The routine and periodic support maintenance needs of bridges are placed in a separate chapter. A detailed review is given of the needs for cleaning and inspection of all bridge structures. The procedures for proper inspection are listed.

The maintenance needs for road surfaces are divided into four types. Bitumen-sealed roads are treated for their needs of water runoff and surface repairs. A detailed procedure is given for earth and gravel roads. The potentials for lime-stabilized roads are cited.

## SUMMARY

The technical reference manual is planned for distribution throughout the county road agencies of Indonesia. The manual is in the local language, which more than 60 percent of the staff can read. It is planned for distribution to all county road engineers, officials, and contractors. It is envisioned that more than 2000 copies will be printed. Following the adoption of this manual, the Ministry of Public Works may issue additional types of manuals. After four or five years of use for this first manual, a gradual introduction of updated techniques can be made. Changes in maintenance practices on the county roads may occur by that time.

Taken individually, the county roads are not of major importance to the central government. However, collectively these roads are the capillaries to be used by government for implementing new social, economic, and agricultural programs for the continued development of all strata of Indonesian society. As such, this program for county road maintenance will play a crucial role. If successful, it will become a modest daily routine without special fame. However, if it fails, the costs for attempting to keep roads open will increase severalfold and the social and economic benefits desired for rural citizens will be in jeopardy.

## ACKNOWLEDGMENT

We take full responsibility for the statements made here. Such comments may not represent the policies or views of any other individual, firm, agency, or ministry of the Government of Indonesia. Such viewpoints may not reflect the plans or policies of international agencies or bilateral national trading partners.

# Low-Volume Roads: Closure and Alternative Uses

CLETUS R. MERCIER

**The problem of low-volume secondary roads in Iowa is discussed. Specifically, this paper summarizes the position of counties as they seek to close roads, and their financial dilemma as they try to stretch limited funds to cover a large amount of maintenance and construction needs. Current status of the secondary road network is reviewed in terms of needs and budget constraints. In particular, applicable elements of the Code of Iowa are reviewed and related court cases are evaluated. An analysis of road-closure problems is provided, along with a description of a set of three alternative uses for the vacated road right-of-way. The three alternatives are use as a private access road, conversion to agricultural use, and conversion to agricultural use and as a shelterbelt. An assessment of benefits and costs is included for the three alternatives. The paper ends with a set of policy recommendations. In essence, it is recommended that the state legislature act to mandate road closure and vacation and to provide assistance in the form of a more appropriate functional classification system and technical and legal assistance.**

Significant portions of Iowa's current secondary road system are used very lightly. In fact, of the more than 90 000 miles of secondary roads in Iowa, nearly one-fourth (more than 22 000 miles) carry an average of less than 25 vehicles/day. Expressed in terms of vehicle miles, this one-fourth of the secondary road network carries slightly more than three percent of the total secondary road traffic.

Managers of the secondary road network are facing the problem of rapidly escalating costs while growth of revenues has slowed. Closure of some of these low-volume roads would help road budgets in the short term and benefit Iowa's economy in the long run by making more land available for tillage. One of the problems to be faced is how to use the right-of-way of the closed and vacated roads. This is the topic of this study.

## BACKGROUND

When the road network was created in Iowa more than 100 years ago, the average farm was about 90 acres in size. The road network was a grid, generally with roads at 1-mile intervals, both north-south and east-west, and the land was subdivided into pieces about 640 acres in size. This pattern was only interrupted by natural barriers such as rivers and lakes.

The road network greatly facilitated land development, as it provided access from the land to markets for the farm's products. In addition, most of the state's population lived on farms, and the road network was also used for social interaction and as an access to necessary goods and services.

Mass migration into the cities accompanied major increases in the productivity of the individual farmer due to improved technology, and the average farm size increased to 158 acres in 1930 and to 253 acres in 1976. Iowa's rural population was 1 528 000 in 1920 but dropped to 1 318 000 in 1960 and 1 097 000 in 1980. Farm population dropped from 662 000 in 1960 to 512 000 in 1970 and 294 000 in 1980. (The 1980 figure is probably understated, as the method used for classifying farm population was changed for that census.) Rural road mileage dropped during this period, but not significantly.

