A Primer on the Clear Zone

DANIEL S. TURNER

This paper is intended to serve as an introductory guide for those who want to become familiar with the clear zone concept. A design engineer might find this document a good way to gain proficiency, or a transportation agency might consider it to be the first step toward developing its own clear zone policy. The clear zone philosophy has been defined at the federal level, but practicing engineers at the state or especially the local level have not fully grasped the procedure. One reason is that engineering judgment is required for virtually every application at virtually every site. Design concepts and applications for treatment of specific fixed hazards have developed on a number of fronts. For example, AASHTO has at least 10 separate publications. The local engineer may not be aware of where to obtain the appropriate design guidance before addressing each site. In addition, difficult decisions must be made about funding priorities and timetables. This document presents a brief synopsis of roadside clear zone topics. It condenses and sets forth the overriding principles, and gives several general example applications that should prove useful to the practicing engineer.

One state transportation agency defines the clear zone as follows *(1)*:

> Clear Zone—The policy employed by the Department to increase safety, improve traffic operations, and enhance the appearance of highways by designing, constructing and maintaining highway roadsides as wide, flat and rounded as practical and as free as practical from physical obstructions above the ground, such as trees, drainage structures, massive sign supports, utility poles and other ground-mounted obstructions.

The basic premise is that a vehicle that strays from the roadway might be able to recover and return to the travelway if it does not encounter obstacles during the recovery maneuver.

This paper presents a brief synopsis of current clear zone topics. It condenses and sets forth the overriding principles and gives several example applications. It might be considered as a primer for an engineer interested in becoming familiar with the clear zone concept, or as a first step for an agency interested in developing its own clear zone policy.

Several independent research projects between 1940 and 1966 identified a relationship between roadway safety and the width of the clear zone *(2–4)*. The general relationship is a second-order curve, as shown by Figure 1. This information was used by a special committee of AASHTO (originally AASHO) to draw conclusions about safety aspects of the roadside, which were released in the 1967 AASHO publication, *Highway Design and Operational Practices Related to Highway Safety* (the Yellow Book) *(5)*. This document was formally adopted by AASHTO as a guide for the states.

The Yellow Book indicated,

> For adequate safety, it is desirable to provide an unencumbered recovery area up to 30 feet from the edge of the traveled way; studies have shown that about 80% of the vehicles in run-off-road accidents did not travel beyond this limit.

The committee recognized the impossibility of including a 30-ft clear zone on both sides of all streets, and outlined acceptable alternative safety treatments including breakaway devices, barriers, and vehicular guardrails *(2)*.

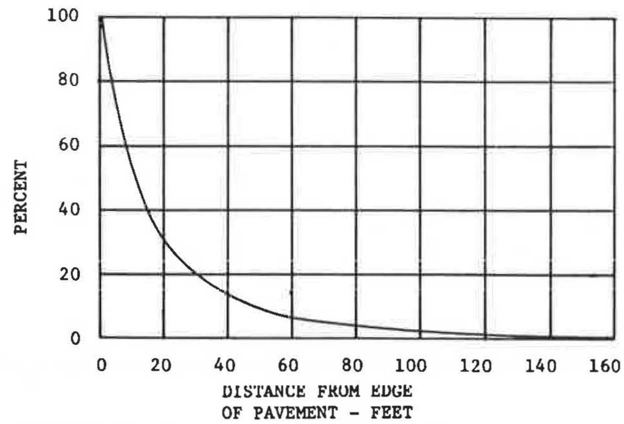

FIGURE 1 General relationship for distribution of accidents in clear zone.

The original clear zone concept was created for a straight, flat roadway section with level or nearly level roadside slopes. These conditions are not always present. Several examples will illustrate how the clear zone must be modified in the absence of optimum conditions.

Front slopes require greater clear widths because a vehicle on them is traveling downhill and requires more distance to stop or maneuver. Likewise, high-speed vehicles, sharp horizontal curves, nontraversable drainage ditches, and similar situations require greater width recovery areas.

By the early 1970s, it was apparent that the 30-ft clear zone was excessive in some instances and too narrow in others. The AASHTO publication *A Guide for Selecting, Locating and Designing Traffic Barriers (6)* included a section that modified the basic 30-ft concept to recognize geometric and side slope conditions. Additional modifications have been prepared since then *(7)*. A thorough treatment of these modifications may be found in the technical literature *(2, 6, 8)*. Tables, charts, and figures are available in these references to allow selection of the appropriate clear zone treatment for each site.

