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# Roadside Development

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# Report of Committee on Roadside Development

WILBUR J. GARMHAUSEN, Chairman, Chief Landscape Architect, Ohio Department of Highways

•The Committee on Roadside Development continues to research the many aspects of Roadside Development for the purpose of benefiting the development of the complete highway.

For 1963, the theme of the Committee's program emphasized highway construction, design and maintenance as they relate to Roadside Development. At the 42nd Annual Meeting of the Highway Research Board, the Committee conducted three business meetings and three program sessions. Fourteen papers were prepared and one panel discussion was presented. Nineteen persons participated in the program on the following topics: the role and progress of the landscape engineer in a highway organization, highway location as a problem of urban and landscape design, education and recruitment of landscape architects for highway organizations, aesthetic consideration in arterial urban route planning, suggested activities for future roadside development research, policing safety rest areas, progress report on noise abatement, progress report on nonburning magnesium fertilizer, panel on compatibility of utilities and trees on the roadside, mulching practices and materials, control of soil subject to wind erosion, common sense turf management on today's highway, the advantage and disadvantage of active sludge as a mulching material, application of photogrammetry to landscape development, and the adaptation of turf species for various micro-climates and soils in Virginia.

During 1962 the Committee published its annual proceedings report and four distributions of material from its clearinghouse.

The program for 1964 will be primarily a continuation of the theme for the past year. The program subcommittee will consider, among others, such additional topics as urban treatment, roadside cleanup, woody plant material and maintenance costs. In addition, work will be continued on the preparation and distribution of fifteen circulars on subjects such as fertilizers, noise abatement, snow barriers, firebreaks, and salvage of materials.

# Role and Progress of the Landscape Engineer in a Highway Organization

HOWARD S. IVES, Commissioner, Connecticut State Highway Department

•A VERY HOT, glaring sunny afternoon makes one appreciate the complete and refreshing temperature change made possible by the delightful shade from the trees along sections of Connecticut highways. The aesthetic enhancement of this environment had been achieved by the thoughtful consideration and accomplishments of people many years ago. These tree-lined avenues were planted before the turn of the century as a result of the foresight of the late John H. MacDonald, Connecticut's first State Highway Commissioner.

Such thoughtful early work is evident throughout many parts of the country. Trees were planted along highways and byways, on village greens and within parklands to make possible today's enjoyment of the functional beauty and the environmental comfort of this landscape treatment. So, too, through the generations that followed, thoughtful citizens and public officials continued this traditional effort. This type of planting perhaps represents the first consideration of landscape development along the country's highway system.

In the early 1920's, the Board of County Road Commissioners of Wayne County, Mich., gave considerable attention to the landscape development of the highway system under its jurisdiction, and an organization to undertake this work was formed. Thirty years ago, in a book entitled "Roadsides, The Front Yard of the Nation," J.M. Bennett wrote, "Roadsides constitute the front yard of every community and because of this, if for no other reason, they should be developed and maintained in a manner befitting such a distinction. Everyone is benefited by an intelligent, economical and progressive public policy and the improvement of the roadsides is important." He also stated, "that the maximum in comfort and attractiveness cannot be obtained for the traveling public without the mutual improvement of both roadways and roadsides is obvious, and in this respect, roadside development plays a most important part."

Bennett recommended that in order to achieve these objectives that "the best procedure at the present time appears to be the employment (in every highway department) of landscape foresters or men who not only have training and experience in landscape design and civil engineering, but who also have training and experience of a practical nature involving the actual planting and maintenance of trees and vegetation."

During this same period, the Parkway Commission of Westchester County, N.Y., developed a system of roads that are today an integral part of the countryside. These parkways continue to handle tremendous volumes of traffic as well as bringing delight and comfort to thousands of daily users. The abutting property owners also have found that locations adjacent to these highways have been desirable sections in which to reside. Such work is evident in other sections of the country and may be found in the Mount Vernon Memorial Highway along the Potomac River. The thoughtful consideration of making highway systems an integral part of the landscape was started by pioneers who gave superb examples that are still being followed.

On January 1, 1926, the Connecticut State Highway Department started its first organized landscape work with the employment of a technically-trained engineer-forester. At that time, an informal beginning in Connecticut consisted mostly of planting trees, careful maintenance of existing trees, and the conservation of natural vegetation. After enactment of laws giving the Highway Department authority to carry out this type of work, a preliminary landscape development unit was organized on July 1,

Paper sponsored by Committee on Roadside Development.

1927. The responsibilities for all vegetative maintenance within the roadsides of State highways were turned over to this unit. During the years that followed, a great deal of effort was placed on improving the roadsides and intersection areas, the continued planting of appropriate shade trees, and the general enhancement of the highway system. At that time, it was known more or less as beautification, or "window dressing" which brought to the attention of the public the values of aesthetics.

Numerous other States also formed units within their departments, and trained personnel were appointed to carry out the objectives of roadside improvement or roadside development. This became, therefore, a national feature and the Highway Research Board and the American Association of State Highway Officials recognized the importance of these activities. Representatives met in the early 1930's and formulated and published a definition of roadside development, which is still appropriate: "Roadside development must conserve, enhance and effectively display the natural beauty of the landscape through which the highway passes, as well as provide maximum safety, utility, economy, and recreation facilities by means of proper location, design, construction and maintenance of the highway."

During these early years of organization, the practical aspects of the establishment, maintenance and control of vegetation were considered the principal functional matters. Many efficiencies and economic practices with materials and equipment have been developed by this group that now are recognized as standard performance. The development of the method of hydraulic seeding and fertilizing for turf establishment is just one example of the efficient methods that has been successfully accomplished. Today establishment of turf cover for erosion control is possible at one-third pre-World War II costs for the same unit of measurement, and under the most adverse soil conditions in very rugged terrain. This, and other important features, is the result of landscape engineers working collaboratively in a highway organization and cooperating with private industry.

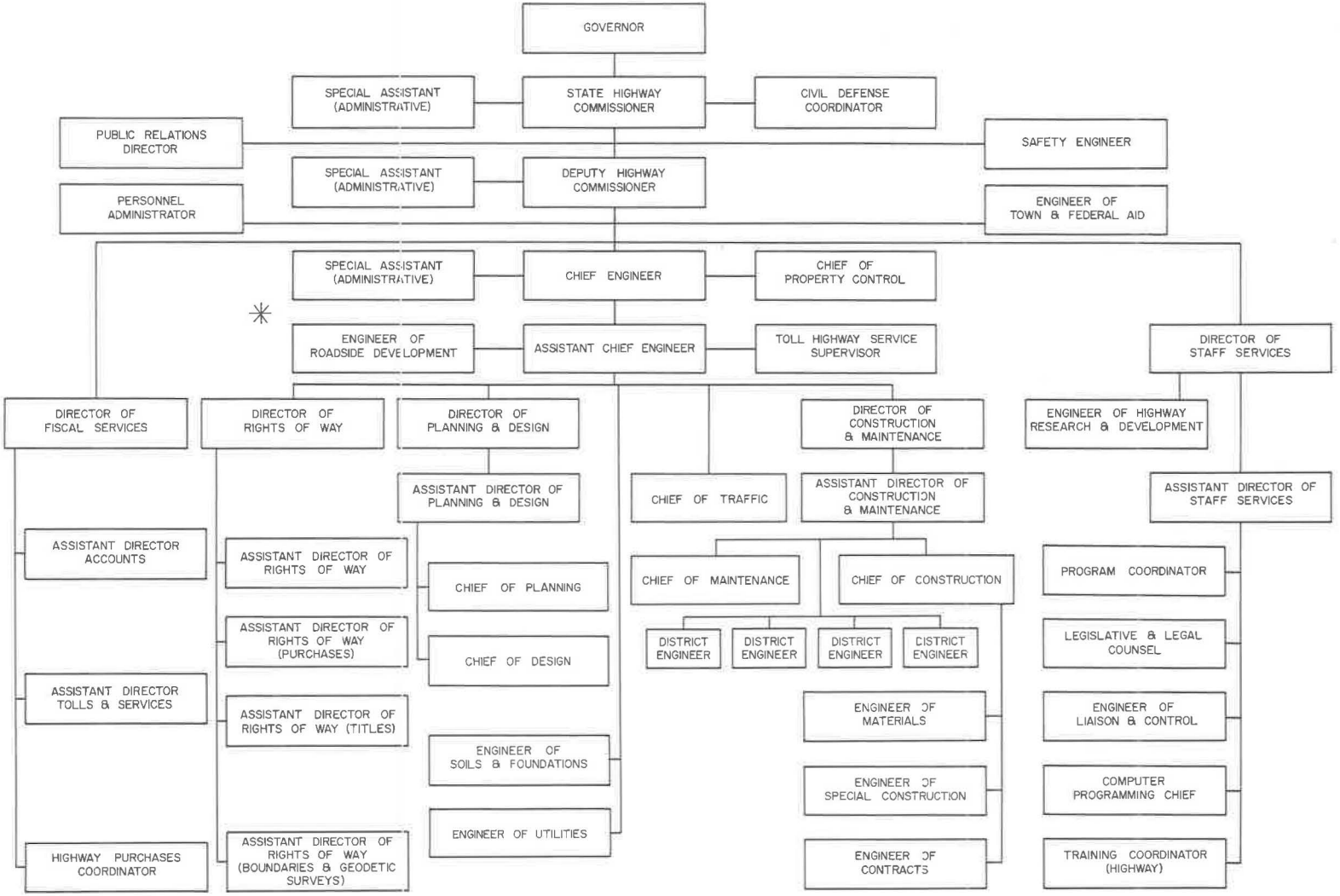
In the early 1940's, during World War II years, with more and more attention being given to the roadsides as an integral part of highway systems, the definition of the "complete highway" was formulated. This is one that embodies safety, utility, economy of operation, and beauty for the service of transportation. Today, work with such factors in the programs on the tremendous system of Interstate and Defense highways reflects on what the "complete highway" must be. These are but a few examples of the beginnings of roadside development and the importance of trained landscape engineers in a highway organization.

Education and communication have been important factors in the work of landscape development. Last October, the Ohio Roadside Development Short Course held its twenty-first meeting. The Short Course is one of the most important contributions to the nation's road system, because it brings together so many interested and well-informed people with appropriate exchange of improved methods and ideas. This organized effort has come of age and the Short Course is now an annual highlight.

It also has inspired work of a similar nature in other sections of the country—meetings with important, valuable, pertinent and educational subjects on the agenda from which the highway administrator and the highway user benefit.

The role of the landscape engineering staff is becoming more and more important to the highway administrator, the man responsible for the complete operation of the highway system for the service of transportation. The staff in that position must be versatile, capable, and familiar with the many intricate items essential to the activities in such an organization. A few illustrations and examples are cited as follows:

1. Planning, location, and design of highways.
2. Construction activities.
3. Safety factors.
4. Maintenance techniques.
5. Conservation of existing landscape features, land values, and historical objects and sites.
6. Planting and its functional as well as aesthetic values.
7. Fiscal and business features.
8. Public relations and all the ramifications that are required to serve effectively


GOVERNOR
SPECIAL ASSISTANT (ADMINISTRATIVE)
STATE HIGHWAY COMMISSIONER
CIVIL DEFENSE COORDINATOR
PUBLIC RELATIONS DIRECTOR
SAFETY ENGINEER
SPECIAL ASSISTANT (ADMINISTRATIVE)
DEPUTY HIGHWAY COMMISSIONER
PERSONNEL ADMINISTRATOR
ENGINEER OF TOWN & FEDERAL AID
SPECIAL ASSISTANT (ADMINISTRATIVE)
CHIEF ENGINEER
CHIEF OF PROPERTY CONTROL
ENGINEER OF ROADSIDE DEVELOPMENT
ASSISTANT CHIEF ENGINEER
TOLL HIGHWAY SERVICE SUPERVISOR
DIRECTOR OF STAFF SERVICES
DIRECTOR OF FISCAL SERVICES
DIRECTOR OF RIGHTS OF WAY
DIRECTOR OF PLANNING & DESIGN
DIRECTOR OF CONSTRUCTION & MAINTENANCE
ENGINEER OF HIGHWAY RESEARCH & DEVELOPMENT
ASSISTANT DIRECTOR OF PLANNING & DESIGN
CHIEF OF TRAFFIC
ASSISTANT DIRECTOR OF CONSTRUCTION & MAINTENANCE
ASSISTANT DIRECTOR OF STAFF SERVICES
ASSISTANT DIRECTOR ACCOUNTS
ASSISTANT DIRECTOR OF RIGHTS OF WAY
CHIEF OF PLANNING
CHIEF OF MAINTENANCE
CHIEF OF CONSTRUCTION
PROGRAM COORDINATOR
ASSISTANT DIRECTOR OF RIGHTS OF WAY (PURCHASES)
CHIEF OF DESIGN
DISTRICT ENGINEER
DISTRICT ENGINEER
DISTRICT ENGINEER
DISTRICT ENGINEER
LEGISLATIVE & LEGAL COUNSEL
ASSISTANT DIRECTOR TOLLS & SERVICES
ASSISTANT DIRECTOR OF RIGHTS OF WAY (TITLES)
ENGINEER OF MATERIALS
ENGINEER OF LIAISON & CONTROL
ENGINEER OF SOILS & FOUNDATIONS
ENGINEER OF SPECIAL CONSTRUCTION
COMPUTER PROGRAMMING CHIEF
ENGINEER OF UTILITIES
HIGHWAY PURCHASES COORDINATOR
ASSISTANT DIRECTOR OF RIGHTS OF WAY (BOUNDARIES & GEODETIC SURVEYS)
ENGINEER OF CONTRACTS
TRAINING COORDINATOR (HIGHWAY)

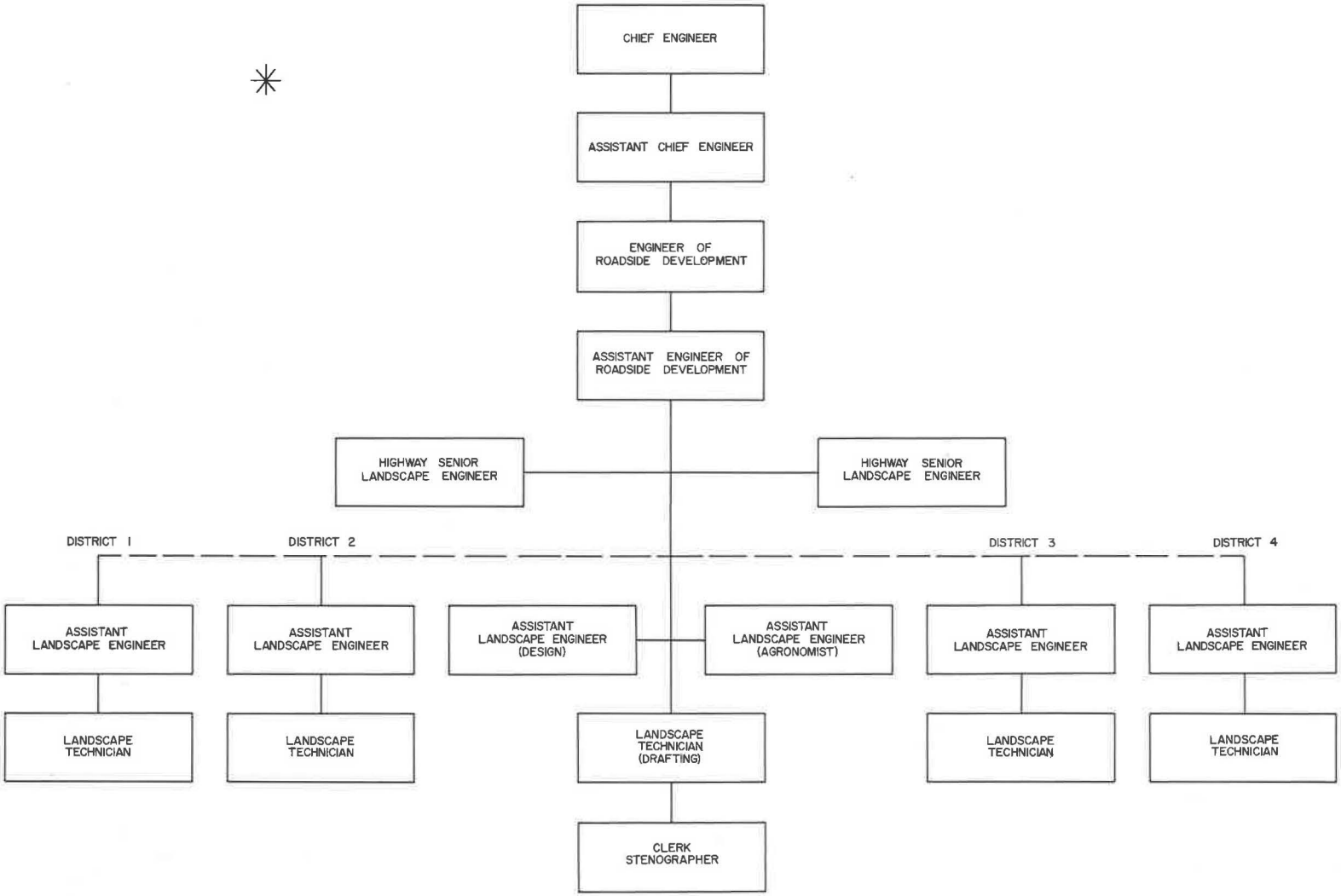



Figure 1. Organization chart for Connecticut State Highway Department and details for Roadside Development.

the highway user, deal with the abutting property owners, and carry on complete communications with other State agencies and public organizations.

