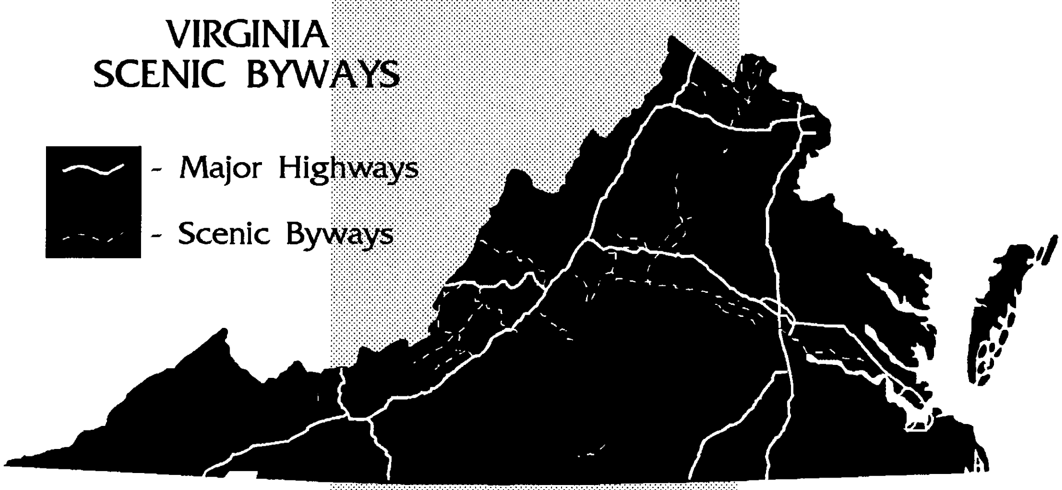
FINAL REPORT

# DESIGN AND INFORMATION REQUIREMENTS FOR TRAVEL AND TOURISM NEEDS ON SCENIC BYWAYS

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Supplementary Notes



Abstract

The purpose of this study was to develop a system design and information evaluation process that could be used to review proposed or designated scenic byways. The process was intended to ensure that the geometric and traffic design of these roads were compatible with their intended use. The process that was developed involves the following steps: (1) collection of data pertaining to traffic accidents and geometric elements, (2) analysis of accident and traffic data, (3) identification of improvements for motorized and nonmotorized traffic, and (4) provision of information and services. The process was successfully used to identify design and information requirements for an existing scenic byway: Route 711, located in Powhatan County, Virginia.

The authors recommend that VDOT develop a design guide and maintain a database of information pertaining to scenic byways. They also recommend that the system design and information methodology be tested by VDOT for other designated and proposed scenic byways.

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## TABLE OF CONTENTS

## ABSTRACT

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## INTRODUCTION

In recent years, there has been considerable interest in the development of scenic roads at both the state and national levels. A nationwide effort, the scenic byways movement, is now fully underway to promote the development of scenic roads for both economic advancement and the preservation of historical, scenic, and cultural aspects of the states involved in the effort.

Today's tourists may travel by automobile, motorcycle, camper, recreational vehicle (RV), bicycle, or tour bus. Whether or not they arrive by air or rail, recreational travelers will eventually use state roads to see the countryside or reach a site of historical value, entertainment, or scenic beauty. Nationally, on average, 23 percent of all vehicle trips and 30 percent of all vehicular miles driven are for recreational purposes such as vacations, trips to visit friends and relatives, and pleasure drives.[1] The importance of recreational travel and tourism is reflected in the following statistics[2]:

- In 1989, U.S. residents took more than 1.3 billion person-trips to places 100 miles or more away from home and spent $350 billion doing so.

- Travel and tourism generate more jobs in the United States than any other industry except health services.

- In terms of business receipts, the travel industry is the third largest retail or service industry (after automobile dealers and food stores).

- On a national basis, foreign visitors account for only 3 percent of the trips away from home in the United States but more than 10 percent of the travel expenditures. In 1989, the United States registered its first surplus in its international travel and transportation account. The United States now garners 10 percent of the world's international arrivals and 16 percent of global international travel spending.

Although a significant portion of recreational travel occurs on interstate and multilane highways, the ever-increasing number of travelers brings about the need to design safe two-lane roads to accommodate the needs of tourists. Many states have designated particular secondary routes as scenic byways and have developed statewide programs to oversee the designation process. The purpose of the scenic byway designation is to highlight these road segments as having special historic, cultural, or recreational value and significant beauty and encourage the vacationer or leisure traveler to divert from the main highway to these roads. Virginia has had a program since 1966 that provides for the designation of qualifying roads as Virginia Byways. Nationally, nearly 26,000 miles of highways have been designated scenic byways since 1960.

Scenic byways are unique by virtue of their form and function—the function being to attract new tourist traffic. If scenic byways are successful in this, then roadway and user characteristics will change. Four factors that differentiate scenic byways from ordinary low-volume, two-lane roads are (1) the characteristics of the driver, (2) the characteristics of the vehicle, (3) the purpose of the trip, and (4) the increased potential for conflicts with nonmotorized transport. Where formerly the road served primarily for access to and from homes, schools, and businesses in the area, the traffic mix on the byway includes a higher percentage of first-time motorists. Also, many users are older, as older drivers have more leisure time and can travel during weekdays and off season. There is also a greater variety of vehicle types, ranging from bicycles to large motor homes. In addition to being unfamiliar with the roadway, recreational drivers may be inattentive, be distracted, and travel at lower speeds than would nonrecreational drivers, thus increasing the likelihood of traffic accidents.

A prior study conducted by the Virginia Transportation Research Council addressed the design issue of scenic byway by considering their nature.[3] Although no specific design or informational requirements were developed, the authors did conclude that, due to the traffic mix, scenic byways require special design considerations so that they can serve their intended purpose safely and efficiently.[3] Another study by the Transportation Research Board developed design guidelines for low-volume roads undergoing minor improvements.[4] The findings of this report can be used as a starting point for evaluating the geometric adequacy of scenic byway roadway elements such as lane and shoulder width. Also, the National Scenic Byways Study included 26 case studies, some of which addressed design issues.[1,5,6]

Although these studies are useful in defining the parameters for the design of scenic byways, most of these roads, particularly in Virginia, are already in place. Accordingly, to prepare them adequately for their new function, a system design and information review process is required to evaluate the adequacy of existing scenic byways (or roads that are proposed for designation as scenic byways) and consider what additional elements, if any, these roads might need.

## PURPOSE AND SCOPE

The purpose of this study was to develop a system design and information review process for examining roads that are being considered for designation, or that have already been designated, as scenic byways. The process was intended to ensure that the geometric and traffic design of these roads is compatible with their intended use. The study considered appropriate design measures that allow for variations in user and vehicular characteristics such as speed differentials, driver age, vehicle size and mix, and nonmotorized travel. The research included the development of the review process and a sample application of its use.

The scope was limited to two-lane, two-way roads because of their unique design requirements. Other roads may be of scenic quality (such as interstates and multilane arterials), but such roads are familiar to first-time users due to their uniformity in traffic/information signage and geometric design standards and thus do not require special analysis. Thus, in this study, a scenic byway was considered to be a low-volume, two-lane road that is designated to attract tourists, sightseers, and visitors but is not restricted to such traffic.

For the purposes of this report, it was assumed that the scenic byway was already designated or would be designated through a process involving local and state agencies as well as community leaders. The procedure for designating a scenic byway in Virginia has been previously described.[7]

## APPROACH

The approach used in this study involved the following elements:

1. *Define a system design and information review process that is appropriate for evaluating proposed or existing scenic byways.* The process should be a logical series of tasks a designer can follow when evaluating a scenic byway and selecting necessary improvements. It should also recognize and incorporate the Virginia Department of Transportation's (VDOT) current procedures for design review of rural roads.

2. *Develop a detailed description of methods, procedures, and techniques that can be used to carry out each activity in the design review process.* Activities include such items as data acquisition and accident analysis. The basis for the proposed procedures was developed from a review of current practices and methods as described in the literature. Consideration was given to design elements identified as relevant to scenic byway travel, such as geometric cross-section, user information needs, roadway features, nonmotorized travel, and traffic signing.

3. *Validate the design review procedure by completing an evaluation of an existing scenic byway in Virginia.* This case study should be used to (1) demonstrate the use of the review process and (2) identify potential problems or shortcomings in the design review process in order to identify the needs for further research and testing. A segment of Virginia Byway Route 711 in Powhatan County was chosen because it exemplified the design problems often encountered with rural scenic two-lane roads.

