corporate them into the design, construction, and maintenance of the roadside. Each of the disciplines recognizes the team goal and subsequently makes the necessary trade-offs that are an inherent part of any team effort. It is important that they recognize that the concept of roadside management applies not only to roadside improvements, but also to those roadsides that have never had an improvement project.

By using aerial photos illustrating existing field conditions as base sheets, all roadside management plans must provide at least the following information: goals and objectives; key plant materials; views to be preserved or screened; vegetation to be protected, supplemented, controlled, eradicated, or selectively thinned; general horticultural requirements (e.g. fertilizing, pest control); irrigation needs (including programing of irrigation controllers); mowing limits and frequency; roadside drainage (design and maintenance); priority of each activity; manpower requirements (annually and monthly and skill levels); equipment needs; and estimate of costs.

A roadside management plan is of great benefit as a communications tool connecting top management with the employee on the job. Too often we overlook the need to provide the employee with a communications device to interpret what is desired. The plan can also be used as a basis for the supervisor in preparing his next year's program needs that will be passed up through channels to be incorporated in the overall annual maintenance program. Once the plan is approved, the supervisor has a document to follow. At the same time, performance in the field can be evaluated by higher management.

The plan also illustrates what will not be done and acts as a basis for lower expenditures on equipment, materials, work hours, improved product quality and as a common reference for all levels of decisions.

We believe that the management approach to roadside design, construction, and maintenance is the responsible approach to making our highways aesthetically pleasing elements of the environment through which they pass. After the development of a roadside management plan, continuing maintenance should fall below previous expenditure levels, and benefits should increase.

A roadside management plan will ensure that a right-of-way will serve its highest and best use, whether this be habitat for upland game birds or landscape planting throughout a city. The goals and objectives of roadside design, construction, and maintenance can be accomplished at the lowest organizational level, if it is accomplished as a part of the plan.

Publication of this paper sponsored by Committee on Roadside Maintenance.

Abridgment

Economics of Roadside Mowing

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Expenditures for highway maintenance in the United Kingdom are being severely cut at the present time. The policy of the central government is to reduce 1975-76 expenditures by 20 to 25 percent by 1980.

As a result of this policy, the highway authorities have had to examine their maintenance standards, even though many engineers maintain that current standards are already inadequate and for some functions have not achieved the recommended target standards laid down as national criteria in the Marshall Report (1). Some of these standards for greenery cutting follow.

THE MARSHALL REPORT

The object of grass, tree, and hedge cutting is to prevent obstruction of sight lines at bends and traffic signs, to inhibit the growth of injurious and other weeds, to maintain a tidy appearance, and, in the case of trees adjoining roads, to prevent them from becoming a danger to road users.

Suggested Standards for Grass Cutting

Rural Roads

On the first 2 m (6 ft) of verges and on central reserves of motorways and trunk roads, grass should be kept below 15 cm (6 in) and elsewhere on the roadside below 30 cm (12 in).

For other roads, the minimum suggested is one cut width of one pass of the mower per year plus additional cuts as necessary to maintain visibility at bends. On more important roads and on roads with well-used footways, more frequent and wider cuts (including up to the full width every second year) may be considered necessary. Steep banks starting from the edge of the carriageway should be cut more frequently to avoid reducing its effective width or obstructing pedestrians.

Urban Roads

On motorways and trunk roads in urban areas, all grass should be kept down to 7.5 cm (3 in). On other roads, however, for highway purposes the same standards as for rural roads should apply.

Suggested Standards for Hedge Trimming

Where it is the responsibility of the highway authority, hedge trimming once a year should be sufficient on rural roads; it is needed more frequently in urban areas. Where there is a special requirement, for example to preserve visibility at bends or across central reserves, cutting should be done as required. (In the United Kingdom, highway boundary hedges are normally the responsibility of the adjoining landowner.)

Chemical Sprays

It may be necessary to use chemical sprays to eliminate weeds and control growth around posts carrying signs, along guardrails, on the edges of curbs, and on footways. They may also be used to control the growth of grass on the strip adjoining the edge of the carriageway

and on central reservations. Their use should be the minimum compatible with the required results.

Trees Adjoining Roads

All trees adjoining roads, whether owned by the highway authority or not, should be periodically inspected for potentially dangerous conditions. In the case of trees owned by the highway authority, any necessary corrective measures should be taken as soon as is reasonably possible. In the case of privately owned trees, the owner or occupier of the land should be warned of any danger and requested to take the necessary action.

REPORT ON ROADSIDE MAINTENANCE, APRIL 1974

In April 1974, the Lincolnshire County Council reviewed its attitude toward roadside maintenance and adopted the following policy.

The close cutting of highway verges ensures a dense, weed-free surface able to be scavenged and maintained in a clean and tidy condition for use as required by pedestrians and equestrians.