At the meeting of the Operating Committee on Roadside Development of the American Association of State Highway Officials in July of 1960, various objectives were formulated. It was considered, first and foremost, necessary to bring to the attention of every highway administrator, the importance of roadside development (landscape development) as an integral part of each and every highway organization. At the committee meetings held in Detroit in 1960, a theme was developed that would incorporate trained personnel into every organization to work collaboratively with the civil engineers and other personnel to develop highways. Many of the States had organizations listed under maintenance; others under design; and one or two had the units in their proper category. After careful study the location of these landscape units was recommended to be placed near a top administrative official in the highway organization to permit collaborative work with the planning engineer, the design engineer, the construction engineer and the maintenance engineer. Each of these engineers, responsible for separate phases of highway activities, could benefit by the technical qualifications of a landscape engineer. Also, at that time, a check list was sent to every highway administrator and suggested organizational charts were issued. At this time appropriate recognition has been given in numerous States. Many have formed such units; others have increased the responsibilities of the landscape units; and in several others, who had appropriate organizations, the units have been more completely staffed by competent, technically-trained personnel with salaries adjusted and commensurate with the responsibilities of their positions.

Such reports indicate progress. However, this progress can be hindered unless competent, technically-trained personnel are found to staff such units within a highway organization. It is essential, in order to benefit each and every highway administrator, that this personnel be versatile and have an adequate educational background.

Figure 1 is a result of a national survey, which has been put into effect in the Connecticut Highway Department. It illustrates where the landscape engineer, with his staff, may work most effectively in a highway organization to carry on the many and varied activities required. The position has been placed where it is an arm of the chief engineer, an important staff unit with prestige and with a free flow of communications to all other segments of the department--planning design, construction and maintenance, as well as public relations and all the other sections necessary to administer the intricate operations of a highway organization. There are direct communications between the headquarter's office and the field personnel connected with roadside development. In turn, these men are in close contact with all the operating units on the district level. Now, more than ever, there is complete collaboration among all units of the department. Men trained in landscape engineering are actively participating from the inception of the projects, and they are carrying through into maintenance operations.

This indicates that the landscape engineer is receiving deserved recognition, and some progress is being made. However, there is still a long road ahead and it will be necessary to continue to try to convince the top officials of every highway organization that such units are important and essential parts of every department. No matter how dedicatedly and devotedly every man in landscape work serves his State and Nation, it is still not enough. Action, and the results of that action, cannot be achieved until proper authority and prestige is given the landscape engineer. The top official in each highway department must be made aware of the total values of landscape engineering.

A concerted and vigorous effort will be made during 1963 for more progress and recognition of the landscape engineer by every top highway official. In order to develop the highway system, through both urban and rural areas, with safety, utility, economy and beauty, it is necessary that the landscape engineer be an active part of every highway organization, working collaboratively with every other segment. With such personnel the responsible highway administrator may develop a system of roads that will be a credit to the Nation.

# Highway Location as a Problem of Urban And Landscape Design

BORIS PUSHKAREV, Senior Planner, Regional Plan Association, New York

•RECENT YEARS have witnessed the sudden emergence of considerable public opposition to new freeway construction in several parts of this country. The arguments against urban freeways vary from the "hardships of relocation," to "withdrawal of tax base," to the "destruction of neighborhoods." But more often than not, these are in part rationalizations for a basic objection on aesthetic grounds, which frequently does become explicit.

In the days when the first parkways were built in Westchester County, on Long Island, in New York City, New Jersey, and around Washington—parkways that set a very high aesthetic standard—opposition to limited-access highways seemed inconceivable, and the first urban freeways were eagerly awaited. It was not until the first aesthetic failures hit the public eye (the Boston Central Artery, the Embarcadero Freeway, the Northwest Expressway in Chicago) that opposition began to emerge. It is also significant that the freeway program has suffered its greatest setbacks in the three places where both the need for added traffic service and the visual values at stake are the highest—San Francisco, Washington, D.C., and Manhattan. Apparently in all three places the irate public has chosen visual amenity above traffic service, however misguided their counsels might have been.

There is no valid reason why the concern with civic beauty should not occupy the highway planner from the start, without waiting for the emergence of an "anti-ugly" opposition. In functional planning, it is now axiomatic that the highway network is calculated and planned as a system related to the land use of an entire urban region. Similarly, in visual design, the freeway system must be thought of as the skeleton of a large-scale regional landscape first of all, and be related harmoniously to the surrounding natural and man-made features.

Because of its size, continuity, and use, the freeway will remain, for decades to come, a key visual design feature in many urban areas and now offers the greatest single opportunity for coherent urban design on the regional scale. It may be argued that very few cities possess anything resembling a visual design plan, and hence guidelines for an architecturally successful freeway location are lacking. But, by the same token, very few cities possess a rational and convincing land use plan, and it is highway planning that prods the others along to attempt to develop one. The fact that the same sequence can work in the realm of aesthetics is amply proven by the example of New York City where the parkway and expressway system, begun in the thirties and basically completed now in the absence of any urban design plan, proved a tremendous visual asset.

Before the era of Robert Moses, New York had its famous skyline, which could be seen only from a boat; it had large bodies of water which could be seen only from the top of some skyscrapers; and it had a few, large isolated parks accessible by subway through miles of disjointed and undifferentiated urban tissue. The series of five or six parkway and expressway belts that were built did four architecturally decisive things for New York:

1. They made New York's two greatest visual assets, its skyline and its water, accessible to public view providing an unsurpassed dynamic progression through space.
2. They linked the hitherto isolated open spaces into a continuous, interconnected

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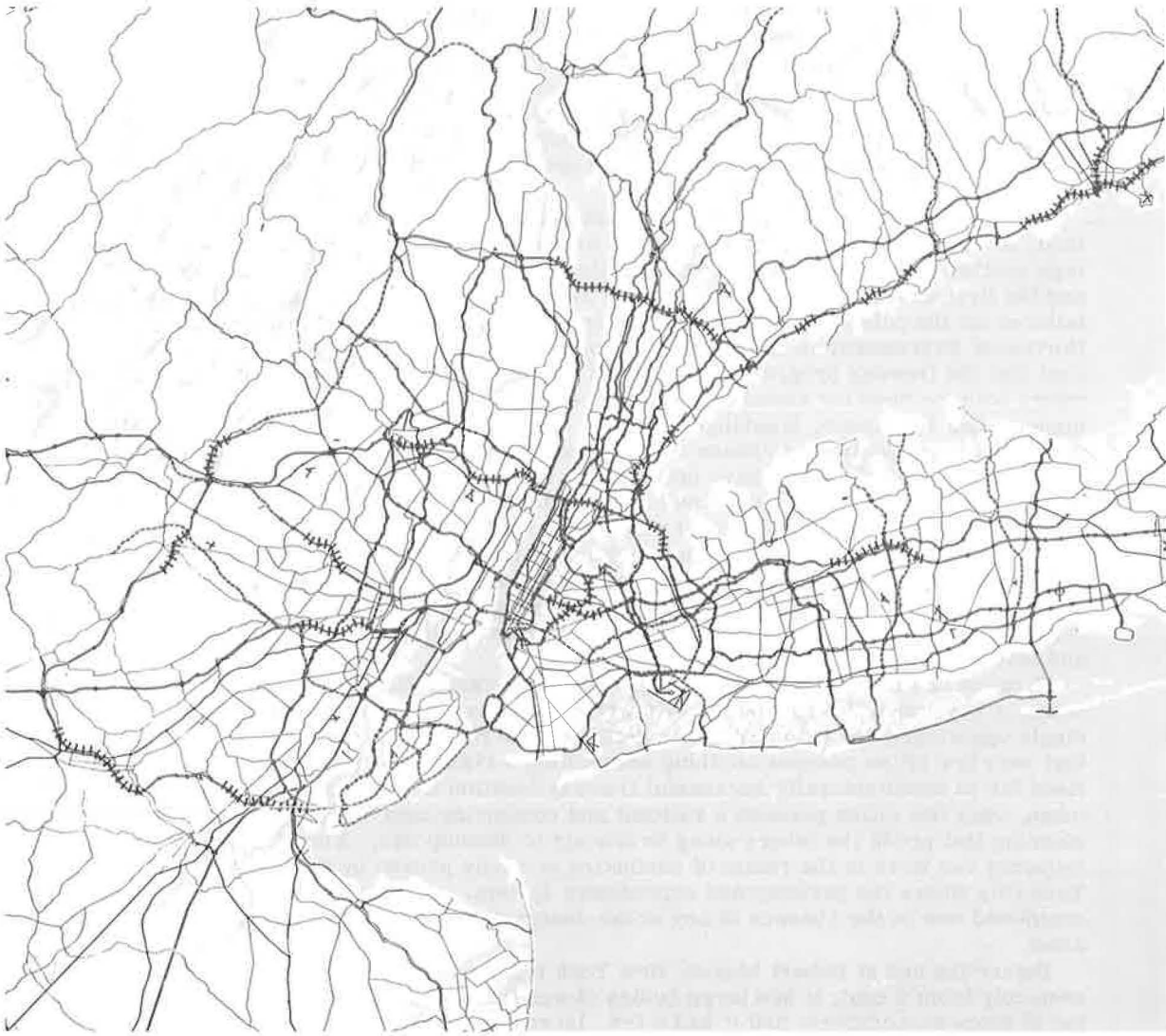

Figure 1. The freeway system (left) and the open space
few exceptions (indicated by crosshatching) the freewa

ystem (right) in the New York metropolitan region. With a
closely follow the topography and the basic street grid.

system eminently fitted to both the natural topography and to the man-made order of the street grid.

3. They articulated a hitherto incomprehensible urban mass into visually distinctive chunks, with a visually comprehensible silhouette or mass, cleaning up and upgrading junky and dilapidated edges of the urban tissue.

4. They provided a set of magnificent gateways and landmarks in the form of new bridges.

Needless to say, these developments did not come by accident, for the metropolitan area had a mature tradition of sound landscape design. The concept of the parkway may be traced to Frederick Law Olmsted and Calvert Vaux. In their project for Prospect Park, Brooklyn in 1865 they included a system of tree-lined boulevards (called "park ways") to join the parks of Brooklyn and New York from the Hudson River to the ocean at Coney Island. The concept was adapted to the motor age by the landscape architect Herman Merkel, whose Bronx River Parkway (1916-1924) incorporated not only grade-separated interchanges and limitation of access, but also sections of divided, independent alignment. Landscape-sensitive highway alignment was further refined by Clarke and Rapuano in the Westchester Parkway System, and by the landscape architect Clarence C. Coombs, who played an important role in the design of the parkway network on Long Island. Aside from this concentration of talent, the rugged topography of the region, with its pronounced ridges and large bodies of water, as well as the extreme variations in land value and building density made an important contribution to visually convincing design: there were only a limited number of logical corridors which the new highways could follow, and aesthetic and economic considerations, very often, went hand in hand.

The unique conditions of the New York metropolitan area are not easily duplicated and to some extent, they do not even prevail there any more, for most of the logical freeway corridors have been occupied. Today the huge sums of money available for freeway construction permit cutting through an urban fabric or through rock ledges indiscriminately, and user cost-benefit methods allow justification of this expenditure economically. On the other hand, guilt feelings about the expenditure of public funds for aesthetic purposes too often prevent making this slash through the urban fabric really grand and convincing; for example, placing the urban freeway in a new, 600 ft wide, depressed park strip, or in a tunnel. The result of this half-hearted approach is often visually disastrous.

Very often, when a new freeway is being located, a centerline is simply drawn on paper picking up a heavily-traveled street here, avoiding somebody's backyard there, following the invisible desire lines of existing traffic for maximum use, and avoiding some likewise invisible property lines of existing real estate for minimum cost. When completed, however, the road will become a highly visible feature, and its visually arbitrary alignment resulting from the above utilitarian procedure is likely to outlast both the shifting centroid of traffic density and the shifting nature of land use. To give the road a sense of permanence and belonging in the landscape or cityscape, aesthetic factors must be given a much greater weight at the location stage, along with the usual economic, engineering and political considerations. In fact, much of the political resistance can be obviated by an aesthetically successful solution: its occasionally higher cost can bring unexpected and often tangible dividends in the future. Patterns of land development around elevated vs subway rapid transit lines, or around urban parks are an instructive example. Moreover, some indirectness of service in areas of very high traffic demand can on occasion be beneficial by relieving the freeway of purely local movements.

The aesthetic criteria in freeway design are classified elsewhere under the categories of internal and external harmony (1). The former concerns the free-flowing continuity and three-dimensional coordination of the pavement ribbon as a sculptural element in its own right, irrespective of its setting. The latter concerns a proper integration between the highway and its environment, both on the micro-scale (treatment of the roadside) and on the macro-scale (highway location). With regard to the micro-scale, significant advances in design standards have been made in this country in the past decades, both as a result of safety research (wide medians, open overpass design), and as a result of applying the landscape design lessons of the parkways (flat, rounded and warped

Figure 2. Integration with the environment: an imaginative solution under congested urban conditions (Interstate 278 in Brooklyn Heights).

slopes, and adequate planting). Visual criteria on the macro-scale, i.e., those pertaining to location, however, are less fully developed and deserve special emphasis.