FIXED OBJECTS

Fixed objects in the clear zone represent potential hazards to motorists. Typical fixed objects include mailboxes, utility

The University of Alabama, P.O. Box 1468, Tuscaloosa, Ala. 35487.

poles, signs, trees, bridge wingwalls, and many others. It is irrational to believe that these objects could always be removed from the clear zone; alternative treatments are necessary in many cases *(2)*.

General Treatment Procedures for Fixed Objects

In treating fixed objects, engineers have developed the following sequence of actions *(2, 6, 9)*:

1. Remove the object,
2. Relocate the object,
3. Make the object breakaway, or
4. Protect the vehicle from hitting the object.

The preferred order of consideration is the sequence shown in this list. If practical, objects should be removed. Typically this involves actions such as conducting a survey to identify unneeded signs and removing them. Other fixed objects should be treated in the same manner. When fixed objects cannot be removed, they may be relocated as far from the roadway as possible. Signs and utilities may be moved near the right-of-way or placed behind existing barriers. In general, relocated objects should be placed where there is a low probability of their being hit.

When objects cannot be relocated, they may be made breakaway by using small support posts that yield or bend when vehicles strike them. Larger posts may be equipped with a special hinge or slip-plate feature that allows them to break away.

If none of the three previous steps is practical, then protective devices may be employed to redirect errant vehicles or to cushion vehicles during a crash. These devices should not be used indiscriminately. They must be designed to fit each site and they must be carefully maintained to ensure that they will work.

The decision concerning which action may be appropriate is site specific *(9)*. It is difficult to say that certain objects should always be removed or relocated or that crash cushions should always be installed at certain locations. These decisions are site specific and discretionary in nature. They require an engineering examination of each object or location to determine the appropriate treatment.

Sample Recommended Horizontal Clearances

The design criteria and guidelines of the 1984 AASHTO Greenbook *(10)* reflect wider, straighter, and flatter roadways, more recovery area, and greater built-in factors of safety than those contained in previous AASHTO documents. These new criteria are not meant to be all encompassing and absolute *(11)*. The foreword to the Greenbook states,

> The intent of this policy is to provide guidance to the designer by referencing a recommended range of values for critical dimensions.

It does not present a series of precise roadway design standards; instead, it is a set of design guidelines that recommend various ranges of values for consideration in design.

The 1984 AASHTO Greenbook provides basic statements of recommended clearances to general fixed objects, which are listed in Table 1. The clear zone width was found to be highly dependent upon the type of street and the speed of traffic, ranging from a minimum of 1.5 ft to a maximum of 30 ft or more.

In addition to the general clearance widths suggested in the Greenbook, individual guidance has been developed for several specific fixed objects. The list of typical objects addressed herein should be considered as illustrative and not all inclusive. In the same vein, the reader should obtain and use the referenced materials to obtain detailed design data, rather than depend completely upon the condensations in the following paragraphs.

Mailboxes

Mailboxes are found along most streets and highways, and are a seemingly harmless part of everyday life. Motorists would do well to remember that when a vehicle strikes a mailbox at 55 mph, it could be exactly the same as having a mailbox shot through the windshield at them at 55 mph. From 1980 to 1982, mailbox collisions killed 61 motorists and injured 1,570 people in Texas. National estimates suggest that there may be as many as 700 mailbox-caused deaths each year *(12)*.

Mailbox accidents occur for a number of reasons *(10)*. The boxes may be located so that vehicles have to stop on the travelway to use them. Sight distance may be insufficient for approaching vehicles to see the mailbox owner in time to avoid collision. The boxes may be so large or so rigid that they are substantial fixed objects that cause great damage to vehicles that strike them. On the other hand, they may be so fragile that they shatter upon impact to become lethal flying hazards.