4. *Develop conclusions and recommendations based on the information acquired from the literature and the case study of the design process.*

# RESULTS

## Guidelines for Analysis of Scenic Byway Elements

In order to improve safety and operational conditions for scenic byways, improvements can be made in the roadway geometrics, traffic engineering, roadway signing, and facilities for bicycles and pedestrians. A case study for the National Scenic Byway Study[5] listed the following measures to achieve this end.

- Reduce the speed differential between recreational and other traffic through signs and warning messages.
- Use larger and brighter signs to compensate for an increased number of older drivers.
- Erect advanced warning signs announcing lane width changes (extremely important for oversized vehicles on two-lane roads).
- Provide adequate clear zones outside the traveled roadway in which errant vehicles can recover.
- Install adequate curbs and guardrails and place barriers where clear zones cannot be provided.
- Provide parking turnouts at major viewing areas and short passing bays on long grades where continuous climbing lanes are infeasible.
- Remove, where possible, dangerous fixed objects too near the roadway, such as large boulders and abandoned structures.
- Provide parallel but separate hiking and biking trails.
- Install escape ramps for recreational vehicles on long, steep downhills.
- Improve sight distance on horizontal and vertical curves.
- Rehabilitate or replace bridges and culverts inadequate for larger RVs.
- Provide adequate access and facilities for police, medical, and fire emergency vehicles.

The following measures are discussed in the next section: geometric design elements, user information needs, and accommodations for bicyclists and pedestrians.

### Geometric Design Elements

The roadway and roadside design elements that are relevant in scenic byway design are design speed and speed limits, cross-sectional elements, vertical and horizontal alignment, passing opportunities and pull-offs, and clear zones. In order to determine the design speed and other relevant cross-sectional elements, a classification system for scenic roads was developed that groups scenic roads into five categories, lettered *A* through *E*.[5] The categories are used to indicate the type of service provided for activities related to scenic and recreational travel.

- *Category A* would include urban and rural principal arterials as well as freeways and expressways with full control of access. Such byways could provide special design amenities for recreational drivers, such as scenic overlook pull-offs, while still maintaining the minimum design standards required on such highway facilities.

- *Category B* would include urban and rural principal arterials with partial control of access, parkways, and principal park roads. Most would have two or more lanes and a design speed exceeding 45 mph.

- *Category C* would include urban and rural minor arterials and major collector roads without control of access. Most would be paved two-lane roads with a design speed of 40 mph or greater.

- *Category D* would include rural secondary routes and urban and rural local roads. Most would be two-lane roads with a design speed of 30 to 40 mph, depending on terrain. Road surfaces would be paved, but there would be narrow or no shoulders.

- *Category E* would have the lowest design standards, with only one or two lanes of gravel or natural graded surfaces and no shoulders. The design speed could be as low as 10 mph. Users of these roads would be advised to expect a considerable degree of difficulty in driving on them.

The selection of the appropriate scenic road category establishes needed design parameters, such as design speed, maximum grade, and minimum lane and shoulder width. Table 1 provides suggested design guides and standards for scenic roads for each category. For the purposes of this study, scenic byways were considered as two-lane paved roads and thus are in Category C or D.

Since scenic byways typically carry a large proportion of first-time users, often in larger vehicles, as well as bicyclists and pedestrians, the cross-sectional and roadside elements may be altered to provide a higher level of safety. The following sections discuss ways in which scenic roadways can be improved through geometric design to enhance safety and performance.

*Cross-Sectional Elements*

Cross-sectional elements that have been shown to be effective in reducing the number of "related" accidents include wider lanes, wider and paved shoulders, greater recovery distance, flatter terrain, and flatter sideslopes. Each incremental change in these cross-sectional elements should improve safety. The safety cost-effectiveness of either an individual improvement or a combination of improvements, and the extent to which these elements are changed, should be the basis for selecting the improvements to be made.

**TABLE 1[a]**

**SUGGESTED DESIGN GUIDES AND STANDARDS FOR SCENIC ROADS[b]**

| Scenic Road Category | Terrain | Design Speed (mph) | Maximum Grade % | Number of Lanes | Minimum Lane Width (ft) | Pavement Surface Type[c] | Minimum Shoulder Width (ft) |
|---|---|---|---|---|---|---|---|
| A | Level | 70 | 3 | ≥ 4 | 12 | H | 10 |
| | Rolling | 60 | 4 | ≥ 4 | 12 | H | 10 |
| | Mountain | 50 | 7 | ≥ 4 | 12 | H | 10 |
| B | Level | 70 | 3 | 2-4 | 12 | H | 8 |
| | Rolling | 60 | 4 | 2-4 | 12 | H | 8 |
| | Mountain | 50 | 7 | 2-4 | 12 | H | 8 |
| C | Level | 60 | 8 | 2 | 8 | H | 8 |
| | Rolling | 50 | 8-12 | 2 | 8 | H | 6 |
| | Mountain | 40 | 12 | 2 | 8 | H | 6 |
| D | Level | 50 | 7 | 2 | 8 | I | 2 |
| | Rolling | 40 | 11 | 2 | 8 | I | 2 |
| | Mountain | 30 | 16 | 2 | 8 | I | 2 |
| E | Level | 15 | 10 | 1-2 | 14" | I,L | 0 |
| | Rolling | 15 | 10-16 | 1-2 | 14" | I,L | 0 |
| | Mountain | 10 | 16 | 1-2 | 14" | I,L | 0 |

[a]Federal Highway Administration. 1990. *Safety Impacts, Design Standards, and Classification Systems for Scenic Byways*. Washington, D.C.: Bellomo-McGee, Inc.

[b]Minimum travelway width.

[c]H=high (concrete, bituminous); I=intermediate (surface treatments, bituminous); L=low (earth roads of stabilized or loose material).

Increases in the lane and shoulder widths should enhance safety for tourist-related vehicles such as RVs, campers, motor homes, and buses, as well as passenger cars. These improvements may also provide a sense of security for tourists who are distracted by the features along the corridor. On the other hand, those already familiar with the road might drive faster through sections with wider lanes and extended shoulders.

*Vertical and Horizontal Alignment*

Changing the alignment is one method used to smooth horizontal and vertical curves, and thus enhance safety. Such changes provide a greater sight distance and a smoother ride. However, it is often not possible to make geometric changes due to cost, right-of-way, and other environmental constraints. A scenic byway design should provide "ground fitting, graceful horizontal and vertical alignment with appropriate curves and striking vistas.",[8 p.7-2] Other elements or improvements related to the vertical and horizontal alignment may instead be incorporated to mitigate certain dangers associated with steep grades, sharp curves, and other safety problems. These include (1) climbing lanes, acceleration and deceleration lanes, and runaway ramps that can be used to accommodate the mix of heavy vehicles and other traffic; (2) fixed objects that can be removed to improve the sight distance around some curves and provide greater safety to errant vehicles; (3) traffic control devices that can be used to guide vehicles into and around safety problem areas; and (4) vehicle restrictions that may allow for a safer and more enjoyable environment.

On sections of the roadway where steep grades cause heavy vehicles to slow while climbing, a climbing lane can be added to eliminate delays and conflicts between heavy vehicles and others in the traffic stream. Warning signs and runaway ramps can also be used to enhance the safety of heavy vehicles on steep downgrades. At intersections and driveways, especially in areas where the sight distance is limited due to sharp curves or steep grades, the addition of acceleration and deceleration lanes would also act to eliminate delays and conflicts caused by vehicles entering the scenic byway.

Sharp curves without adequate sight distance and those that are concurrent with steep grades are a safety issue. If funds are not available for straightening curves and smoothing the vertical alignment, other actions might be considered, such as removing roadside obstacles, reducing approach speed limits, and adding curve warning signs and delineation devices.[6]

Restricting certain types of vehicles may also enhance the tourists' trip. For instance, large trucks may be restricted in order to improve visibility and maneuverability. To minimize the negative impacts of restricting certain vehicles, special time or seasonal restrictions (to coincide with peak tourist travel) can be implemented.

*Passing Opportunities and Pull-Offs*

Due to the tendency of tourists to drive more slowly on scenic byways than regular users, adequate passing opportunities are necessary to minimize delays encountered by other drivers. If an additional lane to provide passing opportunities is not a viable alternative, gravel or stabilized pull-offs with appropriate signing regarding their location may provide the same result. Similarly, extended stabilized shoulders can be used to enable slower-moving vehicles to pull over to the side of the road and allow others to pass. It is also important that leisure drivers be made aware of their responsibility to maintain a particular speed or remove themselves periodically from the traffic stream to avoid creating a safety hazard and delays.