A freeway cannot be aesthetically satisfying unless it looks as though it belongs where it is put. It should not look like a foreign body in the landscape or cityscape. To achieve this effect, the planner must sense the dominant visual order in its environment, and inscribe the freeway into this order. For example, a rectilinear pattern of streets demands that the freeway run parallel to it. This results in a quiet rhythm of regular, perpendicular overpasses, and the order of the surrounding buildings is strongly felt. Crossing a rectilinear street grid diagonally or on a curve looks arbitrary and disturbing (overpasses occur at haphazard angles to the centerline, odd triangles of land are left over along the right-of-way, and a motorist leaving the freeway is more likely to lose orientation, for he cannot easily relate the freeway location to the geometry of the street grid). If a diagonal or curvilinear location is necessary, the ideal right-of-way ought to be so wide as to divorce the order of the street grid from that of the freeway. This will prevent a visual friction between the geometry of the city fabric and that of the freeway.

Rivers, lakefronts and strong ridges demand that the freeway be placed parallel to them, emphasizing an existing relationship. If a watercourse has to be crossed, a narrow spot is the visually correct place. For example, there is the contrast between the magnificent location of the George Washington or the Verrazano Narrows bridges

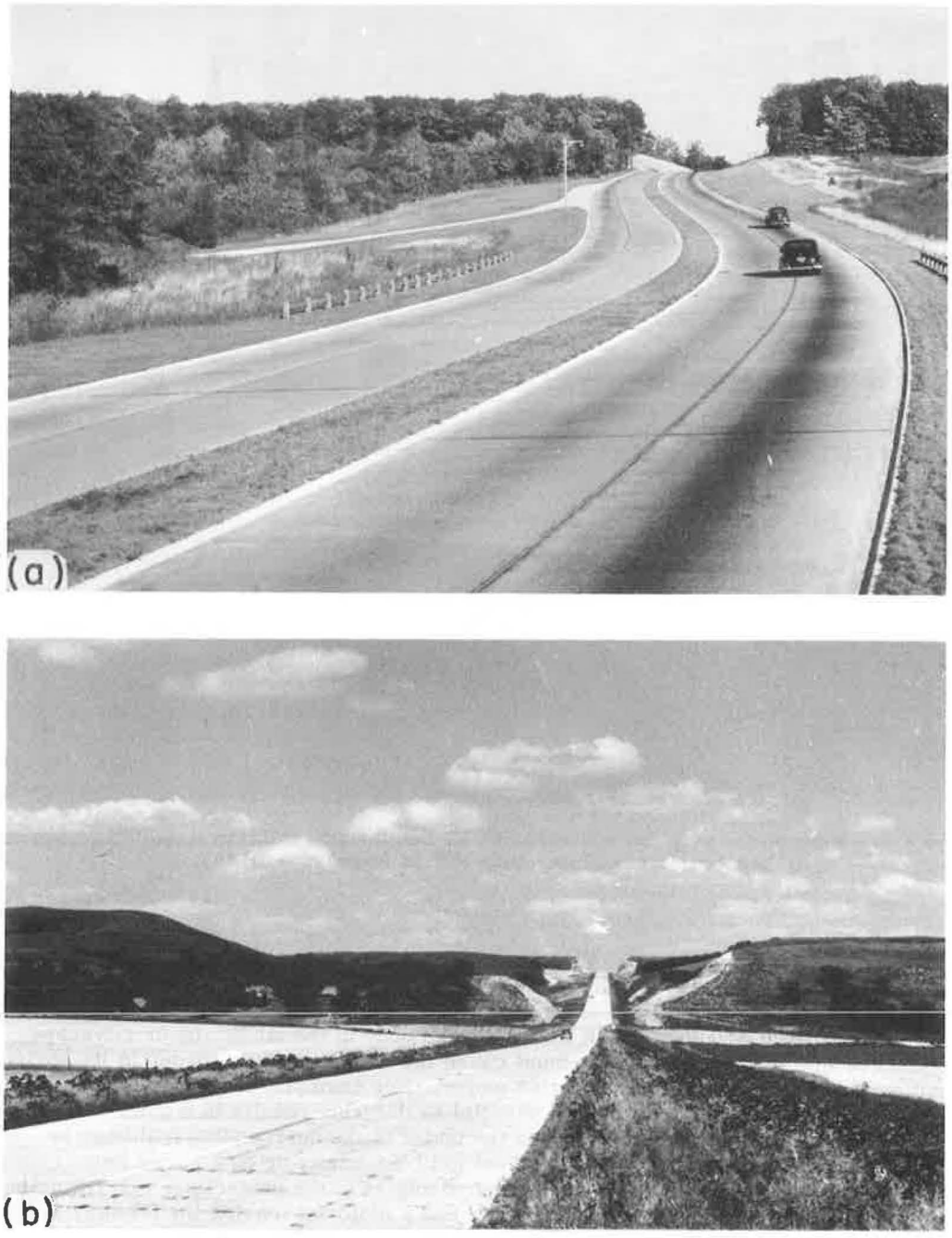


Figure 3. The ascent of a hill: (a) right and (b) wrong.

with the visually arbitrary location of the Tappan Zee or the Throggs Neck bridges in New York. The former frame an open space with a convincing gateway effect—the latter destroy a natural open space. A special culprit in the destruction of natural open spaces, particularly valleys, is the high embankment which is usually cheaper than a tall, open viaduct. Even when a viaduct is chosen to cross a valley, its column spacing

is often so close that the visual continuity of the valley is destroyed. A deep girder and a few heavy columns will invariably look better than the conventional I-beam deck supported by a forest of thin columns.

Crossing hills or ridges is different from crossing deep gullies or bodies of water. From the aesthetic standpoint such a crossing should not be perpendicular unless it is done in a tunnel. Rather, the freeway should ascend the hill gently, at an oblique angle to the contours, preferably on a curve, and should seek out a natural saddle. This can be deepended whenever necessary, but a straight slash through the hill should be avoided. Rock cuts look particularly disturbing and arbitrary when they occur at a high point in the ridge, especially if a nearby natural depression is visible but was left unused for the sake of a straight alignment. When the hills are surmounted with an undulating, curvilinear alignment in both plan and profile, no violence is done to the topography with excessive excavation or fill. Gentle curvature is also visually advantageous when entering a forest, even on flat land. In this way, the visual continuity of the forest is preserved, the roadside (seen ahead, rather than peripherally) is brought into view, and the optical guidance of the driver is reinforced.

Next to following, rather than violating the dominant natural or man-made geometry of the landscape, it is important that the freeway respect existing space enclosures. This was pointed out in connection with bridge design over valleys, but applies particularly to compact urban spaces where the dual visual nature of the freeway becomes apparent. It acts as a link longitudinally and a barrier transversly. Longitudinally, it gives the road user "views from the road"; transversely, it gives the non-user "views of the road." In locating the facility and selecting a particular design (at grade, elevated, depressed, tunnel) the engineer-architect team must firmly decide what the dominant visual values in a particular situation are, which of the two views is more important, and what can be done with them.

Figure 4. Integration with the landscape: Massachusetts Turnpike around Greenwater Lake. Notable are the relationship to both water and hill, the sculptural use of rock outcrops, and the treatment of existing vegetation.

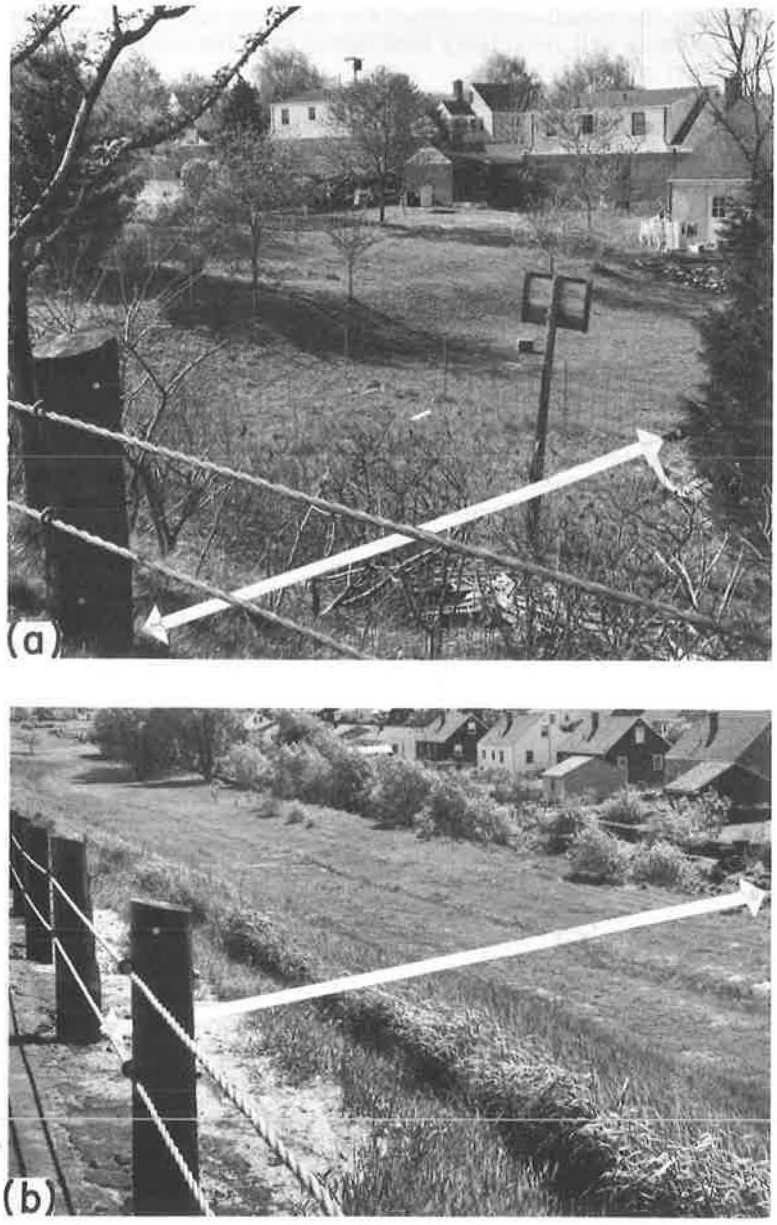


Figure 5. Right-of-way width: (a) 50 ft vs (b) 100 ft roadside border in a suburban area.

For example, a residential section of a city might be blighted because of haphazard blending with an industrial area. This may call for a boundary that will frame the former, or for a firm barrier between the two which a landscaped highway embankment can provide. At the same time, it will give the road user an interesting panorama of the urban skyline.

In another situation, such as within a purely industrial area, a barrier as strong as an embankment may be undesirable, but a lighter barrier, such as an elevated structure, might do no harm since the non-use space it traverses on the ground is aesthetically of no value. Some of the most breathtaking views are offered to motorists from elevated

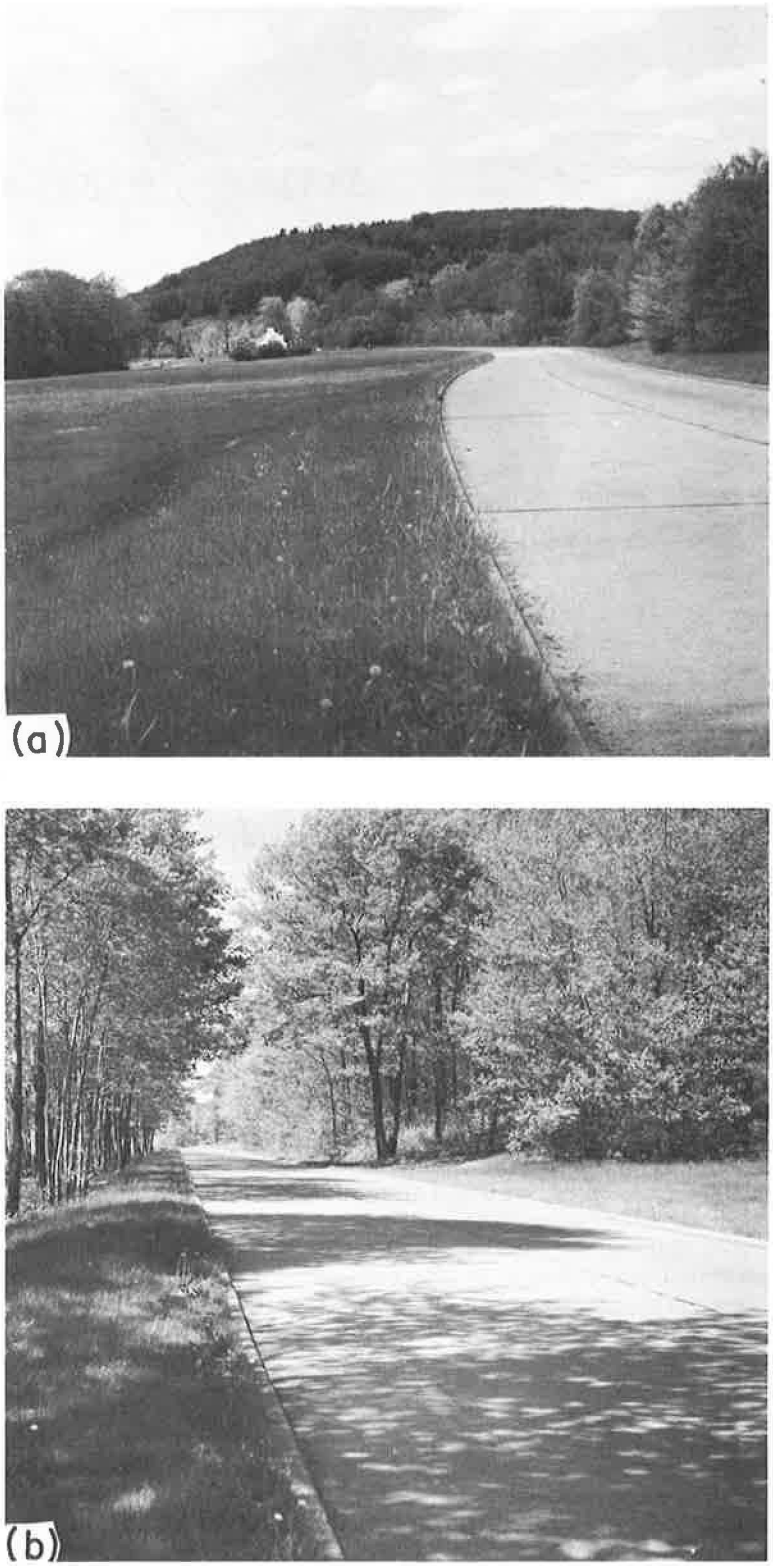


Figure 6. Alternation of openness (a) and enclosure (b) on the Taconic Parkway.

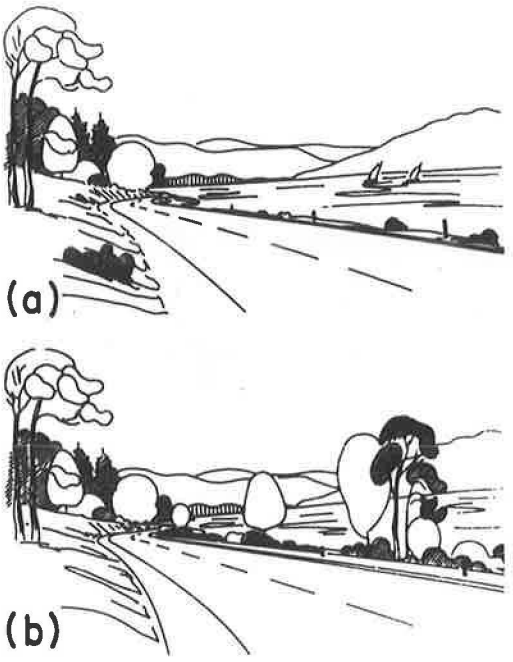


Figure 7. (a) Suggested landscape treatment between highway and body of water, from recent German landscaping standards; (b) the use of the planting veil to increase depth perception is similar to that employed on the Henry Hudson Parkway.

