT's original system of 111 safety rest areas constructed in the 1960s and 1970s. Construction and maintenance cost data for many of the facilities developed during this time period are no longer available. According to TxDOT's official record retention schedule, non-critical facility (i.e., bridges) documents and data, with the exception of as-built plans, are destroyed after 10 years.

Federal Transportation Enhancement Funds supported the construction and/or renovation of safety rest area facilities at 21 sites since 1999. Construction and maintenance cost data for safety rest areas developed during this time period were more readily available to support this investigation. In Texas, TxDOT uses a variety of electronic information systems that document costs during the lifecycle of recently developed safety rest areas. These systems include the:

- Design and Construction Information System (DCIS).
- Right of Way Information System (ROWIS).
- Trns*port Bid Analysis Management System/Decision Support System (BAMS/DSS) and SiteManager Construction Management System (CMS).
- Construction and Maintenance Contract System (CMCS).
- Maintenance Management Information System (MMIS).
- Financial Information Management System (FIMS).

Each of these databases may be used, to varying extents, to obtain direct cost data related to initial right-of-way acquisition, design, construction, and ongoing operations and maintenance of safety rest areas in Texas. The project Control Section Job number is the key attribute to relate data from these various systems.

Design and Construction Information System. The Design and Construction Information System (DCIS) is used by TxDOT to track safety rest area projects during the planning and design phases of the project development process. DCIS provides project identification and evaluation data, project planning and finance data, project estimate data, and contract summary data (Files 121 through 124). Although approximately 500 related attributes exist in these four files, many are optional and hence, are left blank. Record completeness varies by district and project engineer. DCIS provides a high-level view of project data, and does not include project scheduling, task status, document tracking, or project accounting functions. Access to the DCIS program and data is restricted but available through special request.

In a preliminary query of this database where DCIS PROJECT CLASS = SRA (safety rest area), 89 CSJ numbers were returned but only 39 of the 89 CSJ numbers involved the construction, reconstruction, rehabilitation, and renovation of safety rest areas. These projects were let from 2001 to 2011 and totaled $209 million dollars. Project attributes provided in this preliminary query included the following:

- CSJ
- Actual let date
- Ancestor CSJ
- Approved let date
- Contract CSJ
- CST/ROW CSJ
- Descendent CSJ
- District let date
- Estimated cost
- Highway
- Layman description
- Limits from/to
- Low bid
- Project class
- Type of work

Additional attributes are available upon request.

Right of Way Information System. The Right of Way Information System (ROWIS) is used by TxDOT to track and report financial data associated with ROW acquisition for safety rest areas (see Figure 8). The system, implemented in 1997, enables users to track ROW:

- Parcel attributes including description, appraised value, acquisition status, and key dates (i.e., possession date, parcel release date, and total paid date).
- Project attributes including project type code, beginning/ending limits, project CSJ, ROW CSJ, and key dates (i.e., estimated letting date or ROW clearance date).
- Control Section Job number attributes including CSJ type, project limits, and federal funding eligibility.

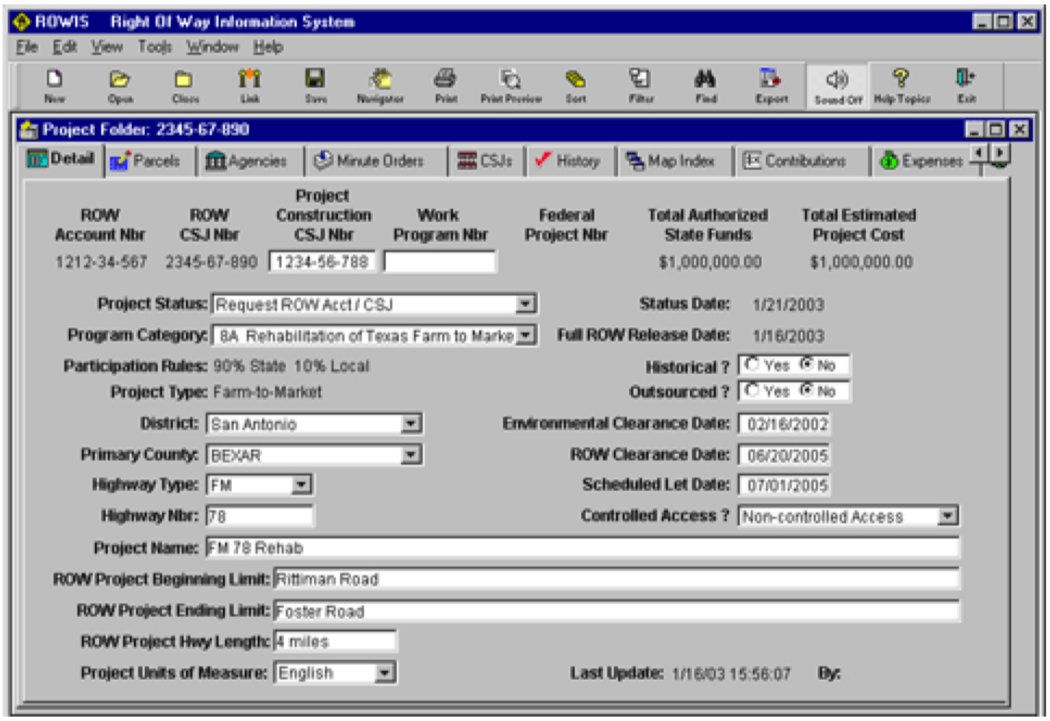


Figure 8. Right of Way Information System Screen Capture.

The ROWIS database also includes information about parcel development and fee appraiser work orders during events such as negotiations, settlements, or eminent domain proceedings. In a preliminary query of this database, right-of-way costs were identified for 19 of the 39 safety rest area CSJ numbers identified in the DCIS database. Right-of-way costs were separated into acquisition expenditures ($4.41 million), relocation assistance expenditures ($27,000), utility adjustments ($3.96 million) and ROW acquisition professional services (ROWAPS) ($76,600).

Trns*port Bid Analysis Management System/Decision Support System and SiteManager Construction Management System. Since 1984, the Trns*port Bid Analysis Management System/Decision Support System (BAMS/DSS) database has been used by TxDOT's Construction Division to track highway construction projects during the letting and construction phases of the project development process.

According to TxDOT Maintenance Division representatives, the initial construction bids for safety rest areas are estimated in two categories: one category includes estimated quantities and unit prices for all roadway related items and a second category includes estimated quantities and unit prices for the safety rest area structures (i.e., building, picnic arbors, etc.). Original estimates for the safety rest area structures are further refined into more detailed work items after the bidding process.

The BAMS/DSS database provides a detailed view of the letting and proposal phase of projects, including detailed historical unit bid data, but does not provide detailed construction data such as change orders, actual project costs, and actual completion dates. This information is instead available through a companion SiteManager Construction Management System (CMS). Access to both BAMS/DSS and SiteManager is restricted; however, data are available through special request. In a preliminary query of this database, project letting and proposal data were identified for 19 of the safety rest area CSJ numbers identified in the DCIS database with a total award amount of $114.8 million dollars.

