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16. Abstract

A procedure for reducing vehicle-tree accidents was evaluated. The procedure, developed by the Michigan Department of Transportation, consists of five steps: (1) preparing a base map and plotting roadway information, (2) assigning priorities for field verification, (3) field verifying the higher-risk road sections, (4) selecting appropriate treatments, and (5) performing the treatments selected. The procedure was used in Albemarle and Prince William counties.

The procedure was described and evaluated. Overall, the procedure was useful. Several changes were recommended in the procedure to reduce the time required to perform the task and to increase its effectiveness. It was suggested that the procedure be expanded to include other fixed-object, off-the-road accidents to increase the impact on roadside management.

It was recommended that the revised procedure be considered for adoption by the Virginia Department of Transportation.

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SI CONVERSION FACTORS

To Convert From	To	Multiply By
Length:		
in	cm	2.54
in	m	0.025 4
ft	m	0.304 8
yd	m	0.914 4
mi	km	1 . 609 344
Area:		
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yd^2	m^2	8.361 274 E-01
mi^2	Hectares	2.589 988 E+02
acre (a)	Hectares	4.046 856 E-01
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pt	m^3	4.731 765 E-04
qt	m^3	9.463 529 E-04
gal	m^3	3.785 412 E-03
in^3	m^3	1.638 706 E-05
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yd^3	m^3	7.645 549 E-01

NOTE: $1 m^3 = 1,000$ L

To Convert From	To	Multiply By
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yd^3/min	m^3/sec	1.274 258 E-02
gal/min	m^3/sec	6.309 020 E-05
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dwt	kg	1.555 174 E-03
lb	kg	4.535 924 E-01
ton (2000 lb)	kg	9.071 847 E+02
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lb/yd^3	kg/m^3	5.932 764 E-01
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mi/h	m/s	4.470 400 E-01
knot	m/s	5.144 444 E-01
mi/h	km/h	1.609 344 E+00
Force Per Unit Area:		
lbf/in^2 or psi	Pa	6.894 757 E+03
lbf/ft^2	Pa	4.788 026 E+01
Viscosity:		
cS	m^2/s	1.000 000 E-06
P	Pa's	1.000 000 E-01

Temperature: $(°F-32)^5/9 = °C$

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FINAL REPORT

EVALUATION OF A PROCEDURE FOR REDUCING VEHICLE-TREE ACCIDENTS

by

B. H. Cottrell, Jr.
Research Scientist

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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ABSTRACT

A procedure for reducing vehicle-tree accidents was evaluated. The procedure, developed by the Michigan Department of Transportation, consists of five steps: (1) preparing a base map and plotting roadway information, (2) assigning priorities for field verification, (3) field verifying the higher-risk road sections, (4) selecting appropriate treatments, and (5) performing the treatments selected. The procedure was used in Albemarle and Prince William counties.

The procedure was described and evaluated. Overall, the procedure was useful. Several changes were recommended in the procedure to reduce the time required to perform the task and to increase its effectiveness. It was suggested that the procedure be expanded to include other fixed-object, off-the-road accidents to increase the impact on roadside management.

It was recommended that the revised procedure be considered for adoption by the Virginia Department of Transportation.

FINAL REPORT

EVALUATION OF A PROCEDURE FOR REDUCING VEHICLE-TREE ACCIDENTS

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INTRODUCTION

Problem Statement

Accidents in which vehicles strike trees constitute a substantial percentage of all accidents, especially fatal accidents, in the Commonwealth of Virginia. The 1982-1984 statistics for this type of accident in Virginia are shown in Table 1 (1,2,3). From this table, it can be seen that vehicle-tree accidents accounted for 14.9% (289), of all fatal accidents and 6.9% (12,927) of all accidents in Virginia. For the secondary system, where over 60% of all vehicle-tree accidents occurred, they accounted for 23.6% of all fatal accidents and 11.0% of all accidents.

Table 1

Statistics for Vehicle-Tree Accidents in Virginia, 1982-1984

Road System	Fatal Accidents No.	Fatal Accidents %	Injury Accidents No.	Injury Accidents %	Property Damage Accidents No.	Property Damage Accidents %	Total No.	Total %
Secondary	149	23.6	4,685	15.6	3,627	7.9	8,461	11.0
Primary	127	11.8	2,123	5.9	1,609	3.1	3,859	4.4
Interstate	13	5.4	276	3.2	318	2.6	607	2.9
Total	289	14.9	7,084	9.5	5,554	5.1	12,927	6.9

Source: Reference (1,2,3)

A procedure that can reduce vehicle-tree accidents has considerable merit. The Michigan Department of Transportation (MIDOT) has developed such a procedure; it is described in a manual intended to provide guidance for county road commissions in Michigan (4,5). There are five basic steps in the procedure: (1) preparing a base map and plotting roadway information, (2) assigning priorities for field verification, (3) field verifying the high-risk roadside sections, (4) selecting appropriate treatments for alleviating or reducing the risk of vehicle-tree accidents, and (5) implementing the selected treatments. The title of the manual, "Guidelines for Removing Hazardous Trees...," is misleading, since the removal of trees is only one of many alternative treatments. The procedure is outlined in Figure 1.

This procedure has potential, but it needed to be field tested and improved to become a model program for reducing vehicle-tree accidents.

Objectives and Scope

The objectives of this research were (1) to evaluate the practicality of the procedure developed for the MIDOT through field tests, (2) to develop and verify a rating formula for hazardous roadside sections, (3) to develop a plan for determining the cost-effectiveness of vehicle-tree accident countermeasures, (4) to provide recommendations for improving the management manual, and (5) to provide recommendations on a procedure for reducing vehicle-tree accidents in Virginia.

The guidelines of the management manual were applied in two counties in Virginia. Implementation of the selected treatment (step 5) was not included in the scope. Recognizing the need for improving the procedure, the MIDOT developed a significantly revised procedure, entitled "Guidelines to Management of Roadside Trees" (5). The revised draft was based on field testing of the original guidelines in Ingham County, Michigan, and reviewed by other state DOTs and other Michigan county road agencies. Two draft versions of the guide were received during the conduct of this research. The evaluation was revised to evaluate the most recent guide. Some features of the original version of the guidelines are discussed.

Selection of Counties

The ten counties with the highest number of vehicle-tree accidents on primary and secondary roads from 1981-1983 are listed in Table 2. Fairfax County was eliminated from consideration due to the effort required to plot its extremely high number of vehicle-tree accidents and its large road network. Chesterfield, Albemarle, and Prince William counties were selected for the study. Chesterfield County was later eliminated due to delays in the research, the large number of vehicle-tree accidents, and the size of its road network. Consequently, Albemarle and Prince William Counties were studied.