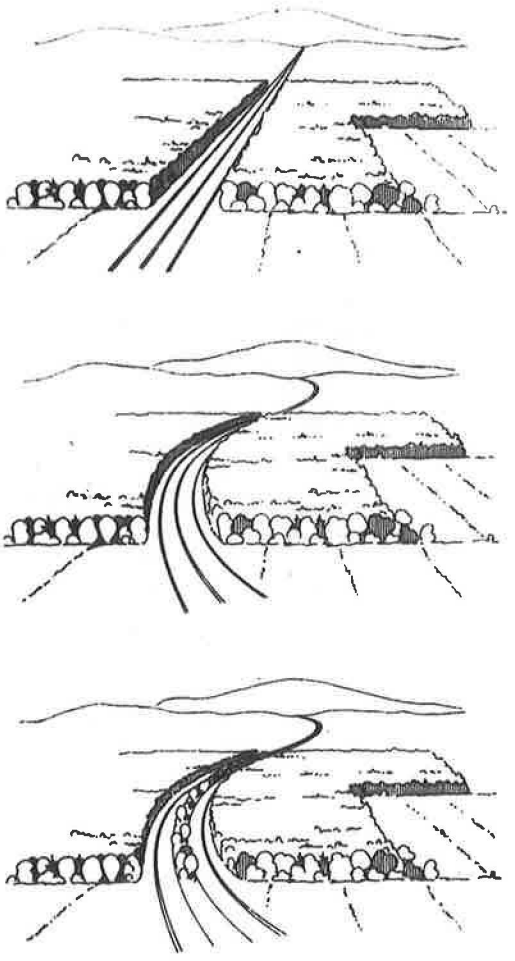

Figure 8. Adaptation of curvilinear alignment to penetrate a forest on flat land—another recommendation from 1960 German landscaping standards.

structures through industrial areas—the Queens-Midtown tunnel approach, or several structures on the New Jersey Turnpike are well known examples. However, even in industrial areas, a clean and open structural design of these facilities is desirable (such as that of the elevated Bruckner Expressway in New York.) On the other hand no amount of good design will save an elevated structure if it is incorrectly located. Structurally, the Embarcadero Freeway is quite clean and attractive; what makes it an eyesore is the fact that it separates San Francisco from the sea. In an analogous situation in New York, the elevated highway dips into a tunnel under Battery park, preserving the unity of the dominant visual space which, in this case, belongs to the non-user exclusively.

There are many high-density urban situations, particularly in central business districts, where the continuity of existing streets and squares cannot be violated by a viaduct, and where the compactness of the urban fabric makes a wide, open cut intolerable as well. In these cases, a tunnel or tunnel-like structure (such as the George Washington Bridge approach in Manhattan) is the only visually appropriate solution. Then too, there are situations in which a positive barrier would do harm, but an open space separating two sections of a city merely by distance and not by a wall is harmless or even desirable. In this case, which is so frequent, a depressed freeway design is needed. Aside from its well-publicized operational advantages at on- and off-ramps and its noise-abating qualities, a depressed freeway offers a good compromise between the visual values of the user and the non-user; both are given adequate light and air, and neither has to suffer from claustrophobia.

Figure 9. Urban skyline opened up by an elevated highway through an industrial and harbor area: Interstate 95 in New Haven.

The value of a depressed freeway as a new kind of urban open space (so sorely lacking in most central cities) can be greatly enhanced by a wide right-of-way properly landscaped and integrated with parks and playgrounds. The frequency with which even narrow and fenced-off rights-of-way are used as play or picnic areas by children or adults in spite of the law testifies to the need to integrate highway and recreational planning regardless of administrative obstacles. Again, the New York parkway tradition has been responsible for some, though often modest, experiments in this area.

Visually, the value of a wide, landscaped right-of-way in an urbanized area is manyfold. For the non-user, it provides a park-like green open relief from the sameness of an urban pattern, be it older apartment houses or new one-family house subdivisions. It can be used to delineate neighborhoods or other visually or functionally coherent areas of urban activity and at the same time to connect isolated reservoirs of open space into a continuous "matrix" of green—as mentioned in the example of Olmsted's plan. It also shields abutting properties from noise and glare. For the highway user, visual separation from adjacent uses is most important. In suburban areas, a wide right-of-way will eliminate the unpleasant sensation of driving through private backyards. In downtown areas it will preclude the encroachment of high-rise structures upon the space that visually belongs to the freeway. Moreover, the most objectionable aesthetic feature in many new urban freeways is the excessive amount of shiny metal—guiderails, fences, railings, lampposts, sign standards, etc. A wide, gently graded, right-of-way eliminates the need for some of these, and helps to make the others less prominent.

Of course, the essential price that has to be paid for these visual amenities is the acquisition of more land. The AASHO policy on landscape development for the Interstate System recommends a minimum 50-ft roadside border. Meanwhile, the same document rightly advocates 1:3 slopes to permit mechanical mowing, and rounded edges 1.5 times depth of cut. On this basis, for the typical 20-ft deep cut, so frequent in urban areas where the freeway is depressed, a roadside border of at least 80, and more likely 100 ft is essential. If frontage roads or an additional landscaped buffer are to be provided, 150-ft becomes necessary. This suggests rights-of-way at least 400-ft wide or wider,

depending on the width of the median. It appears that only such width can do justice to the inherent visual strength of the freeway and provide amenity to adjacent development. Experience suggests that roadside borders narrower than 100 ft usually result in visual conflicts. The only exceptions are probably areas of flat farmland which can encroach on the freeway quite closely (provided that no development in the area is ever anticipated), arid areas where no roadside planting can be provided, and extraordinary tunnel-like urban situations.

Although a wide right-of-way will generally provide a much more pleasant spatial sequence for the road user than a narrow one, added effort is needed to make it interesting. The three recognized devices for achieving this end are varying the width of the median and the elevations of the separate roadways, providing a sequence of open and enclosed spaces, and providing opportunities for long views in the line of sight of the driver—not peripherally. Again, the opportunities for employing any one of these devices have to be spotted in the location stage—they cannot be fully exploited once the centerline of the road is established. It is an irreparable loss that only a few short glimpses of Long Island Sound, lasting less than four minutes, are to be seen while driving for more than two hours on Interstate 95 from the New York City line to New London, hardly ever more than two miles away from the coast. The longest one of these views—at New Haven—is also the only one that was deliberately designed. The others, a few seconds each, are more or less accidental. By contrast, one of the most exhilarating freeway rides on this continent is the drive along Henry Hudson Parkway. It does not simply parallel the Hudson River, but due to changes in vertical and horizontal alignment, it brings that expanse of water and the panorama of the river into the driver's forward cone of vision. It makes adroit use of planting between the river edge and the roadway to create a veil effect that gives depth to the panorama, and it varies the driver's vantage point from near sea level to high above. With regard to varying openness and enclosure, the Taconic State Parkway is probably the most successful. Flat open meadows are deliberately alternated with dense forest growth. This contrasts favorably with the somewhat monotonous "green corridor" design of the Merritt Parkway.

Aside from the provision for long-distance views, from the alteration of openness and enclosure, the location of individual landmarks is also important. The most ordinary structures—a water tank, a telephone relay tower, a tall building—can become prominent landmarks if properly located at an elevation near a horizontal curve in the line of sight of oncoming traffic. They help the driver to orient himself and to measure his progress. Unlike advertising signs, often located in similar situations, these large-scale, abstract technological structures will neither distract nor irritate the driver. A detailed study of the desirable frequency and progression of roadside views has been recently carried out by others (2). It shows how orienting the freeway alignment toward heretofore unseen views, and anchoring it to prominent landmarks can enrich the driver's experience.

Needless to say, the aesthetic location principles of close adherence to topography, respect for an existing man-made geometry, preserving the continuity of existing spaces, separating the freeway from adjacent development and providing a deliberately designed succession of views are not presented here to supersede familiar economic and engineering considerations. Aesthetics and economics do have to be balanced. But the compromise should be the result—not the starting point of a design.

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# Education and Recruitment of Landscape Architects for Highway Organizations

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•THE PROFESSION of landscape architecture has a unique contribution to make in planning, constructing, and maintaining the highways of America. Historically, an almost automatic thought envisions highways in which landscape architects have served in important capacities throughout the conceptual and developmental stages. The Boston Fenway, the Westchester County Parkways, the Mount Vernon Memorial Highway, and the National Parkways are all prime examples of highways which continue to hold the respect of professionals and laymen alike for design adequacy and sympathetic integration into the environment.

Somewhere along the way, however, the development of highways became a less creative design process and more of an engineering process in which the application of standardized geometric design data and the yardstick of comparative economy were the major if not total criteria for the expansion of highway systems. Furthermore, the growing complexities in dealing with all of the elements that went into the highway facility—right-of-way acquisition, soils exploration, soil mechanics, grading, drainage, pavement, etc.—led inevitably to specialization. In this division of responsibility, conceptural thinking was all too often replaced by strictly applied technology. In this framework the landscape architect was for the most part relegated to the position of a specialist in erosion control, plant materials, and "general beautification." The latter meant for the most part an ipso facto application of a green mantle that would distract highway users from recognizing inherent shortcomings of the rigid application of geometric design formulas, much as an undertaker serves other aspects of society.

A landscape architect is basically more of a generalist than a specialist. He may become the latter through preference, aptitude and experience, but his greatest contribution is in the creation of purposeful order through the integration of design and technology. In a highly-specialized and complex society more generalists are needed to give a directional purpose through conceptural thought.

A landscape architect is not a civil engineer, botanist, horticulturist, agronomist, architect, hydrologist, geologist, pathologist, entomologist or forester, although he must be well grounded in many aspects of each of these fields and may acquire specialized knowledge in one or more of them. He is a planner of land and the objects upon it. His function is to integrate these arts and sciences into an entity through the process of creative design. The greatest contribution he can make to a highway organization is an integral part of the planning, reconnaissance, location and geometric design process. This does not preclude him from continuing and expanding his contributions in roadside development and maintenance operations as they have developed in recent years. It merely permits focalization of his ability and energy to areas where, by talent, training and experience, he can make his greatest contribution.

## LANDSCAPE ARCHITECTURAL EDUCATIONAL PROGRAMS

The curricula of most landscape architectural schools are oriented to a design base; that is, major emphasis is given to instruction in and analysis of creative design and the graphic tools needed for its expression and explanation. In order to apply these skills to the planning of land, it is necessary to be versed in the technology of related sciences

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and the elements of companion arts. Thus, most schools will include in their curriculum, courses in art, horticulture, architecture, civil engineering, geology, administration, and recreation to the extent that time and the individually determined curriculum balance permit. Variations in the attention given to each of these segments and to landscape design reflect both the parent institution in which the course evolved (i.e., architecture, horticulture, city planning, forestry) and the philosophies and backgrounds of the teaching staffs.

Thus, one school may have a stronger sequence of horticultural courses because it evolved in an agricultural or horticultural college; another will stress architecture, engineering, or planning for similar reasons. None make any attempt to orient their programs toward the specifics of highway design and roadside development and this is not likely to happen unless the annual demand for such graduates increases substantially.

The American Society of Landscape Architects, in conjunction with various accrediting associations, has established minimum curriculum standards, staff-student ratios and other criteria, the satisfaction of which wins for a school "accredited" status. At present, there are 16 accredited schools and they account for the bulk of graduates entering professional practice each year. The standards under which they are trained preclude any marked degree of specialization toward elements peculiar to highway design and/or roadside development. Also, under the present function of landscape architects in highway organizations, the skills most used are those related to horticulture or agronomy and their application to erosion control, screening and definition. Thus, students particularly interested in these facets are most likely to be attracted to highway work. On the other hand, true collaboration in the planning and design process calls for a high degree of creative design ability, not necessarily possessed by those with strong horticultural interest. This is not necessarily a consistent or axiomatic relationship. Graduates could have equal interest and ability in all phases of landscape architecture. However, an ability to visualize and design creatively is, in part, inherent rather than acquired, and coupled with the relative interests and abilities to master the diversity of technological subjects required, it is inevitable that each graduate will possess greater skill in some phases than in others.

## ATTRACTIONS AND DETERRENTS TO EMPLOYMENT

There are many aspects existing and in prospect that should make employment with highway organizations attractive to landscape architects. The tremendous scope of the expanding highway systems and their impact on environmental design is certainly an appealing challenge. Salary scales are generally consistent with other public works opportunities and also competitive with many comparable positions in private offices. The employment outlook is very good for many years to come, and opportunity for advancement shows a general improvement at least in the northeastern States. However, there are also some real deterrents to such employment, and these all too often more than offset the attractions.

Under most highway organizational setups, the opportunity for landscape architects to do creative design is quite limited and, for the most part expression is found in the layout of roadside rest areas and in the use of plant materials. Since most contemporary landscape architectural graduates have their major interests in the design areas of their professional training rather than in the technologies of the undergraduate curriculum, and since there is no dearth of jobs in private offices and other public agencies where the opportunities in this direction are currently greater, this will continue to prove a major stumbling block in attracting the men who appear most promising at the time of graduation.

Another problem that deters more enthusiastic applications for employment is the variety of titles under which landscape architects are employed in different State highway organizations. This diversity is understandable because of the variety of ways in which initial landscape positions were created in these organizations and the historic lack of a commonly adopted identity that has plagued the profession since early in the century. However, whatever its shortcomings, landscape architecture was the original name adopted by the profession. Through the growth of the American Society of Landscape

Architects as a common rallying point, and the adoption of laws governing the name and practice of landscape architecture in an increasing number of States, it now seems to be firmly established as the official name. It is important to understand the implications of this in relation to titles in highway organizations, since the more promising graduates, as well as establishing practitioners, automatically discount titles other than landscape architect as tending to be nonprofessional. The younger professional, particularly, feels that he cannot afford to associate himself with such a position if he is looking for acceptable experience that will permit him to qualify for a license at some future date in either his own or some other State. This same title ambiguity is often a stumbling block to good advancement opportunity, both intra- and inter-organizational, and reduces the chance for an individual to feel that continued contributions would lead to a satisfying recognition of service by the organization and by his profession.

Not the least of current problems in recruitment is the competition from other sources of employment. At present, the demand for landscape architects annually exceeds the products of the schools, at least the accredited schools. Although it is debatable whether this is an unmixed blessing so far as the future of the professional is concerned, since there is no natural attrition of weaker men beyond standards set for satisfaction of academic requirements, the result is that competition for the better men is strong, and with several jobs to choose from, they tend to select those most nearly approaching their idealized concept of what the practice of landscape architecture should be.