When the road network was originally developed, there were 6-8 farms/mile$^2$, each with a farmstead and each requiring direct access to the road network. Consolidation of farms since that time has reduced that number to between 2 and 4 farms/mile$^2$ and made similar reductions in the number of farmsteads. The road network is still being used for the same purposes as before but by fewer people on fewer farms. Although the number of farms has decreased, there is evidence that the number of trips generated by each farm has increased, as well as the

sizes of the vehicles that use the roads. In addition, major improvements in the quality of segments of the network have caused a greater percentage of the traffic on the secondary road system to choose the improved roads over others, which leaves the others lightly traveled.

This suggests that a significant portion of the secondary roads in Iowa serve only as an access to farm fields. Indeed, for some farmers, they represent a discontinuity in their farming operations, as they have expanded their farms by buying land across the road. The road prevents longer rows in their fields and causes some waste of resources, as more space and fuel are required to turn equipment around at the end of the row for the shorter rows.

## PROJECT OVERVIEW

All of the facts stated above suggest that many of the secondary roads in Iowa serve few people and are of such marginal value as roads that a serious question arises as to whether these are "public" roads in a functional sense. Legally, they remain on the books as public roads and are a county responsibility and a drain on the limited funds available for roads.

Closure of some of these roads would seem to be the logical solution. This solution, however, faces several obstacles:

1. County government is the agency that normally has the right to vacate and close a secondary road (Code of Iowa, Section 306.10). However, the elected county government (board of supervisors) is quite vulnerable to political pressures. The board also generally lacks legal and administrative support, as it represents the interests of the public as opposed to narrower interests in such actions. Further, there is some lack of understanding of the legal implications of such actions.
2. The threat of a civil suit is often enough to cause cessation of the vacating action, especially if the amount of the threatened suit greatly exceeds the perceived benefits of the road closure.
3. The alternative uses of a vacated road right-of-way have not been well known (nor have their benefits and/or disbenefits).

The objectives of this study are to list and evaluate these alternative uses of vacated rights-of-way and to develop a set of policy recommendations related to closure and vacation of secondary road right-of-way.

## LOW-VOLUME ROADS: LEGAL AND POLICY CONSIDERATIONS

### Iowa Road Network

#### Current Status

The road network in Iowa consists of about 115 000 miles of roads, which includes Interstate highways, primary roads, city streets, and secondary roads. Of these roads, about 10 100 miles are the responsibility of the Iowa Department of Transportation (DOT), about 90 400 miles are secondary roads and the responsibility of county governments, and the remainder are city streets. Road-use taxes are collected by the state (mostly from the sale of gasoline) and distributed to the three jurisdictions according to a formula set by state law. Road-use tax funds are distributed as follows:

1. Iowa DOT, for primary roads and Interstate highways, receives 45 percent;
2. Counties, for secondary roads, receive 37 percent; and
3. Cities and towns, for streets, receive 18 percent.

(Note that before distribution, some of the road-use tax funds are reserved for a variety of special uses, such as railroad crossings, park and institutional roads, and the motor vehicle division for the cost of licenses and stickers.)

#### Anticipated Future Problems

In 1978, 39 078 miles of all roads in Iowa were inadequate for current travel needs and an additional 37 341 miles were expected to be deficient according to current standards by 1997 (1). During this time, the number of vehicles that use these roads are expected to increase from 2.9 million in 1978 to about 4 million in 1997.

Although collections of road-use tax funds have increased, the buying power of these funds has decreased, so that agencies responsible for the road network are losing ground. For example, road-use tax collections in 1967 amounted to $170.2 million and in 1978 to $311.0 million. However, when corrected for inflation, 1978 collections were worth only $135.2 million in 1967 dollars. (Note, this figure understates the loss in buying power. The construction price index has consistently exceeded the inflation rate.)

