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Deferred Maintenance

MARION F. CREECH

This study investigated deferred maintenance as it concerned roadside vegetation control and drainage. It was also designed to develop the basis for a deferred maintenance program. Field work revealed that vegetation growth control, especially mowing, was being sharply reduced and that most states visited were rewriting their standards to reflect this. Maintenance deferral for drainage facilities, which are less visible, was even more dramatic; maintenance was performed on an as-needed basis, in many cases only when some catastrophic event such as flooding occurred. Major consequences of deferred maintenance were considered in relation to safety, condition of facilities, liability, social and environmental effects, and level of service. A methodology for developing a deferred maintenance program was formulated. This method, which consists of five discrete steps, has the potential to allow selection of maintenance activities to be deferred and determination of the deferment period that has a minimum of risk.

Deferred maintenance is a subject of much interest and concern to many transportation officials. In this time of shrinking revenues, almost runaway inflation, the unknown future energy situation, and environmental restraints, it becomes clear that there will not be enough maintenance dollars to go around. This simply means that some types of maintenance activities performed in the past on a regular basis will have to be deferred or put off completely. Decisions about which activities to defer and the length of deferment are of prime importance. The questions that must always be asked are, If a certain activity is deferred, what are the consequences it will have on the particular element of the highway with which it is associated and what consequences will it have on the overall integrity of the road?

OBJECTIVES OF THE STUDY

This research project was initiated to investigate the feasibility of deferring the maintenance activities of roadside vegetation control and the cleaning and repair of drainage facilities. A second objective was the formulation of a method for developing a deferred maintenance program by using the information uncovered in the investigation.

After such information as was available had been collected and studied, the expectation was that the consequences of deferring maintenance could be determined or predicted in regard to safety effects, integrity of the facility, legality, effects on users, and environment.

PROBLEMS DISCOVERED IN PERFORMING THE STUDY

Several things discovered at the outset of the study made it difficult to quantify the consequences of deferring maintenance. First, the term "deferred maintenance" had never been adequately defined to my knowledge. Accepting the premise that highways, from the time of construction, begin to deteriorate from use and environmental action, then hypothetically maintenance should begin shortly after construction if a road is to be maintained in a manner to meet the American Association of State Highway and Transportation Officials (AASHTO) definition of maintenance. That definition states that highway maintenance is the "act of preserving the roadway, roadside, structures, and other facilities as nearly as possible in their as-built or subsequently improved condition and the operation of the highway facilities and services to provide safe and satisfactory highway transportation for the motoring public."

Since, from a practical standpoint, it is probably not possible to satisfy that definition of maintenance, the question arises as to when maintenance should optimally be performed and when it falls under the definition of deferred maintenance. Deferred maintenance can be defined as the postponement of maintenance beyond the time it would normally have been performed. This definition would fit very nicely if quality standards had been developed for each maintenance activity to indicate when maintenance should be done and had been subsequently adjusted by feedback to optimize the maintenance investment. This, unfortunately, is not the case.

Another very large roadblock in the study of deferred maintenance and its consequences is the record keeping by the states. In the past, maintenance people have been very interested in getting the work done but not so very interested in keeping records of what they did. This problem pointed out the need for a nationwide standardized record-keeping system. I think that initially such a system might not be popular with the rank-and-file maintenance engineer, but it is the foundation in the development of a unified maintenance program in which the levels of maintenance can be realistically set and the consequences of deferring them predicted.

FIELD STUDY

During the field studies, six states were visited (Virginia, Indiana, Louisiana, Minnesota, Wyoming, and California) and several more contacted to collect data and discuss maintenance programs in the areas of roadside vegetation and drainage facilities. Maintenance, legal, traffic, construction, administrative, and research divisions were visited in each of the six states. The actual interview-discussion was divided into two parts. The first had to do with current practice at the time of the visit and the second concerned the consequences of deferring maintenance beyond current practice for certain fixed periods.

Historical cost data were very difficult to obtain because in many cases they did not exist as written records and because in other cases they were broken into separate items such as labor, equipment, and fuel. These costs were kept in different files, which made them almost impossible to collate and combine into one cost figure.

For the deferred-maintenance portion of the interview, the responses, in all but a few instances, were subjective in nature. These opinions were derived from highway engineering experience accumulated over the years by state officials.