Absolute remedies cannot be suggested for all these problems. Only some of them are pertinent to any given situation and perhaps none are applicable to some of the more progressive organizations. It does seem, however, that these observations should end on a positive note, so in review the following are highlighted:

1. Landscape architects can increase their contributions to highway organizations and highway systems through more continuous collaboration with other responsible personnel throughout the planning, design and construction process. This would not lessen their effectiveness in current responsibilities for items relating to roadside development; indeed, it should enhance it by early elimination of problems before they become remedial in nature. In most highway organizations, such a course would necessitate a change in entrenched attitudes toward landscape architects as well as in the place of landscape architectural sections in the administrative organizations.
2. The opportunity to contribute creatively throughout the planning, design and construction stages would go a long way toward attracting a fair share of the better landscape architects.
3. Establishing landscape architectural titles for all pertinent professional positions and providing an opportunity for advancement that can lead to satisfactory professional recognition in the highway organization and in the profession will certainly identify the potential for professional contributions and make the work more attractive.
4. Constant review of salary scales, to keep them consistent with other public works and private positions of equal status, is especially desirable in the present situation where the demand continues to exceed the supply.
5. More frequent association with and interest in professional schools which most logically could supply future personnel would be mutually beneficial in understanding each other's problems, and might possibly strengthen those parts of the curricula most closely related to highway design and development. This, in turn, would increase student recognition of opportunities in the field and could stimulate enthusiasm for careers in this facet of landscape architecture.

# Aesthetic Considerations in Urban Arterial Route Planning

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•IT HAS BEEN estimated by the National Association of Manufacturers that the year 1962 witnessed a substantial increase in the Gross National Product (GNP), rising to an estimated 555 billion dollars. This indicates that the total dollar value of the nation's goods and services increased 35 billion dollars from the estimated 520 billion in 1961.

The goods produced, and the raw materials going into their manufacture, move from point of origin to point of consumption by various transportation media. Railroads, airlines, waterways, and pipelines carry selected commodities and materials. A large proportion of the raw elements and finished products reach their markets by trucks using the nation's highways. In addition, the automobile movements occasioned by home to work and return, shopping, school, church, recreation, etc., utilize available roads and streets.

The backbone of the highway transportation network is the 41,000-mi Interstate System which should be completed by 1972. Equally important are the primary and secondary systems, and the urban extensions which participate in Federal-aid funds. The public demand for an acceleration of the reconstruction of outmoded and deteriorated sections of existing highways, in addition to superhighways and expressways, is but another manifestation of the mobility of this civilization. As a nation on wheels, the people are more or less slaves to the motor vehicle.

By 1976 it is estimated that 113 million motor vehicles will be on the highways, an increase of 52 percent. A major concern is the distribution of these automobiles and trucks. The Interstate System, when completed, will comprise approximately 1 percent of the highway mileage but will carry 20 percent of the traffic. Urban streets and thoroughfares, although only one-tenth of the road mileage, now carry more than two-fifths of the traffic.

On the Federal-aid systems, the rural mileage is now operating at 64 percent of its practical capacity. On the other hand, the urban mileage is carrying 90 percent of its practical capacity. This augurs ill for the future in terms of comfort and convenience. A trip during the home-to-work period, or traversing the central city core, is all that is needed to convince one of the need for urban improvement in practically any city.

At present, a pressing need is an effective solution to the metropolitan area transportation problem. There are a multitude of governmental jurisdictions each attempting to resolve their problems of housing, water supply, sewage disposal, roads and streets, traffic, education, recreation, health and welfare, protection of persons and property, and a myriad of other activities on a local level. Hemmed in by tax limits, restricted economic bases, and limited ability to sustain financial burdens, municipalities are avoiding the problems or are succumbing to expedients.

This is understandable. Elected or appointed officials of towns, villages, cities and counties are designated to consider and safeguard the interests of their respective communities. The problems of the entire metropolitan area are beyond their interests and horizons. The scope and complexity of the work to be done challenges effective action.

An agency that can plan for a metropolitan region and also translate proposals into action programs is essential. An important consideration is that the agency has both

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the authority and finances to construct the projects that it has determined necessary. This entails public understanding and acceptance so that required legislative action by appropriate political bodies can be obtained.

State public works or highway departments are organizations engaged in highway transportation programs. It is incumbent upon them to provide the leadership necessary to progress the Interstate and other programs to their scheduled completion. To this end, all the disciplines capable of contributing to the ultimate development should be marshalled and utilized.

Freeways, expressways, and arterial route systems located within urbanized areas have such far-reaching effects upon community structure that an understanding of urban growth and development is a requisite for proper site allocation.

## COMMUNITY GROWTH AND DEVELOPMENT

### The Community Concept

An outward view of the concept of a community is confined to the physical environment immediately perceptible to the senses. The evidence of community consists of the houses, stores, factories, streets with motor cars, and people moving about the streets as they pursue the task of making a living. This is, however, a restricted interpretation of the idea of community. Wherever human beings congregate the problems associated with desires, ambitions, prejudices and other social relationships will be prevalent. The basic concept of community must be broadened and made more inclusive. Individual concepts of community will probably relate to nostalgic recollections of experiences when the tempo was slower, the stress of working less dynamic, or social relations more leisurely. Unfortunately, such reminiscences are of no assistance in formulating a workable definition. Fundamentally, community implies a sense of belonging, so that the physical environment and attendant social patterns consititute the framework of its existence.

From a sociological viewpoint, a community may be viewed as an area of common living in which a variety of cooperative and competitive interests are served by a complex of institutions that makes the unit self-contained. This concept recognizes the existence of communities as urban, rural and regional entities. A significant feature of a community in this broad sense is the transcending of political boundary lines.

### The Urban Scene

A perspective of the urban scene will vary in accordance with the location of the observer. A plan view from above will reveal a conglomerate mass which upon closer examination takes the form of cells or blocks. Within these cells are structures of varying form and dimension but which lack any recognizable organic relationship. Generally, a familiar rectangular street pattern will emerge. Open areas will be discernible, some green, others nondescript. These spaces may be devoted to parks, civic centers, recreation areas, or they may be idle waste land. The forces which have molded the structure of American cities can best be understood by analyzing the resulting land use patterns. Three generalized groupings have been distinguished—the concentric zone pattern, the sector pattern, and the multiple nuclei arrangement.

A municipality will present a greater concentration of structures at the central core. This nucleus will be marked by business buildings towering above the neighboring structures. Other similar nuclei may be visible at varying distances from the center, or the community may approximate a series of concentric bands. Wholesale houses, warehouses, and light manufacturing establishments may surround the central core. Interspersed among these business and industrial structures will usually be found dilapidated tenements, deteriorating rooming houses, and other structures characteristic of a blighted area or slum. Pushing outward from this zone in transition, a more inhabitable group of houses or tenements are found which may be distinguished as a worker's residential area. Beyond may be seen a better class of residences with open spaces between them. High-class apartment buildings are often distributed among the single-family residence areas within this band. Further in the distance the high-class

residential areas are discernible. Stretching out from the periphery may be a series of scalloped edges indicating the presence of large residential estates or fringe developments.

### The Sector Pattern

Urban expansion may follow a pattern of sectors or a radial growth from the central core. The city in outline resembles a distorted star-shaped figure. Development occurs along transportation routes with similar types of land use clustering about an axis. A significant characteristic of the pattern is that a particular type of district, while migrating outward toward the periphery, will maintain a position in the same sector. Similar types of land use evolve radially within a quadrant instead of being scattered sporadically.

### Multiple Nuclei Arrangement

City patterns may exhibit a form in which specialized activities form nuclei which tend to arrange themselves in related functional groupings. This multiple nuclei pattern of urban evolution reflects the economic and sociological background of the community. In some instances the nuclei had spontaneous and simultaneous origin, while in others, development of separated nuclei was stimulated by expansive forces.

In each case, nucleation results from a combination of causes. Specialized activities necessitate the availability of facilities peculiar or favorable to the function performed. Similar activities exhibit agglomeration when such cohesion is beneficial. In contrast, certain unlike activities are antagonistic while others must occupy less favorable areas because of competitive economic forces. The size of a city has some bearing on the extent of nucleation—the larger the city the greater are the number and variety of nuclei.

Most cities do not exhibit a distinct outline of a single pattern but include elements of each of the community forms described.

### Profile and Perspective

The city in profile presents an outline which accentuates the extreme variations in building height and bulk. The towering skyscrapers at the central business area dwarf the surrounding buildings. Roof tops form steps of varying height as manufacturing, apartment house, and residential areas progress outward toward the periphery.

A perspective of the city confronts the visitor with a bewildering pattern of ill-assorted structures adjacent to the more recently built office buildings or department stores with modern facings. The noise, the dust, the grime and the confusion of human beings scurrying to avoid motor vehicles or to reach momentarily waiting buses give the city a bizarre atmosphere. The tall buildings arranged along the travel way form canyons which deprive the lower structures of air and sunlight.

Still another facet of this scene is the portion of the city below the surface. The maze of underground wires, cables, ducts, pipes, tunnels and other service connections form a fantastic and tangled labyrinth. The pipes which convey water to the dwellings and industries, the sewers in which storm water and sewage flows to the point of disposal, the wire's which form the communication network are all essential elements of the urban community.

### Urban Causation

Cities may be viewed as the suppliers of urban services to sectors of the economy. The centralization of economic activities within the urban community is the result of technological advance, modern transportation, and the complexity of present-day society. The support of cities has been summarized in three broad categories: (a) cities as central places performing comprehensive services for a surrounding area, (b) transport cities performing break-of-bulk and allied services, and (c) specialized function cities performing one service.

Central cities are the foci for tributary areas. Trade and social activities are

centered in these locations. The distributive pattern of central place communities is influenced by available resources, evenly spaced where the land base is homogeneous, unevenly distributed in areas with uneven resource distribution. Retail and wholesale trade centers are typical central places which furnish comprehensive service to surrounding territory.

Physical features are a determinant in the location of transportation routes. Cities in turn are completely dependent upon transportation facilities. The development of transport centers where break-of-bulk occurs is a familiar pattern. Where the form of transport changes, such as water to rail, the performance of break-of-bulk and allied services is inevitable. Minor changes in transport tend to stimulate the development of servicing points which serve as nuclei for city growth. Many transport cities serve as gateways to regions of specialized production. The form of transportation influences the distributive pattern of cities. Railroad development resulted in a linear pattern of communities along rail lines. The growth of the highway network and truck transportation has aided in achieving a more uniform distribution of communities.

A natural resource, such as a mineral deposit or a favorable climate and physical feature, may serve as a nucleus for the location of a city performing a specialized function such as mining, manufacturing or recreation. Such communities often serve as stimuli for the growth of ancillary services. Mass production, skilled labor, industrial acumen, and associated interdependence may cause expansion and concentration of specialized functions in a particular city. Industry localization is exemplified by the clothing, glove, furniture and automobile industries in New York City, Gloversville, Grand Rapids, and Detroit, respectively. Most cities exhibit a composite urban causation with one feature predominating.

## Land Use Patterns

The central business district (CBD) is the locus for activities characteristic of white-collar type of employment. Here are found the banks, department stores, office buildings and hotels. Theaters, restaurants, variety and specialty shops, men's and women's clothing stores, and a host of service type establishments attract the city populace to the central focus. Professional offices of legal and medical practitioners, home business offices of large companies which deal in insurance, petroleum and other products will be found in buildings bearing their trademark.

It is here, or in close proximity, that the seat of government is established. The city hall is a characteristic landmark of many central business areas.

The convergence of the street system at the central hub facilitates accessibility so that all forms of transportation meet at this common center. Convenient access to both pedestrian and mass transportation movements permits the concentration of large numbers of people who are the economic support of the activities located at the center.

In some cities automobile salesrooms and used car dealers occupy areas bordering the CBD along main travel arteries.

Normally the functions and services that transcend individual use districts and serve the community at large are centralized in the main business area. This is the high-value section of the city. Land costs reach fantastic prices in comparison to those of outlying undeveloped tracts.

Surrounding the city center is an area in transition—the world of furnished rooms, the rialto of the half-world, little Hell—the slum. This is the forgotten area of American cities. Here in the anonymity of the world of furnished rooms may be found shattered hopes, shattered dreams, the malcontents, the failures, squalor and misery. The migrant, the homeless, and denizens of the underworld seek refuge in the tangled pattern. The deteriorating tenements and dilapidated residences are interspersed among warehouses, junk yards, freight houses and railroad yards.

A considerable amount of light manufacturing, wholesaling and associated activities are prevalent. Newcomers to the city and others seeking residence in close proximity to offices, places of business, or means of transportation near the city center will temporarily locate in this belt. This is a relatively low rent area but one of high or inflated land values. Absentee ownership and speculative interests hold control over the properties hoping to reap a bonanza from the land needs of an expanding CBD.

There are no common cultural patterns within the area, although a group consciousness may exist. In many instances, however, the restraints of group pressure for nonconformance are nonexistent. The implications of this belt of distinction are many. Here the meaning of status is vividly illustrated. Group cleavages, social differences, antagonistic social attitudes, the development of the gang, and other sociological patterns are the products of the environment.

Beyond the wholesale and light manufacturing district, is generally found a zone of workingmen's homes. These include multiple dwelling types which are within the rental income level of factory, industrial, and related workers. The structures are better maintained than those in the transition slum area but are of a lower classification than those in the middle-class apartment area which adjoins. The apartment house area houses a higher income group more able to afford the rentals necessary to provide a better type of residence and environment. A localized neighborhood business center serves the populace. Here many of the goods and services are available that are usually obtainable only at the CBD.

Near the city's extremities are found the heavy industries. Extensive land requirements preclude a close-in location, although in large or older cities, heavy industrial areas are not far removed from the urban center. These locations mark the earlier boundaries of the city. As expansion occurred the industrial area was enveloped.

Odors, fumes, noise, and similar characteristics dictate that industries be situated in the undeveloped areas near the periphery of the city. Adequate transportation facilities are a prerequisite for satisfactory industrial sites. Rail sidings from main line railroads which have a minimum of interference with street traffic circulation encourage the growth of industrial districts in the outlying regions. Modern truck transportation and the construction of highway networks have facilitated the dispersal of individual industrial plants to meet present day conditions.

The location of high-class residential districts is influenced by land values, physical features, and environmental factors. Single-family residences require sufficient land area to provide spaciousness for lawns, trees, garages, driveways and other open areas. Land costs must be reasonable if crowding is to be avoided. These residences seek high well-drained land removed from industrial nuisances or the noise of passing trains or trucks.

Beyond the single-family district may be found a suburban area devoted to land subdivisions, scattered estates, driving ranges, farm lands, an occasional industrial development and interspersed dwellings.

It will be found that most urban communities display features of each type of urban support and of the land use patterns discussed. Consequently, it is desirable to be familiar with these frameworks to evaluate properly the evolutionary forces which have conditioned a community's past development or which will influence its future growth. The uncontrolled land use pattern is not rigid but in a state of flux. City growth is reflected by a flight of population from the center outward. This causes a progressive invasion of one zone into the next so that many of the structures are discarded during the transition in land use.

Thus the city has an internal structure and a typical growth cycle which are significantly conditioned by the existing rights of ownership and speculation in land and by the competitive economic regime characteristic of contemporary American society.

This fluid pattern of land use generates many perplexing problems. The maintenance of deteriorating slum structures in the transition zone near the city center is neglected. Antisocial conditions develop which are a frequent cause of high costs for municipal services in the form of police, fire, and health protection. Premature land subdivision in the fringe areas of urban communities has resulted in the withdrawal of agricultural land from productive use, unnecessary and costly public improvements, inflated values, high governmental costs and a high per capita debt burden—results which have had repercussions in other phases of community affairs.

The eventual culmination has been widespread tax delinquency with an attendant shifting of the costs of government from these abandoned vacant parcels to the owners of improved properties.

These constantly changing land use patterns have given rise to a host of situations

that necessitate the development of soundly conceived policies in conjunction with a courageous application of effective control measures.