*Clear Zones*

Clear zones provide the necessary area beyond the edge of the travelway that is free from hazardous obstructions so that drivers of errant vehicles can sufficiently regain control. For scenic byways, the clear zone is determined in a manner similar to that used in resurfacing, restoration, and rehabilitation (RRR) projects. Minimum clear zones, as defined in AASHTO's *Roadside Design Guide,*[9] are to be created according to the design speed of the facility, the traffic volume, and the embankment slope (either cut or fill). Since the width of the clear zone for each set of conditions is based on empirical data, recommended widths cannot be considered precise or accurate for every possible design situation and thus should be used with caution. For scenic byways, the application of the clear zone concept may require an evaluation of the actual performance of the facility including accident records, on-site inspections, and review of complaints by citizens or public officials. Consequently, it may not be cost-effective or practical because of environmental impacts or limited right-of-way to bring scenic byways into full compliance with all of the clear zone recommendations provided by AASHTO.

## User Information Needs

Safety depends as much on the information provided to drivers through signs, traffic control devices, and positive guidance elements as it does on physical design. Signs, interpretive kiosks, and historical markers provide guidance onto, through, and to other areas from the scenic byway and information about its scenery, culture, and historical aspects. Concerns that signs, both public and private, will tend to overcrowd a byway and degrade the view can be addressed through effective management and sign control by the state traffic engineer.

### *Informational Signs*

Certain signs guide travelers to particular locations, advertise nearby amenities, warn motorists of possible hazards, and generally help improve driver expectancy. These signs are classified as "warning" or "guide" signs in the *Manual on Uniform Traffic Control Devices.* For first-time motorists or those unfamiliar with the area or the road, signs can also provide a certain degree of security by informing them of where they are, the direction in which they are heading, and what to expect up ahead.

The following types of informational signs can be effective on scenic byways:

- signs warning of slower-moving vehicles
- signs warning of pedestrian and bicycle crossings
- signs directing tourists onto, through, and to the end of the designated scenic byway
- signs guiding tourists to a major paralleling or nearby route
- signs identifying upcoming features for scenic overlooks, picnic areas, boat landings, rest areas, interpretive centers, etc.
- signs identifying the location of commercial and comfort facilities (e.g., gas stations, restaurants, restrooms, telephones).

### *Traffic Control Devices*

Traffic control devices, including warning and directional signs, are used to enhance safety. These include pavement markings that clearly provide positive guidance and warning devices such as arrows, chevrons, and flashing lights. The purpose of traffic control devices is to reduce highway speeds on curves and minimize speed differences between vehicles.

Warning signs are placed in strategic locations to notify drivers that slower traffic may be ahead and have been used effectively to reduce the likelihood of accidents caused by speed differences. Signs are located in front of blind curves, at hillcrests, and in other locations where limited sight distance may inhibit drivers from seeing slower-moving traffic. Since warning signs should be observed immediately by fast-moving drivers, flashing lights attached to the sign have been used.

Traffic calming techniques such as the use of islands, raised or narrower roadway surfaces, and special plantings and lighting are popular in Western European countries and are used to achieve compliance with posted speed limits.[10] By the use of such techniques, the overall safety record of a highway can be improved because regular commuters and tourists will be driving at approximately the same speed.

Uniformity in speed has also been achieved by the use of techniques such as "speed cushions,"[11] which are of unique design, shape, and size and encourage drivers of standard passenger cars to slow down. Buses and emergency vehicles with wide wheel bases can straddle the obstructions and thus mitigate discomfort at higher speeds. Were speed cushions to be used on scenic byways, they could be placed at the beginning of a speed zone and at regular intervals to ensure compliance.

*Interpretive Centers*

Information for tourists about sights and events that lie ahead is often provided on signs or at kiosks at either end of a designated section or route. Kiosks placed at rest areas, pull-offs, and scenic overlooks also provide an interpretation of a particular scene or the historic perspective of the area. A map of the byway and surrounding area is often provided at these locations, as well as brochures or advertisements regarding nearby establishments. These centers assist tourists in reaching their destination and improve the quality of their driving experience.

## Accommodations for Bicyclists and Pedestrians

Safety improvements intended for tourists traveling in passenger cars, RVs, and campers may also affect bicyclists. Such improvements include widening lanes, lowering speed limits, extending shoulders, and removing obstructions to improve sight distance. Also, roadway defects and objects that cause discomfort to bicyclists can be repaired or eliminated to improve the quality of the trip. Bicyclists' safety can also be improved by maintaining the paved surfaces so that they are free of debris.

Recommendations resulting from a system design and information review of a potential or existing byway as they relate to bikeways will rely heavily on accepted design standards and guidelines. By federal law, the construction of bicycle facilities must be considered in the planning process of any major reconstruction or new highway project. Possible facilities or accommodations for bicyclists include separated bicycle paths, dedicated bike lanes on the road surface, or extended paved shoulders shared between motorized vehicles and bicycles. Design guides for the development of bicycle facilities have been published by AASHTO.[12] This document provides appropriate information for planning and design to accommodate bicycle traffic in all riding environments, including scenic byways.

Hiking paths, sidewalks, and crossing opportunities such as crosswalks and tunnels are used to accommodate the pedestrian on the scenic byway corridor. The encouragement of pedestrian activity by the provision of a safe environment may reduce the number of tourists who travel in cars on scenic byways and thereby relieve congestion, reduce delays, and reduce air and noise pollution. Pedestrians can be accommodated by physical separation from the road surface by the use of curbs or separate paths located outside the right-of-way. Warning signs and adequate sight distance in advance of the crossing offer additional safety to pedestrians. In some situations, pedestrian and bicycle facilities may be combined, particularly in rural areas.

## A System Design and Information Review Process

This section describes a system design and information review process developed to evaluate a scenic byway and design an improvement program. The techniques involved were based, in part, on the concepts presented in previous research relating to scenic byways, safety, design, and field testing. The process may easily be incorporated into the designation and review procedures of the existing Virginia Byways Program. Figure 1 depicts the six basic tasks involved in the process:

1. data acquisition
2. accident and traffic analysis
3. identification of improvement measures
4. incorporation of pedestrian and bicyclist needs
5. consideration of information and other improvement opportunities
6. selection of design and information improvement projects.

### Data Acquisition

The collection of pertinent data makes it possible to determine the following: (1) existing roadway conditions and the adequacy of the road to serve as a scenic byway, (2) extent of the intrinsic qualities and resources in the corridor, and (3) needed improvements to the roadway and supporting facilities. A periodic review after the designation will establish whether the features of the byway have been maintained and identify the problems to be corrected.