FINDINGS ON CURRENT PRACTICES

Deferred maintenance has been and is being practiced on many highway elements throughout the United States. In some cases, officials are not fully aware of potential consequences. Moreover, in several states that have maintenance quality standards, those standards are being rewritten and relaxed without adequate consideration of the outcome. Maintenance deferral is easily understood in light of the shortage of funds.

Roadside vegetation control was one maintenance activity for which but one of the states visited had written performance standards. Vegetation growth is controlled through a combination of mowing and use of chemical herbicides. The number of mowings performed by any one state during a season seemed to be a combination of policy and climatic conditions. The actual number of mowings ranged from a high of six per year in one state to none in another. The state that had no overall system for annual mowing did mow in areas where the restriction of sight distance was potentially hazardous.

Several of the states that had mowing standards were rewriting them in an effort to hold down increasing costs. This was done in two ways: (a) by reducing the areas mowed and (b) by reducing the number of mowings. At least two states visited were contracting part of their mowing to determine whether contracting would be cheaper than using state maintenance resources. Public acceptance of reduced-area mowing standards was good where portions of roadside that did not affect safety or the integrity of the facility were allowed to return to the natural state. Many motorists seem to like a rustic-appearing roadside. Although the acceptance of the reduction in number of mowings where the roadside is apt to take on a ragged appearance was not so positive, there were instances where this too evoked a positive response. One of these was the very positive response by the garden clubs in the Shenandoah Valley of Virginia along I-81. There are a number of early-blooming wild flowers along that route and, because mowing occurred somewhat later than in previous years, the flowers were able to come into full bloom.

Although most states did have mowing programs with fixed mowing standards, this was not the case when it came to maintenance and repair of drainage facilities. Drainage facilities, which included ditches, culverts, drop inlets, and catch basins, are subject to variances in cleaning and repair thoughout the country.

Inspection routines, the key to maintaining proper drainage, varied to some degree in different areas but were characterized as follows:

1. Those elements that can be observed from the road, such as ditches, paved flumes, and certain culverts, are inspected on a continuous basis by the area superintendents on their rounds.
2. All elements are inspected after severe storms or twice annually.
3. Drainage facilities are inspected at fixed times when high levels of runoff can be predicted (for example, in Minnesota, the drainage facilities are inspected each fall before the snow season begins because the drainage facilities must operate at maximum efficiency in spring during the thaws).
4. Large structures, such as box culverts above a certain size [usually 20 ft (6 m)], are inspected at the same time as bridges.

The cleaning and repair of drainage facilities are performed on an as-needed basis and are scheduled as routine maintenance in other than emergency situations. A review of the standards shows that maintenance is necessary for ditches when water is ponding, when there are obstructions, or when the ditches have lost their cross section (emphasis is placed on ditches that have excessive silting and blocked drainage structures) and for other drainage structures whenever drainage is impaired.

Percentages of total maintenance funds allotted to clean and repair drainage facilities ranged from 3 to 14 percent in the states visited; one state (not visited) spent 19 percent of total secondary maintenance funds on drainage maintenance. In some areas, drainage facilities were cleaned only in such emergency situations as flooding, clogged ditches, plugged pipes, or stagnated water.

CONSEQUENCES OF DEFERRED MAINTENANCE

When maintenance is deferred on any highway element, it will affect not only that element but most often other elements as well, since highways are made up of integrated parts. In addition, it may have an effect on safety, both motorist and pedestrian; on the environment; on the level of service of the facility; on individuals who live near the facility (social effect); and on the liability of the administering authority.

The consequences of deferred maintenance in the majority of cases are negative. Since the potential exists that the consequences of deferred maintenance may far outweigh the savings of postponing maintenance, the following previously mentioned major consequences were examined: safety, condition of facilities, liability, social and environmental effects, and level of service.

Safety

Providing safety to the users of transportation facilities should be listed as the number one priority in any consideration of deferring maintenance activities. Dangerous conditions may arise if maintenance is not performed in a reasonable manner. In the case of reduced mowing, regardless of the allowable vegetation height, safe sight distance must be maintained. This is probably more critical now than in the past since cars are decreasing in size and, consequently, are more easily hidden. An actual example of this occurred where crimson clover had been planted in the median strip because it needed no maintenance. It grew to the unexpected height of 3 ft (0.9 m) within the median and caused blocked vision at the intersection that resulted in a collision and a fatality. The highway department of that state was held responsible in judgment for the death.