## Community Planning

There is a difference of opinion as to the future of the cities. In some quarters it is held that today's cities are obsolete. Consequently, all conventional planning efforts are futile. Urban renewal and other resuscitation expedients may afford temporary revivification but the changing function of the city will ultimately prevail. If this premise is valid, it indicates a greater need for planning, comprehensive in character and regional in scope.

Community planning is conceived with space organization, spatial arrangement, and space relationships. The land is devoted to activities varying in character, intensity of use, and areal demands. Most of the land is in private ownership. What is the optimum arrangement of these land use areas with respect to each other considering comfort, convenience, livability, service, internal and external harmony, and the satisfaction of human wants?

The opportunity to plan a city from its inception is seldom available. Nonetheless, the search for an organic form for the new city is a continuing process. Le Corbusier proposed his skyscraper city. Hilberseimer and Milyutin advanced the linear city with continuous industrial and residential zones paralleling transportation lines, each zone separated by a greenbelt of open space. Jose Sert suggests the assembly of a group of townships composed of community cells connected by transportation arteries.

The emerging city form appears to be a regional entity combining the linear and concentric-ring patterns, having neighborhood units as basic elements with supporting ancillary and central services. Internal harmony of a neighborhood is achieved by providing an organized and balanced allotment of space for residential use, parks and playgrounds, local shops, school and church sites, and streets. The internal street system is laid out to discourage through traffic use.

A network of minor and major thoroughfares weaves the residential neighborhoods, business and industrial use areas, and central city service areas into an organic whole.

A challenging question is, which mode of living is to be preferred, happy chaos selected as a matter of free choise, or impersonal efficient, organized cellular frigidity autocratically planned and ordered?

Existing land use patterns, future trends and growth potentialities, contemplated redevelopment or urban renewal plans are of utmost importance to those responsible for planning urban arterial routes. These arteries must provide service to the community without disrupting the present patterns of community living or stifling sound redevelopment.

In replanning CBD areas care must be exercised not to pre-empt the logical corridors for arterial relief routes in a zeal to assemble plottage for a contemplated use, nor to establish traffic movements to serve individual establishments that are impediments to a free flowing artery.

## The Complete Highway

The features that constitute the complete highway in non-urban locations and on parkways are just as important to urban arterial routes. The complete highway, according to the Committee on Roadside Development (1943), incorporates four basic elements into the design: utility, safety, economy and beauty.

Adequate service is essential to populated areas, the motorist on business trips, or the traveler just taking a ride. The comfort and convenience of people must be considered as fundamental.

A properly designed highway will be a safe highway insofar as engineering can make it. It will incorporate curvature appropriate to field conditions, sight distances commensurate with driving speeds, flattened side slopes, minimum grades, and, of course, adequate capacity.

Economy of construction, maintenance, and operation is a prerequisite. The competition for governmental funds demands that cost of construction be in keeping with the

type of facility, required maintenance expenditures be a minimum, and that road-user benefits be appreciable.

In the triumvirate of philosophic values—beauty, goodness, and truth—beauty is not an equal among equals. The cult of beauty is suspect. Aesthetic tendencies in engineering are taken as indicators of Sybaritic excesses. The morphology of land forms furnishes clues as to the action of natural forces in effecting change. Man-made alterations should not do violence to the natural scenic environment.

Rural highways can be fitted into the landscape so as to retain existing scenic values. The AASHO Policy on Landscape Development for the National System of Interstate Highways (1961) gives comprehensive guidelines to landscape design involving conservation of landscape features, cross-section elements, rest areas, trees, planting design, and controls. Many of the suggestions are applicable to aesthetic planning for urban arterial routes.

## Urban Arterial Patterns

The New York State Department of Public Works has prepared arterial route plans for 57 cities, exclusive of New York City. These are based upon comprehensive planning studies covering the entire urbanized area. The arterial patterns consist of radial routes, inner loops, outer loops, grid systems, intersecting main thoroughfares, and combinations of those elements. Arterials are depressed below grade, at grade, and elevated as conditions dictate.

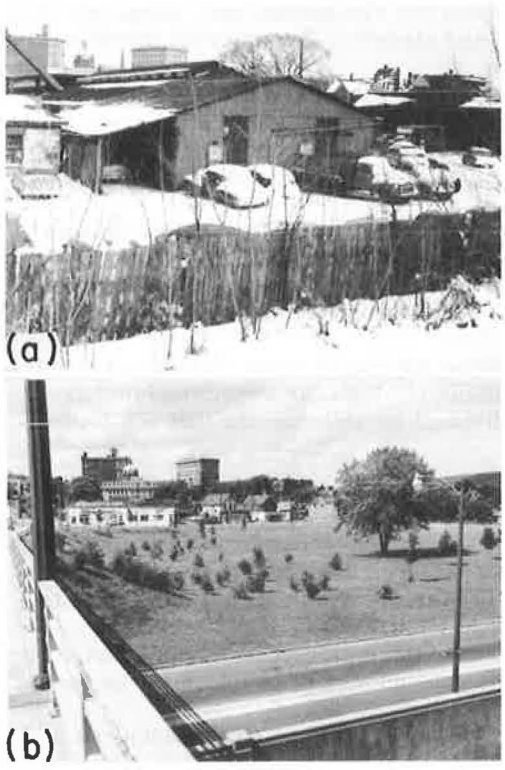


Figure 1. (a) Before: Colliers St. Bridge site looking north towards business district of Binghamton, N.Y. (b) After: same view; note new planting in foreground.

The Bi-Modal, Two-Level Central Core Area.—Until there is a change in the individual, it is unrealistic to believe that people will live in close proximity to their places of employment in order to reduce the traffic load on expressways and the urban street systems. An alternative would be to disperse the employment opportunities to locations outside the CBD or other places of concentrations. Urban renewal programs for rebuilding the core areas combined with new arterial route construction afford opportunities for bold, imaginative development.

When conditions necessitate elevated traffic ways, the elements for a bi-modal, two-level central community are available. There are already two-level highways; for example the George Washington Bridge and structures in San Francisco.

The integration of office facilities, shops, parking terminals, and service establishments with the motorway is the new exploration. Surface congestion results from attempting to accommodate unlimited volumes of people and automobiles simultaneously in a limited area.

The vehicles on an overhead arterial are already separated from ground level interferences. Why bring them down to street grade to intermingle with traffic on a local street? Keep them on their aerial way. Provide parking terminals properly located and of sufficient capacity for present and future needs. Storage lanes and ramp connections can deliver the cars to service elevators which will convey them

to their cubicle resting places. Direct passageways from the garages to department stores, office buildings and other establishments will facilitate pedestrain movement. Elevator service to ground floor and other levels will be available. This arrangement will achieve an effective separation of vehicle, pedestrian, parking, and business requirements.

The complex of motorway, stores, hotels, offices, terminals and other services must be planned and designed as an entity. Segmental development could upset the unity of design needed for successful landscape treatment.

It is possible to develop a parklike environment within an inner loop arterial complete with pathways, promenades, and sitting areas. When the open space is of sufficient area, it can be used as the site for buildings devoted to public use, such as libraries, museums, auditoriums, and governmental affairs. The grouping of governmental units, which are often scattered throughout a city, into a central location will make these services more convenient and accessible to the public. It also makes it possible to develop them into a civic center.

Figure 2. Sitting area developed along the south approach to the Colliers Street Bridge.

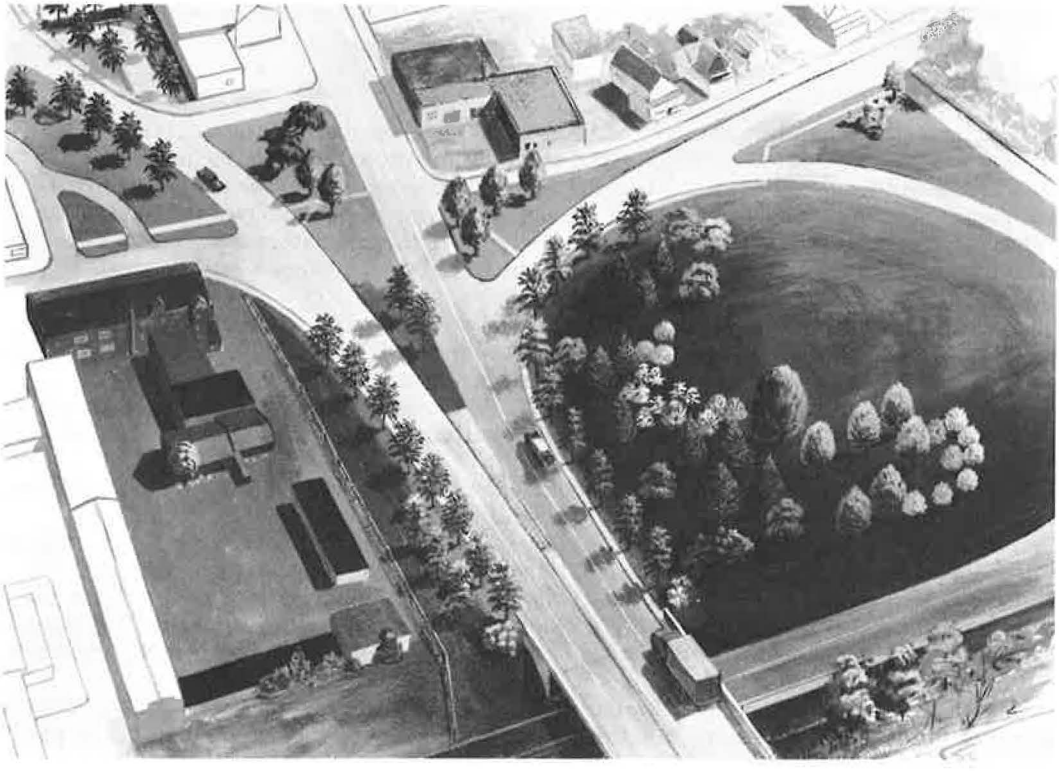

Figure 3. Sketch of Colliers Bridge looking north. Note landscape screen treatment of industrial area on left.

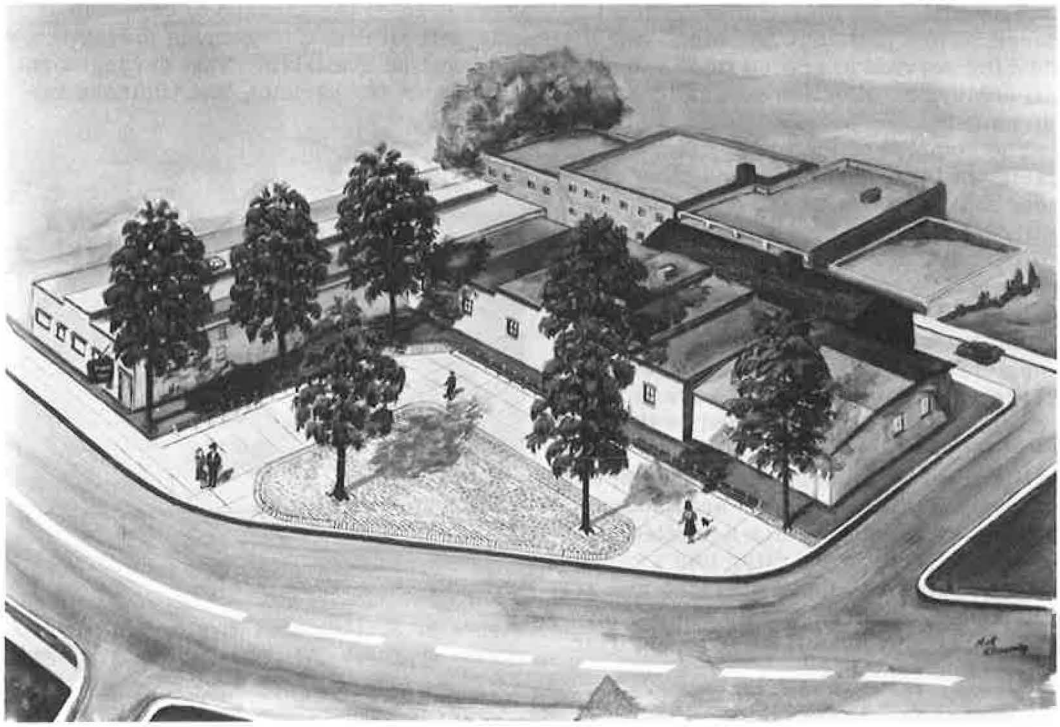

Figure 4. Sitting area perspective of north bridge approach utilizing small triangle in business district right-of-way.

The pedestrian can be protected against inclement weather by constructing underground passageways from terminals and selected locations to the various buildings. Overhangs cantilevered from the buildings and covered passages would protect those walking along the store fronts. An electrically-driven surface conveyance using the sidewalk area would be available for those who wish to ride rather than walk. The arrangements can be modified to fit other arterial route patterns while retaining the basic concept.

In the meantime the motorist on his elevated roadway can explore, with bird's eye clarity, the casual ground scene or the drab rooftops with their innumerable protusions, maze of clothes lines, pigeon roosts, sunning mats, and junk piles.

But this panorama is going to be changed. The new motorways will be constructed across the rooftops, through buildings, along building faces, or soaring in the open all as an integrated grand design.

A new roofscape will appear. Rooftop gardens with lawns, shrubs, trees, pathways, sitting areas, and pools will replace the present dreary-gray monotony.

The 3½-acre Kaiser Center Roof Garden in Oakland and the Equitable Plaza Mall in Pittsburgh transformed garage rooftops into an enchanting parklike environment. Similar treatment of adjacent roof spaces can create "the parkway in the sky" for the motorist. In addition, the bordering roof gardens or "parklets" will create a pleasant outlook for building tenants and provide comfort and enjoyment for shoppers, workers, and sightseers.

There is a world within and a world without—bathed in light and shadows—an exciting world of motion, color, form, function, and gaiety for the landscape architect to pattern and mold.

The Surface Level Arterial.—Surface level arterials afford streetscape possibilities of such scope that various art forms and techniques can be applied to achieve aesthetic

enhancement. The task of the landscape architect is to obtain a totally integrated artery—one possessing fluidity of section and alignment, and harmony with the invironment. This total integration is a fusion of the dynamic and the static. The canvas is a continuous one; the backdrop everchanging. The motorist and his passengers, the strolling pedestrian, the purposeful walker, the residents of bordering apartment dwellings, and the business houses with their customers are the viewers and the viewed.

Aesthetic awareness of the human organism is psychologically rooted. The psychological process follows the familiar S-I-R equation of stimulation, integration, and reaction. The range and character of personal experience will have an affect upon the level of aesthetic recognition and appreciation.

## Aesthetic Elements

The basic principles of landscape design may be summarized as unity, balance, proportion and scale, accent, rhythm, repetition and sequence, and focalization. These principles have been termed "forms of order" because they are utilized to help organize space into pleasing relationships. Masses of data cannot be fed into computers that will automatically create the perfect landscape design.

The landscape architect should walk and ride the selected alignment in both directions in company with the design engineer. He can appraise for himself any restrictions on curvature, grades, and construction before making suggestions for aesthetic improvement. The engineering survey will give the location of structures and other physical features. The landscape designer should re-observe the roadway scene to determine the space organization relationships along the borders and within the scope of its influence. He will require a continuous sequential visualization using photographs, sketches or Thiel's space establishment element position indicators. He will note dominant points and foci of interest such as gas holders and water spheres, public or historic buildings, distinctive examples of architecture, streams and bridges, monuments, tree-shaded areas and shelters, open spaces, plain greenery, street scenes, colorful and interesting window displays, walkways, and the permanent background of skyscape.