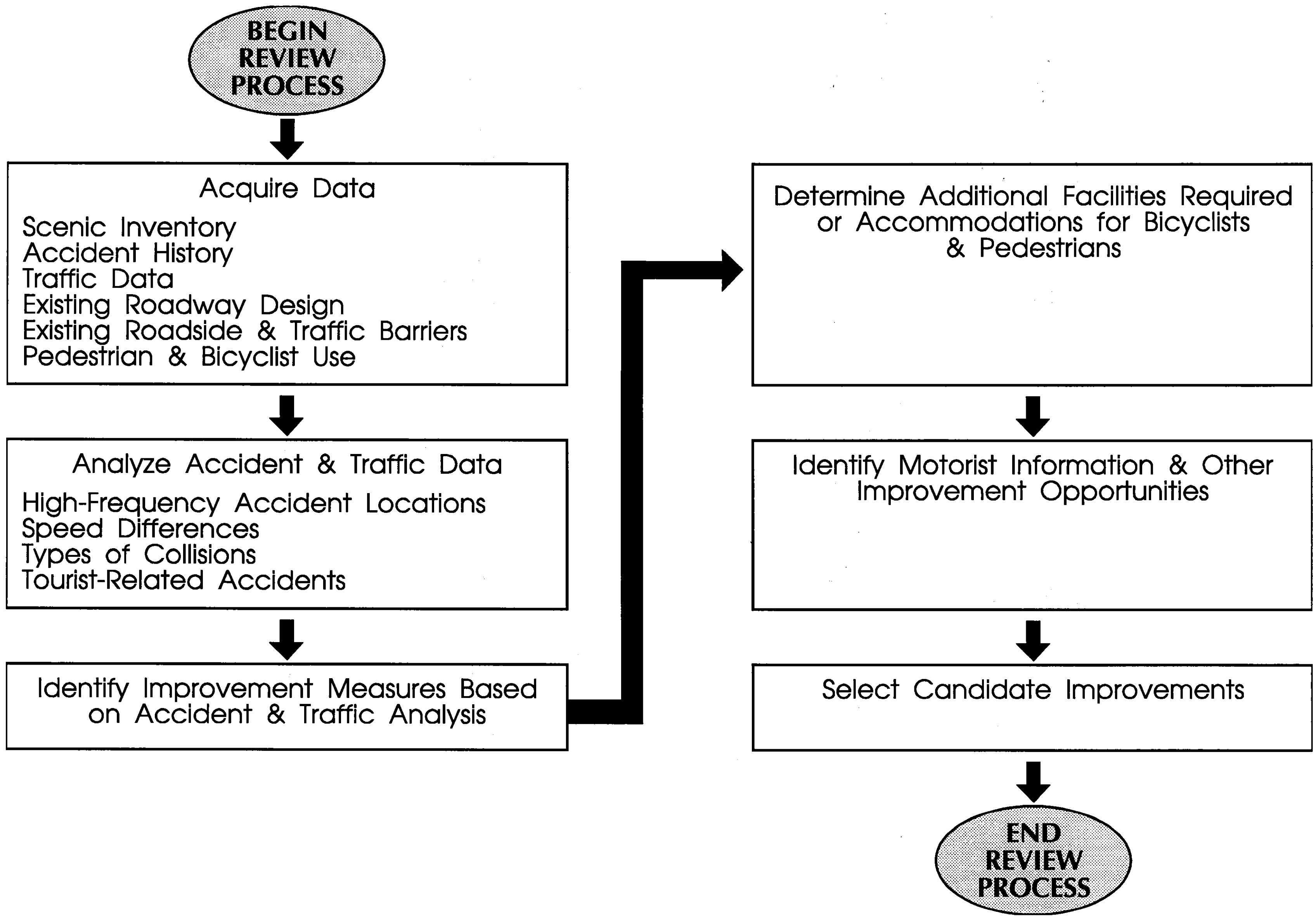


Figure 1. System design and information review process.

The following data must be collected (if the road is already designated as a scenic byway, it may be assumed that items 1 and 4 have been gathered):

1. location and type of scenic, historic, cultural, recreational, and other features in the corridor

2. accident patterns, types, and locations

3. traffic volumes by type, tourist or regular user, and overall traffic count and percentage of tourist traffic

4. existing geometric design and roadside data, including lane width, shoulder width and type, right-of-way width, grades, general location and type of roadside obstructions, length of vertical curves, and radius of horizontal curves

5. existing traffic control devices and barriers, including warning signs, pavement markings, positive guidance devices, and guardrails

6. pedestrian and bicycle information.

A description of how these data are collected follows. Where appropriate, and to distinguish from approaches used elsewhere, reference is made to Virginia practice.

*Scenic Resources*

The first step in the review is to determine where scenic, historical, cultural, recreational, and other attractions exist within the corridor. This can usually be accomplished by the review team making two drive-by passes. In the first pass, one team member takes photographs of the scenes or points of interest and records the nearest tenth mile for each photograph taken. In the second pass, the survey team videotapes the roadway and right-of-way using a wide-angle lens. The driver states the following information during the videotaping: route number and county, direction of travel, each tenth of a mile, and the speed of the vehicle. The driver attempts to maintain a speed that would be similar to that of a tourist unfamiliar with the road.

The photographs and videotape provide baseline data to which information obtained in future reviews can be compared to ensure that preservation and protection measures have been effective. The videotape also provides engineers and designers the opportunity to familiarize themselves with the road. Information such as lane width, shoulder width and type, condition of sideslopes and embankments, roadside hazard rating, pavement markings, passing opportunities, signs, and other traffic control devices can be extracted from the videotape.

*Accidents*

All accidents that occur on Virginia's interstate, primary, and secondary routes to which the police are summoned are entered into a database known as the Centralized Accident Processing Project (CAPP). CAPP is a result of the cooperation among VDOT, the Department of

Motor Vehicles, and the Department of State Police to create and maintain a complete and non-overlapping database of accident data and statistics. VDOT is primarily responsible for acting as the information supplier, and it maintains the accident records.

Records for incidents that occurred on the byway are to be obtained for the 3-year period prior to the road's designation and for any and all succeeding years. For potential byways, accident data would be obtained for the 3 most recent years, but a longer period may be necessary to determine with accuracy the locations with a high accident frequency. The specific data in each accident record necessary for the evaluation are as follows:

1. *the milepost,* which is marked at every one-hundredth of a mile (to determine the high-frequency accident locations)

2. *the surface condition, surface width, alignment, roadway defects, traffic control, visibility, and drivers' actions* (to determine the existing conditions and actions that may have been contributing factors)

3. *the speed limit and the speed of the vehicle(s) at the time of the accident* (to determine if speeding or speed differentials contributed to the accident); this information is extracted from the accident records for those accidents involving more than one vehicle at both the high-frequency accident locations and the entire length of the road

4. *the type of collision* (to determine if the type of accident is related to the cross-sectional design of the road, as discussed earlier); these data are extracted for all accidents occurring on the potential scenic byway during the study period

5. *what fixed object(s), if any, was (were) a factor;* this information combined with the milepost data offers engineers the opportunity to investigate whether the object(s) should be removed or relocated

6. *the major contributing factor* (to determine if the cause can be eliminated through improved design)

7. *the type of vehicle(s) and residence of driver(s) involved in the accident* (to determine if there is an over-representation of tourist vehicles in the accidents.

*Traffic*

VDOT conducts traffic counts either annually or semiannually, depending on the class of the road and the availability of equipment and personnel. These data do not include separate counts of tourist traffic; therefore, an assumption has been made by the Environmental Division of VDOT and VDCR that prior to any statewide promotional efforts of the byways system, tourist traffic comprises between 0 and 5 percent of the total traffic. Once a Virginia Byways Map is published, the tourist traffic is expected to increase to between 10 and 15 percent of the total volume.

*Roadway and Roadside Dimensions*

Roadway and roadside data can be obtained from the videotape. Some measurements may be required in order for the reviewer to get a perspective of the size of objects. These may include measurements of the lane and shoulder width and the distance from the edge of the pavement to the centerline of the ditch. The measurements are taken at one specific site near one end of the potential byway section (and far enough from the intersection to compensate for the transition if the road segment starts at an intersection) and recorded according to the nearest tenth of a mile from that end of the road segment.

The roadway graphical logs and/or HTRIS (a computerized version of the graphical logs) can also provide these data. Using the graphical logs may be time-consuming, and they may not provide the latest and most accurate information about the roads, which may have undergone improvement since the latest edition was published. HTRIS, likewise, may not be the most effective source for examining existing roadway data because it is available to only a few individuals in VDOT. Instead, an automated data acquisition system, such as the Automatic Road Analyzer (ARAN), can be used to collect data if services can be solicited or if the state owns one of these or similarly equipped road analyzing vehicles. District engineers, or those performing the review of proposed byways, may want to schedule the use of ARAN (or equivalent road analyzing vehicle) to collect data on proposed byways and other roads in the region at the same time. This would be a more cost-effective approach than analyzing roads individually, whether or not the state owns a road analyzing vehicle.

*Pedestrian and Bicyclist Usage*

Counts of pedestrians and bicycles are typically not made unless a particular study calls for them. Local residents can be asked to share their experiences with bicyclists and pedestrians or their use of the road as bicyclists or pedestrians. Otherwise, only assumptions can be made regarding pedestrian and bicyclist use in the particular corridor, based on the proximity of the road to generators of pedestrian and bicyclist use.

Planning for bicycle use requires investigation of a wide variety of issues. AASHTO's *Guide for the Development of Bicycle Facilities*[12] states that an inventory of existing conditions requires information pertaining to (1) the bicycling environment and its suitability for use; (2) the existence and location of other roadway and roadside elements that affect the safety of bicyclists and motorists; (3) the availability of suitable bicycle parking areas; (4) the existence of barriers (i.e., rivers and freeways) that affect bicycling; (5) bicycle accident locations; (6) the amount of recreational versus utilitarian riding; (7) the ages and experience of bicyclists; (8) the views of the bicycling and nonbicycling public; and (9) education, existing laws affecting bicycling, and enforcement programs (to determine their effectiveness). Many of these items can be determined from the drive-by inventory or the videotape.