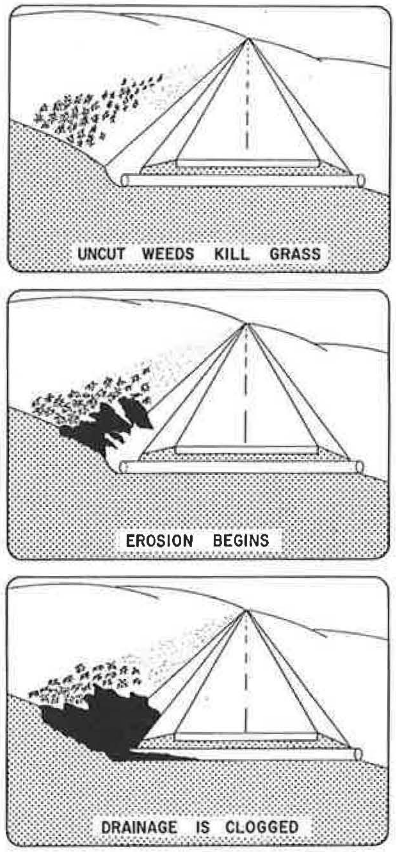
Some of the conditions that result from insufficient levels of maintenance and may produce safety hazards to motorists are reduced mowing, worn-out pavement markings, dirty or faded signs, potholes, fire, flooding, trees lying across the road, landslides, and shoulder drop-off.

Condition of Facilities

A highway begins to deteriorate through use and environmental action as soon as construction is completed. Although maintenance efforts are made to preserve or restore the road on a continuing basis to its original condition, degradation takes place. The level of maintenance to a great extent determines the rate of degradation (1).

Careful planning must be undertaken to protect the large highway investment if deferred maintenance is to be practiced. The Highway Users Federation reports that between 1914 and 1975 approximately $461 billion (excluding expenditures for right-of-way administration and maintenance) was spent by all levels of government on roads and streets. The value of roads remaining in service at the end of 1975 was approximately $262 billion (2).

Figure 1. Reduced vegetation maintenance on a highway that results in its deterioration.



Ill-advised reductions in maintenance programs can speed the deterioration of highway facilities and lead to greater costs in the long run. Figure 1 indicates one way in which maintenance deferral may cause serious roadway problems. A dense weed growth forms that is not mowed; this shades or crowds out the turf; the weeds die in the fall, exposing bare spots; and erosion sets in, which fills the drainage ditch.

In actual maintenance practice, a gradual physical deterioration of the road elements is accepted, and at intervals reconstruction is programmed. However, this is not the type of situation referred to here.

Liability

Closely related to safety are the legal aspects of postponing maintenance activities. In the past, government entities have operated under a doctrine known as sovereign immunity. Briefly, sovereign immunity is that principle that bars suit against the sovereign (here federal, state, or county government) without the sovereign's consent or permission (3). This "immunity" from legal action has been taken away over the years by the courts and legislatures to the point that in 1961 the California Supreme Court held in the case of Muskopf versus Corning Hospital District that "the rule of governmental immunity...must be discarded as both mistaken and unjust" (4).

There is a large backlog of cases pending against state transportation organizations in which sovereign immunity has been abandoned. Courts have taken a hard line on cases, and the burden of proof lies on the plaintiff. Nevertheless, some large judgments have been rendered against transportation agencies. Further, conversations with legal experts throughout the country about reduced maintenance and its legal ramifications indicate that a highway traveler, lawfully using the highway, is entitled to have that highway maintained in a reasonably safe condition.

The ultimate decision on what is reasonable and safe has often been determined by courts of law. However, there are many instances that are obviously unsafe. Some representative examples of potential state liability in case of accident that results from maintenance or lack of it are missing, deteriorated, or improper traffic control devices; blocked critical sight distance (as in the previously cited instance in which crimson clover grew to such a height that it restricted sight distance and a fatal accident resulted); drainage failure that causes flooding on a private citizen's estate; and herbicidal maintenance of highway rights-of-way (states have been found liable for the killing of crops and livestock by herbicide sprayed on the highway right-of-way).

Social Effects

The social effects stemming from highway construction and maintenance can be substantial for populations living near a road. Rough road surfaces, when run over by a car, produce distracting and disturbing noise. Transverse grooves cut into concrete pavements for skid-preventive purposes in earlier times, before random spacings were introduced, created such noise as to seriously disturb nearby dwellers. As a result of the disturbing noise produced by motor vehicles on freeways, many states in urban areas are constructing noise barriers.