Selecting elements to be utilized and how to build them into the streetscape is the art of the landscape architect. Which are worth preserving? Which should be screened or accented? How to use to advantage seasonal changes in line, mass, and color. His is the art of revealment and concealment. He must give the road a personality, a unique individualism. He must create the totally integrated highway in scale with the localized urban environment. Every opportunity to accomplish this end result must be utilized.

Pathways and Beyond.—To the landscape architect experienced in park design the interrelationship of roads and paths is well understood. On arterial ways, the pedestrian is normally excluded. There are circumstances where deviation from this policy is warranted.

In Binghamton, N.Y., an arterial route borders the Susquehanna River. For a portion of its length the stream is concealed from the motorist by an earthen flood control levee. The levee changes to a concrete wall through a built-up section of the city and resumes the earthen section beyond the developed river frontage. The top of the earth levee is an excellent location for a footpath. It affords attractive views of the river. The footpath leads to the river's edge where many pedestrians relax and fish.

Apartment houses, residences, and business establishments front on an arterial street connection facing the river and the concrete flood wall. The area between the wall and the street has been developed as a park strip with tree and shrub plantings. On a ramp approach, a small sitting area has been built for use of the adjacent residences. Another sitting area sheltered by tree plantings has been provided near a bridge approach section in the midst of a solidly built-up business area. This refuge from business cares during the noonday period appears to be a welcome installation. Aesthetically the green foliage offsets the somber grayness of the buildings.

A barrier-type fence was used to control encroachment and for safety purposes. Any open space available has been quickly used as a play area by children, sometimes to the detriment of the plantings. At street intersections along both business and residential properties, a wooden parkway type of railing has been substituted for woven wire fence.

Structures in the Landscape. —What about the aesthetic treatment of structures, particularly bridges? Aesthetic treatment must be differentiated from embellishment. A bridge, because of its prominence in the landscape, needs special attention. There must be unity and harmony in the relationship of line, mass, and material of the structure itself and the larger entity, the roadway. The bridge structure has two values in a landscape. It punctuates space and is a unifying linkage in the landscape. In flat topography the approaches merit special attention. Contour grading and appropriate plantings will aid in obtaining a pleasing landscape effect.

Commercial Signs. —A feature to which the landscape architect must give serious thought on a business district arterial is commercial advertising. This does not refer to outdoor billboards, but to the normal business and store front advertising. Here is what should be viewed as a spectacular new art form.

As the artist has progressed from one school of expression to another, he has deepened his source of inspiration. He has departed from the purely imitative naturalistic form. In its place, there is the nonobjective abstraction of color, shape and arrangement.

Here is a medium of expression—glass tubing, banks of light sources, colored light, reflectorized sheets and paints—available for experimentation. It has been left to commercial exploitation. Some of the results are garish, raucous, and loud,

Rather than decry what is not liked, it would be more appropriate to remold it to what is desired. If a painting by a master depicted "Man Blowing Smoke Rings," it would be taken as a work of art. Is it not just as appropriate to accept as an artistic expression, a similar composition in which the figure blows visible smoke rings into the atmosphere?

Commercial signing is an accepted way of American economic life. The landscape architect can exert a beneficial influence on the advertiser. He will have to accept a dual responsibility. First, he will have to modify advertising displays to be in better taste and more in scale with the structure of which they are a part. Second, he will have to integrate these displays into the urban scene. They can open up a colorful changing panorama.

Urban Arterial, Industrial Areas. —Urban arterial routes in central city industrial areas afford opportunities for aesthetic rehabilitation of the environment. The characteristic atmosphere in the older areas is reminiscent of a veritable wasteland. Smoke and smog contaminate the air; untreated industrial wastes pollute streams and lakes. The cold, depressing effect of the surroundings leads people to shun the area unless necessity demands their presence.

Van Vleck Road (Route 48) from the New York State Thruway into the downtown area of Syracuse services the New York State Exposition, steel mills, and other industries along its borders. The pollution in Onondaga Lake rendered it useless for recreation purposes. Solvay process waste beds cover an area of 521 acres bordering the lake and rise to a 75-ft elevation above the lake level.

A northwest arterial connection was designed to meet traffic demands and to serve the area. The entire problem was studied with a view to reclaiming the lake potential and revitalizing the area. The final plan developed includes a lake-front park and needed parking areas. The proposed park development posed two conditions: how best to utilize the spoil beds, and the development of the ribbon area along the lake shore to the north.

A portion of the main spoil area opposite the State fair grounds was used as a parking area. The remainder to the lake edge was proposed for development as a golf course. The plan included a restaurant, a recreational area with an overlook for viewing acquatic sports, an acquatic stadium and theater, and active sports areas. At the southern tip, a passive recreational area was proposed. The area could include a botanical garden and parade grounds. The old spoil bed (about 53 acres) to the south, nearest to the city, was proposed as a city park with overlooks, park walks, sitting areas, active sports recreational facilities, and parking spaces.

It was suggested that the shore area to the north be stripped and the material used to provide a covering mat for the spoil areas to encourage the growth of vegetation. After stripping an area it could be brought to final elevation by hydraulic fill from the lake and blanketed with the stripped and stockpiled topsoil.

The northwest shore area was proposed as a ribbon park development similar to the easterly end. A park road would connect to the northwest arterial at several points. Two beach developments were proposed with bathhouse facilities and other recreational features.

The proposed plan presents a comprehensive lake-front park development with active and passive recreational facilities suitable for all ages. An integral part of the plan is a six-lane divided urban arterial route connecting the New York Thruway with downtown Syracuse.

The arterial connection has been constructed with a consequent improvement in the physical environment and traffic service. A major parking area, with a capacity for 16,000 cars, has been built adjacent to the State fair grounds. The construction of a new sewage treatment plant is helping abate the lake pollution.

The park development awaits the decision of the local authorities and industries involved as to the sequence of development and a project time schedule.

Circumstances do not always permit aesthetic treatment to the scale contemplated on the northwest arterial connection in Syracuse. The severity of outlook in industrial areas demands that landscape enhancement be achieved to as great a degree as economically feasible. The planting of shade trees along the margins of the artery and group plantings in small parklike rest areas will afford a welcome relief from a barren landscape. In some cases industrial complexes possess architectural characteristics that make them interesting elements in the highway scene.

Plants and Plantings.—The process of plant selection and placement should be governed in part by the timing requirement of specific areas. Vistas and enframement desirable in open country, may be used only in the broadest sense in urban plantings.

It may be desirable to transmit neighborhood characteristics to the traveler with special plantings, composed to stimulate interest in the immediate area. The reverse may be true. A screen may be called for, designed to limit the view of the observer until passage through the area has been completed. Thus, disturbing elements in the urban scene may be modified by plants and planting to increase the safety of the facility.

Driver guidance, related to the intricacies of interchange design, can be provided by proper plant composition used to accentuate the primary directions of travel. Alerting the traveler to anticipate a change can be accomplished with appropriate plantings.

Mass plantings in marginal areas can be designed to give a particular character to the facility, much as a single tree in colonial times served to designate a meeting place in a common. The planning should incorporate the required maintenance features, aesthetics, and economies common to urban arterial ways.

Treatment of median areas in an urban complex does not often permit planting other than that which can be integrated with maintenance practices. This usually limits the major treatment to turf areas and narrow band plantings to restrict traffic and segregate movement. Strong approaches within this sector will call for accent plantings of major importance.

An urban arterial route constructed to engineering standards of excellence in quality of materials and workmanship might give satisfaction. It cannot, however, kindle that exuberant feeling of pleasure that goes with a highway combining both practicability and a sense of order and fitness with the living environment. Aesthetic unity evokes a pleasurable emotion because of the quality of beauty. Santayana states, "Beauty is pleasure regarded as the quality of a thing." Proper space organization and utilization achieve economic unity as well as aesthetic completeness.

The resulting attractiveness is a community asset. Hammer says, "Attractiveness attracts dollars." With the CBD encountering keen competition from decentralized shopping plazas, the need for improving the business area environment is paramount. Urban arterial route construction can play an important role in this endeavor.

In a visual inventory of the urban scene, it is possible to detail the perceptual reaction to such an extent that the analytic result will have limited practical application. An evaluation of the aesthetic unity of individual scenes, a series of views, segments between critical points, or an entire artery is desired. On the basis of his observations, a landscape architect can suggest appropriate community action.

The use of a beauty potential would be of considerable interest in the evaluation process. The range of values would have to be adjusted to the judgment factors associated with each degree of beauty. However, Hubbard says, "Beauty can exist in one degree only, perfect beauty; ugliness, being disunity, can exist in all degrees, from what might be called beauty with a flaw to disunity so complete that the mind can hardly grasp the dissimilar mass of detail as forming one entity at all."

Today, it is being more and more realized that natural scenic beauty must not only be protected, but enhanced. Regions possessing distinctive scenic values should be made accessible so that they can be readily reached by the motorist. New York is in process of establishing a system of scenic and historic highways to preserve the beauty of the State for all the people. Cities can do no less. They must be made more attractive. They must be humanized, for cities are for people. The landscape architect has a vital role in the rehabilitation process.

In the words of the late Daniel H. Burnham, "Make no little plans; they have no magic to stir men's blood and probably will not be realized. Make big plans; aim high in hope and work, remembering that a noble, logical diagram once recorded will never die, but long after we are gone will be a living thing, asserting itself with ever-growing insistency. Remember that our sons and grandsons are going to do things that would stagger us. Let your watchword be order and your beacon beauty."

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# *Appendix*

## CHARACTERISTICS OF URBAN ARTERIAL ROUTE PLANTINGS CITY OF BINGHAMTON, NEW YORK

George I. Lawrence
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1. The westerly approach to the city

Pennsylvania Avenue Bridge area:

Treatment: parkway type in quadrants.

Major trees. Northern Red Oak-largest of the species used, typical rugged oak appearance. This tree will develop faster to typify the species than other oaks. It is indigenous to the area. The summer leaf is a deep lustrous green. The fall coloring is a rich red with the leaves remaining on the tree longer than for associated species. These trees were planted where they could develop into a natural form with little maintenance other than some fertilizing.

Ginkgo-(Maiden hair tree) we used only two of this species. The form of this tree is interesting. Its branching habit is different from native species being rather open and irregular with leaves mounted in almost mathematical precision. The distinct shape of the leaf and its summer color of light green arouses the interest of passersby. The fall color is a brilliant yellow. This species is almost devoid of insect and disease troubles. It can withstand air polution.

Red Maple-this native species was used along the moist dike areas. It develops rapidly into a round head crown and attains good size under favorable conditions. It silver grey bark contrasts nicely with the blood-red foliage of early fall. This is the glamour girl of our fall color in this area.

Sugar Maple-was also used in this area to a lesser degree.

The Honey Locust-a tree of major proportions with a picturesque irregular head and dark bark. The leaflets of this species are smaller than the native black locust resembling somewhat the southern Mimosa tree so famous as an ornamental from Washington, D.C., south. The honey locust is hardy, a rapid grower, providing light shade. The small leaflets eliminate the need for leaf pickup after falling.

Flowering Japanese Crabapples- were used along the lower portions of the ramps and open areas to provide color during the spring season. The floral effect of the varieties used vary from white of the Arnolds crab to pink and deep pink of the Floribunda and Hopa crabs. These trees will attain a height of 15 ft or more and vary in crowning effect from semi-upright to spreading horizontally. The fall fruit consists of miniature apples varying in color from deep red to translucent orange. The trees were massed in groups to create a greater floral display. This planting method also reduces moving costs by making machine mowing possible.

Hawthorn Trees-used to plant the slopes adjoining the bridge abutments lend themselves to the extremes in exposure found about these structures. The species (cockspur thorn) has a showy white spring floral effect. The leaves are shiny green during the summer changing to orange hues during the fall season. Vandals have been discouraged from sleigh riding on slopes where Hawthorn is planted. The trees as a specimen will attain a height of 20 ft. They are long lived and take on an oriental habit that is particularly interesting during the winter when the branches are laden with snow.

Flowering Dogwood was used in groups along the north ramp where climatic and especially wind conditions are less severe. This tree is neat, twiggy, with a heavy floral effect, and leaved with deep green half folded leaves all summer which turn a startling red in the fall. The bright clustered red fruit contrasts nicely with the green crown until the birds are attracted by the food supply.

2. Passing under the Pennsylvania Avenue underpass and proceeding easterly: The character of the planting changes from informal area landscaping to transpose into a street tree, planting as we approach South Washington Street. Honey Locusts was used along the north and south sides of the main line. A variety of Honey Locusts known as Moraine was used on the bridge approaches where sidewalks were constructed and some shade was required. The Moraine locust is a sterile variety of the native honey locust and has the same favorable characteristics.

3. Crossing South Washington Street the mainline east and west bound lanes were planted with Sugar Maples to duplicate the street tree character of this portion of the arterial. The sugar maple is the official state tree and was the tree generally selected by the early inhabitants of the area to set out along the highways fronting their lands. It is a long lived (over 100 years) hardy shade tree providing shade during the summers and our most dramatic fall color display varying from yellow to red during October. The open area south of the west bound lane was planted as a parkway planting to give composition to the area and act as a screen against the commercial structures in this area.

Pines, Austrian and White pine were used to lend a year round effect to this planting. The Austrian Pine is extremely hardy, it has a rugged appearance with rather stiff branches supporting long two needled folicles. The cones occur in cluster, are persistent for a number of years and add to the interest of this tree as a decorative species. It is relatively free from insect and disease attack.

4. South approach to Collier Street bridge:

The pedestrian walks were planted to Moraine Locust. Because of the nature of the material in these made areas and the general exposure, smaller caliper trees were used. The vigorous growth of young stock will succeed where larger trees might fail. About six years will be required for these trees to put on enough volume growth to provide the effect anticipated.

5. Crossing the bridge in a northerly direction either side of the bridge approaches were lined with Moraine Honey Locust to give an allé effect toward the main business section. The large open area to the right was planted with a combination of major and minor trees to moderate the barrenness created by the new construction. The meadow area was planted with groups of flowering crabs, a mass of flowering dogwood, intermingled with oak and pine to form a natural overstory. Maples were used to an advantage, sugar maples in the dryer areas and groups of red maple where spring waters will mean wet feet. Once again the slopes about the bridge abutments were planted to Hawthorn. These are shale slopes where only hardy native trees will survive.

Shrubs were avoided again in this area for ease of maintenance.

6. The Brandywine from Robinson Street to Frederick Street was planted with major size Honey locust as a street tree type planting. The soil conditions along this portion of the arterial are artificial being made up of ashes, by-product leather strippings. It was necessary to prepare oversized tree pits here to circumvent the possibility of chemical contamination. This tree used in a mixed commercial and industrial area will aid in the identification of the arterial route. The honey locust is hardy and will tolerate wet conditions which periodically occur in this section of the city. This tree also can occupy space along the highway in harmony with overhead utilities and lighting systems.

7. The Bevier Street bridge where a limited planting was attempted. Along the bridge fills, along the toe of slope Norway Maples were used. This low headed tree has a tenacious root system adaptable to the poor soil existing about this structure. Placement was spaced to reduce the starkness of this structure. Along the westerly slopes and flats we were able to use some flowercrabs to add interest to the area during the spring season. A sitting area adjoining State Street was planted to Norway Maple to provide a maximum shade effect. These were placed to eventually replace some Elm in the area which we will probably lose to Dutch Elm disease.