## Accident and Traffic Analysis

The second step in the process is the analysis of accident and traffic data. The accident records obtained from CAPP can be analyzed using a statistical software package (e.g., SPSS or dBase). Of particular importance are the sites at which (1) the accident frequency is high, (2) the roadway and roadside conditions contributed to accidents involving a speed differential, (3) cross-sectional design deficiencies contributed to the accidents, and (4) tourists or tourist-type vehicles were involved in the accidents. Standard software programs can be used to (1) extract certain data from the records that are relevant to scenic byways, (2) determine the frequency of occurrence, and (3) list the desired data. The following sections describe how these factors relate to key safety and traffic elements.

### *High-Frequency Accident Locations*

One commonly used method for determining high-frequency accident locations is to compare the number of accidents that have occurred at a particular location with the average number of accidents that have occurred for similar roadway conditions. If the actual number of accidents is higher than the expected value, the site is considered to be a high-frequency accident location. Another procedure involves calculating the critical rate factor, a value that when exceeded by the actual number of accidents that occurred at any one location indicates the high-frequency accident locations. This method takes into consideration the average annual daily traffic (AADT), the number of annual average accidents, and the expected number of accidents for a particular type of roadway segment. Often, engineers simply rely on citizen complaints; communication among district engineers, resident engineers, and citizen groups; and the number of accidents that have occurred at any location considered to be potentially hazardous. Whichever method is used, VDOT's Hazard Elimination Program[13] can be used to determine the accident reduction measures and design improvements for these high-frequency accident sites.

If the data collected are insufficient for determining the critical rate factor, or the expected values for the region in which the road is located are not available, then an assumption is made that any location where three or more accidents have occurred in a 3-year period (or five accidents within a 5-year period) is a high-frequency accident location. A rate of one accident per year in any one location is generally accepted as high frequency by VDOT's Traffic Engineering Division. If the sites identified using these guidelines are too few or too many for VDOT to evaluate reasonably, then the threshold number of accidents may be adjusted to provide a more manageable number of sites. For high-frequency accident locations, factors that may have contributed, such as surface conditions, lane and shoulder widths, alignment, roadway defects, driver actions, and visibility, can be investigated.

### *Speed Differences*

For all accidents that involve two or more vehicles at both the high-frequency accident locations and the entire length of the byway, the speed limit, the speeds(s) of the vehicle(s) involved in the accidents, and the milepost should be extracted from the database if available. If the difference in speed between the two vehicles is greater than 10 mph, then the speed differential can be considered a possible contributing factor, although speed differences may not be the cause in all cases. The conditions and geometrics at these locations can be further examined to determine if approach speeds need to be lowered, sight distances need to be improved, or warning signs need to be erected.

*Type of Collisions*

An analysis should be performed to determine if related accidents make up a significant portion of the total. This accident type can be reduced by incorporating elements in the geometric design of the roadway, including wider lanes, wider and paved shoulders, greater recovery distance, lower roadside hazard rating, flatter terrain, and flatter sideslopes. If a significant number of accidents are identified as related, then one or more of these general safety improvement measures bear exploration as a mitigating measure and opportunity to reduce future accidents.

*Nonresident Involvements*

To develop an estimate of the extent to which nonresident drivers are involved in accidents, an involvement ratio can be determined for the number of out-of-state drivers that were in accidents. This step in the analysis is appropriate for roads that have already been designated as scenic byways. However, if a safety problem can be identified that is related to drivers' lack of familiarity with the particular road, then mitigating measures can be identified and implemented before a road is designated and possibly before more accidents occur. Typically, these measures involve those that assist first-time motorists, including wider lanes and shoulders, adequate warning signs, passing lanes and pull-offs, and additional warning distance for stops and roadway changes.

## Identification of Improvement Measures

The previous tasks assist the highway planner to assess the features of the scenic byway and suggest improvements where deficiencies are found. The process of design is an intuitive one based on judgment, experience, and knowledge. Accordingly, it was not within the purview of this study to provide definitive guidelines that could be followed as one would solve a formula. Rather, the approach used was to identify various design elements, list the operational deficiencies they create, and provide a menu of improvement strategies that could be considered.

Table 2 identifies design deficiencies that may exist on proposed or designated scenic byways and lists potential improvement measures. The design elements are speed, highway cross-section, and vertical and horizontal alignment.

## Incorporation of Pedestrian and Bicyclist Needs

Many of the safety and operational improvements recommended for motorized vehicles will also improve safety for pedestrians and bicyclists. However, if roadway improvement measures are not implemented, separate facilities for bicyclists may be appropriate. Table 3 identifies safety measures that are intended to accommodate bicyclists and pedestrians. As noted earlier, the design of bikeways, paths, or bike lanes should adhere to the guidelines developed by AASHTO for the planning and design of bicycle facilities. It has been recommended that wide shoulders (at least 4 ft on both sides) or an overall wider pavement surface (15 ft in the outer lane, especially where the traffic mix includes heavy trucks) can easily accommodate bicyclists. In general, once the vehicle lane width falls below 12 ft, passing motorists must leave the

**TABLE 2**
**GEOMETRIC DESIGN PROBLEMS AND RELATED SOLUTIONS**

| Design Element | Problems/Needs | Improvement Measures |
|---|---|---|
| Design Speed & Speed Limit | Speed differentials — a known factor in delays and congestion | • Lower speed limits and increase enforcement<br>• Improve driver expectancy with properly placed warning signs<br>• Use traffic calming techniques, such as "speed cushions"<br>• Provide speed zones indicating the maximum safe speeds through scenic areas<br>• Provide adequate passing opportunities |
| Cross-Sectional Elements | Some cross-sectional elements are known factors in "related" accidents | • Wider lanes<br>• Wider and paved shoulders<br>• Greater recovery distance (clear zone)<br>• Flatter terrain<br>• Flatter sideslopes |
| Vertical & Horizontal Alignment | Steep grades causing speed differentials between heavy vehicles and others | • Climbing lanes<br>• Acceleration and deceleration lanes<br>• Passing lanes and opportunities<br>• Runaway ramps |
| | Sharp curves | • Improve sight distance by clearing roadside obstacles<br>• Reduce approach speed limits<br>• Add curve warning signs and delineation devices for positive guidance |

**TABLE 3**
**ACCOMMODATIONS FOR BICYCLISTS AND PEDESTRIANS**

| Design Element | Problems/Needs | Improvement Measures |
|---|---|---|
| Bicyclists | Safety improvements that accommodate bicycles | • Widening lanes<br>• Lowering speed limits<br>• Extending shoulders<br>• Improving sight distance by removing obstructions<br>• Keeping paved surfaces free of debris<br>• Fixing or eliminating roadway defects (e.g., potholes) and objects (e.g., grates and manhole covers) |
| | Facilities for bicyclists | • Separated bicycle paths<br>• Dedicated bike lanes on the road surface<br>• Extended paved shoulders |
| Pedestrians | Facilities for pedestrians | • Hiking paths (outside the right-of-way)<br>• Sidewalks (separated from the road by curbs)<br>• Adequate crossings (with warning signs and adequate sight distance in front of the crossing) |

lane in which they are traveling to pass a bicyclist safely. Where traffic volumes are low, this does not normally present a problem. For pedestrians, the needed improvements may include the addition of highway crossings and markings, sidewalks, and hiking paths.

### Consideration of Motorist Information and Other Improvement Opportunities

The provision of rest areas, scenic pull-offs, interpretive kiosks, and other design techniques such as plantings used to screen unattractive views and the clearing of brush to open up scenic vistas, can improve the scenic quality and provide for better enjoyment of the scenic corridor when considered along with safety and operational improvements. Table 4 describes the design elements for motorists' information, the problem or need that is addressed, and the application of specific improvement measures.