Total needs for road funds between 1978 and 1997 (based on 1978 dollars) are estimated to be about $20.28 billion, with revenues expected to be about $10.46 billion, which leaves a shortfall of more than $9.82 billion. (Note, these figures do not include any additional revenue collected by the increase in gasoline taxes based on the legislation passed in 1981.) This shortfall would certainly affect the counties, since about 80 percent of the total road network are secondary roads and about half of the shortfall in revenue is in the county jurisdiction--an estimated $4.99 billion.

### Legal Aspects of Secondary Road Disposition

#### Jurisdiction

The agency that has control over a given highway has the right to alter or vacate and close it (Code of Iowa). This action is subject to requirements for provision of notice and public hearings.

Title to the land generally reverts back to the owners of adjoining land after closure, as the original title to the right-of-way was usually in the form of an easement for road purposes. Fee title has been acquired for some right-of-way land, but this form of conveyance has usually been used only for rights-of-way acquired for Interstate or primary highways.

#### Liability--Road Maintenance Activities

Lightly traveled rural roads pose real problems for counties. The fact that they are used very little tempts system managers to maintain them at lower levels. However, since 1965, government bodies in the state have not had immunity for negligent acts by the body itself or by its employees acting in the scope of their employment. This means that counties can be (and occasionally are) sued for monetary damages.

A 1981 addition to the Code of Iowa provides for two classifications of maintenance levels. Service A classification is maintenance in conformance with applicable statutes, while service B classification provides for a lesser level of maintenance, which is a level specified by the county government. At the

time of this writing, no counties in Iowa have adopted this classification, but four are actively considering it.

### Evaluation of Recent Court Tests

The threat of tort claims resulting from alleged highway defects introduces an additional concern to counties that are the usual jurisdiction providing highway service (2). This means that any decision relating to highway design, construction, or maintenance may eventually be reviewed in a court of law. One obvious solution is to close any road that is lightly traveled. Normal expenditures on these roads would be relatively small, since improvements on them would normally receive a low priority.

A special compensatory damage arises, however, from the closing of a secondary road or part thereof when access from the land to the general system of roads is substantially impaired (3). This general rule has been tested in Iowa courts on many occasions.

Court cases to date have clarified two key issues regarding road closure and left one issue largely resolved, but with some exceptions:

1. County boards of supervisors have the appropriate jurisdiction and the right to close a road and vacate its right-of-way;
2. The power to vacate is absolute, providing there is no evidence of fraud or bad faith on the part of the supervisors; and
3. No special damages are suffered by a property owner due to closure as long as ingress or egress is not denied or substantially interfered with.

The words "or substantially interfered with" are important, in that they are a key to decisions that have gone against counties. In each case, the vacated road included a bridge that was used to get from one part of a farm to another. In similar cases, which involved two or more units of land with one owner, the rulings favored the counties. Of course, a special damage arises whenever a secondary road closing landlocks a property.

### Conclusion

It is clear that the county board of supervisors has the appropriate jurisdiction. What is not clear is what conditions might result in the need to pay damages to a landowner. It is safe to say that, in general, the courts have favored the agency with jurisdiction and that counties should not hesitate unduly to vacate lightly used secondary roads. The prudent approach would be to examine each case thoroughly to be sure no conditions exist that might be cause for awarded damages and either drop the proceedings (if one or more of these conditions exist) or make adjustments to solve the problem before vacation proceedings begin.

## Analyses of Road Closures

There seems to be general agreement that Iowa has too many roads. One measure that is often quoted in support of this contention is the number of miles of road per square mile of land area. By using this measure, Iowa ranks in a tie for third for all states in the country, with an average of 2.0 miles of road per square mile of land area. This ties Iowa with Michigan and is only exceeded by Illinois (2.4) and Pennsylvania (2.6). The next three states are Missouri (1.7), Kansas (1.6), and Minnesota (1.5) (4).