In one location where mowing had been reduced and a trash receptacle was present, nearby homeowners complained that rats from the highway right-of-way were infesting the area. This is an example of an environmental consequence of poor maintenance that had negative social effects.

Any act that produces a negative social condition must be carefully considered, since there are a number of conditions that can be an outgrowth of postponing maintenance. For example, if maintenance and repair of drainage facilities is deferred, water may stagnate and produce foul odors, a breeding ground for mosquitoes, and the potential for disease.

Environmental Effects

Highways may contribute significantly to the pollution of the environment. Construction disturbs or destroys ecosystems and disrupts soil equilibrium. An imbalance is then produced that nature tries to correct. Much of the balance may be restored during construction, but this depends on the design and it is seldom complete. For this reason, it becomes a constant struggle to keep the highway facility from becoming a polluter of streams, lakes, etc., as nature seeks its balance.

Aside from the imbalances built into highways, certain maintenance activities, or their lack, may have an effect on the environment. There are many activities having to do with pavements, especially hot plant mixes of aggregates that contain asbestos minerals (serpentite), that are under scrutiny by environmental agencies. More in keeping with this study, however, are those environmental effects that occur when maintenance is deferred.

Level of Service

The level of service, according to the Highway Capacity Manual (5), denotes

> any one of an infinite number of differing combinations of operating conditions that may occur on a given lane or roadway when it is accommodating various traffic volumes. Level of service is a qualitative measure of the effect of a number of factors, which include speed and travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience, and operating costs.

Maintenance may affect the level of service in a number of ways, but anything that tends to restrict lateral clearance, such as trees or brush near the road, will adversely affect the level of service. Shoulder drop-off and surface conditions of the pavement affect the safety, comfort, and convenience of the motorists, as well as their car-operating costs.

Potholes, a pavement-surface condition caused by the failure of the subgrade, affect several level-of-service factors. They severely restrict speed, produce a potential safety hazard, reduce comfort, and cause considerable damage to motorists' vehicles.

DEFERRED MAINTENANCE: THE DECISION PROCESS

Data collected in this study indicate that transportation organizations are searching for methods of conserving funds. Maintenance is a segment of the transportation field in which large sums are expended; therefore, it is an area of potential savings. However, all maintenance activities do not carry equal weight. To lessen or discontinue maintenance on some activities would reduce a facility to the need for reconstruction in a short time, as well as create a multitude of safety hazards and other undesirable consequences; to defer maintenance on others would have lesser consequences. Some organizations are deferring certain maintenance activities (most notably mowing). Others are experimenting with deferring activities, and still others are contemplating completely discontinuing a number of activities. In some cases, the planning and projections of these actions' possible consequences were thorough and in other cases practically nonexistent.

State highway administrators often have to make decisions with a minimum of information and without a clearly defined logic to follow. Sometimes decisions made under these conditions are excellent, but the risk of a wrong decision or one with less than optimum return is great. There are many reasons for deferring maintenance. However, two of the prime reasons are (a) to save resources so they may be applied to other areas and (b) that no funds are available to perform the maintenance activity.