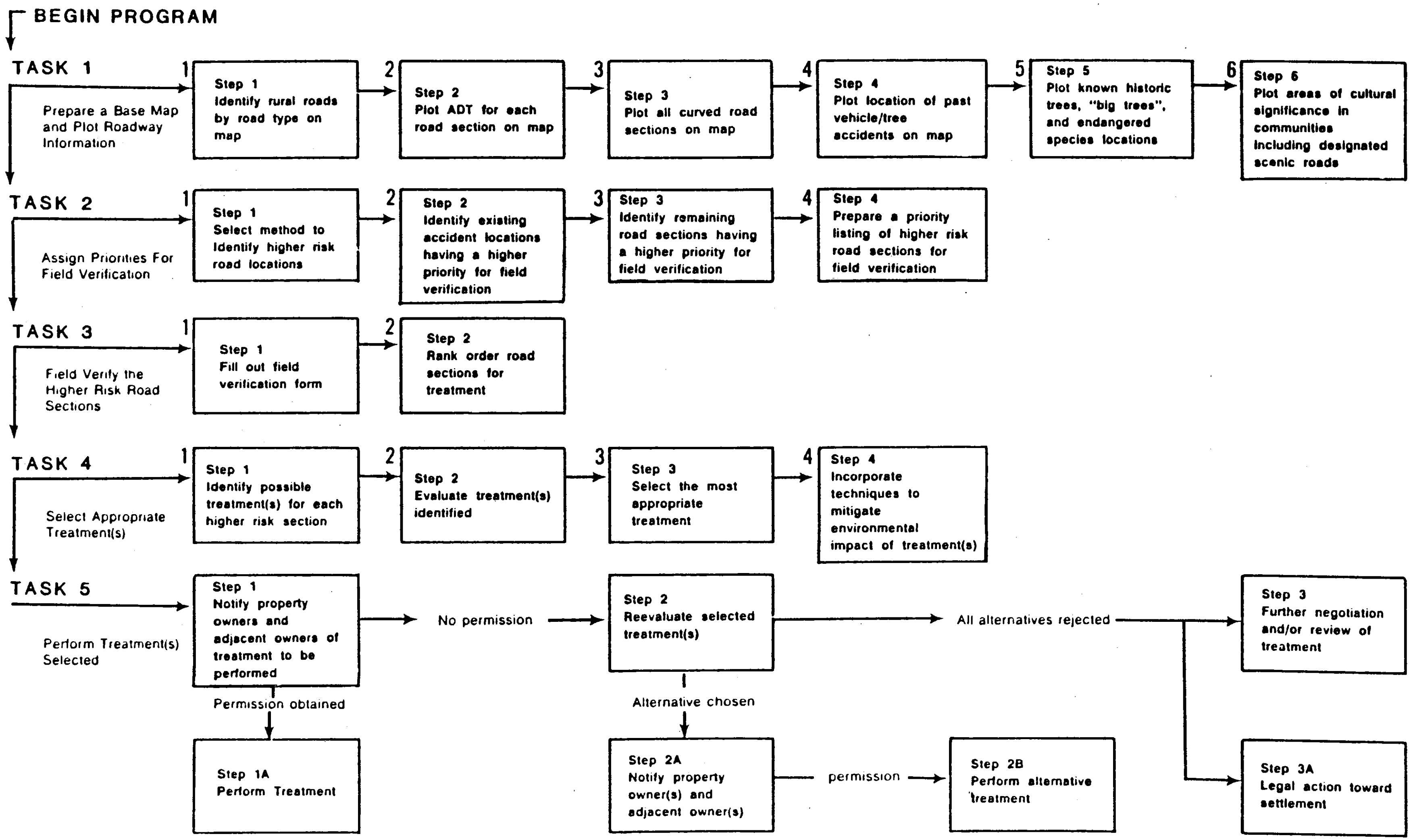


Figure 1. Method for evaluating higher risk roadside environments. (5)

Table 2

Ranking of Vehicle-Tree Accidents on
Primary and Secondary Roads by County during 1981-1983

	County	Number of Vehicle-Tree Accidents
1.	Fairfax	1,830
2.	Chesterfield	617
3.	Albemarle	363
4.	Prince William	341
5.	Hanover	325
6.	Loudoun	243
7.	Spotsylvania	227
	Pittsylvania	
9.	Franklin	224
10.	Buchanan	223

TASK 1: PREPARE A BASE MAP AND PLOT ROAD INFORMATION

Description and Assessment of Task 1

Step 1. Identify rural roads on a county map by road type: interstate, rural U.S./state (primary), rural local (secondary), and city.

This step may be broadened to the selection and review of a base map with road type being one map feature. The map should have a minimum of 1 in= 1 mi scale and be as detailed as possible. Ideally, the entire road system should be on one map. However, supplements may be used. Maps are a disadvantage because any map will only be representative of the road system at this scale and will not reflect adequately every geometric feature.

Step 2. Write the average daily traffic volume (ADT) or a best estimate, adjacent to each rural primary and secondary road section on the map.

Writing ADT data on the map was the longest and most tedious step in this task. This is especially true for the secondary road system where counts are made between each intersection. Consequently, there was a substantial amount of ADT data. This step was completed in an average of 43 hours for each county.

Step 3. Circle all curved rural primary and secondary road sections.

A major problem in this step is in defining a curve. Since defining a curve is judgmental, guidelines were developed to provide some degree of consistency in defining curves. It is noted that the guidelines below are not the only possible ones but merely the ones chosen for this study.

1. A road section is a curve if the horizontal offset difference of the curve is greater than 1/8 in from a straight line less than 2 in long (Figure 2.).

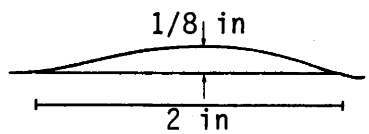


Figure 2. Definition of a curve.

2. Two or more short curves (less than 1 in long) with less than 1/4 mi between them and with curved sections no more than 2 mi long is a winding or meandering road section. A winding road section may appear as a curve on the map.

The guidelines were used primarily where there was some question as to whether a gently curved section should be viewed as a curve. Several research studies have shown that a frequency of curves greater than 3 degrees is related to the total accident rate on two-lane roads (6). The objective of the first guidelines was to omit gentle curves (less than 3 degrees).

As mentioned previously, all curves on the roadway will not be displayed on the map.

Step 4. Place an "X" in locations of past vehicle-tree accidents (fatal, injury, and property damage) that have occurred over an accident data period of 3, 4, or 5 years. Locate accident sites as precisely as possible, taking care to plot locations by distance from road intersections and proper side of road. The original guideline included writing the accident file number on the map when available.

Incomplete accident reports were the major problem with accident plotting. In order to locate the accident on the map, the following information was needed for each accident.

1. Route number
2. Location by mile post
3. Direction of travel (assists in determining which side of the road the vehicle ran off)
4. Curve or straight section (verifies location on map)
5. Type of maneuver, e.g. run-off-the-road right (determines which side of the road the vehicle ran off and verifies the type of accident)
6. Number of vehicles involved (determines if this is a single vehicle accident)

The absence of one or more of these items, constituted an incomplete report. The data in the computerized accident files is only as accurate and reliable as the information provided on the police accident reports. The most common problem was an unreported accident location along the route.

For Albemarle and Prince William Counties, 24.2% and 19.3% of vehicle-tree accidents had an unreported location. Data and experience have demonstrated that identification of the accident location is very difficult, especially on secondary or local roads. Discrepancies were occasionally noted between (a) the map and the graphic logs and (b) the map and accident reports. For the former, the graphic logs were assumed to be correct, and for the latter, judgment was used to resolve the difference.

Step 5. Plot, using a "T", the locations of trees known to have historic significance, "big trees," and/or endangered/threatened species.

Step 6. Circle with a dashed line areas considered by the community to be of cultural significance (cultural or historic properties). This should specifically include locations of existing or potential "scenic roads."

Steps 5 and 6 were relatively easy to perform because they involved small amounts of data. However, these steps would benefit from more detailed information including location relative to the nearby roadway, size of the area, and what is included in the area. No data were available on culturally significant areas that may best be identified at the community level.

Evaluation of Task 1

The persons performing the map plotting described it as long, boring, and tedious. The average time required for each step for one county is shown below.