Construction and Maintenance Contract System. The Construction and Maintenance Contract System (CMCS) is used by TxDOT's Construction Division to track safety rest area maintenance and construction contracts. The CMCS database may have limited utility for this investigation but is worthwhile noting here.

Maintenance Management Information System. The Maintenance Management Information System (MMIS) is used by TxDOT to track the operation and maintenance costs of safety rest areas. MMIS collects data on routine maintenance functions, generates reports of maintenance costs for specific roadway segments, and maintains an inventory of reference markers for state-maintained highways using a variety of standardized forms:

- The Daily Activity and Weekly Activity Report (Forms 1757 and 1784) are used by maintenance crews to record cost distribution and maintenance activity data.
- The Notice of Change/Roadway Maintenance File (Form 1125) is used to notify TxDOT's Finance Division and Transportation Planning and Programming Division of changes in the status of state maintained roadways and TxDOT's Maintenance Division of changes to the MMIS Roadway Inventory (Form 1125 must be used by a district to indicate that a rest area is closed).

The location of safety rest areas along a highway is characterized using Highway Class, Highway System, Highway Number, Beginning Reference Marker, and Ending Reference Marker codes or values. Within a specific county, safety rest areas are assigned consecutive Highway Class code values, beginning with the number 40. Maintenance activities for safety rest areas are categorized as Roadside and Median Maintenance, with a function code of 532.

Financial Information Management System. The Financial Information Management System (FIMS), managed by TxDOT's Finance Division, is the accounting information system for TxDOT. Access to FIMS is highly restricted but data are available through special request. FIMS shares data with DCIS, ROWIS, BAMS/DSS and SiteManager, CMCS, and MMIS. FIMS contains financial information for current safety rest area projects (FIMS code = 31) in the planning, design, and construction phases, as well as historic data for safety rest areas that have been completed. As described below, FIMS comprises several files or "segments" that provide various aspects of financial data.

Segment 76: Construction and Maintenance Projects. Segment 76: Construction and Maintenance Projects includes data for highway construction and other projects managed using TxDOT's construction program procedures. Highway construction projects include preliminary engineering construction, construction engineering, right of way, and beautification. Maintenance jobs contracted through the letting process are also included. Associated costs can originate from outside contractors or state forces and are coded in terms of CSJ numbers, function codes, and expenditure object codes.

CSJ numbers, as contained in Segment 76, have been previously described. Segment 76 function codes are unique 3-digit values that identify a task or function within a broader classification of activities, where the first digit reflects the broader classification of activities. For example, a first digit of 1 reflects functions that are associated with preliminary engineering; functions associated with preliminary engineering include Feasibility Studies (102), Field Surveying and Photogrammetry (150), Drainage (161), and Bridge Design (170). Segment 76 expenditure object codes are 3-digit values that identify the types of goods or services received. Examples of expenditure objects include Regular Full-time Employees on Salary Basis (111), Office Equipment (464), and Building Materials and Supplies (691).

In a preliminary query of this database, life-to-date expenditures—grouped by CSJ number, function code, and expenditure object code—were identified for the 39 safety rest area CSJ numbers identified in the DCIS database. These data, available in PDF or Microsoft Access database format, comprised 2,190 expenditure records for safety rest area construction projects, with expenditures totaling $159.4 million between 2000 and 2011.

Segment 78: Routine Maintenance. Segment 78: Routine Maintenance documents direct expenses to the roadway as incurred, and distributes associated indirect costs. Maintenance expenditures are characterized by district, maintenance section, county, function code, and expenditure object code. The same expenditure object codes are defined for Segments 76 and 78 but Segment 78 function codes are 3-digit codes identifying unique maintenance tasks. Relevant Segment 78 function codes for this investigation include:

- Picnic Area Maintenance (Without Restrooms) (531).
- Rest Area Facility Maintenance (532).
- Rest Area Facility Maintenance through Regional Contracts (533).
- Maintenance of Specialty Facilities (535).

In a preliminary query of this database, routine safety rest area maintenance comprised 6,651 expenditure records totaling $23.2 million in FY 2006, $22.6 million in FY 2007, and $22.1 million in FY 2008.

Segment 71: Functional Expenditures. Segment 71: Functional Expenditures documents general and administrative expenses not readily identifiable with a specific project, roadway, or clearing account. The same expenditure object codes are defined for Segments 71, 76, and 78 but Segment 71 function codes are 3-digit codes identifying unique miscellaneous items, such as participant training (025).

General and administrative expense data for travel information centers are maintained separately under unique account numbers and in reference to a single function code (020). In a preliminary query of this database and considering data exclusive to travel information centers, general and administrative expense data comprised 1,217 TIC expenditure records totaling $7.62 million in FY 2006, $7.12 million in FY 2007, and $7.1 million dollars in FY 2008.

APPENDIX C:
SURVEY INSTRUMENT AND SUMMARY OF RESULTS

SAFETY REST AREAS AND TRAVEL INFORMATION CENTERS IN TEXAS PUBLIC OPINION SURVEY

Safety rest areas and travel information centers generally serve to improve highway safety, enhance the comfort and convenience of highway travel, and facilitate the transmission of information to highway users. The Texas Department of Transportation (TxDOT) currently operates and maintains a system of 80 safety rest areas and 12 travel information centers statewide to support these objectives. To ensure that this system of facilities continues to meet the needs of the traveling public, TxDOT—in cooperation with the Texas Transportation Institute, Texas A&M University System—is conducting a survey to characterize the nature of public safety rest area and travel information center use statewide.

The survey consists of 18 questions and is expected to take no more than 10 minutes to complete. Your participation in the survey is voluntary, and your responses to this survey are anonymous. You will receive no direct benefit from participating in the survey, however, the information that you provide will assist TxDOT in establishing future transportation-related priorities and allocating resources for improving safety rest areas and travel information centers in Texas. If you have questions about the survey, please contact Dr. Jodi Carson at j-carson@tamu.edu or (512) 467-0946.

1. You must be at least 18 years of age to participate in this survey.

   ❍ I am at least 18 years of age (by selecting this option, you are consenting to the eligibility requirement).

   ❍ I am under 18 years of age.

This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (979) 458-4067 or irb@tamu.edu.

2. Where do you currently live?

   _____City/Town   _____State/Province   _____Country

3. Are you:

   ❍ Female?
   ❍ Male?