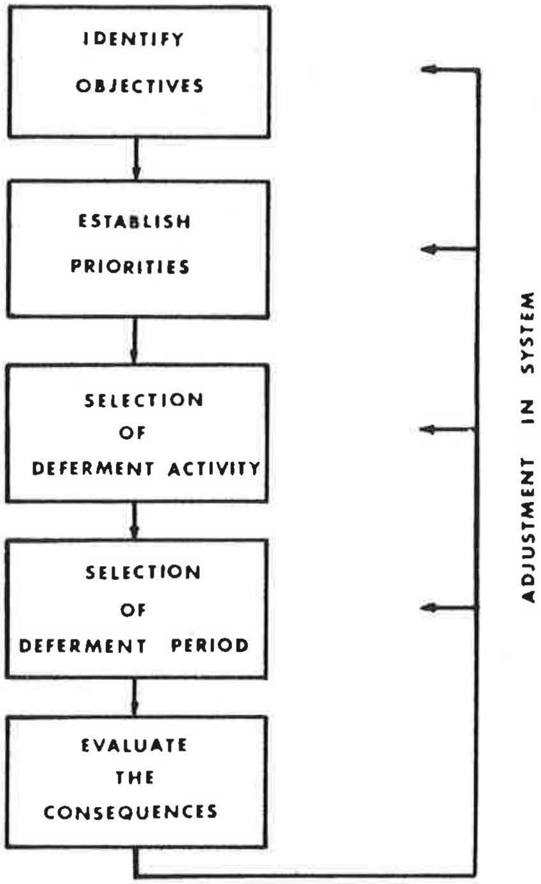
METHOD FOR DEVELOPING DEFERRED MAINTENANCE PROGRAM

The method indicated in Figure 2 was developed with the purpose of aiding maintenance managers and budget and administrative personnel in making decisions concerning deferred maintenance programs.

Step 1: Identify Maintenance Objectives

The first step in the decision process is the identification of maintenance objectives. Maintenance objectives may vary depending on the location of the road, the functional class, the average daily traffic (ADT), climatic conditions, the environment,

Figure 2. Logic in planning a deferred maintenance activity.



etc. In general terms, the maintenance objectives are those previously cited in the AASHTO definition. The validity of those objectives is well established; however, specific objectives must be fitted to the situation. Overall maintenance objectives include

1. Providing safe highway facilities (including structures),
2. Preserving the capital investment,
3. Providing adequate drainage,
4. Providing a road that is aesthetically pleasing both to the traveling public and to the residents of the abutting properties, and
5. Providing adequate levels of service.

For example, on the state level the maintenance objectives of mowing are to provide safe sight distance, provide cover for wildlife breeding, prevent the spread of noxious weeds, and provide an aesthetically pleasing appearance. The objections for cleaning and repair of drainage facilities are to protect investment, provide adequate drainage, prevent water pollution, and preserve a pleasing appearance.

<u>Step 2: Establish Priorities for Maintenance Activities</u>

The second step is to assign priorities to maintenance activities. The AASHTO operating subcommittee on maintenance suggests that maintenance priorities be adopted to direct maintenance activities toward more effective and efficient utilization of our energy resources, materials, personnel, and available funds and that a continued effort be made to provide the consistently high level of service demanded by the traveling public. In light of the objectives cited in step 1, this AASHTO subcommittee listed the following 19 items in order of decreasing priority:

1. Elimination of hazards or other conditions leading to road closure (avalanche danger, mud slides, washouts, heavy snowflow, severe icing conditions, severe bridge damage, pavement blowups, and so on);
2. Hazardous objects in roadway;
3. Repair of damaged or structurally inadequate structure;
4. Hazardous pavement conditions such as bumps, holes, slippery areas, minor heaves and blowups, or snow and ice;
5. Replacement or repair of damaged, obscured, or missing signs, signals, pavement markings, and lighting;
6. Pavement drop-off at shoulder;
7. Repair of damaged guardrail, guiderail, barricades, traffic barriers, impact attenuators, and other off-roadway safety features;
8. Repair of nonhazardous pavement deficiencies, including overlays, to preserve capital investment;
9. Maintenance of drainage features;
10. Minimal landscape maintenance to keep landscaping alive;
11. Maintenance and minor repair of signing and signals;
12. Routine maintenance and minor repair of structures;
13. Safety rest-area maintenance;
14. Mowing to maintain adequate sight distance, prevent erosion, or maintain drainage;
15. Routine maintenance of roadside features (including guardrails, fences, and so on);
16. Motorist aid patrols;
17. Roadside cleanup;
18. Mowing and other work for aesthetic purposes; and
19. Work for other agencies.

This listing makes it possible to assign maintenance activities to the objective groupings previously developed. These objective groupings may vary somewhat according to the needs of the particular organizations that use the process; however, the top two priority groupings in order of importance should be safety and investment.

The California Department of Transportation has also developed a set of priority groupings and subsequently assigned activities to them. These priority groupings in descending order of importance are (a) safety, (b) investment (preservation of capital investment), (c) user service (snow removal, etc.), (d) aesthetic appearance, and (e) miscellaneous (work for other agencies).