Task 1		Time Required (hr)
Step 2. ADT Plotting		43
Step 3. Curve Circling		9
Step 4. Accident Plotting		27
Step 5 and 6. Plotting historically significant trees and areas		8
	Total	87

An additional 30 hr were spent obtaining and preparing data on vehicle-tree accidents and historically significant trees and areas for plotting. Therefore, 120 hr were needed to complete Task 1. The person performing the task probably proceeded at an above average rate, probably 30 percent faster than average. Consequently, it is expected that an average of 160 hr are needed to complete Task 1. It is unrealistic to expect VDOT field personnel to perform this task. It is noted in the guide that computerization of the method in part or whole would expedite the process. Automation would greatly expedite this task.

The completed map appeared cluttered with all the data plotted on it. There were several locations with data clustered making the map difficult to read. On the other hand, the color coding of data items recommended in the original guidelines was helpful.

Two factors, the lack of detail on roadway alignment displayed on the map compared to actual roadway conditions and the incomplete and unreliable accident data, reduce the value and usefulness of the map plotting. The guide implies but does not state that four-lane roadways should be omitted to focus on two-lane rural roads.

In the guide, alternative road system classifications, such as a single class with differentiation based on ADT or a functional classification, may provide additional benefits and are optional.

TASK 2: ASSIGN PRIORITIES FOR FIELD VERIFICATION

Description and Assessment of Task 2

Step 1. Select method to identify higher risk road locations.

The objective of this task is to identify roads having a higher priority for treatment based on both the expected and existing accident occurrence. The expected number of accidents is determined using the accident prediction formula.

$$ACC_j = \alpha_c \, (ADT_j)^{0.7} M_j \tag{1}$$

where
ACC_j = the annual expected number of accidents of segment j
ADT_j = the average daily traffic on segment j
M_j = the mileage for segment j

$$\alpha_c = \frac{\text{Total accidents per year for a given road class}}{\sum_{i=1}^{n} (ADT_i)^{0.7} M_i}$$

i = each segment in a given road class

The expected number of accidents are used to identify the accident potential of road sections that do not have a significant accident history or have no accidents at all.

The accident threshold, or minimum number of vehicle-tree accidents per year warranting priority consideration for field review and treatment, is based on standard statistical quality control methods designed to trigger action on outliers. Twice the standard deviation, which is the square root of the expected number of accidents, is considered an intolerable deviation from the expectation. The threshold formula is

$$\text{Threshold}_j = ACC_j + 2\sqrt{ACC_j} \qquad (2)$$

In other words, if the number of accidents per year is greater than the accident threshold for segment j, then segment j should be a priority candidate for treatment.

Tables are provided in the guide for determining the expected and accident threshold values for a given road segment based on data from Michigan. To be more responsive to actual roadway conditions the above equations may be applied to local data. Consequently, the methods to choose from are (1) tables in the guide based on Michigan data and (2) equations 1 and 2 based on local accident data. The use of local data is preferred because it is more responsive.

An alternative method for identifying hazardous locations is the rate quality control method (7). This method calculates a critical rate using the following equation.

$$R_C = R_A + K\sqrt{R_A/M} + 0.5/M \qquad (3)$$

R_C = critical rate for a road section in accidents per million vehicle-mi (MVM)

R_A = average accident rate for a road type in accidents per MVM (An R_A value was calculated for each of the four road types--primary curve, primary tangent, secondary curve, and secondary tangent--for each county.)

K = constant that determines the level of confidence at which deviation from R_A is significant and have not resulted by chance For a 95% level of confidence, K = 1.645

M = exposure in MVM

The term R_A/M is the estimate of the variance, whereas 0.5/M is a continuity correction. The critical rate is the upper limit beyond which deviation from the average rate is intolerable. For this study, only vehicle-tree accident rates are used.

If the vehicle-tree accident rate for a road section is greater than the critical rate, then the section is a definite candidate for priority treatment. Roads are ranked by their level of criticality, that is, the difference between the actual accident rate on the section and the critical rate for the section (8). The highest ranked road sections where the critical rate does not exceed the vehicle-tree accident rate are possible candidates for priority treatment.

Comparison of the Two Methods

The methods are similar in that both use standard statistical quality control techniques and consider exposure. The methods are different in that (1) the expected accident method is based on frequency, whereas the critical rate method is based on rate, and (2) the critical rate method has been used extensively, whereas documentation of the use of expected accident method is limited. The Traffic Engineering Division of the Virginia Department of Transportation uses the rate quality control method for identifying hazardous locations in their highway safety improvement program (9).

Consequently, the critical rate or rate quality control method was selected for identifying higher risk road locations based on its extensive use, familiarity with the method in Virginia, and its use of rates rather than frequency.

Step 2. Identifying existing accident locations having a higher priority for field verification.

Step 3. Identifying remaining road sections having a higher priority for field verification.

Steps 2 and 3 were revised because of the selection of an alternative method for assigning priorities and because a microcomputer was used to facilitate Task 2. However, for completeness, the original steps 2 and 3 are described.

In step 2, each road section (defined by crossroads or logical boundaries) having any vehicle-tree accidents are divided into 1/4 mi sections on a sepia or reproducible mylar of the base map. A template scaled into 1/4-mi sections will facilitate drawing the reference marks. Next, determine the average number of vehicle-tree accidents per year for each 1/4-mi section and note this number on the map. Compare this number with the threshold value for each road section by road type. If the average number of vehicle-tree accidents per year meets or exceeds the threshold value, underline the average number on the map and circle the entire section. This will identify the sites with unusually high vehicle--tree accident frequency. Erase the remaining vehicle-tree accident numbers that do not meet the threshold.

In step 3, identify the expected number of vehicle-tree accidents per year for each remaining curved road section. The sections may be of variable length and/or will include the 1/4-mi curved road sections not meeting the threshold values in step 2. Write the expected number of vehicle-tree accidents adjacent to each curved road section on the map. This identifies the remaining higher risk curved road sections not having a significant accident history. Identify and write on the map the expected number of vehicle-tree accidents per year for each remaining straight road section not meeting the threshold values. Because of manpower and budget constraints, the number of locations was limited to those with higher ADTs.

To facilitate its completion, task 2 was automated using an IBM compatible microcomputer and Lotus 1-2-3 software. The road section data from the county maps described in task 1 were arranged into a primary and secondary route file. These files were sorted and divided into curve or tangent road sections to make four files: primary curve, primary tangent, secondary curve, and secondary tangent. Calculations were made to determine the following:

1. The expected number of accidents per year
2. The accident frequency threshold
3. Whether the actual number of accidents exceeded the threshold for each section
4. Ranking using the rate quality control method
5. The critical rate
6. If the accident rate exceeded the critical rate for each section
7. Ranking

Finally, these four priority lists were combined to produce a listing of road sections of high priority for field verification as shown in Tables 3 and 4.

Evaluation of Task 2

The most time consuming task in this process was developing the data file with the information from the map. The sorting and calculations were relatively fast. The length of the road sections was determined by geometric changes or substantial changes in ADT in lieu of each section length being 1/4- mi. This significantly reduces the number of sections.

The use of the microcomputer is an interim solution for expediting this task as well as task 1. The ultimate system is a statewide computerized roadway management system that includes, among other data systems, a roadway inventory and accident data. A program could be written to perform tasks 1 and 2 using computer files rather than a county map. The Traffic Engineering Division of the Virginia Department of Transportation is in the process of developing such a roadway management system called the Highway Traffic Information System (HTRIS). The rate quality control method appears to have advantages over the expected accident frequency method for assigning priorities.