4. How many people live in your household, including yourself?

   ❍ One (1)
   ❍ Two (2)
   ❍ Three (3)
   ❍ Four (4)
   ❍ Five (5) or more

5. What is your highest level of education?

   ❍ Did not finish high school
   ❍ High school
   ❍ Community/technical college
   ❍ College/university
   ❍ Post-graduate college/university

6. What is your age?
   - ❍ 18–33
   - ❍ 34–49
   - ❍ 50–64
   - ❍ 65 or Over

7. For driving trips over 100 miles (one-way), how many people, including yourself, are most often traveling in your party?
   - ❍ One (1)
   - ❍ Two (2)
   - ❍ Three (3)
   - ❍ Four (4)
   - ❍ Five (5) or more

8. For driving trips over 100 miles (one-way), what type of vehicle do you most often travel in?
   - ❍ Motorcycle
   - ❍ Passenger car, pickup truck, van, or sport utility vehicle (SUV)
   - ❍ Recreational vehicle (RV), vehicle with pull-behind camper trailer
   - ❍ Semi-truck/tractor trailer
   - ❍ Commercial bus
   - ❍ Other _____ (Please specify)

9. For driving trips over 100 miles (one-way), how much of this mileage typically occurs in Texas?
   - ❍ None or almost none
   - ❍ Less than half
   - ❍ Approximately half
   - ❍ More than half
   - ❍ Almost all or all

10. During the last 12 months, how many driving trips over 100 miles (one-way) did you make?
    - ❍ 0 (zero)
    - ❍ 1–10
    - ❍ 11–25
    - ❍ 26–100
    - ❍ More than 100

11. During the last 12 months, including today, how many times did you stop at a public safety rest area or travel information center in Texas? (please enter a number equal to or greater than 1) _____

12. How often do you access the Internet using the free wireless connection offered at public safety rest areas and travel information centers in Texas?
    - ❍ Never
    - ❍ Almost never
    - ❍ Half the time
    - ❍ Almost always
    - ❍ Always

13. During your stop today, what activities did you or will you or any of your passengers perform? (Check all that apply)

	No	Yes
Allow children to play	❍	❍
Attend to pet needs	❍	❍
Change baby's diaper	❍	❍
Change drivers	❍	❍
Check/repair vehicle	❍	❍
Dispose of trash	❍	❍
Get water from drinking fountain	❍	❍
Observe interpretive displays of local history/points of interest	❍	❍
Obtain information regarding gas/food/lodging	❍	❍
Obtain information regarding weather/road/traffic conditions	❍	❍
Obtain free Texas map	❍	❍
Obtain tourist event/attraction information	❍	❍
Purchase newspaper from vending machine	❍	❍
Purchase beverages/snacks from vending machine	❍	❍
Purchase motor carrier permit	❍	❍
Purchase TxTag toll tag	❍	❍
Rest/sleep	❍	❍
Seek shelter during a tornado threat or bad weather	❍	❍
Stretch/walk	❍	❍
Take photos at 'Welcome to Texas' photo area	❍	❍
Use free on-site professional Travel Counselor services	❍	❍
Use pay telephone	❍	❍
Use picnic area	❍	❍
Use restroom	❍	❍
Watch videos depicting Texas attractions	❍	❍
Other _____ (Please describe)	❍	❍

14. If you received free on-site professional travel counseling assistance, did you extend your stay in Texas because of the information provided?

❍ No
❍ Yes

15. If you answered Yes to Question 14, how much longer did you or will you remain in Texas?

❍ up to 1/2 day
❍ 1 day
❍ 2 days
❍ 3 days
❍ More than 3 days

16. How important are the following public safety rest area or travel information center features and amenities to you?

	Not at All	Somewhat	Very
Air-conditioned/heated lobby and restrooms	❍	❍	❍
Beverage/snack vending machines	❍	❍	❍
Building/shelter architecture and design	❍	❍	❍
Diaper changing stations	❍	❍	❍
Family/assisted use restrooms	❍	❍	❍
Free Texas maps	❍	❍	❍
Free wireless Internet access	❍	❍	❍
Gas/food/lodging information	❍	❍	❍
Grounds/landscaping	❍	❍	❍
Group picnic facility	❍	❍	❍
Interpretive displays of local history/points of interest	❍	❍	❍
Motor carrier permits or TxTag toll tags for purchase	❍	❍	❍
Newspaper vending machines	❍	❍	❍
On-site professional Travel Counselor	❍	❍	❍
Overnight parking	❍	❍	❍
Playground equipment	❍	❍	❍
Security/surveillance cameras	❍	❍	❍
Separate passenger car and truck/RV parking	❍	❍	❍
Sufficient passenger car and truck/RV parking	❍	❍	❍
Sufficient restroom stalls	❍	❍	❍
Tornado shelter	❍	❍	❍
Tourist event/attraction information	❍	❍	❍
Video theater on Texas attractions	❍	❍	❍
Walking/interpretive trails	❍	❍	❍
Weather/road/traffic condition information	❍	❍	❍
‘Welcome to Texas’ photo opportunity	❍	❍	❍

Consider the photos, features, and amenities in Example 1 below.

EXAMPLE 1. PUBLIC SAFETY REST AREA OFFERING EXTENDED SERVICES

Features/Amenities

- Air-Conditioned Lobby and Restrooms
- Diaper Changing Stations
- Drinking Water
- Family/Assisted Use Restroom
- Handicap Access
- Interpretive Displays
- Men's/Women's Restrooms (two sets)
- Picnic Tables
- Playground
- Separate Truck and Passenger Car Parking
- Telephones
- Wireless Internet Access

17. If comparable features and amenities were offered by a nearby private business (convenience store, restaurant, truck stop), which facility would you choose to visit?

❍ I would choose to stop at a public safety rest area similar to the facility in Example 1.

❍ I would choose to stop at a private convenience store, restaurant, or truck stop.

Please explain why. ______

18. If you indicated a preference for private facilities in Question 17, how many miles out of your way are you willing to drive to access a convenience store, restaurant, or truck stop instead of stopping at a public facility similar to Example 1?

❍ Less than 5 miles
❍ 6–10 miles
❍ 11–15 miles
❍ 16–20 miles
❍ More than 20 miles

Consider the photo, features, and amenities in Example 2 below.

EXAMPLE 2. PUBLIC SAFETY REST AREA OFFERING BASIC SERVICES

Features/Amenities

- Drinking Water
- Handicap Access
- Men's/Women's Restrooms
- Picnic Tables
- Telephones
- Wireless Internet Access

19. If comparable features and amenities were offered by a nearby private business (convenience store, restaurant, truck stop), which facility would you choose to visit?

   ❍ I would choose to stop at a public safety rest area similar to the facility in Example 2.

   ❍ I would choose to stop at a private convenience store, restaurant, or truck stop.

   Please explain why. ______

20. If you indicated a preference for private facilities in Question 19, how many miles out of your way are you willing to drive to access a convenience store, restaurant, or truck stop instead of stopping at a public facility similar to Example 2?

   ❍ Less than 5 miles
   ❍ 6–10 miles
   ❍ 11–15 miles
   ❍ 16–20 miles
   ❍ More than 20 miles

Consider the photos, features, and amenities in Example 3 below.