Once the groupings are accomplished, it is possible to assign the maintenance items. It is not expected that all transportation organizations will place the same items in similar groups; in fact, some maintenance items fit into more than one group. A sample listing follows:

1. Safety--shoulder drop-off repair, sign maintenance, pothole repair, rock patrol;
2. Capital investment--ditch cleaning, crack and joint maintenance, resurfacing, bridge maintenance;
3. User services--snow removal, repair of bumps, correction of slippery areas; and
4. Aesthetics--mowing, painting, cleaning.

Step 3: Select Activities to Be Deferred

If maintenance objectives are first identified and priorities are then established, the selection of activities to defer is simplified. The selection of items to defer will be based on previously assigned priorities, maintenance policy, and magnitude of savings as determined by a benefit-cost ratio (6).

Step 4: Assign the Deferment Period

If the results of different levels of maintenance were known, it would simplify the task of assigning deferment periods. In many instances, quantitative measures are not available. However, sources of information that can be used in the decision process are historical data, models, engineering judgment, and research.

Historical Data

One of the prime sources of information available for use in determining deferment periods is historical data. Since the advent of maintenance systems and road data banks, large amounts of precise usable information have been stored on such topics as maintenance frequencies, rates of repair, materials used, cost data, road data, skid-resistance of pavements, and pavement serviceability ratings.

In addition, data systems can be programmed to print out selected information that is based on predetermined occurrences. For example, on the subject of resurfacing information, if history indicates that pavements on high-design roads have been resurfaced on an average of every eight years, a computer program may be written in which a list of all sections of pavements that reach this age during a year will be automatically printed out. Files are available in many states for different highway activities. The value of information is greatly increased when it is integrated with other data, such as skid resistance. Not only can the rate of deterioration be observed and decisions on deferments be made, but the causes of deterioration can often be determined also. Pavements sometimes get slick long before they are worn out and this condition requires maintenance to correct. Historical data can indicate the best type of pavement mix to use to avoid this type of situation.

Maintenance Prediction Models

Maintenance models, although not perfected, are valuable tools to determine deferment periods. Two types of models under development in Massachusetts to compute the condition of the accumulated deterioration of inventoried items are

1. Physical models that establish explicit functions between the condition or deterioration and the pertinent physical, environmental, and traffic-induced factors thought to affect life or performance and
2. Frequency models that assume that the underlying physical relationships can be adequately represented by a time-dependent function.

The choice of which model is best for each activity series or group is a matter of judgment and depends on several criteria:

1. The relative importance of the activities modeled (this can be in terms of maintenance costs, as well as in terms of public responsibility, such as safety or legal requirements);
2. The nature by which the demand for maintenance arises, i.e., whether physical factors dominate the time dependencies;
3. The consequences of deferring maintenance to a later date, i.e., whether the maintenance is merely postponed (the level of maintenance effort required does not increase substantially if it is performed later rather than now, e.g., picking up litter), in which case frequency models are most appropriate, or forgone (the opportunity for relatively minor corrective effort exists for only a limited time and if maintenance is deferred beyond this time more expensive actions may be called for, e.g., pavement maintenance), in which case physical models are most appropriate; and
4. The reliability and level of detail of the data available (in general, physical models require more data than do frequency models).

Engineering Judgment

A resource that should not be overlooked is the professional judgment of personnel. Members of select committees given the responsibility for planning deferred maintenance should possess extensive field experience with the activity under consideration.

Research

Much maintenance-activity research, at little or no additional cost, can be blended into regular maintenance performance routines and can offer the additional advantages of providing opportunity for evaluation and comparison with the "normal" schedule by both researchers and field managers. In addition, field maintenance personnel who perform the work have an opportunity to become familiar with the new procedure. One of the more difficult steps in implementing new procedures is to get them carried out as prescribed. Researchers claim that in the implementation of deferred or reduced mowing programs, one major problem was to get the mowing-machine operators not to cut the vegetation until it had reached the new height. If the operators had been mowing vegetation at a height of 8 in (20 cm) for 20 years, they were very apt to continue. Many times, issuing instructions and putting up signs were not sufficient to accomplish the results. With research, to which deferred maintenance appears to lend itself especially well, the training of personnel can be carried on simultaneously. Research has many points to recommend it, but there are two very specific ones:

1. The risk factor is greatly minimized by the controlled conditions and the ability to discontinue on short notice.
2. It is possible to study the interrelationship between activities, i.e., the effects that deferring the repair of scour damage around a culvert might have on the integrity of the shoulder and on drainage or, for that matter, the effect of deferred mowing on pavement deterioration.