Table 3

Albemarle County Vehicle-Tree Priority List

ROUTE	TANGENT / CURVE	MILE POST	LENGTH	NUMBER ACCIDENTS	ACCIDENTS PER YR	ADT	ACCIDENT RATE	CRITICAL RATE	CRITICAL HAZARD?	CRITICAL RANKING
* 53	C	1.71	1.13	8	2.67	4330	1.50	1.38	1	1
* 250	T	0.00	4.38	14	4.67	3885	0.75	0.84	0	2
* 22	C	6.63	0.75	5	1.67	4415	1.38	1.67	0	3
250	T	12.75	8.13	8	2.67	7915	0.11	0.59	0	4
250	T	21.54	7.25	7	2.33	4405	0.20	0.70	0	5
22	T	4.76	1.88	5	1.67	4415	0.55	1.10	0	6
* 22	C	2.63	0.63	3	1.00	1520	2.88	3.48	0	7
53	T	8.52	0.63	3	1.00	1540	2.85	3.46	0	8
20	C	10.51	2.00	4	1.33	2115	0.86	1.48	0	9
6	T	0.00	3.25	4	1.33	1900	0.59	1.24	0	10
250	T	7.88	1.88	1	0.33	17360	0.03	0.69	0	11
20	T	20.10	3.71	1	0.33	8610	0.03	0.70	0	12
250	C	9.75	0.88	0	0.00	21120	0.10	0.81	0	13
250	C	11.50	1.25	0	0.00	21120	0.00	0.73	0	14
250	C	6.88	1.00	1	0.33	15860	0.06	0.86	0	15
250	T	10.63	0.88	0	0.00	21120	0.00	0.82	0	16
250	C	4.38	1.88	0	0.00	9385	0.00	0.83	0	17
20	T	17.16	2.06	0	0.00	8610	0.00	0.83	0	18
* 231	C	6.50	0.75	3	1.00	2680	1.36	2.19	0	19
20	T	9.26	1.25	3	1.00	2115	1.04	1.89	0	20

* Field Verification Sites

Table 4

Prince William County Vehicle-Tree Priority List

ROUTE	TANGENT / CURVE	MILE POST	LENGTH	NUMBER ACCIDENTS	ACCIDENTS PER YR	ADT	ACCIDENT RATE	CRITICAL RATE	CRITICAL HAZARD?	CRITICAL RANKING
678	T	0.00	0.10	9	3.00	30	2739.73	582.12	1	1
* 215	T	3.15	3.78	6	2.00	3305	0.44	0.35	1	2
* 234	T	26.74	4.73	6	2.00	4050	0.29	0.28	1	3
28	T	0.00	5.00	2	0.67	6875	0.05	0.21	0	4
15	T	0.00	6.73	1	0.33	4650	0.03	0.22	0	5
234	T	6.90	1.73	2	0.67	6225	0.17	0.39	0	6
28	T	5.00	3.10	0	0.00	9650	0.00	0.22	0	7
234	T	5.90	1.00	2	0.67	8820	0.21	0.43	0	8
234	T	15.45	1.00	2	0.67	8600	0.21	0.44	0	9
234	T	11.40	1.80	1	0.33	8600	0.06	0.31	0	10
* 234	C	4.65	1.25	4	1.33	8820	0.33	0.60	0	11
234	C	1.30	1.88	4	1.33	13260	0.15	0.42	0	12
234	T	3.18	0.85	1	0.33	13260	0.08	0.38	0	13
55	T	2.43	3.83	1	0.33	2570	0.09	0.41	0	14
234	C	23.99	0.75	3	1.00	4050	0.90	1.22	0	15
234	C	25.11	1.55	3	1.00	4050	0.44	0.80	0	16
234	T	22.75	1.05	1	0.33	6150	0.14	0.53	0	17
253	C	0.00	1.50	2	0.67	10849	0.11	0.50	0	18
234	T	4.03	0.63	1	0.33	8820	0.17	0.59	0	19
234	C	13.20	2.25	1	0.33	8600	0.05	0.47	0	20

* Field Verification Sites

TASK 3. FIELD VERIFY THE HIGHER RISK ROAD SECTIONS

Description and Assessment of Task 3

Step 1. Fill out the field verification form for each road section.

The field verification form consisted of a survey to observe and note the findings of the field review as well as a summary of the information provided in the priority listing of higher risk road sections. In the author's opinion, the survey was too long, redundant, and much of the information may be more useful if presented on a sketch or observation map of the road section. Consequently, the field observations were primarily recorded on a sketch of the road section and the field verification form was eliminated.

Figure 3 is a checklist for the observation map and Figure 4 displays a sample observation map . The field observation map was drawn during a walk through the higher risk road section under review.

The road sections studied in task 3 were different from the highest priority sections listed in Tables 3 and 4. The selected sections were ranked the highest based on (1) a ranking by section type scheme which included all sections in which the critical rate was exceeded, and (2) accident rates. This was done before the ranking was chosen that was based on the difference between the accident and critical rates. Since different ranking schemes were used, the selected section may not be the highest ranked section. Where a high-priority road section was greater than one mile, the road section was reduced to the section with the higher accident experience to reduce the size of the study section.

The important aspect of the assessment of task 3 is the review of the process of task 3. Consequently, the review of the process is more important than the specific sites for the purpose of this study.

The eight road sections that were field verified are summarized in Table 5. Five sections were in Albemarle County, and three were in Prince William County. Only one road section had a number of recent tree scars equal to or greater than the number of vehicle-tree accidents. It was speculated that the low number of trees with accident scars identified was because (1) errors were made by police in identifying the accident location, (2) the removal of trees and (3) the fact that some accidents did not result in a tree scar.

The recommendation for treatment was based on the number of accidents, number of trees with accident scars, roadway geometrics and roadside slope. Two sections were recommended for treatment. One section that would have been recommended for treatment had recently been treated with the installation of guardrails.

FIELD OBSERVATION MAP CHECKLIST

A. Location Identification, Reviewer, Date

B. Sketch or note the following road features:

1. All traffic control devices (signs, pavement markings) and improvements needed, if any.
2. Roadway width.
3. Lane width.
4. Shoulder type, width and problems.
5. Sight distance