AASHTO has recently adopted a guide for mailboxes *(13)*. The following items have been summarized from this booklet:

A. Control Regulations

If an ordinance is enacted for mailboxes, the following points should be considered:

1. Reference to appropriate local or state statutes,
2. Statement requiring conformance with U.S. Postal Service requirements,
3. Statement requiring conformance with transportation agency, policy for location and structure of mailboxes,
4. How and where to obtain copies of transportation agency policy statement,
5. How to obtain permits (if required),
6. How exceptions may be obtained,
7. Responsibilities of transportation agency and postal patrons for new installations, and
8. Responsibilities of transportation agency and postal patrons for identifying and removing existing unsafe installations.

B. Box Location and Mail Stop Design

General principles of safety should be followed in setting locations. For example, boxes should be allowed only on the

TABLE 1 SELECTED GREENBOOK HORIZONTAL CLEARANCES

Type Facility	Horizontal Clearance	References in Green Book
1. Fixed Objects or Non Traversable Slopes in the Clear Zone	Design tables & charts in "AASHTO Guide for Selecting, Locating and Designing Traffic Barriers" (6), where feasible	page 539
2. Freeways, Rural Arterials, & High Speed Rural Collectors	Zone width related to speed, embankment slope and curvature. See Reference (6), for design details	page 371
3. Low-Speed Rural Collectors & Rural Local Roads	10' minimum	page 371
4. Urban Arterials, Collectors & Local Streets:		
A. With Curb	Min 1.5' behind face of curb	page 371
B. No Curb, But Paved Shoulder	Use commensurate rural clearances	page 371
5. Urban Arterials, Curbed Street	Min 1.5' behind curb, 3.0' desirable (particularly near turning radii)	page 577-8
6. Rural Collector with Design Speed:		
A. At or Below 40 MPH	Min 10' from edge of through-traffic lane	page 516
B. At or Above 50 MPH	Full treatment of Reference (6)	page 517
C. Between 40 & 50 MPH	"B" conditions desirable, "A" conditions permissible under some circumstances	page 517

right side of the road so that drivers don't have to cross over and face opposing traffic to pick up their mail. Placement of mailboxes should be avoided if possible on high-volume, high-speed roadways. Table 2 contains a summary of recommended lateral clearances for mailbox installations.

C. Mailbox and Support Design

All exposed mailboxes should be firmly attached to supports that yield or break away safely if struck by a vehicle. General criteria can be summarized as follows:

- Mailbox supports should be no more substantial than required to resist service loads and wind loads and minimize vandalism. Nominal 4- × 4-in. or 4-in.-diameter wood posts, or 1½-in.-diameter standard pipe posts are the maximum strength supports that should be considered.
- Mailbox-to-post attachments should be strong enough to prevent mailboxes from separating from their supports under vehicle impact.
- Multiple mailbox installations must meet the same criteria as single mailbox installations. This requirement precludes the use of a heavy horizontal support member that could pierce a vehicle and impale the occupants.

TABLE 2 SUGGESTED MAILBOX CLEARANCES *(14)*

Highway Type and Traffic Conditions	Width of All-Weather Surface of Turnout or Available Shoulder at Mailbox (Feet)		Distance Roadside Face of Mailbox is to be Offset Behind Edge of Turnout or Usable Shoulder (Inches)	
	Preferred	Minimum	Preferred	Minimum
Rural highway ADT over 10,000 vpd	Over 12	12	8 to 12	0
Rural highway ADT=1,500-10,000 vpd	12	10	8 to 12	0
Rural highway ADT=100-1,500 vpd	10	8	8 to 12	0
Rural road ADT under 100 vpd	8	6	8 to 12	0
Rural road ADT under 50 vpd Speed=40 mph or less	6	2	8 to 12	0
Residential street without curb or all weather shoulder	6	0	8 to 12	8
Curbed residential street	NA	NA	8 to 12 Behind Traffic Face of Curb	6 Behind Traffic Face of Curb

Trees

Trees must be regarded as fixed objects, but they also deserve consideration beyond that given to other objects. The 1984 AASHTO Greenbook has an interesting comment about trees adjacent to the travelway.

> Other roadside obstacles such as trees that might seriously damage out-of-control vehicles should be removed from the roadside wherever feasible. However, the potential benefits from the removal should be weighed against the adverse effects that their removal may have on the roadside environment, and they should be removed only when necessary for reasons of safety *(10)*.

Therefore, trees located near the edge of the travelway do not necessarily have to be removed. Engineering judgment that considers traffic safety and the potential for accidents should prevail in making a decision to retain or remove them *(9)*.