**TABLE 4**
**MOTORIST INFORMATION NEEDS**

| Design Element | Problems/Needs | Improvement Measures |
|---|---|---|
| Signs | Guide travelers to certain locations<br>Advertise nearby amenities<br>Improve driver expectancy | • "WATCH FOR SLOWER VEHICLES"<br>• Pedestrian and bicycle crossing signs<br>• Tourist-oriented directional signs, e.g., "ENTERING (or LEAVING) VIRGINIA BYWAY," and signs indicating directional changes<br>• Signs guiding tourists to the major parallel or nearby route, e.g., "S.R. 60, 5 MILES —>"<br>• Signs for such features as pull-offs, scenic overlooks, picnic areas, boat landings, rest areas, interpretive kiosks, etc.<br>• Signs indicating the location of supporting facilities, i.e., gas stations, restaurants, rest rooms and phones |
| Traffic Control Devices | Improve safety and reduce delays and congestion | • Pavement markings that are clear and effective in positive guidance<br>• Coordinated traffic signals to provide improved flow in the traffic stream<br>• Warning devices such as arrows, chevrons, and flashing lights. |
| Interpretive Centers | Educate about and guide visitors to special features along a corridor | • Located at either end of a designated route to provide information about sights and events along the byway and any special conditions or restrictions<br>• Kiosks at rest areas, pull-offs, and scenic overlooks to provide interpretation of a scene or a historical summary of the area<br>• A byway map, brochures, and advertisements of local businesses, accommodations, etc. |

## Selection of Design and Information Improvement Projects

Any set of design or information improvements should be evaluated on the basis of cost-effectiveness or another suitable measure. The improvements that are chosen for implementation should be those that are most effective in improving the safety, operation, and enjoyment of the scenic byway for all its users, and that can do so at the least cost. User preferences can also assist in prioritizing candidate design and information improvements. To illustrate, the various design feature preferences according to user groups are listed in Table 5.

**TABLE 5[a]**
**SELECTING SCENIC HIGHWAY DESIGN FEATURES**

| Highway User | Preferred Design Features |
|---|---|
| Recreational Vehicle Users | • Extrawide lanes, especially in wind gust areas<br>• Signage warning of wind gust areas<br>• Passing lanes and pull-offs<br>• Large radius curves<br>• Wide shoulders for vehicle breakdowns<br>• Additional warning distance for stops and roadway changes<br>• Additional uphill lanes |
| Bicyclists | • Wide shoulders or bike lanes<br>• Smooth debris-free surfaces<br>• Lower auto speeds<br>• Lower curve speed rather than curve straightening<br>• Preservation of rural scenic roadside environment |
| Older Travelers | • Higher sign illumination for night travel<br>• More and better rest stops on rural sections for driver fatigue |
| Travelers in General | • Frequent scenic pull-offs<br>• Passing lanes<br>• Adequately signed points of interest<br>• Recreational area access |

[a]Oregon Department of Transportation. 1990. *Scenic Byways Development on the Oregon Coast: Economic Benefits and User Preference.* Publication No. FHWA-ED-90-034. Washington, D.C.: Federal Highway Administration.

## A Case Study of the Design and Information Review Process

This section illustrates the application of the design and information review process. The final step in the process, examining the financial feasibility of the candidate design and information improvements and setting priorities for their implementation, was not carried out due to the lack of information pertaining to the cost of improvements and funding opportunities.

The scenic byway selected for this case study was Virginia Byway Route 711 located in Powhatan County, also known as Robious Road. This road begins at the intersection of Route

522 and ends at Route 673, about 1 mile from the Chesterfield-Powhatan county line, and was designated as a Virginia Byway in February 1990. The portion of Route 711 from its intersection with Route 522 to the Powhatan County line, a distance of 14.56 miles, was used as the test section for the case study. Figure 2 illustrates the extent of the Route 711 byway. Note that it connects with Route 673 in Chesterfield County and with Route 617 (also designated as a scenic byway) in Powhatan County. Figure 3 depicts the portion located in Powhatan County.

A report prepared by the VDCR described Route 711 as follows:

> As Old Gun Road (Route 673) turns to the south, it intersects with Robious Road (Route 711) about 1 mile from the Chesterfield-Powhatan County Line. This segment also passes large lot subdivisions with single family residences. Near the Powhatan County line, the route roughly parallels the James River. Although a mile or more away, the bluffs along the north side of the river in Goochland County are frequently visible. As the corridor changes to a more rural character, the large farms become prominent. Some of the structures have considerable historic significance. There is a variety of architectural styles that afford visitors with a pleasing view of the countryside.[14]

Route 711 dates back to the time the area was settled by the Huguenots and is rich in historic structures and scenic beauty. Many of these historic sites and their location are identified in Figure 2. The recreational amenities are numerous, including a golf course, access to a public boat landing, and the dedicated East Coast Bike Route. Also, many of the historic homes, mills, and other buildings that are privately owned are opened for display during special occasions, such as Virginia Garden Week.

No roadway improvements have been made to the road since it was designated a scenic byway. The corridor has experienced growth, especially on the east end, where a new school and several residences have been built. Though limited development is intended for the western sections of Route 711 (Robious Road), the use of setbacks and landscape screens will likely lessen the impact on the corridor's scenic aspects.

## Data Acquisition

Categories of data collected for Route 711 included location and type of scenic, historic, cultural and recreational features; accident patterns; and traffic counts. Roadway and roadside data already existed or were videotaped, and pedestrian and bicycle data were not obtained directly.

### *Scenic Resources Inventory*

A scenic resource inventory was conducted by videotaping and photographing the corridor while driving the test section two times in both directions. In the first pass, photographs were taken of scenic vistas, historic sites, and roadway features. The approximate mileposts and the general location with respect to the direction of travel were noted for each photograph taken. This helped to identify the location of sites that may cause tourists to slow down in order to

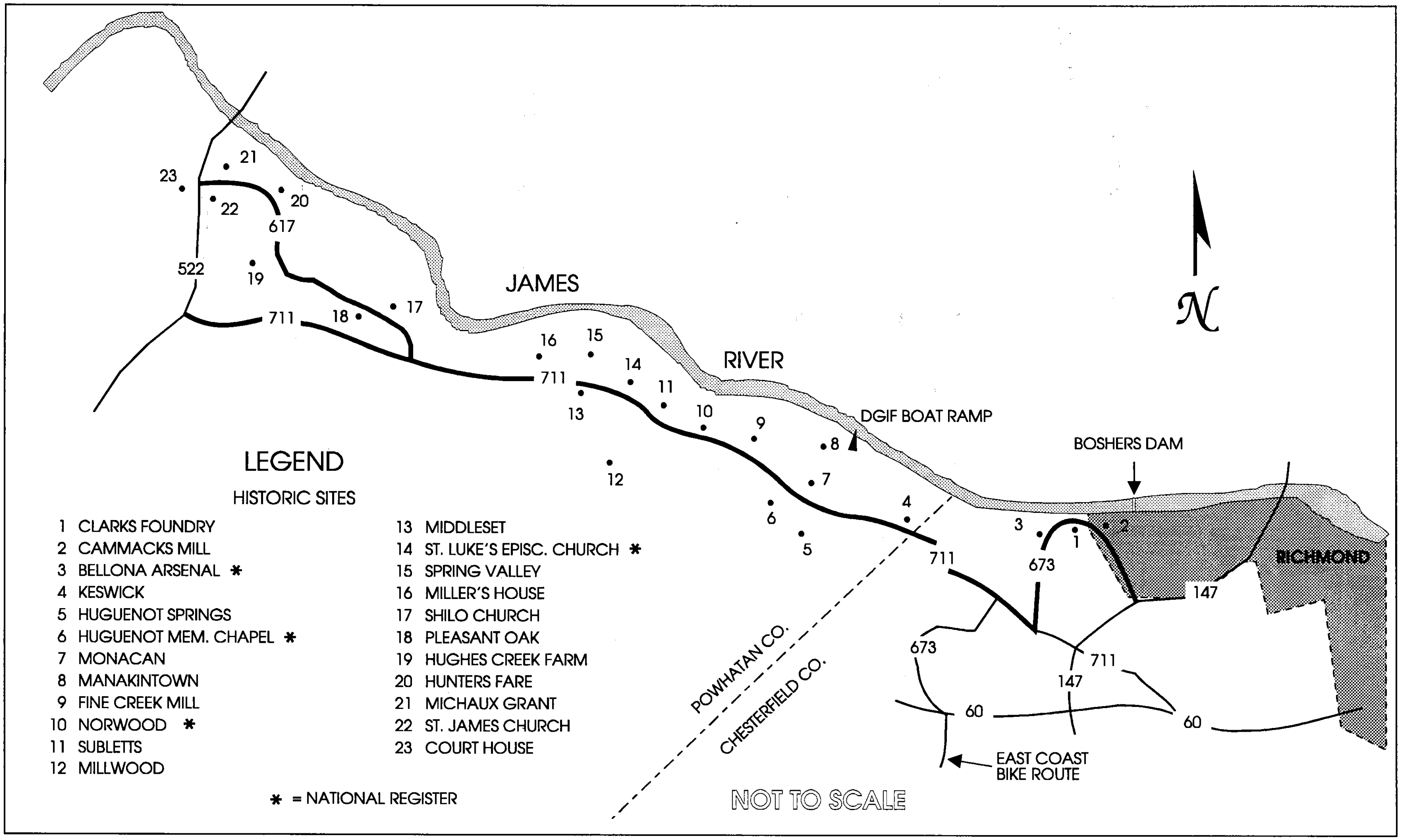


Figure 2. Virginia Byways Routes 617, 673, and 711, Chesterfield and Powhatan Counties and City of Richmond.