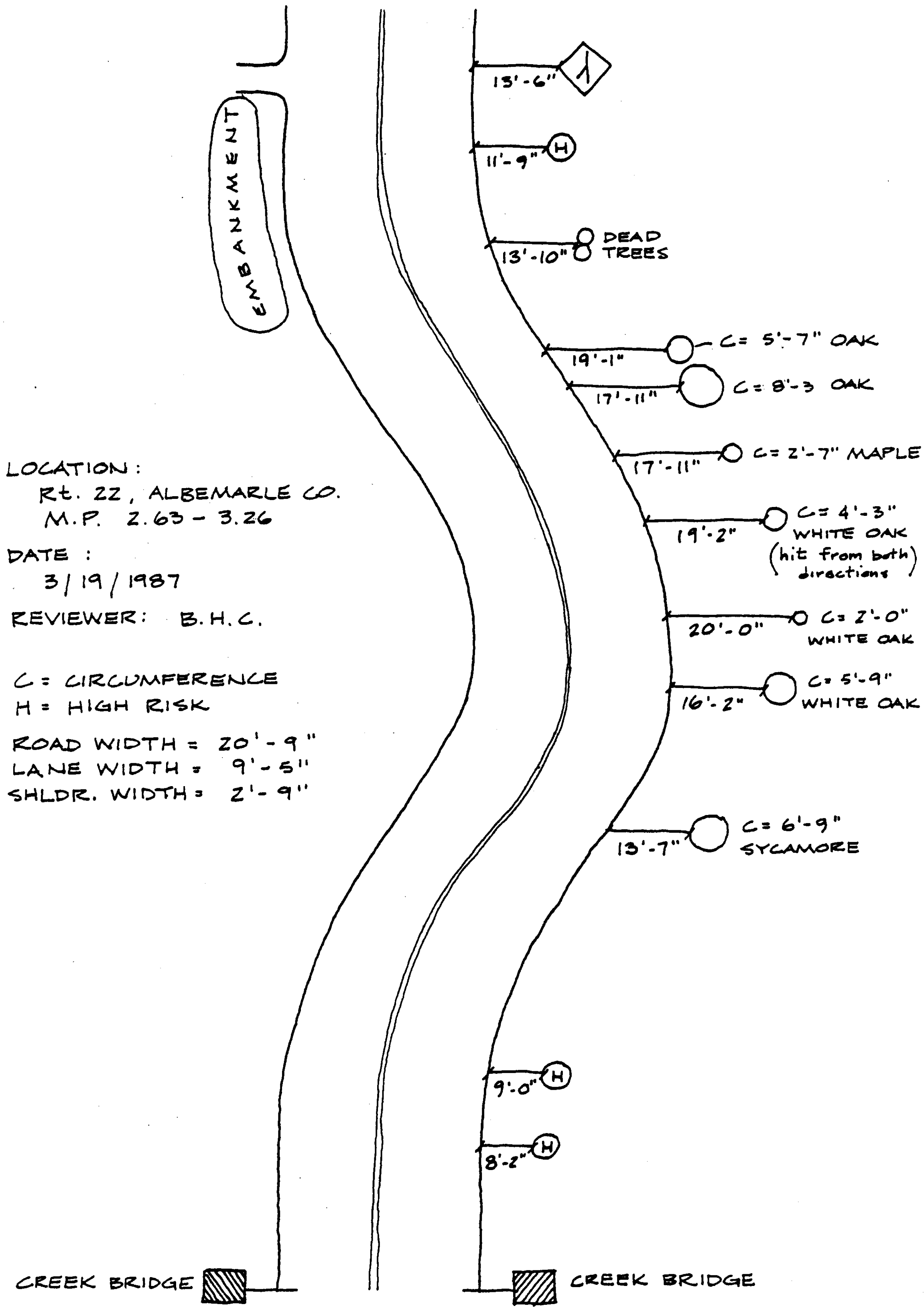
C. Sketch or note the following roadside features:

1. For trees with accident scars, the distance from the road, circumference and species.
2. For dead or diseased trees, the distance from the road.
3. For trees closer to the road than average for the road section
4. Driveway entrances.
5. Fences.
6. Tree clusters.
7. Roadside embankments and slopes.
8. Land use characteristics.
9. Steep ditch slopes

D. Note recommendations for treatment.

E. Optional-Photograph or videotape the section.

Figure 3. Field observation map checklist.


EMBANKMENT
13'-6"
11'-9"
H
13'-10"
DEAD TREES
19'-1"
C= 5'-7" OAK
17'-11"
C= 8'-3 OAK
17'-11"
C= 2'-7" MAPLE
19'-2"
C= 4'-3" WHITE OAK
(hit from both directions)
20'-0"
C= 2'-0" WHITE OAK
16'-2"
C= 5'-9" WHITE OAK
13'-7"
C= 6'-9" SYCAMORE
9'-0"
H
8'-2"
H
CREEK BRIDGE
CREEK BRIDGE
LOCATION:
Rt. 22, ALBEMARLE CO.
M.P. 2.63 - 3.26
DATE :
3/19/1987
REVIEWER: B.H.C.
C = CIRCUMFERENCE
H = HIGH RISK
ROAD WIDTH = 20'-9"
LANE WIDTH = 9'-5"
SHLDR. WIDTH = 2'-9"

Step 2. Rank order road sections by risk for treatment.

The information provided on the field verification form, especially the field recommendation for treatment, is used to eliminate road sections not having trees or no longer presenting a significant hazard due to safety improvements or other changes. The remaining sections should be rank ordered based on any changes in risk, derived from the field verification. The higher risk locations should be considered for treatment in task 4 first.

As a result of rank ordering of the eight sections based on field verification, the top two sections in Table 5 were high priority sections.

Evaluation of Task 3

Assessment

The field verification task is a useful and important activity. The field verification was shortened and simplified to facilitate the task process. The field verification was not a difficult task to perform; the time required averaged approximately 45 minutes per section.

TASK 4: SELECT APPROPRIATE TREATMENT(S)

Description and Assessment

Step 1. For each higher-risk road section, identify possible treatments, keeping in mind the following considerations:

1. The treatment recommended in the field for the particular roadway and roadside environment (adjacent land use) being considered.

2. The presence of other considerations.

3. Alternative treatments for higher risk sites. (See Table 6: Alternative Treatments).

4. The functional classification of the road.

The field recommendations for treatment are a starting point for identifying possible treatments and are identified below for the two sections selected for treatment.

Section	Treatment
Route 22 (MP 2.63-3.26)	Guardrail
Route 53 (MP 2.00-2.25)	Delineators

Table 5

Summary of Field Verification

Route No.	MP Location	No. Accidents	ADT	No. Trees with Scars	No. Dead/ Diseased Trees	Other	Recommendation
Albemarle County							
22C	2.63-3.26	3	1520	18	4	2 hazardous trees	treatment needed
53C	2.00-2.25	5	4330	3	5		treatment needed
250T	0.91-1.33	4	3885	2	0		no treatment
231C	6.30-7.01	3	2680	0	1	2 guardrail dents	no treatment
22C	7.07-7.44	4	4415	2	1	1 damaged sign	no treatment
Prince William County							
234C	25.60-25.90	3	4050	4 old [1]	0	guardrail recently installed	(treated already)
215T	5.25- 6.00	4	3305	3(2 old)[1]	0	1 curve in tangent	no treatment
234C	5.00- 5.53	4	8820	1 old [1]	0		no treatment

1 Old accident scars were estimated to be more than five years old.

The other considerations to be examined include:

- Tree or property ownership
- Endangered/threatened species and unique habitats
- Tree species size (big trees)
- Historic vegetation
- Erosion/sedimentation
- Safety issues as a result of treatment
- Mitigating environmental impacts
- Maintenance of the roadside after treatment
- Aesthetic impacts

Due to the steep down slope on part of the roadside of Route 22 (MP 2.63-3.26), (Figure 5), guardrail is the only practical solution. The guardrail with reflectors may be supplemented with chevron delineators. On another part of this road section, tree removal or raised pavement markers are alternative treatments for two hazardous trees near the road (see the bottom of Figure 3.).

For Route 53 (MP 2.00-2.25), raised pavement markers supplementing the delineators and tree removal were alternative treatments on one side of the road. On the other side, slope alternation was an alternative.

Other considerations and functional classification were not factors at either section.

<u>Step 2. Evaluate the treatment(s) identified</u>.

"Consider the following points, and be careful to appropriately document choice. Professional judgment and experience is important to decide the level of analysis necessary. Simple notes, comments or detailed descriptions may be more or less appropriate depending on potential issues or controversies. Considerations for each site may be different.

1. Consider the road section involved. Rural/local curved roads are generally the higher risk, followed by curved rural U.S./state, straight rural local, and straight rural U.S.state roads.

2. When available, consider the accident frequency and rate and whether the critical accident rate was exceeded (Task 2).