A road-closure program would have some impacts, both good and bad (4). Some of the benefits are

1. Increased farm productivity due to slightly greater acreage and larger, contiguous fields;
2. Reduced nonfarm use, accompanied by a stabilization of land values;
3. Increased tax base; and
4. Savings from maintenance and construction costs, which could result in additional improvements being made to the remaining roads, which could mean reduced operating costs for vehicles that use these roads.

There are disadvantages as well, which are related to individual needs:

1. Some farmsteads would have reduced accessibility,
2. There would be some increase in trip lengths by area residents, and
3. Some disruption of social interface within the rural community would be likely.

Iowa has done some research on the problem. A project was funded in 1969 by the Iowa Highway Research Board and completed by the Midwest Research Institute. The study concluded that there are a significant number of roads in the county road networks that contribute very little to the network and that through traffic would be inconvenienced very little by closure and vacation of these roads. The study further concluded that there was no serious impediment to such a program and suggested a procedure for selecting candidate roads for closure and vacation (3).

Certainly, Iowa has incentives to rigorously pursue such a program. Iowa DOT records on conditions of secondary roads in the state show that 20 percent of all bridges on secondary roads in the state are structurally deficient (posted for less than legal load) and an additional 30 percent are functionally obsolete (5). The cost of replacing only the posted bridges (at 1981 prices) is estimated to be about $360 million.

It is clear that there is a need to agree on a method of identifying candidate roads and proceeding with a program of road closure. There have been some very usable suggestions on how to begin (3,4). More work needs to be done on development of a program that is beyond the scope of this study, but the results of this study should prove to be useful to administrators of such a program.

## Conclusion

A perfect highway, from a safety viewpoint, is a goal that will never be achieved due to its costs. The prevailing attitude is that the public agencies responsible for highways are not required to guarantee safety to travelers. They are only required to build and keep roads in a safe condition for the reasonably careful driver.

The motoring public, however, does have the right to assume that a given road is safe for ordinary traffic demands. This suggests that if a public agency responsible for roads within its jurisdiction does not have sufficient funds to meet this criterion, it has three choices:

1. Generate more funds through tax increases,
2. Build and/or maintain some lightly used roads at a lower standard, or
3. Close some of these lightly traveled roads to the general public and release the funds that would be required for these roads to be used on the remaining roads in the system.

The first choice is only feasible if the public is willing to be taxed at a higher rate. Current indications suggest that this is not likely. The second choice ultimately would prove to be unacceptable to the using public and would result in numerous tort claims resulting from highway accidents, along with settlements and awards by the judges and juries in these cases brought to court. The last choice has the greatest potential for public acceptance, especially if objections from adjoining property owners and the few motorists subjected to additional travel for daily trips can be resolved. The solutions described in this paper are intended to assist local officials in resolving this problem.

## EVALUATION OF ALTERNATIVE USES

It is not difficult to make a fairly complete list of the possible appropriate uses for the vacated right-of-way. The problem is that no single use is appropriate for all situations, and local conditions may dictate one use over another.

### Use as a Private Access Road

One approach is to develop a functional classification system that is more relevant for secondary roads. Such a system might provide for classifications of arterial, collector, feeder, and access. A road classified as access could be a candidate for closure if it met a given set of conditions, including lack of a residence or farmstead on that candidate road. However, some roads that fit this description are still important as a means of acccess to fields for the landowners adjacent to that road.

Closure as a public road could still be accomplished by leaving the right-of-way as a private access road, conditioned by an agreement by adjacent property owners to keep it open for the private use of the adjacent property owners. A gate and appropriate signs or barriers could be placed across the closed right-of-way to keep the public off the land, thereby eliminating county government responsibility.

The main costs would be for maintenance of the roadbed and maintenance and/or possible replacement of stream crossing structures. Maintenance of the roadbed should not be a significant expense. Travel on the private road would be light and slow moving, consisting mostly of farm equipment and light trucks. It would also be very seasonal, occurring chiefly during the planting and harvesting seasons. Most of the use of the road should occur during dry, fair weather. This, combined with low speeds, would mean that the road would require very little maintenance due to the traffic. Most of the deterioration of the road surface would be due to erosion or frost heave.