One important use of trees is in landscaping. In essence, trees may provide (a) vegetation that will be an aid to aesthetics and safety, (b) vegetation that will aid in lowering construction and maintenance costs, and (c) vegetation that creates interest, usefulness, and beauty for the pleasure and satisfaction of the traveling public *(14)*.

The hazard associated with large trees cannot be dismissed. They are nonyielding and can cause great damage to errant vehicles. On the other hand, small trees may yield and let vehicles override them. There is no certain size of trunk diameter less than which trees are safe and greater than which they are not. Unfortunately, a small tree that may be quite safe at the present may be unsafe in the future, growing into a relatively large object in a few years.

In research in Michigan *(15)*, it was noted that fatal accidents involving trees were most prevalent on the outside of curves on rural, local roads. A series of guidelines was therefore developed for identifying locations where trees should be treated and for choosing appropriate treatments.

In summary, there are no mandatory rules that govern allowable tree sizes and locations within the clear zone, though Michigan has now developed guidance material. Trees must be regarded as fixed objects, and are subject to the clear zone treatments recommended by AASHTO *(6)*; however, small trunk diameters, limber trunks, and aesthetic considerations merit extra consideration and use of engineering judgment in selecting treatment.

Luminaries

Street lighting is normally concentrated along high-volume roads or at congested intersections. Unfortunately, these conditions that most deserve lighting are the locations that usually experience the highest traffic accident rates. AASHTO has published a special booklet *(16)* to ensure that light poles are made breakaway or that they are placed where they are not likely to be hit. The locations of lighting supports should included safety considerations directed at minimizing the probability of their being struck by vehicles. Their locations should generally adhere to the following guidelines:

1. When possible, they should be placed behind guardrails, on retaining walls, or on bridge walls, or out of the likely path of an out-of-control vehicle. Otherwise, breakaway or yielding supports should be used.
2. Overhead sign supports should be placed as far as feasible from the edge of the traveled way (30 ft desirable).
3. The clearance to a support shall be at least 2 ft beyond the face of unmountable curb or at least 2 ft beyond the edge of the usable shoulder.
4. Supports placed on structures should be outside the railing and away from traffic. Continuity of the railing on the structure should not be interrupted. When the railing is built with a curb, the support may be placed no nearer than 2 ft from the face of the curb.
5. Supports should not be located in the gore unless they are of the breakaway type.
6. Breakaway support footings should not extend above the ground level enough to increase the hazard.
7. Supports behind guardrail must provide clearance between the back of the rail and the face of the support to ensure that the rail will deflect properly.
8. Generally, breakaway or frangible supports should be provided whenever the support is exposed to traffic.

In addition to location and breakaway considerations, aesthetics must be considered. Simple, clean lines are desirable. Many functions (signs, street lights, and so forth) may be grouped on one pole to cut down on ground clutter and to eliminate additional poles that may be hazards to vehicles.

Utilities

More than 4,400 fatal accidents involving utility poles occurred between 1975 and 1977 *(17)*. There were 2,343 deaths in 1983 in which the most harmful event was a collision with a utility pole. Furthermore, Texas data suggest a 45-to-1 ratio for injuries to fatalities for these types of collision. This ratio translates into 125,000 injuries per year on a national basis.

In addition, utility poles have become frequent topics for tort liability actions *(18, 19)*. One source offers the following guidance *(20)*:

> Generally speaking, the liability of the owner of the pole and, vicariously, of the municipality which authorized its placement, depends upon whether the pole is located so close to the highway as to constitute a dangerous obstruction to motorists. . .
>
> It should make no difference whether the pole is in the public right of way or on private land. . . . Occupiers of land abutting a highway must use reasonable care to assure the safety of those using the highway, a duty which has been extended to those who stray from the highway inadvertently. . .
>
> Governments, as well as private parties, are liable for public nuisances which endanger travelers. First, they may be liable for failing to order private parties to remove privately owned public nuisances. Secondly, governmental bodies are liable for their own public nuisances. The general rule is that any artificial device, structure, or excavation adjacent to a highway which poses a threat of injury to travelers can be considered a public nuisance. . .