EXAMPLE 3. PUBLIC TRAVEL INFORMATION CENTER OFFERING SPECIALIZED SERVICES

Features/Amenities

- Air-Conditioned Lobby and Restrooms
- Diaper Changing Stations
- Drinking Water
- Family/Assisted Use Restroom
- Group Picnic Facility
- Handicap Access
- Interpretive Displays
- Men's/Women's Restrooms (two sets)
- Motor Carrier Permits/TxTag
- Picnic Tables (covered)
- Professional Travel Counselor
- Security Surveillance
- Separate Truck and Passenger Parking
- Telephones
- Travel Information/Maps
- Vending Machines
- Video Theatre
- Weather Information
- 'Welcome to Texas' Photo Area
- Wireless Internet Access

21. If comparable features and amenities were offered by a nearby private business (convenience store, restaurant, truck stop), which facility would you choose to visit?

   ❍ I would choose to stop at a public safety rest area similar to the facility in Example 3.

   ❍ I would choose to stop at a private convenience store, restaurant, or truck stop.

   Please explain why. ______

22. If you indicated a preference for private facilities in Question 21, how many miles out of your way are you willing to drive to access a convenience store, restaurant, or truck stop instead of stopping at a public facility similar to Example 3?

❍ Less than 5 miles
❍ 6–10 miles
❍ 11–15 miles
❍ 16–20 miles
❍ More than 20 miles

23. Private businesses can currently advertise for matters of interest to the traveling public (attractions, lodging, restaurants, emergency road service) at public safety rest areas and travel information centers. In your opinion, should the current level of advertising be: (Check all that apply)

❍ Expanded to include more indoor media (digital banners, restroom posters, videos)?
❍ Expanded to include more goods and services (communications, real estate)?
❍ Expanded to include outdoor advertising (signs, billboards)?
❍ Kept the same?
❍ Reduced?
❍ Other _____ (please specify)

24. In your opinion, should private businesses be allowed to provide goods and services at public safety rest areas and travel information centers?

❍ No
❍ Yes

25. If you answered Yes to Question 24, what types of services would you like to see? (Check all that apply.)

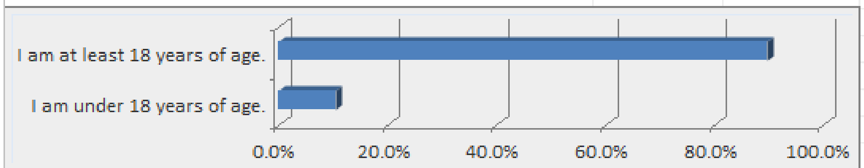
❍ Fast food restaurants
❍ Gas and other automotive services
❍ Sit down restaurants
❍ Stores with local handicrafts and souvenirs
❍ Other _____ (Please specify)

Thank you for taking the time to complete this survey.

8/5/2010-11/8/2010

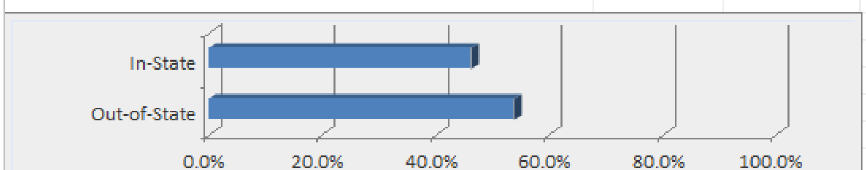
Question 1
You must be at least 18 years of age to participate in this survey.

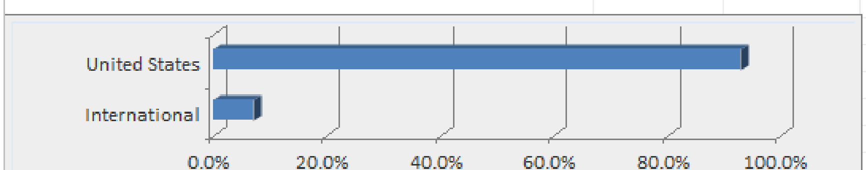
Answer Options	Response Count	Response Percent
I am at least 18 years of age.	678	89.7%
I am under 18 years of age.	78	10.3%
answered question	**756**	**100.0%**
skipped question	**0**	



Question 2
Where do you currently live?

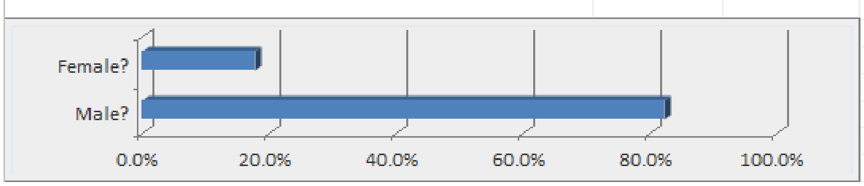
Answer Options	Response Count	Response Percent
City/Town:		
Unique Cities/Towns	326	NA
answered question	**448**	**NA**
skipped question	**308**	
State/Province:		
In-State	207	46.2%
Out-of-State	241	53.8%
answered question	**448**	**100.0%**
skipped question	**308**	
Country:		
United States	382	92.9%
International	29	7.1%
answered question	**411**	**100.0%**
skipped question	**345**	





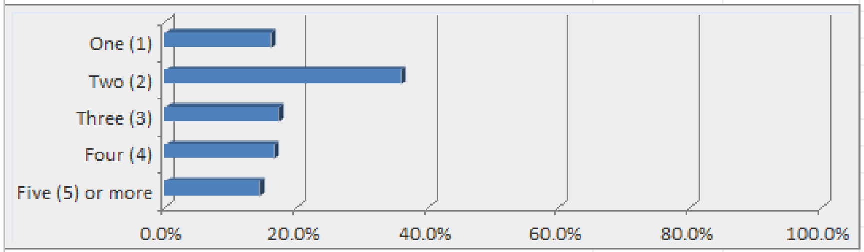
Question 3
Are you:

Answer Options	Response Count	Response Percent
Female?	71	17.8%
Male?	329	82.2%
answered question	**400**	**100.0%**
skipped question	**356**	



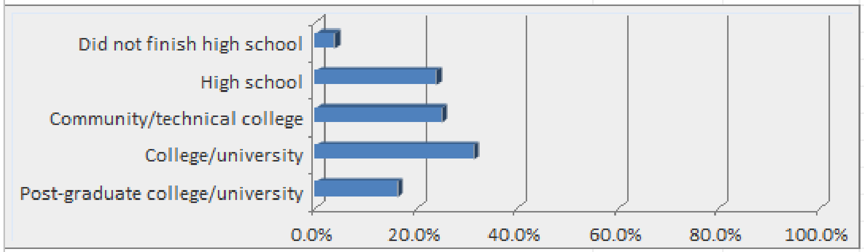
Question 4
How many people live in your household, including yourself?