In urban areas, high standards of verge maintenance are expected by the public, and additional features such as shrubs, tree plantings, and other landscaping are much appreciated.

In rural areas, lower standards of maintenance have been introduced, largely because of limited highway maintenance monies and the interest of naturalists and conservationists. In addition, many verges of rural roads have, by virtue of their apparent neglect, been subject to abuses, including indiscriminate use by vehicles and tipping of rubbish and excavated materials from adjoining ditches, or are so overgrown that they are frequently unusable by pedestrians and equestrians.

In urban areas, locations agreed by the county surveyor (in practice his representative, the divisional surveyor) shall be maintained in a reasonable, weed-free, close-cut condition, free from irregularities. The verges of rural main roads shall be coarse-cut to full width as required during the growing season, subject to the need to protect flora on certain verges. On other roads, one swath width shall be coarse-cut as required during the growing season.

At junctions and corners the verge shall be cut to full width. The verges shall be cut overall not earlier than the end of the flowering season.

TRUNK ROAD POLICY—GRASS CUTTING AND HEDGEROW TREATMENT

In July 1975 the Department of the Environment (now Department of Transport) issued a technical memorandum describing revised and lower standards of roadside maintenance for trunk roads and motorways. Some of these standards are as follows.

1. In future, grass cutting on land forming part of trunk roads and motorways is to cease as a general practice, and grass is to be cut only in certain restricted places and circumstances. These are:
   a. It may exceptionally be necessary to cut a swath alongside fields in areas where stubble-burning takes place on land adjoining the highway, and where there may be a particular danger of fire spreading to the highway. Farmers must, however, be pressed to fulfil their obligation of ensuring that there is no fire risk before they burn, e.g. by ploughing a strip round the fields.
   b. At sites where long grass or weeds would reduce the minimum stopping sight distances set out in "Layout of Roads in Rural Areas" or cause danger, for example, by obscuring junctions with other roads, gaps in central reservations, or road signs. Grass alongside motorway hard shoulders may exceptionally require cutting to preserve sight lines when traffic is actually using the hard shoulders during motorway works.
   c. Treatment by chemical means may be required on central reservations to prevent growth falling on the carriageway and causing "kerb shyness" in the fast lane.
   d. Where long grass or weeds would interfere with substantial pedestrian traffic and particularly with the use of the verge by schoolchildren, or cause danger by concealing from drivers the presence of pedestrians on the verge and particularly of children who might run out onto the carriageway.
   e. In built-up areas where some cutting may be necessary for the preservation of amenity. The frequency of such cutting must be agreed with the Regional Controller (Roads and Transportation).
   f. At sites listed as being of outstanding botanical interest, where a special system of management is required.

   In the new regime newly sown grass will not need treatment beyond that set out in the Specification for Road and Bridge Works.
2. In the course of time it may become necessary to deal with scrub growth where this cannot be tolerated. This problem will not, however, arise for several years. In places noxious weeds (as defined in the Weeds Act of 1959) may establish themselves, and require to be eliminated if they give rise to complaints by seeding onto neighbouring land. This is not seen as a major problem, and if it should arise it can be met by selective cutting or spraying.
3. The use of chemical sprays should be planned in co-operation with the Department's Horticultural Adviser and should be agreed by the Regional Controller (R & T) before being put into operation.
4. One consequence of the new regime may be a tendency for grass and weeds to establish themselves in gravel drains. Special attention would be needed to deal with this, but it is not anticipated that it will amount to more than some intensification of present activity.
5. Hedgerows bordering the trunk road or motorway, but not owned by the Highway Authority, are not to be cut except on repayment unless there is an Agreement to maintain them. Boundary hedges owned by the Highway Authority should be cut only so as to comply with the legal obligation to prevent nuisance caused by growth overhanging neighbouring property, and where necessary for road safety or the visibility of signs. Hedges on central reservations may sometimes need to be cut, so as to avert encroachment on the outside lane of the carriageway.

Implementation of this policy involved considerable effort because the areas described in 1b, 1d, 1e, and 1f can only be identified "on the ground."

Areas where measurements were required were at bends, private entrances (houses, farms, industries), road junctions, urban areas (amenity cutting), and verges used by pedestrians. In addition, the survey team also recorded accident blackspots with particular reference to vertical alignment. The average survey time by a two-man team was 16 to 20 km (10 to 13 miles) per day, but this was very dependent on environment.