Stream crossings could be an expensive problem. The large number of structurally deficient and/or functionally obsolete bridges on the county roads in Iowa will require the expenditure of a significant portion of county road budgets for some years to come. The natural tendency is to give those bridges on the more heavily traveled roads a higher priority and replace those bridges on lightly traveled roads last. In fact, the existence of a structurally deficient bridge on a low-volume road may be one of the best reasons to close the road. It would seem to be an inefficient expenditure of limited resources to build an expensive bridge for just a few vehicles per day. The problem is that a stream crossing may be necessary to get farm equipment from one part of a farm to another. Normally, this would be an expected expense related to farming, but the courts have been inclined to rule in favor of the farmer when a public road has been available for this purpose.

The seasonal nature of the traffic on a private access road would suggest that a low-water-crossing structure could be used as a stream crossing. A low-water crossing is a stream crossing designed to allow flooding of the structure about once a year without significant damage to it. It could be a paved ford (or dip), a vented ford (a dip with culverts), or some other form of low-water structure (6). They are far less expensive to build and maintain than a stream crossing designed for a 25- to 50-year flood and should prove to be more than adequate. If stream characteristics are such that persistent flooding occurs regularly, then a low-water crossing may not be the best choice.

### Conversion to Agricultural Use

Another alternative is to allow the ownership of land in the right-of-way to revert. There are some obvious advantages to such a move:

1. It would represent a potential for increase in farm production by allowing an increase in the amount of land under cultivation without signficant cost;
2. The county government would receive slightly greater property tax revenues, since the effective size of the farm is now a little larger; and
3. The farmer who owns land on both sides of the road can now clear out the fences and extend the rows through the road, thereby reducing the amount of fuel, time, and space required for row ends.

There are problems with this alternative, which lessens its attractiveness:

1. The roadbed would have to be regraded to approximate the contour of the adjacent land for cultivation;
2. The compaction of the soil done in the original grading and regrading limits root penetration of the crop plants and provides a very limited amount of capillary water for plant growth; as a result, the land would have a minimal crop yield without extensive deep-plowing operations to loosen the soil; and
3. The exposed soil would not be of high quality, but a mixture of some topsoil with clay and gravel or crushed limestone (if the road had ever received an all-weather surface).

The first and last problems can be solved reasonably easily. Conventional earth-moving equipment can solve the grading problem quite well and would not be prohibitive in cost, especially in comparison to the market value of most land in Iowa. Also, commercial fertilizer can be used to quickly build up necessary plant nutrients.

The compaction problem is not so easily solved. One approach--deep tillage--has been tested at the Iowa Coal Project Demonstration Mine (7). (Note that the project involves reclamation of land that was previously mined for coal. Soil spread over the spent coal mine had been compacted by the equipment.) Deep tillage was accomplished as one management option to disrupt layers of compacted soil. Average depth of tillage was about 3.28 ft with the biggest variations being the direction, frequency, and spacing of the passes with the tiller.

Results of the deep tillage are not yet conclusive. The disruption appears to help develop natural capillary action, although not back to original conditions. The surface of the soil at the depth of the tillage tends to act as a nonporous layer, trapping water above it, much as a constricted aquifer. Plant roots reaching this depth of free water are subject to root rot.

### Conversion to Agricultural Use and as Shelterbelt

If the property on both sides of the vacated road is not owned by the same party and there is no incentive to keep the right-of-way as a private access road, then a third option is feasible. This option provides for a normal property line down the centerline of the right-of-way. Some regrading would be necessary to be able to farm the land closer to the property line, but probably not as much as for the second option. Rows on both sides could be extended and equipment could be turned around on the old right-of-way. For that reason, the reclaimed land would not have to be as productive.