3. Consider both the road conditions present at various locations as well as the average daily traffic (ADT).

Figure 5. Location selected for treatment on Route 22, Albemarle County (MP 2.63-3.26).

Table 6

Alternative Treatment

Treatment Type	Environmental Impact	Feasibility	Effectiveness	Cost
Pavement marking	None	All roads	Effective for all paved road conditions	Least costly
Delineators and advance warning signs	None	All roads	Effective	Least costly
Advisory speed signs	None	All roads	Little effect	Least costly
Designation of special purpose roads (e.g. scenic or recreational route)	Vegetation may grow closer to road edge reducing sight distance and increasing road icing in winter. Positive implications for natural and cultural resources.	Low volume roads at least 0.5 miles long	Questionable effect Selective removal of trees increases effectiveness	Least costly
Raised pavement markers	None	All roads	Effective	Low. Depends on section length
Tree removal	Varies depending on location. Possible loss of aesthetic and/or functional value such as shade, visual buffer, wind protection, soil erosion and sedimentation protection, and change in landscape character.	All roads	Effective	Low
Superelevation or modification of road cross-slope	Generally no impact if activities are restricted to within the road shoulders.	All roads	Somewhat effective	Moderate

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Table 6 continued

Treatment Type	Environmental Impact	Feasibility	Effectiveness	Cost
Guardrails	Minimal impact. Visual quality may be reduced. Grading and augering may result in erosion.	All roads	Effective in reducing the severity of fixed object impacts. Possible increase in the number of accidents when the guardrail protects a narrow object.	Moderate. (Plus repair cost when hit.)
Regrading ditch section	Varies depending on location. Primary impact is on soil erosion and sedimentation during and after construction. Some impact on drainage. If additional right-of-way is required, possible impact on adjacent land use.	All primary roads. Feasible with limits on secondary roads.	Effective in eliminating the problem of vehicles becoming trapped in ditches and channelled into trees.	Moderate
Slope alterations	Similar to regrading ditch section.	All primary roads. Feasible with limits on secondary roads	Effective	Moderate
Protection plantings	Positive environmental impact (e.g. aesthetics,wild-life habitat, etc). It should not reduce sight distance.	Feasible with limitations on all roads depending on available right-of-way	Effective. Aesthetic replacement for tree removal. Especially effective in curves with wood lots.	Moderate
Road relocation/realignment	Long term impact is site-specific. Short term impact will occur.	All roads	Effective. May create difference hazards	High

4. List the feasible (physically possible) treatments for each site. For each of these alternative treatments, consider the following:

   A. Implementation cost: tree cutting, sign or barrier erection, grading, etc.
   B. Maintenance cost: clearing, painting, brush control, etc.
   C. Replacement or repair costs: repair or replacement of damaged sign, guardrails, protective vegetation, etc.

5. On a site-specific basis, evaluate the suitability of each treatment in terms of its effectiveness in preventing or reducing the severity of roadside accidents, and functional classification.

6. Add site-specific costs. If an easement on private land must be purchased for a specific treatment (e.g., clearing trees beyond the right-of-way limits of the road section), these costs should be added as appropriate.

7. Consider the environmental effects. The expected environmental impact of each treatment is listed in Table 6. It cannot be over--emphasized that aesthetic and ecological impact of a given treatment must be considered along with direct monetary costs. In certain cases, a lower cost treatment will be ruled out by the environmental impact or public controversy involved" (5).

The following are the evaluations of Route 22 (MP 2.63-3.26) and Route 53 (MP 2.00-2.25).

<u>Route 22 (MP 2.63-3.26)</u>

1. Primary curve section.

2. 1.0 vehicle-tree accidents per year, 2.88 accidents per mvm, rank-#7 (Table 3). The critical rate was not exceeded.

3. Major problem: curve with a steep downslope on one roadside (Figure 5). Consequently, there are 7 trees with accident scars in a 116 ft section. ADT=1,520.

4. If the objective is to prevent vehicles from reaching the roadside, then feasible treatments include: (a) guardrail with chevron delineators or (b) realignment/relocation. For guardrail with delineators, the implementation cost is moderate, maintenance cost is low, and repair cost is low to moderate. For realignment/relocation, the implementation cost is high, the maintenance and repair cost is low.

5. The guardrail with delineators is very suitable and effective. The realignment/relocation is effective but costly.

6. There are no additional site-specific costs for the guardrail with delineators; however, it will be necessary to acquire a substantial amount of right of way for realignment.

7. There are no significant environmental impacts expected from the guardrail with delineators. There are potentially significant environmental impacts with the realignment.

Route 53 (MP 2.00-2.25)

1. Primary curve section.

2. 1.67 vehicle-tree accidents per year and 4.23 accidents per mvm, this is the 0.25 mi section with the highest number of accidents within the 1.13 mile section that is ranked first on Table 3. The critical rate was exceeded.

3. Major problem. A horizontal curve with three trees with accident scars between 5 ft 10 in and 9 ft 2 in from the road on one side. A scarred embankment 2 ft 9 in from the road on the opposite side (Figure 6). Also, on the westbound approach, a wood fence less than 5 ft behind the trees had two new sections that were apparently repaired after run-off-the-road accidents. ADT=4,330

4. Feasible treatments: (a) chevron delineators, (b) guardrail on westbound roadside, (c) raised pavement markers, (d) slope alterations on the eastbound roadside, (e) chevron delineators and raised pavement markers, and (f) tree removal.

5. All alternatives are suitable and effective.

6. There are no additional costs for any alternative.

7. Slope alteration would cause soil erosion and sedimentation.

Step 3. Select the most appropriate treatment(s).

If tree removal is selected, determine the distance from the edge of road that trees must be removed to reduce the risk of vehicle/tree accidents. This determination should be based on specific roadside conditions, field observations from the field verification, and professional judgment.