Improperly designed, located, or installed utilities may lead to accidents and liability. AASHTO has addressed location, design, and safety aspects, and has developed two guideline publications *(21, 22)*. Major points from these texts are as follows:

General Utility Locations

1. Utility lines should be located to minimize need for later relocation and to permit servicing.
2. Longitudinal installation should be located as near as practicable to the right-of-way line.
3. Utility lines should cross the highway perpendicular to the centerline.
4. The location of utility lines should conform with the clear zone policies applicable for the type of highway and specific local conditions involved.
5. Consideration should be given (reflecting sound engineering principles and economic factors) to preserving and protecting highway traffic, maintenance efficiency, and integrity of the highway.
6. Location of utility installations on urban streets with closely abutting improvements are special cases.

At least one state has expanded the AASHTO reports into a table of approved clearances, as shown in Table 3. AASHTO guidance recognizes that narrow or irregular rights-of-way and urban streets are special cases. For these conditions, the utility location may be altered to recognize the limitations.

Traffic Control Devices

Signposts and signal support posts pose the same type of hazard as utility or luminary poles, and they are subject to clear zone types of treatment *(16, 23)*. To ensure that supports are placed a reasonable distance from the travelway, guidance has been included in several manuals *(24, 25)*.

Sign Supports

The following guidelines represent typical traffic signpost information *(24)*:

TABLE 3 LOCATIONS FOR ABOVE-GROUND UTILITY APPURTENANCES AS APPROVED BY ONE STATE *(1)*

ROAD TYPE	EDGE CONDITION	CLEARANCE
Other Than Freeways, Design Speed 50 MPH or More	With Shoulders	Min. 30' from Edge of Traveled Way
	Curb & Gutter, Without Parking Lane	Min. 6' Back of Face of Curb
	Curb & Gutter, With Parking Lane Adjacent to Curb	Min. 2' Back of Face of Curb
Highways With Design Speed Less Than 50 MPH	With Shoulders	Min. 20' from Edge of Traveled Way
	Curb & Gutter, Without Parking Lane	Min. 6' Back of Face of Curb
	Curb & Gutter With Parking Lane Adjacent to Curb	Min. 2' Back of Face of Curb

> Signs should have the maximum practical lateral clearance from the edge of the traveled way . . . Advantage should be taken of existing guardrail, overcrossing structures and other conditions to minimize the exposure of sign supports to traffic. Otherwise, breakaway or yielding supports should be used . . . In urban areas a lesser clearance may be used where necessary. Although two feet is recommended as a working urban minimum, a clearance of one foot from the curb face is permissible where sidewalk width is limited or where existing poles are close to the curb.
>
> The minimum clearance outside the usable shoulder for expressway signs . . . should be six feet . . . . Large guide signs especially should be further removed, preferably 30′ or more to the nearest traffic lane. . .

It is desirable, where existing supports are available, to affix signs and other traffic control devices to them because: (a) one less post, a fixed hazard, is located in the clear zone, (b) the existing pole may be more visible if a new, reflective sign is affixed to it, and (c) it is easier to mow the clear zone if there are fewer poles.

Traffic Signals

In the interest of safety, signal supports and controller cabinets should be placed as far as practicable from the edge of the traveled way without adversely affecting signal visibility *(24, 25)*:

> Supports at a street with curbs shall have a horizontal clearance not less than two feet from the face of the curb. Where there is no curb, supports shall have a horizontal clearance not less than two feet from the edge of a shoulder, within the limits of normal vertical clearance.
>
> No part of a concrete base for a signal support should extend more than four inches above the ground level at any point. . .
>
> On medians, the above minimum clearances for signal supports should be obtained where practicable. Any supports which cannot be located with the required clearances should be of the breakaway type or should be guarded if at all practical.

Drainage Features and Facilities

The clear zone concept implies that the roadside should be as wide and flat as possible, and should be as free as possible from fixed objects. This includes front slopes and ditches, drainage pipes, inlets, headwalls, and other appurtenances. The effects of the front slope have been outlined previously in this report, are documented elsewhere *(6)*, and will not be repeated here.

Ditches parallel to the roadway can trap out-of-control vehicles and cause them to overturn or to skid extended distances within the confines of the ditch. Ditches perpendicular to the roadway can cause a jolt to errant autos, can cause them to become airborne, or can cause the driver to lose control.