Answer Options	Response Count	Response Percent
One (1)	74	16.1%
Two (2)	165	35.9%
Three (3)	79	17.2%
Four (4)	76	16.5%
Five (5) or more	66	14.3%
answered question	**460**	**100.0%**
skipped question	**296**	



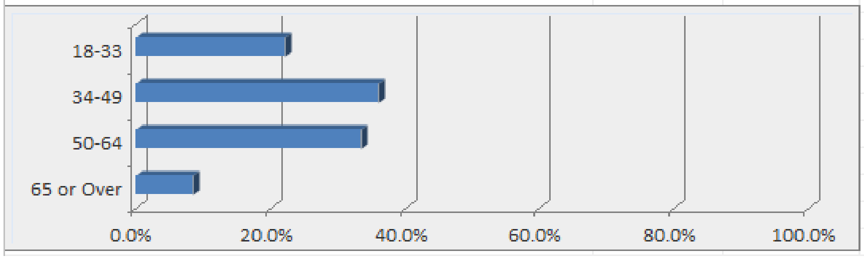
Question 5
What is your highest level of education?

Answer Options	Response Count	Response Percent
Did not finish high school	18	3.8%
High school	112	23.9%
Community/technical college	117	24.9%
College/university	146	31.2%
Post-graduate college/university	76	16.2%
answered question	**469**	**100.0%**
skipped question	**287**	

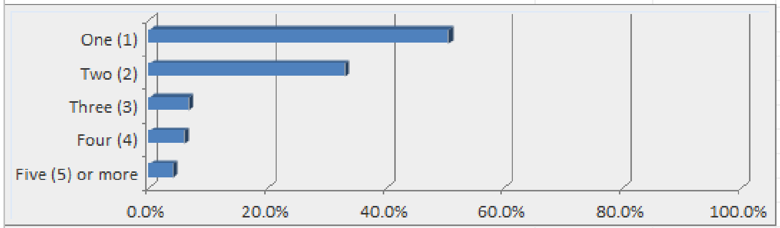


Question 6
What is your age?

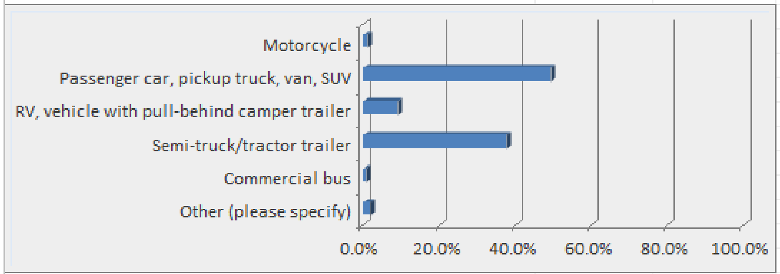
Answer Options	Response Count	Response Percent
18-33	103	22.2%
34-49	167	36.0%
50-64	155	33.4%
65 or Over	39	8.4%
answered question	**464**	**100.0%**
skipped question	**292**	



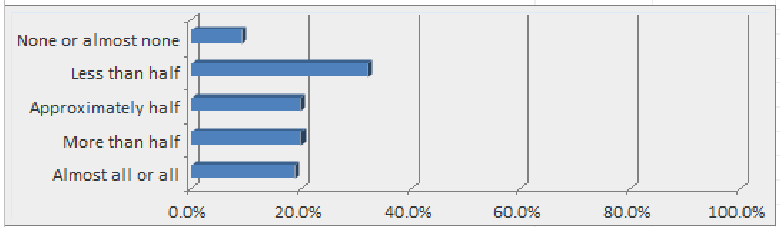
Question 7 For driving trips over 100 miles (one-way), how many people, including yourself, are most often traveling in your party?		
Answer Options	**Response Count**	**Response Percent**
One (1)	219	50.5%
Two (2)	143	32.9%
Three (3)	29	6.7%
Four (4)	26	6.0%
Five (5) or more	17	3.9%
answered question	**434**	**100.0%**
skipped question	**322**	



Question 8 For driving trips over 100 miles (one-way), what type of vehicle do you most often travel in?		
Answer Options	**Response Count**	**Response Percent**
Motorcycle	5	1.1%
Passenger car, pickup truck, van, SUV	218	49.5%
RV, vehicle with pull-behind camper trailer	40	9.1%
Semi-truck/tractor trailer	166	37.6%
Commercial bus	3	0.7%
Other (please specify)	9	2.0%
answered question	**441**	**100.0%**
skipped question	**315**	

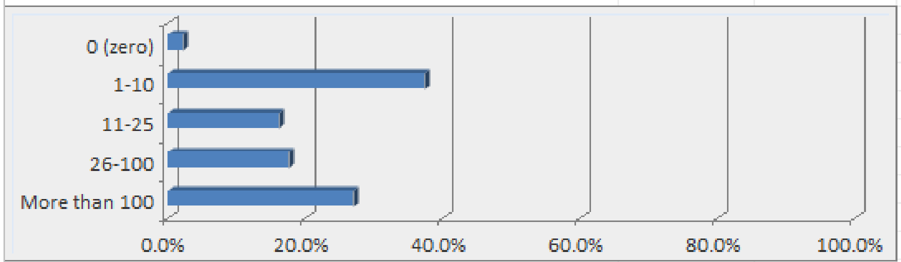


Question 9 For driving trips over 100 miles (one-way), how much of this mileage typically occurs in Texas?		
Answer Options	**Response Count**	**Response Percent**
None or almost none	40	9.2%
Less than half	140	32.1%
Approximately half	86	19.8%
More than half	87	20.0%
Almost all or all	82	18.9%
answered question	**435**	**100.0%**
skipped question	**321**	



Question 10
During the last 12 months, how many driving trips over 100 miles (one-way) did you make?

Answer Options	Response Count	Response Percent
0 (zero)	9	2.1%
1-10	163	37.4%
11-25	70	16.1%
26-100	76	17.5%
More than 100	117	26.9%
answered question	**435**	**100.0%**
skipped question	**321**	

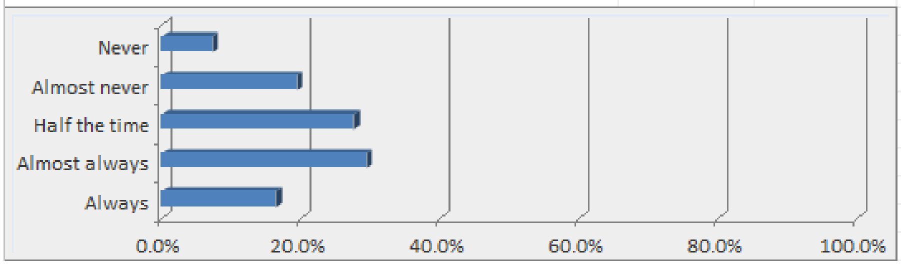


Question 11
During the last 12 months, including today, how many times did you stop at a public safety rest area or travel information center in Texas? (please enter a number equal to or greater than 1)

Answer Options	Response Outcomes
Minimum	1
Maximum	1,000
Mean	25
Median	9
answered question	**395**
skipped question	**361**

Question 12
How often do you access the Internet using the free wireless connection offered at public safety rest areas and travel information centers in Texas?