Step 5: Evaluate the Consequences of Deferment

The final step in the decision process is to consider the consequences of deferring a maintenance activity. Most of the previously discussed results of deferred maintenance have shown negative aspects. The negative consequences of deferring maintenance activity beyond normal routine do not carry equal weight. For example, a pleasing roadside appearance (aesthetics) will not be ranked equally with a road hazard.

Figure 3. Flowchart for evaluating the consequences of deferred mainenance.

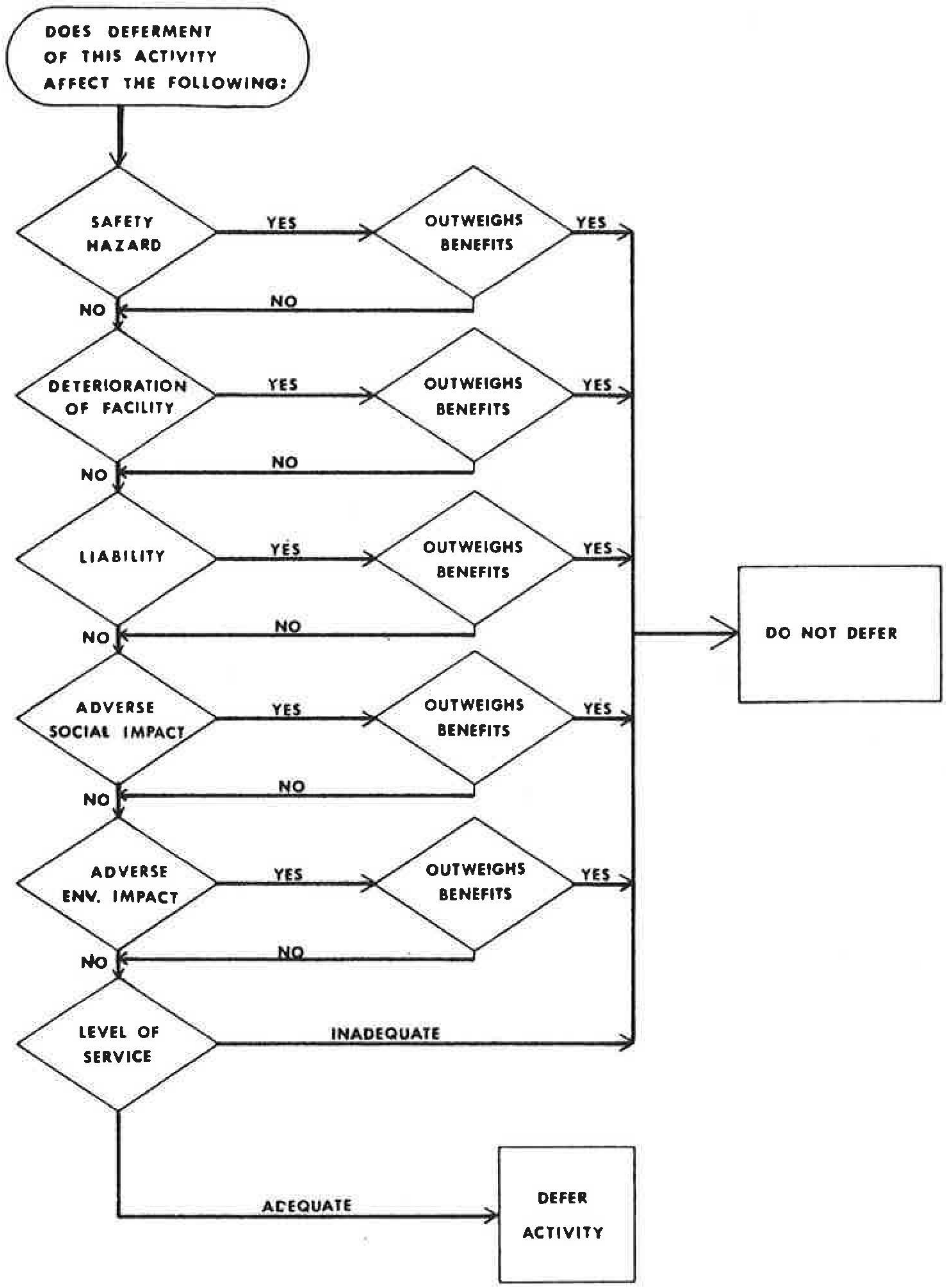


Figure 3 is a flowchart that evaluates the consequences of deferred maintenance. Each deferment activity should be evaluated in terms of these major consequences. This does not imply that every maintenance activity will affect all of the consequences; however, in many cases the results of deferral will show up in more than one of the consequences.