Ditches

A special NCHRP study was conducted to assess the ability of vehicles to traverse various ditch shapes and sizes *(26, 27)*. Four shapes were tested: vee, rounded, trapezoidal, and rounded-trapezoidal. A summary of these tests is contained in FHWA Technology Sharing Report 80-228 *(2)*.

The results of the studies are presented in the AASHTO *Guide for Selecting, Locating and Designing Traffic Barriers* *(6)* as a series of charts, figures, and curves. This material provides the design engineer with guidance for selection of traversable slope combinations and ditch shapes under high speed and steep angle of encroachment conditions such as might be encountered on high-speed facilities.

Drainage Structures

The principal function of the drainage structure is to remove water from the roadway area, but safety considerations may necessitate some level of compromise. Good practice requires consideration of both hydraulics and safety, in the following order of priority *(2)*:

1. Unnecessary drainage structures should be eliminated.
2. Necessary drainage structures should be located so that they create the least reasonable hazard.
3. Structures that cannot be eliminated should be designed to inflict minimum damage.
4. Where the first three objectives cannot be feasibly accomplished, a traffic barrier may be needed.

Treatment of Drainage Pipe Ends

The end of the drainage pipe can be a serious hazard when located within the clear zone. Out-of-control vehicles sliding along a ditch might coast to a safe stop if there were no protruding pipe ends. Where drainage pipes are perpendicular to the traffic lane, the vehicle may snag and spin out, or overturn. The pipe end or headwall should be flush with the side slope to minimize collision damage. When pipes of more than 30 in. diameter are used, a grate should be provided over the pipe opening.

Pipes parallel to the roadway pose a similar threat. For example, where a driveway joins the main road, a pipe under the driveway is parallel to the main road and offers a blunt surface to a trapped car sliding along the ditch. It is desirable to slope the headwall to match the driveway slope, and to place bars over pipe openings greater than 30 in. to ramp the vehicle over the pipe end.

Treatment of Culvert Headwalls

Culvert headwalls located on the face of a side slope are safest when they conform to the slope. When the resulting opening exceeds 30 in., a grate system with clear openings less than 30 in. should be provided. Generally, a 3-in. steel pipe grate is adequate for this purpose. Grates with these basic dimensions are hydraulically efficient and functionally safe *(8)*.

Roadside Barrier (Guardrail)

A clear, unobstructed, flat roadside is highly desirable. When these conditions cannot be met, there is a need to treat or shield roadside objects. If it is not feasible to remove or relocate a hazard, then a barrier may be necessary. However, a barrier should be installed only if it is clear that the barrier offers the least hazard potential *(6)*. The installation of a roadside barrier is actually the installation of a fixed object to protect a vehicle from hitting another fixed object. It should be installed only if the severity of a collision with the barrier is much lower than the severity of a collision with the fixed object that it is designed to shield *(9)*.

Barrier warrants for roadside obstacles are a function of the nature of the obstacle and its distance from the edge of the traveled way. These warrants are carefully spelled out in the AASHTO *Guide for Selecting, Locating and Designing Traffic Barriers (6)*. A series of design charts and tables cover situations such as high embankments, rounding of slopes, degree of curvature, nontraversable hazards, and other categories. A methodology is outlined whereby appropriate and nonappropriate barrier use may be determined.

Other Fixed Objects

The preceding discussion has been devoted to specific standards for typical fixed objects found within the roadside clear zone. The objects so outlined were not intended to compose an exhaustive list, but to illustrate treatments for some of the most common types of roadside hardware.

Many more fixed objects may be noted on a casual drive on any local road. For example, large rocks and boulders are sometimes used in aesthetic arrangements alongside the road. Beautification projects may depend upon large brick planters for their visual appeal. Subdivision developers are prone to build ornate signs or massive columns to distinguish the entrance to their subdivision.

In all of the examples outlined, and for many similar locations all across the country, the objects represent fixed hazards. They must be addressed and treated within the clear zone concept. Each site and each object is unique. Each must be examined to determine the appropriate treatment within the limitations of motorist safety, and for the transportation agency's time, manpower, and money.