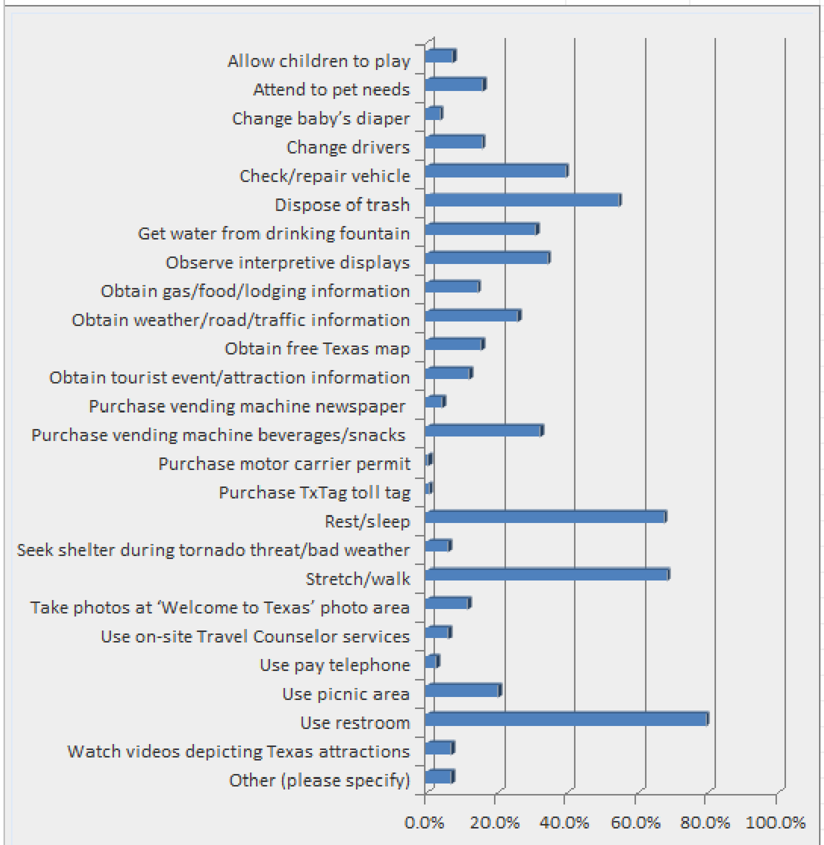
Answer Options	Response Count	Response Percent
Never	28	7.3%
Almost never	74	19.3%
Half the time	106	27.6%
Almost always	113	29.4%
Always	63	16.4%
answered question	**384**	**100.0%**
skipped question	**372**	



Question 13

During your stop today, what activities did or will you or any of your passengers perform? (check all that apply)

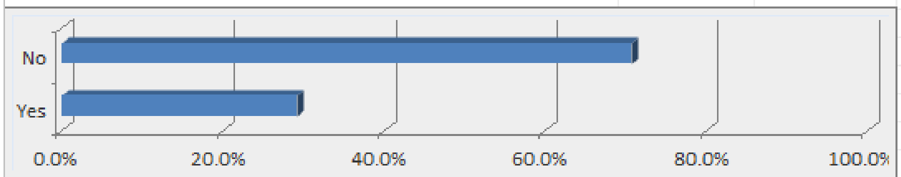
Answer Options	Response Count	Response Percent
Allow children to play	29	7.2%
Attend to pet needs	64	15.8%
Change baby's diaper	14	3.5%
Change drivers	63	15.6%
Check/repair vehicle	159	39.3%
Dispose of trash	220	54.3%
Get water from drinking fountain	125	30.9%
Observe interpretive displays	138	34.1%
Obtain gas/food/lodging information	58	14.3%
Obtain weather/road/traffic information	104	25.7%
Obtain free Texas map	62	15.3%
Obtain tourist event/attraction information	48	11.9%
Purchase vending machine newspaper	17	4.2%
Purchase vending machine beverages/snacks	130	32.1%
Purchase motor carrier permit	1	0.2%
Purchase TxTag toll tag	2	0.5%
Rest/sleep	272	67.2%
Seek shelter during tornado threat/bad weather	24	5.9%
Stretch/walk	276	68.1%
Take photos at 'Welcome to Texas' photo area	46	11.4%
Use on-site Travel Counselor services	24	5.9%
Use pay telephone	10	2.5%
Use picnic area	81	20.0%
Use restroom	321	79.3%
Watch videos depicting Texas attractions	27	6.7%
Other (please specify)	27	6.7%
answered question	**405**	**>100%**
skipped question	**351**	



Question 14

If you received free on-site professional travel counseling assistance, did you or will you extend your stay in Texas because of the information provided?

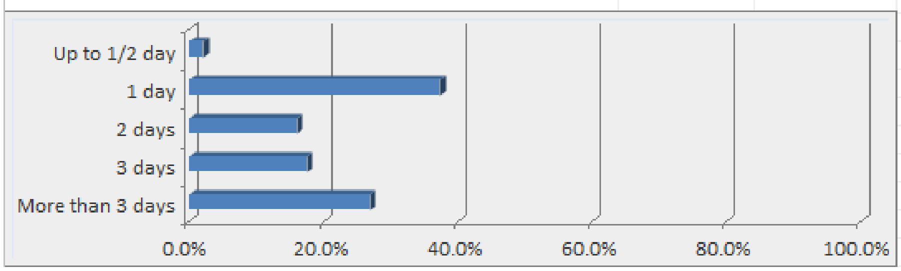
Answer Options	Response Count	Response Percent
No	198	70.7%
Yes	82	29.3%
answered question	**280**	**100.0%**
skipped question	**476**	



Question 15

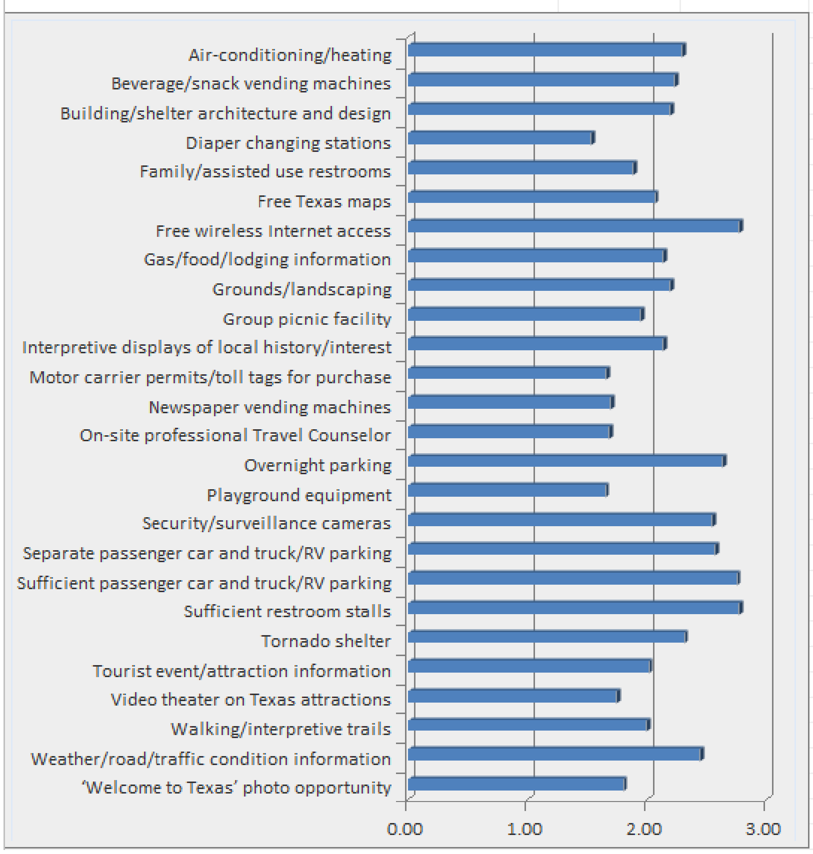
If you answered Yes to Question 14, how much longer did you or will you remain in Texas?