The unique feature of this option is the use of a shelterbelt, either in place of a property fence or with one. The shelterbelt concept provides three significant benefits to the area:

1. A properly planned and executed shelterbelt will slow wind velocities and reduce the amount of wind erosion for some distance from the shelterbelt. The distance affected would be a function of the type and size (mostly height) of the row of trees and/or shrubs used.
2. The same shelterbelt will also reduce wind velocities during the winter and make snow and snowmelt management possible.
3. The row of trees and shrubs plus the associated ground cover will provide an excellent habitat for a variety of small animals and birds.

A further benefit that is somewhat more difficult to quantify is that of appearance. To many people, the appearance of a well-planned shelterbelt is a welcome addition to an area that has had most of the trees removed in order to enlarge the amount of tilled land on the farm.

### Assessment of Benefits and Costs

One of the most important benefits of road closure is the removal of that road segment from the county road budget. The savings attributed to the closure of a 1-mile segment will not be great, since it would not have received a very high priority in the budget and would have received only minimal maintenance. Little, if any, construction funding would be used on this segment for the same reason. As long as funds are limited, these roads will deteriorate and cause increased accident rates and higher vehicle operating costs.

Tax revenues will also increase, as closure of a typical 1-mile road would return eight acres to private ownership. The tax rate would vary, depending on the alternative use chosen. Current state law requires that farmland be assessed according to its productive capacity (Section 441.21, Code of Iowa), and the amount of tillable land will vary with each alternative.

The operator of the adjoining farm will benefit from the return of the land to cultivation should either alternative two or three be chosen. Reclaimed land will provide additional income, and if several roads in the county are closed and vacated, countywide income will increase.

Benefits of the addition of a shelterbelt are more difficult to quantify. Decreased wind erosion, provision of more wildlife habitat, and snow and snowmelt management to decrease spring flooding and increase groundwater are all worthy goals that shelterbelts can help to achieve. All these need to be balanced against costs of the shelterbelt and losses of production that would be possible should the shelterbelts not have been planted.

A unique feature of the road-closure and vacation process is that the principal benefits are repeating; that is, they occur every year. Costs associated with road closure and conversion tend to be one-time expenditures, which may need to be made again, but certainly not annually. It does seem to be a choice of "do it now or do it later", since it appears inevitable that some roads will be closed. Growth in farm size is likely to continue (at least not reverse), and there will be more pressure to close any unnecessary roads.

## RECOMMENDATIONS

A significant portion of Iowa's secondary roads needs to be closed to use by the public. How this is to be done is the immediate question. Although county boards of supervisors have the authority to do so, progress is slow due to the vulnerability of the boards to political pressures.

Counties need the assistance of initiatives from higher levels of government, the most likely choice being the state legislature. Legislation should be passed mandating an examination of each county's road system to detect roads that are candidates for closure. Specifically, the legislation should include the following:

1. Guidelines for determining whether a given road is a candidate for closure and vacation: One possibility is the development of a detailed set of functional classifications more appropriate for secondary roads. This would provide descriptions of various levels of public roads and suggest that others are access roads and candidates for closure.
2. Provision for legal and administrative support in actions that involve closure: Specialists could provide advice, checklists and review procedures, and technical advice at hearings.
3. Provision for technical support: One area of technical expertise that is badly needed is in structural engineering. A major stumbling block to road closure is the existence of a bridge that is used by adjoining landowners to get from one part of a farm to another. Low-water bridges would be low-cost but satisfactory solutions to many situations, but technical knowledge is lacking in their use and design. Some studies are currently being done, and there is interest in their use.
4. Provisions for land use analysis: Choice of land use for a given right-of-way parcel that has been vacated is dictated by the situation. Adjoining landowners, given a land use compatible with their needs, are far less likely to object to the proceedings and more likely to be pleased with the results.

It is important that steps be taken to speed up the road-closure and vacating process. The current pace is too slow. Counties have budget incentives to do the job and the state legislature can do much to facilitate action by providing the mandate and the tools needed.