IMPLEMENTATION PROCEDURE

A policy that calls for a perfect clear zone is an idealized situation. Faced with the realities of current government, roads constructed to old (or no) standards, insufficient manpower and funding, and other limitations, it is not always possible to remove or relocate fixed objects. Even the AASHTO select committee that established the clear zone concept recognized these limitations and established alternative treatments. Each transportation agency must examine its own roadways, then decide the appropriate type of treatment at locations throughout its jurisdiction.

Procedures for the Future

Obviously, it would be self-defeating to correct current deficiencies without establishing a methodology to prevent their recurrence. The first order of business should be the preparation and adoption of statutes, ordinances, standards, and operating policies to fit the local jurisdiction and to minimize future violations of the clear zone. Sufficient information has been outlined in this report to guide in preparation of many of these ordinances and policies.

Actions for the Present

The most difficult part of developing an effective policy is determining how to treat existing deficiencies. It is important to concentrate first upon those areas of the most public accident exposure. Establishing and following a priority system is also essential.

1. Concentrate first upon known conditions of high hazard, using historical accident data.
2. The second step should be to develop a strategy to inventory roadsides throughout the agency's jurisdiction.
3. An inventory should then be conducted, using trained personnel to catalog existing fixed objects.
4. Appropriate treatments should be identified for all fixed objects and locations identified during the inventory.
5. Priorities should be established for correcting difficult situations. Budgets should be prepared and funding identified. It will take many years to treat all objects in the clear zone, and a priority list is essential to ensure that the most worthy locations are addressed first.
6. Where necessary, the public should be warned until the location can be treated.

SUMMARY

This paper has attempted to outline the clear roadside concept and to address specific treatment for several of the most prominent obstacles. A thorough treatise has not been possible due to space limitations; however, a major theme should have become obvious to the reader. To the extent practical, the transportation agency should adopt a philosophy that allows errant motorists to recover and return to the pavement, or to minimize damage upon unavoidable impact. This policy takes a substantial commitment of time, money, and other resources.

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DISCUSSION

DUANE F. DUNLAP AND LAURA M. MERRIHEW
Cnawlaecan, Inc., 204 East Church St., Adrian, Mich. 49221.

One would gather from Professor Turner's paper that the clear zone philosophy would lead to safe roadsides. This has not proven to be the case. Unfortunately, the ideas that were developed and implemented at the General Motors Proving Ground in the 1950s have been modified and watered down to the extent that the concept of safety has been replaced with one of, to quote Professor Turner, "as practical."

The clear zone concept resulted from the concerns of safety engineers for providing a safe working environment for test drivers on the Proving Ground road system *(1)*. In considering the situation, General Motors faced the financial trade-off of paying for the cost of accidents in the form of lost work days, worker compensation, lost vehicle investment, and so forth, or improving the Proving Ground road system to make it as safe as an industrial factory. The choice was for the latter and the results were spectacular. In a 6-year study of accidents prior to implementing the clear zone concept, some 64 man-days were lost due to test driver injury. In the 6 years following the clearing and flattening of the roadsides, not a single day was lost due to injury from a vehicle accident *(2)*.

When the clear zone concept was implemented at the Proving Ground some 30 years ago, the standard for the roadside was as follows *(3)*:

> Where reasonably high speed may be anticipated, above 35 to 40 mph, the roadside will be clear of obstacles including drainage structures for 100 ft from the edge of the road.

When this standard is compared with the *Guide for Selecting, Locating and Designing Traffic Barriers (4)* and its supplement *(5)*, which, as Professor Turner notes, is the basis for present-day clear zone recommended practice, the result for a straight road with a flat roadside is as follows:

Operating Speed (mph)	*Clear Zone (ft)*
40	15
50	20
60	30
70	35

Clearly, we've come a long way in removing the "excessive" features from the clear zone requirements, to quote Professor Turner. What has been the consequence of this national policy on clear zone requirements? Statistics show that 32.8 percent of the fatal accidents occurring in Michigan in 1971 resulted from striking fixed objects, whereas the same statistic in 1984 was 32.2 percent *(6, 7)*. National statistics are similar *(8)*. Clearly, there has been no discernable progress. If accident statistics are unchanged, then what has occurred in the interim that would justify the reduction in the clear zone requirements? The answer is nothing.