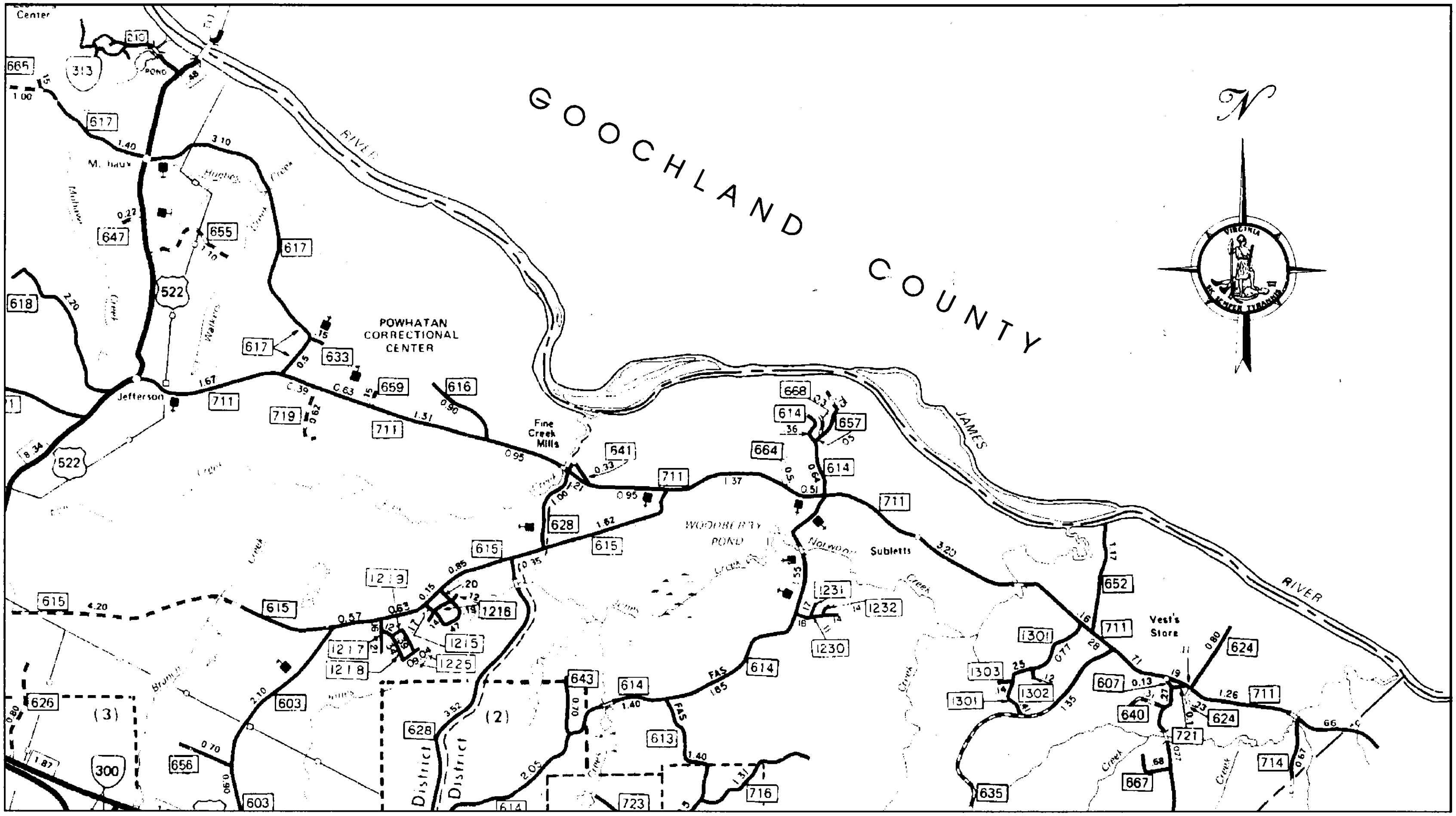


Figure 3. Portion of Powhatan County map with Route 711 highlighted.

enjoy the view. On the next pass, a video camera recorded the roadway and roadside. The driver stated the route number and direction of travel at the beginning of each pass and at every one-tenth mile.

### *Accident Information*

Accident records for the years 1985 through 1991 were retrieved from the CAPP database. The following data were extracted to create a new database for the years 1987 through 1991: milepost, surface type, surface width, speed limit, intersection type, intersection route number, accident location, traffic control, alignment, surface condition, road defects, type of collision, fixed object, major contributing factor, number of vehicles involved, type of vehicle(s), speed(s), actions of driver or pedestrian, and visibility.

### *Traffic Data*

Traffic counts were obtained from VDOT's Traffic Engineering Division for the period 1985 to 1991. These counts were taken every other year during this period, and at different times of the year: October/November 1985, April 1987, June 1987, and July 1991. Counts taken in 1987 and 1989 included only 7 of the 19 stations along the length of the route. For the other two years, 1985 and 1991, traffic counts were taken at all 19 count stations. A summary of the traffic counts is given in Appendix A.

## Accident and Traffic Analysis

The analysis, using SPSS, identified four high-frequency accident sites; those accidents where speed differences were 10 mph or greater; related accidents that were attributed to cross-sectional design deficiencies; and accidents that might be tourist related. In total, during the period 1987 to 1991, there were 203 collisions on the test section.

### *High-Frequency Accident Locations*

Four sites were identified as high-frequency accident locations, each having 5 or more accidents within two adjacent mileposts in a 5-year period, accounting for 23 of the total number of accidents. The determination of whether these are classified as high-frequency accident locations depends on the critical rate factor or a comparison with the expected value. These procedures were not used in the evaluation of these accident locations because (1) the AADT, which is necessary for the calculation of the critical rate factor, could not be determined for all sections of the road based on the traffic data for Route 711, and (2) the expected values were not known for the roadway segments and intersections in this region. Therefore, any location that had an average of 1 accident per year was considered to be a high-frequency accident location.

A description of each site follows:

- *Site 1* (Milepost 7.58) is situated on a hillcrest and in the center of a curve, which inhibits the opportunity for a faster vehicle to pass a slower one safely. The roadside on the inside of the curve includes a steep embankment approximately 5 ft high, which contributes to the limited sight distance. This appears to be a difficult curve to negotiate, giving motorists a false sense of security as one that could easily be negotiated while driving the speed limit.

- *Site 2* (Milepost 8.99) is also situated along a horizontal curve. The pavement is narrower than along other stretches of Route 711, and roadside obstructions also contribute to the difficulty in negotiating this curve.

- *Site 3* (Milepost 9.49) is located along a straight segment of roadway that is contained within two horizontal curves, one before and one after. The straightaway offers sufficient space for drivers to increase their speed after coming out of one curve, which makes it difficult to negotiate the other curve. The narrow lanes and roadside obstructions contribute to the design deficiencies along this section of Route 711.

- *Site 4* (Milepost 13.90) is a T-intersection of Route 711 and 714, which from the eastbound direction is situated just beyond a blind curve and follows directly after a narrow bridge. Although a higher number of accidents is expected at intersections than on other roadway segments, due to the higher number of possible conflicts, this intersection poses a greater risk due to its surroundings. Guardrails surround this intersection with trees just beyond them, which inhibits sight distance from each approach.

Milepost 0.00 marks the beginning of the route, at the intersection of Route 711 and Route 522, and is incremented every one-hundredth of a mile heading eastbound on Route 711. Appendix B itemizes the existing conditions and factors for each accident. Most of the accidents were the result of driver inattention or error.

Upon review of the videotape of Route 711 (eastbound), several design elements were identified at high-frequency accident locations, as well as throughout the length of the designated roadway, that, if altered, could improve the safety and quality of the experience for all users of the scenic byway. For example, much of the roadbed along Route 711 appears to be cut through the existing terrain, leaving steep banks on the far side of the ditch on either side of the road and for much of the length of the route.