Answer Options	Response Count	Response Percent
Up to 1/2 day	15	11.9%
1 day	31	24.6%
2 days	27	21.4%
3 days	7	5.6%
More than 3 days	46	36.5%
answered question	**126**	**100.0%**
skipped question	**630**	



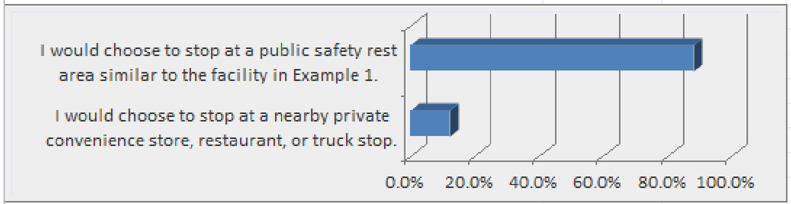
Question 16
How important are the following public safety rest area or travel information center features and amenities to you?

Answer Options	Not at All	Somewhat	Very	Response Count	Rating Average
Air-conditioning/heating	54	144	156	354	2.29
Beverage/snack vending machines	49	172	128	349	2.23
Building/shelter architecture and design	55	167	120	342	2.19
Diaper changing stations	199	66	51	316	1.53
Family/assisted use restrooms	129	111	89	329	1.88
Free Texas maps	85	144	105	334	2.06
Free wireless Internet access	10	62	283	355	2.77
Gas/food/lodging information	64	162	106	332	2.13
Grounds/landscaping	42	188	107	337	2.19
Group picnic facility	101	144	80	325	1.94
Interpretive displays of local history/interest	58	171	100	329	2.13
Motor carrier permits/toll tags for purchase	163	99	54	316	1.66
Newspaper vending machines	148	125	49	322	1.69
On-site professional Travel Counselor	152	116	50	318	1.68
Overnight parking	31	63	248	342	2.63
Playground equipment	159	106	49	314	1.65
Security/surveillance cameras	30	95	210	335	2.54
Separate passenger car and truck/RV parking	32	80	225	337	2.57
Sufficient passenger car and truck/RV parking	16	54	270	340	2.75
Sufficient restroom stalls	8	62	269	339	2.77
Tornado shelter	49	127	150	326	2.31
Tourist event/attraction information	77	167	81	325	2.01
Video theater on Texas attractions	136	135	51	322	1.74
Walking/interpretive trails	84	156	82	322	1.99
Weather/road/traffic condition information	33	121	180	334	2.44
'Welcome to Texas' photo opportunity	121	121	61	303	1.80
Other (please specify)				22	*See Comments*
			answered question	**371**	
			skipped question	**385**	



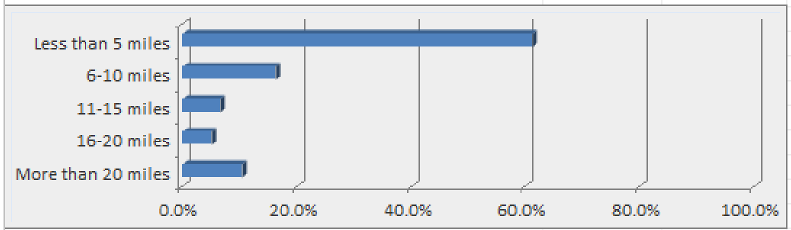
Question 17
If comparable features and amenities were offered by a nearby private business (convenience store, restaurant, truck stop), which facility would you choose to visit?

Answer Options	Response Count	Response Percent
I would choose to stop at a public safety rest area similar to the facility in Example 1.	303	87.8%
I would choose to stop at a nearby private convenience store, restaurant, or truck stop.	42	12.2%
Please explain why.	137	*See Comments*
answered question	**345**	**100.0%**
skipped question	**411**	



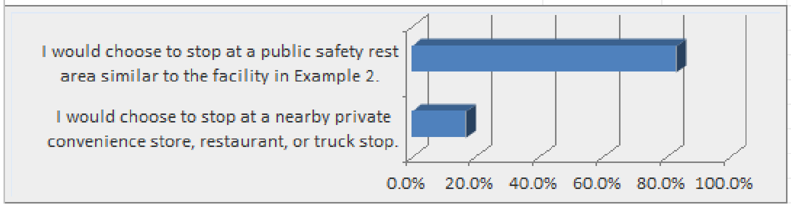
Question 18
If you indicated a preference for private facilities in Question 17, how many miles out of your way are you willing to drive to access a convenience store, restaurant, or truck stop instead of stopping at a public facility similar to Example 1?

Answer Options	Response Count	Response Percent
Less than 5 miles	83	61.4%
6-10 miles	22	16.3%
11-15 miles	9	6.7%
16-20 miles	7	5.2%
More than 20 miles	14	10.4%
answered question	**135**	**100.0%**
skipped question	**621**	



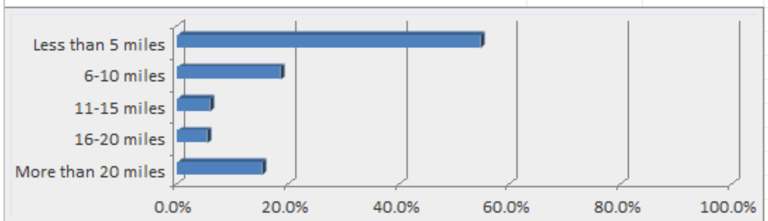
Question 19
If comparable features and amenities were offered by a nearby private business (convenience store, restaurant, truck stop), which facility would you choose to visit?