The decision to continue deferment of a maintenance activity will be a summation of the individual analyses of the various consequences shown in Figure 3. For example, in the case of deferred mowing, a ragged appearance may not justify a return to the normal schedule. However, a ragged landscape, insufficient sight distance, and deterioration of the facility would justify such action.

A number of highway measurements and tests may be used to analyze the consequences of maintenance deferment. Examples include sight-distance measurements, pavement serviceability ratings, skid tests, and road roughness tests. In addition, accumulated highway data on accidents, flooding, and citizen complaints are sources to aid in evaluation. Engineering judgment will also be a factor in assessing the consequences of deferring maintenance.

The results of the analysis may be listed in the form of warrants for each activity. An example of this, applied to mowing, might read as follows:

Defer mowing to the point that one or more of the following conditions exist:

1. Sight distances become inadequate (vehicles hidden in crossovers, intersection sight distances blocked, signs hidden, driveways obstructed, etc.),
2. Drainage becomes partly obstructed by vegetation,
3. Noxious weeds become a threat to both the

highway right-of-way and adjacent croplands, and
4. Lack of mowing leads to the deterioration of the roadside.

The analysis and development of warrants for each activity would be based on a comprehensive investigation.

CONCLUSIONS

Deferred maintenance is now widely practiced, sometimes without an in-depth consideration of possible consequences. Since all indicators point toward a simultaneous shrinking of the maintenance dollar and an increase in maintenance requirements that results from the aging and the wearing out of road systems, especially Interstate highways, deferred maintenance will increase in the future. This is a just cause for concern among highway engineers. If the wrong decisions are made, disastrous results could occur and bring harm to the entire highway system. It is hoped that the deferred maintenance logic suggested in this report will aid highway administrators in making as many correct decisions on deferments as possible.

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Roadside Management

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The functional requirements of a transportation facility, and its neighbors' needs, dictate roadside management activities as part of the total highway maintenance program. Aesthetic improvement is a no-cost fringe benefit. The roadside is defined as the area between the outside edge of a shoulder and the right-of-way boundary. The median strip on multilane highways and interchange areas are included. The Washington Department of Transportation manages the roadside, either constructed or natural, as a public resource. Four methods of vegetation control are discussed; special emphasis is given to chemical control. Three work zones and separate treatments for each are identified. Planning and timely accomplishments are the keys to effective long-range vegetation management. Roadside maintenance managers must be trained to recognize the roadside as a resource and learn to manage it in the most efficient and effective way. Field-level employees must be well trained before the planned program can be implemented.

The opening paragraph on roadsides in the 1976 American Association of State Highway and Transportation Officials (AASHTO) Maintenance Manual (1) describes the philosophy of the Washington Department of Transportation (WDOT) on roadside management.

> Recent changes in public attitudes have given roadside maintenance new dimensions. As much as any other part of the roadway, the roadside, when properly maintained, presents a new look that recognizes the value of a pleasing and ecologically balanced environment. Roadsides with natural growth present a challenge to the maintenance manager to combine objectives of low cost and effectiveness with elements to improve the roadside environment.

The roadside includes the area between the outside edge of the shoulder and the right-of-way boundary. The median strip and interchange areas within a multilane highway are also part of the roadside. Roadsides can be constructed or be in a natural condition that includes the land remnants adjacent to the construction zone. Constructed roadsides should be maintained to a level that provides a satisfactory contribution to the safety, convenience, appearance, and pleasure of the public and the preservation of the roadway itself. The composite areas, either constructed or natural, need to be managed as a public resource.

Each state or region obviously has its own unique ecosystems within its boundaries, and they must be appropriately controlled and stabilized if the roadside is to function as intended. Special knowledge and treatment are necessary to control the dense brush and tree growth indigenous to the coastal regions of the Pacific Northwest; the juniper, desert grass, and cactus of the Southwest; the mixed hardwoods and brambles of the Northeast; the pine forest, kudzu vines, and aquatic weeds of the Southeast; and the grasslands of the Central States. Washington State's several climatic regions foster many different ecosystems that may be similar to