*Speed Differences*

Ten of the 23 accidents involved two vehicles, and 8 of these involved a speed difference of 10 mph or more. At Site 1, one collision involved a speed differential of 7 mph and was a result of driver error. At Site 3, one rear-end collision involving a speed differential of 45 mph was a result of one vehicle attempting to pass in a no-passing zone. Four of the 8 accidents at Site 4 were the result of speed differentials. One collision, between a bicycle traveling at 10 mph and a passenger car traveling at 55 mph, resulted from improper turning on the part of the bicyclist. The other 3 accidents were caused by driver error or other violations.

*Type of Collisions*

At each of the four locations, at least two collisions could be considered related (single-vehicle accidents consisting of fixed object, roll-over, and other run-off-road accidents and multivehicle accidents including head-on, sideswipe opposite direction, and sideswipe same direction accidents). These accidents were attributed to cross-sectional design deficiencies and could be reduced by wider lanes, wider and paved shoulders, greater recovery distance, flatter terrain, flatter sideslopes, and lower roadside hazard rating. For the entire route and for 5 years of accident data, 153 of 203 collisions (approximately 75 percent) were related accidents that could be decreased by these improvements.

*Nonresident Involvements*

No tourist vehicles (campers and RVs) were identified as having been involved in accidents at any site in the test section. Eight collisions (approximately 4 percent) involved persons from out of state. This appears to be a very low involvement ratio and indicates that a lower tourist traffic volume than expected exists. However, tourists also drive passenger cars and pickup trucks, as well as RVs and campers, and can travel to Route 711 from within state, especially if the trip is intended as a short tour, side trip, or deviation from another route. Currently, no means exist by which tourists can be identified in the accident database and in traffic counts.

*Bicyclists*

A portion of this byway is a dedicated bike route (the East Coast Bike Route), which implies that it is traversed by many bicyclists each day. It is likely that some well-experienced riders use this route to commute to work, shops, and school in the northwest end of Chesterfield County and that many bicyclists are on this highway to travel to recreational facilities.

Route 711 has lanes 9 to 10 ft wide with no paved shoulder. This poses a safety hazard for both bicyclists and the motorists who attempt to pass them.

## Selection of Improvement Measures

Upon completion of the analysis, a number of design and improvement opportunities were identified and are furnished without priority or cost considerations.

1. *Flatten sideslopes.* In a number of areas, especially near high-frequency accident locations, sideslopes should be cut back or flattened, thus providing increased sight distance and greater recovery distance. The improvement might also open up some scenic vistas.

2. *Widen travel lanes.* Where possible, the paved surface should be widened to a minimum of 14 ft in each direction (to include shoulders). This would provide the recommended minimum width for the safety of bicyclists and motorists who have to pass bicyclists. The need for widening is especially critical at high-frequency accident Sites 1 and 2. The lanes could be marked to provide 10-ft travel lanes with 4-ft bicycle lanes (or shoulders) where larger vehicles are not prominent in the traffic stream or 12-ft travel lanes with a minimum of 2-ft shoulders. Separate bicycle and pedestrian paths are not feasible due to the extensive right-of-way required. Further, if a bike path were built outside the existing right-of-way, grades would be steeper than the existing road, adding difficulty for bicyclists.

3. *Erect warning signs.* At high-accident sites, warning signs should be placed with advisory speeds indicating a maximum safe speed less than 55 mph. These are required at Sites 1 and 2 if lanes are not widened and at Site 4.

4. *Ensure visibility of signs and pavement markings.* All pavement markings and signs should be maintained so they are highly reflective, visible, clear, and effective. Lettering should be enhanced for improved visibility by older drivers.

5. *Construct pull-offs and interpretive kiosks.* There are several historical markers along Route 711 that identify the settlements of the Huguenots and Robert E. Lee's movements in Powhatan County. A pull-off could be built near each marker. In addition, a simple structure could function as an interpretive kiosk, providing maps and short narratives. These improvements would put tourists in touch with their surroundings and direct them to other nearby sites and activities.

6. *Add byway informational signs.* Virginia byways are designated within the corridor with blue and white signs that are decorated with the state bird and a branch of the state tree. These signs are typically placed at the beginning, the end, and approximately every 6-mile interval along the designated section. On Route 711, the designated segment of the route is not clearly marked with signs that state NOW ENTERING and NOW LEAVING a Virginia Byway, and the overall number of Virginia byway signs is minimal. Signs should be used to indicate when the scenic byway follows another route or changes direction and when parallel and/or major routes are accessible from roads intersecting the scenic byway. For example, tourists who wish to return to Route 60 (a major facility in the area) should be advised that Route 615 (approximately 6 miles east of Route 522 along Route 711) can be used to gain access to Route 60.

## CONCLUSIONS

1. *Successful state scenic byways programs rely on the coordinated efforts of decision makers to identify, designate, enhance, manage, protect, and promote those especially qualified roads that have intrinsic value.* There are many interest groups associated with scenic byway development, and an interdisciplinary effort representing many governmental agencies should be involved. Accordingly, the success of a design and information review cess will depend on the input and cooperation of a broad-based team.

2. *The selection and designation requirements for scenic byways will vary from program to program but will generally include provisions for designing safe roadway elements to serve its new users.* The emphasis on safety is of particular importance since new or existing scenic byways will attract first-time users, who, in addition to being unfamiliar with the roadway, may tend to drive more slowly than residents.

3. *Data required for the evaluation of proposed or existing byways include physical attributes, traffic volumes, accident history, and the attractions of the surrounding area.* Much of these data is available, since they are collected within the regular course of of traffic and transportation engineering work within the state. The scenic resource inventory as it relates to Virginia byway designation is already performed as one task of the designation procedure.

4. *Scenic byways can be improved by using standards for designing existing and new scenic byways or by allowing scenic byways to maintain their current classification and making spot improvements as they are identified.* To date, such design guides do not exist specifically for scenic byways .

5. *Scenic byway improvements and design elements involving various aspects of travel and safety generally include (1) more effective use of signs (that are larger and brighter) to warn, direct, and educate the users about the facility or specific features of the roadway and surrounding area; (2) improved clear zones achieved by removing dangerous fixed objects or installing barriers such as curbs and guardrails; (3) improved sight distances on horizontal and vertical curves; (4) reduced speed differentials effected by erecting warning signs and/or providing improved passing opportunities; and (5) other roadside amenities (e.g., kiosks, scenic pull-offs and overlooks, and hiking and biking accommodations).*

6. *The system design and information review process that is described in this report and validated by a case study should involve the following steps:*

   - Collect data pertaining to scenic resources, accident history, traffic volumes, existing roadway geometrics and roadside conditions, existing traffic control devices, and bicyclist and pedestrian needs.

   - Conduct an analysis of the traffic and accident data to allow the selection of possible roadway improvements. The analysis includes examining conditions at high-frequency accident locations to determine what mitigating measures can be effective; determining if speed differentials are contributing factors to a significant number of accidents; examining the types of collisions to determine if a significant number of them are related accidents and, if so, recommending several cross-sectional improvements, singularly or in combination, to reduce the number of these accidents; and examining the per centage of out-of-state residents and tourist-type vehicles involved in all accidents. For accidents involving tourists, the accident records should be examined to determine the contributing causes and any possible mitigating measures that can be implemented.

   - Consider the needs of bicyclists and pedestrians to determine whether proposed design improvements for motorized traffic would assist nonmotorized traffic as well. The provisions for bicyclists and pedestrians should follow published design guides for the development of these facilities.

- Examine improvement opportunities for the information and services provided to tourists along the corridor through the use of pull-outs, rest areas, scenic overlooks, interpretive kiosks, and directional signs.

## RECOMMENDATIONS

1. *VDOT should develop a scenic byway design manual that utilizes the guidelines presented in this report and other national efforts.* The manual should include specifications for all design elements associated with projected users of scenic byways and provide the appropriate method for the selection of design improvements. The development of the design guide should be coordinated between the Environmental and Location and Design Divisions.

2. *VDOT's Environmental Division should develop and maintain a database of information specifically pertaining to all scenic byways.* The data should provide information about the amount of tourist traffic that uses scenic byways. This data would be used to justify scenic byway design improvements. Where possible, data should include information about visitor involvement in traffic accidents to address safety problems attributable to driver lack of familiarity with the road.

3. *VDOT's Location and Design Division or the Environmental Division (which is currently responsible for the Scenic Byways Program) should apply and validate the system design and information review process that was developed as a result of this research.* Appropriate changes in the method should be made as additional experience is gained with its application.

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