Answer Options	Response Count	Response Percent
I would choose to stop at a public safety rest area similar to the facility in Example 2.	269	83.0%
I would choose to stop at a nearby private convenience store, restaurant, or truck stop.	55	17.0%
Please explain why.	125	*See Comments*
answered question	**324**	**100.0%**
skipped question	**432**	



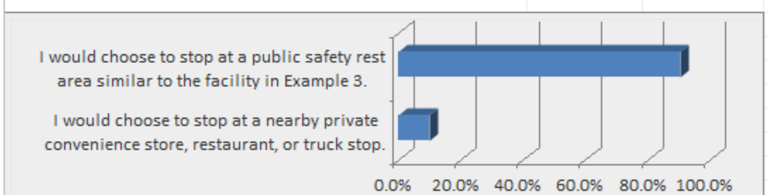
Question 20
If you indicated a preference for private facilities in Question 19, how many miles out of your way are you willing to drive to access a convenience store, restaurant, or truck stop instead of stopping at a public facility similar to Example 2?

Answer Options	Response Count	Response Percent
Less than 5 miles	82	54.7%
6-10 miles	28	18.7%
11-15 miles	9	6.0%
16-20 miles	8	5.3%
More than 20 miles	23	15.3%
answered question	**150**	**100.0%**
skipped question	**606**	



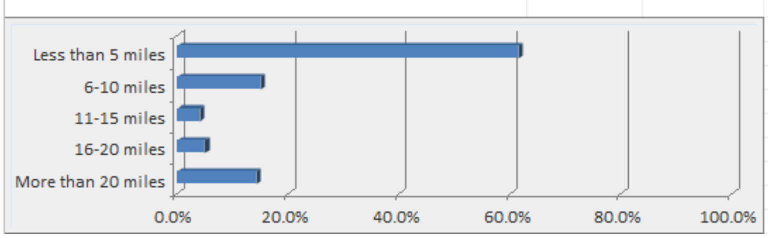
Question 21
If comparable features and amenities were offered by a nearby private business (convenience store, restaurant, truck stop), which facility would you choose to visit?

Answer Options	Response Count	Response Percent
I would choose to stop at a public safety rest area similar to the facility in Example 3.	281	90.4%
I would choose to stop at a nearby private convenience store, restaurant, or truck stop.	30	9.6%
Please explain why.	94	*See Comments*
answered question	**311**	**100.0%**
skipped question	**445**	



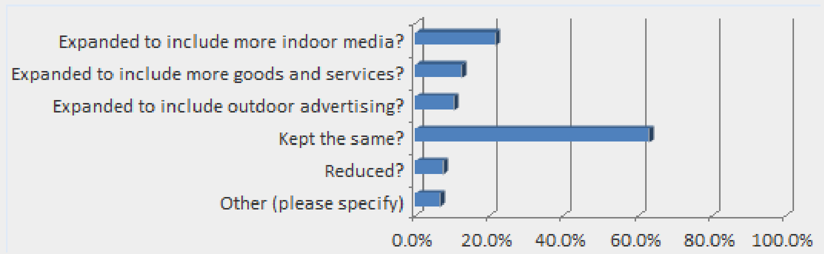
Question 22
If you indicated a preference for private facilities in Question 21, how many miles out of your way are you willing to drive to access a convenience store, restaurant, or truck stop instead of stopping at a public facility similar to Example 3?

Answer Options	Response Count	Response Percent
Less than 5 miles	74	61.6%
6-10 miles	18	15.0%
11-15 miles	5	4.2%
16-20 miles	6	5.0%
More than 20 miles	17	14.2%
answered question	**120**	**100.0%**
skipped question	**636**	



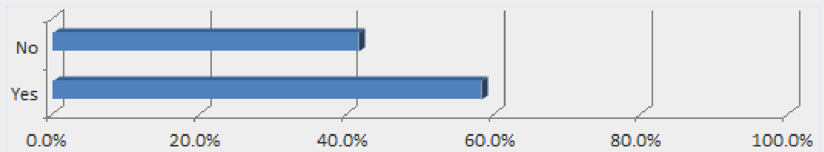
Question 23
Private businesses can currently advertise for matters of interest to the traveling public (attractions, lodging, restaurants, emergency road service) at public safety rest areas and travel information centers. In your opinion, should the current level of advertising be: (check all that apply)

Answer Options	Response Count	Response Percent
Expanded to include more indoor media?	65	21.5%
Expanded to include more goods and services?	37	12.3%
Expanded to include outdoor advertising?	31	10.3%
Kept the same?	191	63.2%
Reduced?	22	7.3%
Other (please specify)	20	6.6%
answered question	**302**	**>100%**
skipped question	**454**	



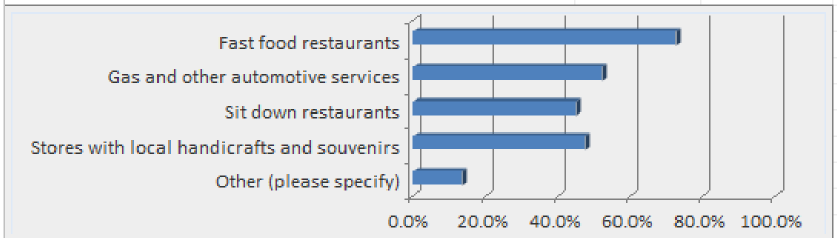
Question 24
In your opinion, should private businesses be allowed to provide goods and services at public safety rest areas and travel information centers?

Answer Options	Response Count	Response Percent
No	129	41.6%
Yes	181	58.4%
answered question	**310**	**100.0%**
skipped question	**446**	



Question 25
If you answered Yes to Question 24, what types of services would you like to see? (check all that apply)

Answer Options	Response Count	Response Percent
Fast food restaurants	139	72.8%
Gas and other automotive services	100	52.4%
Sit down restaurants	86	45.0%
Stores with local handicrafts and souvenirs	91	47.6%
Other (please specify)	26	13.6%
answered question	**191**	**>100%**
skipped question	**565**	



APPENDIX D:
AVERAGE DAILY VEHICLE COUNTS REFLECTING SAFETY REST AREA USAGE

Facility	SRA Usage (Avg. Daily)			Date
	Combined	Cars	Trucks	
US 287 Corridor				
Wise County NB	311	223	88	March 2010
Wichita Travel Information Center	345	327	18	March 2010
Wichita County NB	318	189	129	March 2010
Wichita County SB	263	150	113	March 2010
Hardeman County NB	440	288	152	March 2010
Hardeman County SB	522	370	152	March 2010
Donley County NB	436	292	144	March 2010
Donley County SB	340	211	129	March 2010
Amarillo Travel Information Center	281	174	107	March 2010
IH 45 corridor				
Navarro County NB	916			2002
Navarro County SB	897			2002
Walker County NB	833			2002
Walker County SB	1177			2002
IH 10 Corridor				
Kerr County EB	618			June 2009
Kerr County WB	625			June 2009
Sutton County EB	486			2002
Sutton County WB	481			2002
Pecos East County EB	408			2002
Pecos East County WB	466			2002
Pecos West County EB	428			2002
Pecos West County WB	303			2002
Culberson County EB	697			2002
Culberson County WB	660			2002
El Paso County EB	905			2002
El Paso County WB	994			2002
Anthony Traveler Information Center	613			2002

Applied 3% annual growth rate to bring prior year counts to year 2008 (consistent with average growth rate in counties where safety rest areas were located)