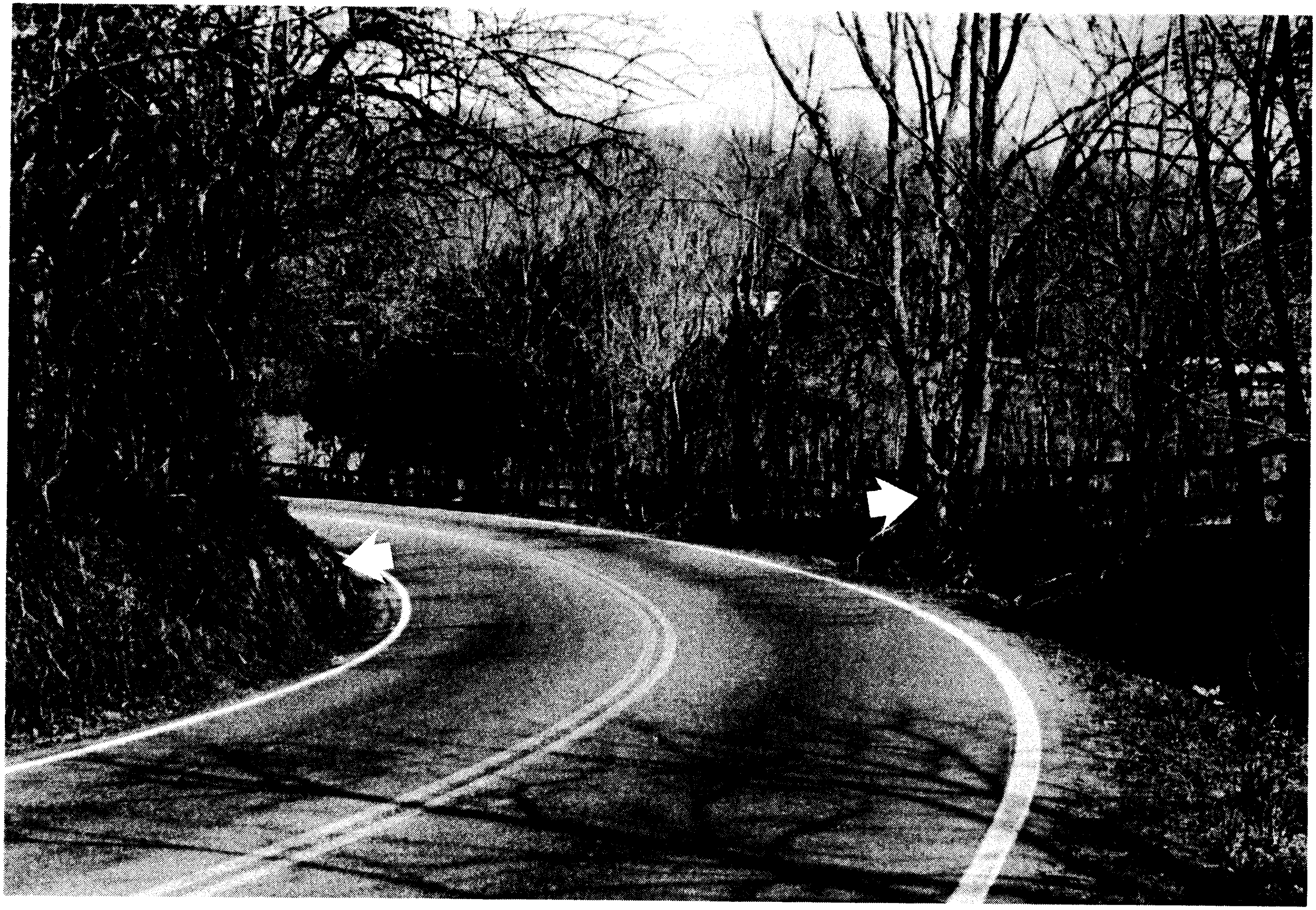

Figure 6. Location selected for treatment on Route 53, Albemarle County (MP 2.00-2.25).

Route 22 (MP 2.63-3.26)

The high cost and long time required to implement the realignment/relocation treatment makes it difficult to justify this treatment. The moderate cost of the guardrail with chevron delineators and their effectiveness results in this treatment being selected.

The approximate installation cost of this alternative is:

120 ft of GR-2 guardrail at $8.50/linear ft	=	$1,020.00
20 ft of GR-2 terminal guardrail at $10.00/linear ft	=	200.00
1 fixed object attachment at $250/unit	=	250.00
1 GR-7 terminal guardrail at $625/unit	=	625.00
4 18 in x 24 in chevron delineators at $17.80/delineator	=	71.20
		$2,166.20

Route 53 (MP 2.00-2.25)

The guardrail alternative is eliminated. There are no downslopes on the roadside to create a danger that would justify guardrail. One fixed object hazard is replaced by another fixed object hazard. Tree removal is preferred to guardrail to eliminate the hazard (Figure 6). However, only removing the trees may result in less severe collisions with the wood fence. Altering the slope of the eastbound roadside is recommended due to the embankment's proximity to the road (Figure 6). Further, the combination of chevron delineators, raised pavement markers, and tree removal are recommended. The chevron delineators and raised pavement markers are preferred to the chevron delineators alone due to the complement of on-pavement and above-pavement delineation. Since detailed assessments are required to estimate the slope alteration and tree removal costs, no approximate costs are given.

Step 4. Incorporate techniques to lessen or eliminate the environmental impact of treatment(s) selected.

This step would be addressed in the detailed assessment of slope alterations. The other treatments are not likely to have environmental impact.

Evaluation of Task 4

The lack of quantitative data on the benefits of the alternative treatment is the only notable weakness in this task. Unfortunately, these data do not exist. Given the absence of quantitative cost-effectiveness or benefit/cost analysis, the evaluation outlined in Task 4 is thorough and useful. Many of the alternatives such as slope alteration, and road relocation and realignment may require a significant design effort to be adequately evaluated. The time required to perform task 4 will vary depending on the detail of the analysis. For the 2 sections examined above, task 4 was completed in less than one hour.

TASK 5. PERFORM THE TREATMENT(S) SELECTED.

Task 5 was not performed in this evaluation. The activities of Task 5 listed below appear reasonable.

" 1. "Notify the property owner(s) and adjacent owner(s) of the treatment(s) to be performed.

   Using sample letters, found in the guide, notify property owners involved by mail. Registered mail may be used, as appropriate, to document receipt of notice by property owners. Typically, where treatment is on right-of-way owned by the road authority, contact with adjacent property owners may be in person with an appropriate record of contact.

2. If permission is received, perform the treatment(s) specified.

3. If the landowner(s) refuses to grant permission, or the adjacent owner(s) voices objections, re-evaluate the selected treatment based on these objections and considerations (return to Task 4, Step 1, and work through the remaining steps). Permission must be granted or received from the property owner before any treatment can be performed on land not owned by the road authority.

4. After re-evaluation another treatment is chosen; notify the property owner(s) and/or adjacent owner(s), obtain written permission, and perform the treatment(s).

5. If after re-evaluation, the original treatment is still preferred, further negotiation or legal action toward settlement must be considered if it involves the property owner" (5).

EVALUATION OF THE REMAINDER OF THE GUIDE

Two chapters of the guide that have not been addressed are discussed below.

Chapter 2. Roadside Tree Risk

This chapter described run-off-the-road (ROR) driver characteristics, trees, and the roadside environment as related to ROR accidents and accident profiles. The accident profiles describe the four road section types evaluated in order of risk from high to low as follows:

curved secondary roads typically with left curves and downgrades
curved primary roads typically with left curves
straight secondary roads
straight primary roads

The major difference mentioned between the primary and secondary roads was that trees are closer to the road on secondary roads.

Chapter 2, which is based on Michigan data, provides a useful overview of the driver, road, and roadside interactions that are related to vehicle-tree accident risks. The descriptions are probably similar to experiences in other states. However, there is no reason to repeat this background information in a revised guide adopted for Virginia.

Chapter 5. Treatment Programs and Public Relations

Three types of public relations activities are connected with procedures in the guide: (1) field interviews during the field verification, (2) letters requesting permission to apply treatment to property owners or for the information of property owners adjacent to a treatment location within the right-of-way, and (3) public hearings as required by state regulations or law. The first type was previously shown on the field verification form. The remaining two types are currently employed by most transportion agencies. The evaluation of the public relations program and litigation as a last resort to perform treatments that are opposed by property owners are also discussed.

Although no new concepts are discussed in this chapter, it does make the guide comprehensive and it is useful for background information.

EXPANSION OF THE GUIDE TO INCLUDE OTHER FIXED OBJECTS OFF THE ROAD.

The guide in conjunction with the recommended changes provided in this evaluation provides an excellent approach for the management of roadside trees. Although management of roadside trees can significantly reduce run-off-the-road accidents, there are other fixed objects off the road that are worth considering in a roadside management plan. These fixed objects include embankments or ledges, utility poles, and fences. Table 7 displays data on the total number of accidents involving these fixed objects and trees in Virginia during 1985 (10). On the primary and secondary system, 18.9 and 29.0 percent, respectively, of all fixed-object, off-the-road accidents involved trees. When all four fixed-object, off-the-road accident types are combined, 63.4 and 80.2% of all fixed-object, off-the-road accidents are included for the primary and secondary systems, respectively. It is obvious that by expanding the guide to include these four types of fixed objects, the percent of fixed-object, off-the-road accidents examined would be substantially increased. The remainder of the fixed-object accidents not addressed involve highway safety hardware (such as guardrails, signs, and impact attenuators), parked vehicles, and structures.