Consider Figure 1 of Professor Turner's paper. *Technology Sharing Report 80-228*, published in 1980, is cited as the source for this figure. The figure, however, was originally published in 1961 *(9)*. The sample of 82 cases studied was not chosen randomly, but represents personal injury accidents for which an in-depth study was undertaken. In all these accidents, the lateral movement of the vehicle was limited because the vehicle ran into an obstacle. In referring to this figure, Kenneth Stonex *(10)* stated:

> This curve is of limited significance. It describes the roadside deficiencies in terms of specific obstacles at the distance noted, and gives no indication of the obstacle-free clearance which is required.

As another example, consider Figure A of this discussion [also Figure VII-C-5 of the AASHTO *Guide for Selecting, Locating and Designing Traffic Barriers (4)*]. The source for this figure is cited as *NCHRP Report 148 (11)*. Reference to that document, however, shows that the source for Figure A is the encroachment study that was published in 1966 *(12)*. Nowhere in this latter study, however, is there a figure like Figure 2. The published graphical data in fact are only divided highways with 40-ft medians, that is, the maximum extent of encroachment observed was 40 ft. Figure 2, therefore, is a mystery. What Figure A shows is that the probability of a vehicle's going beyond 50 ft from the road edge is zero. In other words, excursions beyond 50 ft from the road edge do not occur. This is clearly preposterous. Data collected at the General Motors Proving Ground show excursions all the way to 160 ft (see Figure 3) *(2)*. Further, these data do not include cases where the errant vehicle has been stopped by hitting an obstacle. To this day, they remain the best and only field data suitable for determining clear zone widths.

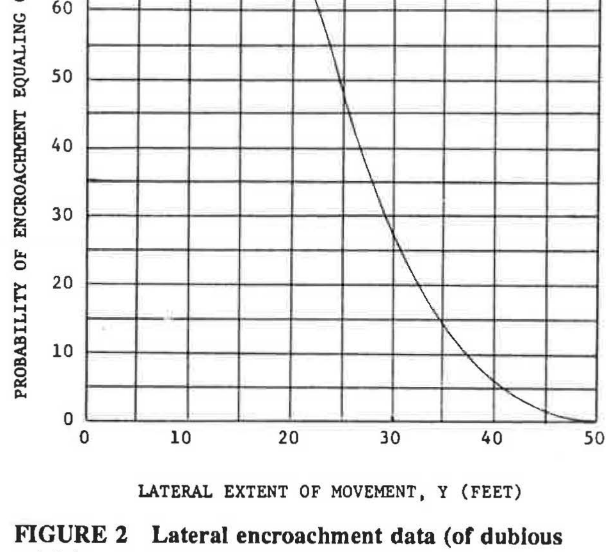

FIGURE 2 Lateral encroachment data (of dubious origin).

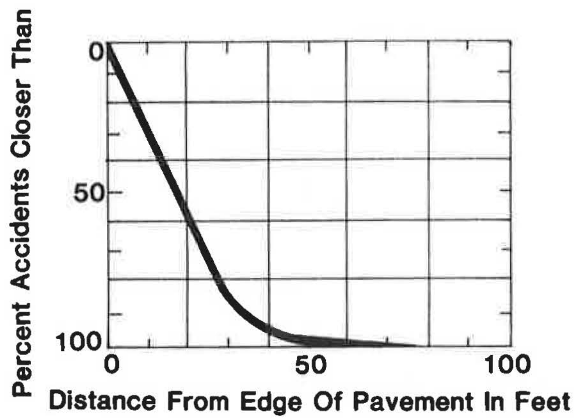

FIGURE 3 General Motors Proving Ground data from the 1950s.

It should be understood that, unlike General Motors, the public agencies responsible for roadways are generally not required to pay both for the costs of accidents and for providing a safe roadway, except, perhaps, as a defendant in a lawsuit. There is a natural tendency, then, toward inaction in connection with safety. Similarly, there is a tendency to develop standards and policies that can be used as a defense for inaction. It must be concluded that the present inadequate requirements for clear zone widths are a result.

As to the practicality of clearing and flattening the roadsides, one is reminded of what is happening in rural Lenawee County, Michigan. Ditches are being filled in and trees are being cut down along back country roads to create more farm land. Farmers are doing this because there is an economic incentive to do so. The by-product of a flat, clear roadside is an unintended bonus, but one that is virtually cost-free to the public. When a buck can be made, a lot of things are practical.

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