REPORT ON ROADSIDE MAINTENANCE, APRIL 1976

The Lincolnshire County Council is the highway authority for 8392 km (5203 miles) of county roads, and views on the application of the revised and lower trunk road standards to the county road network were solicited from elected representatives throughout the county. Typical comments recorded were "present standards on county roads should be maintained"; "non-cutting will give rise to problems with tipping"; "farmers could cut more but there are difficulties with high verges and drainage grips"; "one swath adjoining road is essential for pedestrians"; "visibility at bends must be ensured"; "weeds and coarse grass will swamp wild flowers"; "brush and scrub would cause damage to the carriageway and would hinder maintenance of ditches and hedges"; and "weeds would spread to adjoining agricultural land."

These comments, together with a report on the revised trunk road grass cutting policy, were reported to the County Council transportation committee when they met in April 1976. The members were asked whether they wished to revise the policy for county roads in the interests of economy.

The revised policy that was recommended and adopted goes some way in the direction of the trunk roads policy and will enable some economies to be made in rural areas.

The present policy of close cutting is to be continued on all county roads in urban areas.

On main roads in rural areas the revised policy is a one-swath width adjacent to the carriageway on both sides of the road cut regularly, and the full width of the roadside verge cut regularly at the inside of bends together with splays at junctions and entrances.

Full width cutting will be carried out at the end of every third growing season to prevent the establishment of scrub and to deter other nuisances.

On minor roads in rural areas the assistance of the adjoining landowner should be enlisted, and if necessary severe obstructions should be modified to encourage adjoining landowners to cut the grass. Where the adjoining landowner declines to cut the grass, then those verges will be cut overall every third year to prevent the establishment of scrub.

The future expenditure on roadside maintenance will be carefully monitored to confirm the significance of any savings in real terms in order that the policy may be reconsidered and amended as necessary.

REVISED POLICIES OF ROADSIDE MAINTENANCE

The summer of 1976 was the driest ever recorded throughout England, and consequently grass growth was at an all-time minimum.

It would therefore be inappropriate to draw any comparisons between the roadside maintenance costs of 1976 and other years. However, the long-standing dry grass on trunk road verges presented a considerable fire risk. There were many instances of roadside fires, some of which spread to adjoining property. All presented a traffic hazard by reducing visibility.

REFERENCES

1. Report of the Committee on Highway Maintenance (Marshall Report). Her Majesty's Stationery Office, London, 1970.
2. Report of the Committee on Highway Maintenance (Marshall Report). Her Majesty's Stationery Office, London, 1970, Appendix 1: Proposed Initial Standards of Maintenance.

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Economic Analysis of the Environmental Impact of Highway Deicing Salts

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This paper reports on an analysis of the cost of damages that result from sodium chloride used to melt snow and ice on highways. An extensive literature search and several surveys were made to determine the types and extent of damages that have occurred. The major cost sectors examined were water supplies and health, vegetation, highway structures, vehicles, and utilities. A conservative cost estimate was developed for each sector. The total annual national cost of salt-related damage approaches $3 billion, about 15 times the annual national cost of the salt and its application. The highest direct costs result from damage to vehicles, but the most serious damage appears to be the pollution of water supplies and the attendant degradation of health. It is difficult to assign costs to this, and therefore the estimate may substantially understate actual indirect costs to society. These findings indicate that some areas should, on the basis of local conditions, reduce the amount of salt used.

Extensive use of the salts sodium chloride (NaCl) and calcium chloride ($CaCl_2$) for removing snow began during the early 1960s. Before that time, highway maintenance departments depended primarily on abrasives, such as sand and cinders, combined with plowing, to clear snow and ice from highways; salt was generally added to the abrasives to prevent freezing. However, maintenance departments gradually began to appreciate salt's accelerated melting effect.

Through experimentation, maintenance engineers learned that direct application of salt before, during, and after a snowstorm greatly facilitated their snow removal operations, in terms of both time and money. Since that discovery, the use of salt for snow and ice removal has grown rapidly, in some cases by as much as 900 percent in the past 15 years (1). This extensive use of salt, however, has now been associated with a significant amount of damage.

There is no question that salt is an excellent tool for removing snow. There also is no question that, in terms of time and budget constraints for snow removal operations alone, salt used in large quantities with plowing is essential.

Highway departments trying to create the safest driving conditions believe that providing most bare pavement in least time is best achieved by extensive use of salt—given budget constraints. However, some highway departments, in their eagerness to perform well and meet these goals, have inadvertently used salt inefficiently. The education and understanding fostered by the Salt Institute, the Environmental Protection Agency (EPA) (2, 3), the Massachusetts Special Commission on Salt Contamination (4), and many others have corrected some of this misuse. The result has been a more effective use of salt with no essential reduction in level of usage.

Total salt use for snow and ice removal in this country now stands at approximately 9 million Mg (10 million tons) each year. Many highway departments apply as much as 37 Mg/lane·km (25 tons/lane·mile) in one season. On a four-lane highway, this amounts to 56 kg of salt in the runoff for every meter of the highway (38 lb/ft). As we build more highways, we can expect salt use