Table 7 includes all roads in the primary and secondary system not only rural two-lane roads. This expansion is indirectly implied in that the field verification observations include the total roadside.

Table 7
1985 Data for Four Types of Fixed Object
Off Road Accidents in Virginia

	Primary System		Secondary System	
Fixed Object Type	Number	Percent of Total	Number	Percent of Total
Trees	1,354	18.9	3,050	29.0
Bank or Ledge	2,254	31.5	3,472	33.0
Utility Poles	592	8.3	891	8.5
Fence	336	4.7	1,022	9.7
Sub Total	4,536	63.4	8,435	80.2
Other	2,625	36.6	2,083	19.8
Total Fixed Object	7,161	100.0	10,518	100.0

Source: "Summary of Accident Data-1985"

CONCLUSIONS

Task 1. Prepare a Base Map and Plot Roadway Information

This task was long, boring, and tedious. Since it was unrealistic to expect the VDOT field personnel to perform the map plotting, alternatives were considered. As noted earlier, the computerized roadway management system being developed for VDOT is recommended for performing this task.

Task 2. Assign Priorities for Field Verification

Since this task as presented in the guide also involved map plotting, it was anticipated that it would be time consuming. To facilitate this task, files were developed on a microcomputer using Lotus 1-2-3 software. The method for assigning priorities in the guide based on expected accident frequency was compared with the rate quality control method. Based on the extensive use of the rate quality control method and VDOT's use of the rate quality control method in its highway safety improvement program, the rate quality control method was selected for assigning priorities.

Task 3. Field Verify the Higher Risk Road Sections

The field verification form was shortened to include only the field observation map. The field verification was not a difficult task; however, it was useful and important.

Task 4. Select Appropriate Treatments

Given the lack of quantitative data to assess the effectiveness of the treatments, Task 4 is a thorough and useful procedure.

Task 5. Perform the Treatment(s) Selected

Although not evaluated by performance, Task 5 appears reasonable and useful.

The Remainder of the Guide

The remainder of the guide supplements the five tasks in the method for evaluating higher risk roadside environments.

Expansion of the Guide

The guide can have a substantially greater impact on roadside management of high-risk sections by covering other fixed-object, off-the-road accidents. The other fixed objects include banks or ledges, utility poles, and fences.

Figure 7 displays a revised method for evaluating higher risk roadside environments.

RECOMMENDATIONS

Based on the findings of this report, it is recommended that:

1. The guide to the management of roadside trees with substantial revisions as noted in the report be adopted for implementation by the Traffic Engineering Division with cooperation from the Maintenance and Environmental Quality Divisions (see Figure 7). The guide may be incorporated into the Highway Safety Improvement Program.

2. The plan for implementation by developed with assistance from the author and consideration of the following.

    a. Tasks 1 and 2 should be performed by the Traffic Engineering Division using the Highway Traffic Information System. The results would be sent to the district traffic engineer.

    b. Tasks 3, 4, and 5 should be performed by the district traffic engineering staff with assistance as appropriate from the residencies.

    c. A user's manual should be developed that would serve as a guide for roadside safety management.

3. The Traffic Engineering Division monitor the roadside safety management program to evaluate the program's effectiveness and to obtain data on the effectiveness of each treatment type.

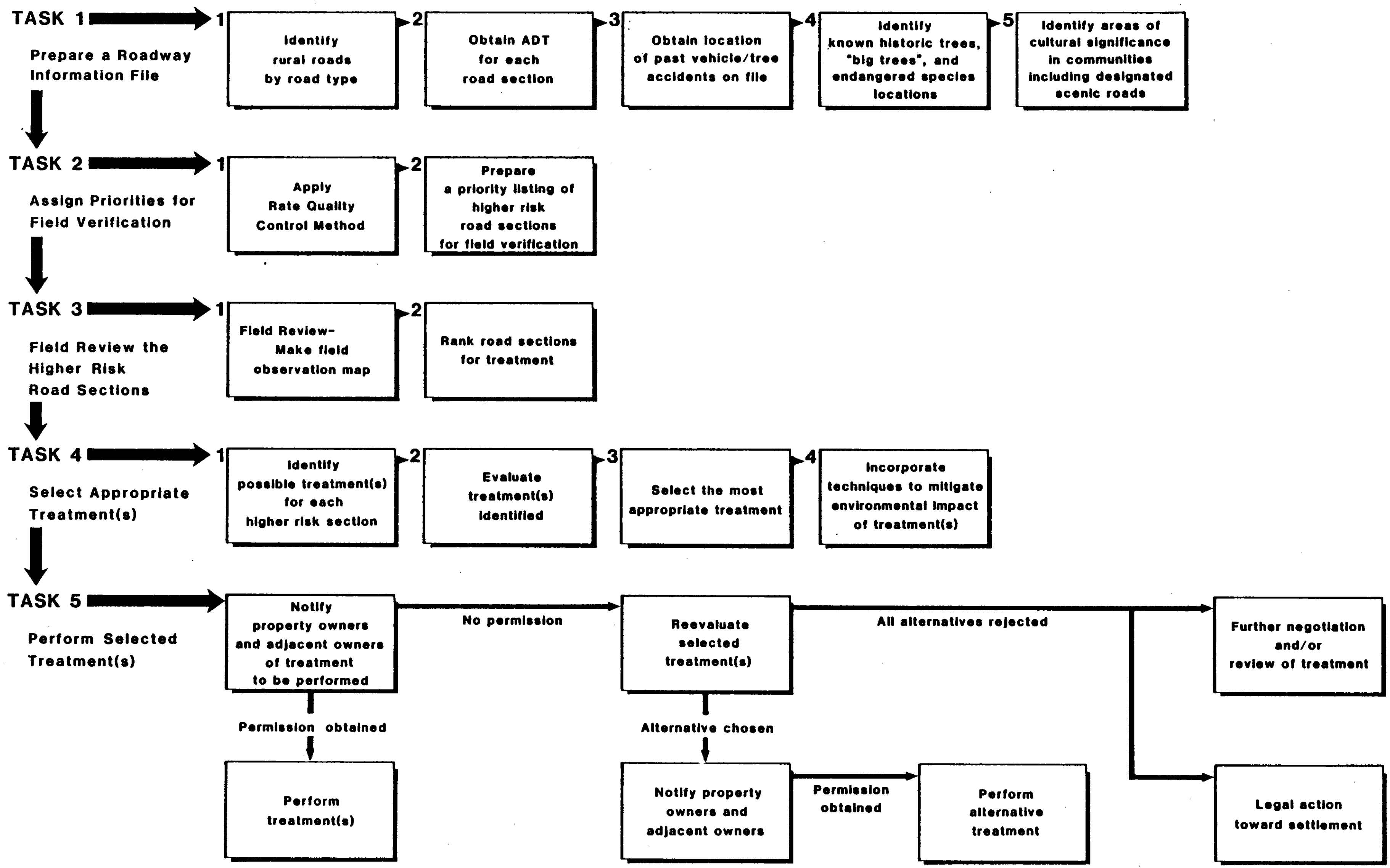

Figure 7. Revised method for evaluating higher risk roadside environments.

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