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# Reducing Tort Liability on Low-Volume Roads Through Analysis of Case Law

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**Low-volume roads appear particularly susceptible to lawsuits since they are typically constructed to lower standards than high-volume routes and because funding levels are not adequate to deal with problem locations. Integrating information from highway case law into low-volume-road decisionmaking offers the potential to reduce liability risk and to provide safer roads. Two types of analyses were conducted: a quantitative analysis of seven years of data from the West Virginia Court of Claims and a qualitative analysis of more than 50 years of appellate court decisions from the South Eastern Reporter for the southern Appalachian region. The case law provided valuable insight into problems on low-volume roads. Relevant claims were classified into one of seven categories: construction signs, traffic-control devices, holes in roadways, wet and slippery roads, bridges, impassable roads, and maintenance activities. The types of claims encountered on low-volume roads followed the same pattern as those on other functional classes of road. However, certain claims on low-volume roads were overrepresented with respect to the amount of travel occurring on them. For example, of all claims involving traffic-control devices, one-third occurred on low-volume roads. Holes in roadways and bridges and impassable roads were the leading causes of claims on low-volume roads. It was concluded that highway agencies could reduce their liability risk through judicious use of case law in conjunction with standard procedures such as record-keeping and warning systems.**

The increased amount of litigation in every area of society has been a cause of concern to highway engineers, who may be liable for accidents attributable to a deficiency in highway design or operation. Low-volume roads appear particularly susceptible to lawsuits since they typically are constructed to lower standards than high-volume routes and, because of the magnitude of the system, funding levels are not adequate to deal with problem locations. In view of the limited resources available, it is important that funds for corrective action be spent where they will do the most good. This can be difficult on low-volume roads since accident records normally are not sufficient to identify problem locations.

Much of the concern that exists about lawsuits is unjustified and is due to a lack of reliable information on road liability law. Many times, the information the engineer receives comes from the news media, which may cite an unusual or spectacular case and omit important details. Such a single decision involves only one facet of a problem; focusing on one decision may lead to an erroneous impression about highway law. To manage highway systems effectively, individual court cases need to be put into a broader perspective.

The existing situation presents a number of problems. Engineers may concentrate on roadway improvements that are helpful in avoiding lawsuits but that have little safety benefit. Likewise, engineers sometimes hesitate about making improvements at a particular location, fearing that this will be an admission of unsafe conditions. In still other cases, misunderstandings about liability may lead to a "cookbook" reliance on standards and guidelines instead of development of creative and imaginative solutions to traffic safety problems. It is important to note at this point that the legal duty to provide reasonably safe roads is really the same objective as that desired by engineers. The problem is to maximize safety while at the same time minimize liability potential.

One way to reduce the liability risk and provide safer roads is to integrate information from highway case law into decisionmaking about low-volume roads. An analysis of legal cases can help identify common types of low-volume road safety problems and where they are most likely to exist.

The study described here reviewed the circumstances presented in published court decisions involving low-volume roads in West Virginia and was supplemented by similar information from surrounding states. Two types of analyses were conducted: a quantitative analysis of seven years of data from the West Virginia Court of Claims and a qualitative analysis of more than 50 years of appellate court decisions from the South Eastern Reporter for the southern Appalachian region of the United States. Cases that could be attributed to a highway deficiency were studied to detect trends, patterns, and characteristics in the accidents that led to the lawsuits. Claims characteristic of low-volume roads were compared with those of other road functional classes.

## BACKGROUND

There have been a number of recent articles in the traffic engineering literature offering suggestions on how engineers can reduce the risk of tort liability. A few of these (1,2) have dealt with the special problems of low-volume roads. Most of the literature is based on the experiences and opinions of the writers as opposed to formal research or data collection on the topic.

Carstens (3) performed one of the few quantitative studies of liability relative to traffic engineers. He used a questionnaire and personal interviews with county engineers to determine the magnitude and type of highway-related tort claims that were filed against counties in Iowa. Carstens pointed out those features of the road system that