Abutting the railroad property to the east a screen planting of Laurel Willow was used. This species is a rapid grower but will not attain the major proportions characteristic of the weeping willow. The dark shiny green leaves give almost an overgreen effect during the summer. The species is native to the northeastern U. S. but is not common to this area. The soil moisture conditions of the planted locations should favor the development of this tree.

The limited space along the easterly side of Brandywine where the railroad property the north bound lane caused us to reduce screen planting technique to a minimum. Some grouping of flowering crabs was possible and an occasional major tree such as honey locust, pine or oak was used. Native hedge rows of grey stemmed dogwood supplemented our planting.

A concentration of oak, maple and pine was used to form a major screen planting along the westerly side of the Brandywine. These trees were planted with masses of Hawthorne to act as filler screen plants for the equipment storage yard area. The planting will eventually put on enough volume growth to act as a screen to maintain the driver's attention to his driving instead of diverting it toward the unattractiveness of this storage yard.

8. The large swamp area along the easterly side of the Brandywine was planted with species that are adaptable to very wet conditions. The red maple and willow are principally used where dry hummocks protruded, the Hawthorne was again used to provide some eye level interest. When these trees size up enough to make dense crowns, native water birds and associated field birds will move into the area. Towards the northerly portions of this swamp area sugar maple was added to the major tree species used in an effort to screen out some billboards on private property.

The westerly right of way on this fill section had to be carefully planted to avoid drowning the plants and at the same time being careful not to interfere with visibility. A combination of hawthorn, willow, white pine, red maple and some honey locust was used in this area to provide some interesting group plantings along this flat plain.

9. The interchange at Chenango Street the standard Honey Locust was used which will eventually provide shade for the pedestrians using these sidewalks. Because of the exposure on the Hillcrest side of the bridge, Norway Maple was used along the adjoining streets.

Some bittersweet was pocketed along the gravel slopes to form a modified slope and ground cover planting. This species has the habit of layer rooting itself to reproduce species. The fall fruiting effect will be visible against the structure. White pine was used to frame the bridge approach from the south. No other planting was attempted in this area due to the cementatious nature of the gravel and the lack of adequate soil moisture to sustain plant life.

A headlight glare problem existed at the southbound access to the Brandywine. Here shrubs and minor trees were used to increase the safety of this area. Shrubs consisting of viburnum and fragrant sumac were utilized in the north sector of this interchange where the traffic divides to go to Chenango Street or south along the Brandywine. The viburnum will attain a height of eight feet and is twiggy enough to provide a winter headlight glare barrier. Both plants have distinctive fall coloring. The viburnum will also provide a spring floral effect.

Flowering dogwood was used in this flat. Clump types were selected to aid in controlling headlight glare where greater height was required than could be provided by the shrubs. In the more open areas groupings of Red oak, sugar maple, white pine, Austrian pine, Honey locust were used to duplicate the northeastern U. S. Hardwood type and add interest and color to this area.

The base of the slope near the abutments and moving back along the bridge slope was planted to a group of flowering crabs and hawthorn where exposure increased the hazard to plant survival.

Along the westerly access, the slope ends in the swamp-type open area that is inundated in the spring flood periods. This was lined with white willow, a species noted for its interesting twig color changing habits of early spring before the leaves appear. It later develops into a picturesque tree sometimes attaining a height of 50 ft.

# Suggested Activities for Future Roadside Development Research

F. S. POORMAN and R. E. CHAMBERLIN, respectively, Deputy Secretary and Chief Engineer; and Chief Division of Roadside Development, Pennsylvania Department of Highways, Harrisburg

•IN THE PLANNING, and particularly in the actual establishment and use of safety rest areas on the National System of Interstate and Defense Highways, numerous aspects are developing with prime reference to their function. Studies of the areas already in operation indicate definite trends of public opinion with regard to services which are acceptable and those which are demanded. Paramount in public acceptance are those features relating to facilities and services. As the motoring public, primarily through direct use, is becoming better acquainted with these areas, an unfavorable reaction is beginning to be felt with respect to a lack of adequate facilities and services. Motor club officials and others feel that the lack of adequate facilities is taking away much of the pleasure these modern highways should provide. Fear of breakdown or mechanical failure (especially at night when patrolling may be virtually nonexistent) is providing motorists with an uncomfortable feeling. In spite of the availability of safety rest area facilities, the lack of service stations, food and lodging accommodations, and even recreational areas, is being questioned.

In Pennsylvania, the Department has been aware for some time that the 1958 AASHO policy on safety rest areas, which was originally followed as the basic State policy, will neither meet public acceptance nor adequately serve the purpose for which safety rest areas are being established. The following, although not officially established as a policy, represents current views regarding safety rest areas on the Interstate System in Pennsylvania.

## SITES

### Location and Spacing

The Department has prepared a statewide map showing locations, in general, for proposed safety rest areas. These locations are spaced approximately 25 to 30 mi apart along each roadway. Site location follows AASHO policy in that they are located either opposite a site along the opposing lane, or in advance of such a site. Proposed plans call for 71 sites on about 1,200 mi of Interstate highway.

The Department holds to the view that safety rest areas are a functional part of Interstate routes, and greater spacing with intervening dependence upon chance service establishments at interchanges does not reflect reasonable service needs on the Interstate System. In consideration of dual usage of sites for rest and information, attention is being given to locating sites as close as feasible to State lines on incoming lanes, and on approaches to metropolitan areas, and on approaches to intersections on Interstate and primary routes that serve areas of special attraction. These considerations, however, are within the framework of 25- to 30-min spacing.

### Size

The actual use area as designed is approximately 4 acres. Such specific limitation of size, however, is considered unrealistic in view of the need to protect rest areas from adverse abutting development. The lumbering off of contiguous wooded areas on

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the remaining part of a severed property has seriously affected one site. It is contended that provision for expansion, future septic tank fields, protection of water supply, as well as the creation of a buffer area, should be considered. Property severance boundaries and natural boundaries should also be considered in determining site area.

The area of each site, therefore, should be determined on basis of appropriateness to site conditions, need for protection, and possible future expansion, rather than on a prescribed maximum acreage. Safety rest areas, where land has already been acquired, should be reviewed with the object of increasing the area if feasible and necessary.

### Factors in Selection

Factors in site selection as per AASHO policy 1958 are being used in addition to those pertinent to utilizing the site for dispensing information.

## LAYOUT AND DESIGN

General features in design as suggested by the 1958 AASHO policy are being followed, and a standardized design, which is believed to be generally satisfactory, is being used. Topography often interferes with acquiring the depth necessary to provide a separate parking area for trucks, as has been done in Ohio. On approximately one-half of the sites selected, however, this could be done. This provision should be considered where feasible along with the possibility of incorporating truck weighing scales.

## FACILITIES

It is contended that facilities for safety rest areas, as an integrated part of Interstate highway travel need, must be considered for 24-hr, year-round use. Although not yet provided for in proposed plans, such rest areas would require the following basic items: heated building, flush-type toilets, lighting, and full-time attendants. Telephones and facilities to dispense information, as well as the usual picnic facilities, are considered essential.

## ADDITIONAL SERVICES

The Department is aware of a growing dissatisfaction on the part of motorists because of the present need to leave Interstate routes for food and fuel. The Pennsylvania Department of Highways contends that this is unrealistic in terms of a motorist's needs and the concept of rest stops for safety in terms of additional traffic and turning movements.

Although recognizing opposition to a provision for business establishments on Interstate routes, the Department contends that growing dissatisfaction could change present policy, or at least modify it. It believes that planning of safety rest areas should consider such changes, even if they appear unlikely at this time. In keeping with this concept, it is not too difficult to visualize the need for two or three different types of safety rest areas. These might fit into the following general categories:

The first safety rest area after crossing a State line could be an orientation point for tourists. Space required for truck weighing or control might well be located here. This area must be adequate in all respects, including flush-type toilets and other modern facilities. Dispensing tourist information in one form or another should not be overlooked. The size of this area would be 10 to 12 acres in order to provide complete service developments like those now in use on the Pennsylvania Turnpike. Similar, but smaller, areas would comprise a second category located near the more important Interstate intersections. A third type, perhaps known as an intermediate type, but not all inclusive with respect to tourist information and other features, would be located between the other two types.

Such a modification in policy might also consider advances made in dispensers of food, coffee, etc., and perhaps gasoline on an emergency higher-price basis so that it would not be competitive. The additional incentive thus provided to stop and take a break would encourage stops for rest and safer driving. This has been demonstrated

on the Pennsylvania Turnpike, especially during night hours when truckers in great numbers stop for coffee. This, of course, applies to all motorists. The availability of toilets and picnicking facilities will not provide the incentive necessary to stop for a rest.

It is anticipated that the increased use of safety rest areas in the future will require full-time attendants. This would cost close to $1,000,000 per year in Pennsylvania. A modification in existing policy to permit sales, as outlined above, would help to defray the cost of full-time attendance.

The proposals described constitute, in general, the position of the Department in regard to safety rest areas. It may be necessary to attain the more complete developments in stages; however, the Department firmly believes that safety rest areas on the Interstate System must aim for lofty standards if they are to meet the motorists' needs and demands.

In order to develop a degree of nationwide uniformity in safety rest areas from the standpoint of available facilities, the need for Federal financial participation for water, toilets, shelter, lighting, etc., must not be overlooked. It is somewhat difficult to visualize the public accepting the lack of modern facilities in some States after using and enjoying such facilities in other States. After all, a modern and complete highway built to certain uniform standards, and taking into consideration safe vehicular operation, should be complete in all respects, regardless of the State where the national highway may be located.

It is fully realized that this may sound like an ambitious program. Frankly, it is. Its impact, if studies merit even a portion of its adoption, will be great and will require considerable modification in existing policies both at State and Federal levels. As more and more mileage on the Interstate System is opened to traffic, it becomes imperative to begin studies of the desirability of providing for modifications of this vital part of the highway system. Since legislation probably will be required to permit the establishment of service stations with necessary accommodations, it is recommended that this and other matters outlined above be given consideration. A greater degree of uniformity in the establishment of these necessary facilities in the various States appears highly desirable.

Another proposed roadside development research project worthy of consideration concerns the use of functional plantings for noise abatement. Although a significant amount of data has already been accumulated, and reports have been compiled by special task committees of the Highway Research Board and others, a difference of opinion as to the degree of noise abatement that can be achieved with buffer plantings still exists among engineers and acoustical experts. It is, however, generally agreed that if predictable results can be guaranteed, property values and settlement costs will be considerably affected. Even if the noise factor is not completely eliminated, the effect of it will be minimized psychologically as a result of a planted barrier.

Since present day techniques and instruments apparently permit recording, measuring, and reproducing all degrees and intensities of sound, would it not be possible to initiate a study involving the recording of noises of different origin, which would be reproduced in situations influenced by existing vegetation, topography and other physical features that might affect the flow of sound waves? This sort of a before-and-after study would permit the presentation of results in tabular form, thus enabling engineers to interpret data and recommend solutions within reasonable performance limits. If such a study is feasible, consideration must be given to topography as related to depressed and elevated roadways, buffer walls, mounds of earth, the different types and densities of vegetation, and the degree of noise permissible in different areas with allowances for local sounds, already characteristic of the area.

# A Concept for Interstate System Rest Areas

EDWARD C. ECKERT, Chief Forester, Michigan State Highway Department

•THE American Association of State Highway Officials Committee on Planning and Design conducted preliminary studies in 1957 leading to formulation of a uniform policy for rest areas along the Interstate System. Two types of service areas were considered: safety turnouts and rest areas.

Since there are marked similarities between these two types of service areas, particularly in regard to the ramp and parking area design, final action by the States on April 30, 1958, combined the two classes into one designation--safety rest area. Subsequent developments have proved the wisdom of this action since, in the majority of cases, the States are constructing rest areas with complete service facilities.

To a large degree, much of the current rest area policy stems from the knowledge and experience gained from the operation of roadside parks, the forerunner of rest areas. Although this procedure was logical and helpful during the first stage of the Interstate System, present developments have shown a marked difference between a rest area and a roadside park. They are separate and distinct service areas. Some of the difference stems from the fact that the Interstate System is limited-access, which is restrictive in driver behavior. This occasions a heavier usage than is true of roadside parks along uncontrolled access facilities. Since many motorists do not wish to leave the freeway, the need for rest areas becomes increasingly important. Rest areas attract greater trucker patronage than do roadside parks, and in addition, they are designed and intended for day and night use on a year-round basis.

Perhaps no single factor can have a greater bearing on the care and policing of rest areas than the attention and study given to site selection and design features. Many difficulties may be avoided if the designer recognizes the potential troublesome administrative problems which are certain to arise from a lack of careful analysis during this period. For instance, in the case of roadside parks, it was thought desirable to select sites where abundant shade existed. There was much merit in this policy as far as roadside parks are concerned. However in the case of rest areas, heavily-wooded sites may tend to discourage patronage, particularly at night. In support of this contention, a rest area survey conducted in Michigan during the summer of 1961 found that 61 percent of those interviewed stated that they would not use a rest area if it were unlighted. Dense woods would similarly influence the 39 percent "Yes" response to this query. A few well-formed shade trees provide a restful environment, but an over-supply acts as a use-retardant. It has been observed that the restful feature of a rest area is a well-maintained lawn. This becomes difficult to establish in a densely-wooded area. Likewise, the mosquito problem is aggravated in heavy woods and site aeration is lessened to contribute to a damp and rather dark situation. Woodlots are often poorly drained, particularly in agricultural areas. With regard to rest area design as related to administrative factors, a location should be selected where the use of lands adjacent to the site is regulated by some form of zoning. Incompatible developments located adjacent to rest areas create difficult administrative problems. Commercial enterprises, for instance, can seriously interfere with economical rest area maintenance.

Generally speaking, it is desirable to select sites for rest areas which are a reasonable distance in advance of sizable urban centers and important trunkline junction points. Such locations allow the motorist to stop and refer to maps before continuing

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his trip, or possibly telephone ahead to make arrangements while still traveling. Referring again to the Michigan rest area study, it was determined that 50 percent of the motorists interviewed expressed the opinion that rest areas should be spaced from 40 to 60 mi apart along each side of divided highways.

The normal shape of a rest area should be rectangular with a long axis of 1,200 to 1,400 ft parallel to the main highway with a depth dimension of 200 to 300 ft, extending beyond the normal right-of-way. From an administration standpoint, the relatively shallow depth permits easier viewing of the entire area by passing patrol vehicles.

All things considered, a site having topographic grades approximating those of the roadway will be found most economical to maintain. Slightly undulating sites will not unduly increase construction and maintenance costs, but sites necessitating excessive cuts and fills should generally be avoided.

With respect to positioning service facilities in the rest area grounds, it will usually be found advisable to place both truck and car parking relatively close to the main roadway. Angle parking of trucks and cars has been found to be the most satisfactory parking pattern. Figure 1 is a plan layout of a typical design incorporating this arrangement.

The toilet structures should be easily accessible and normally in close proximity to the parking area. Winter maintenance is more economical, and the toilets are more quickly reached during rainy weather.

The well should be located according to health department regulations, and again should be placed where easily reached.

Locations for other facilities such as a bulletin board and telephones should be in keeping with the rule of least inconvenience.

All buildings and grounds should be adequately lighted—the "On" and "Off" switch being actuated by a photoelectric eye.

An internal system of sidewalks should be provided so that all interior units are joined with the parking area.

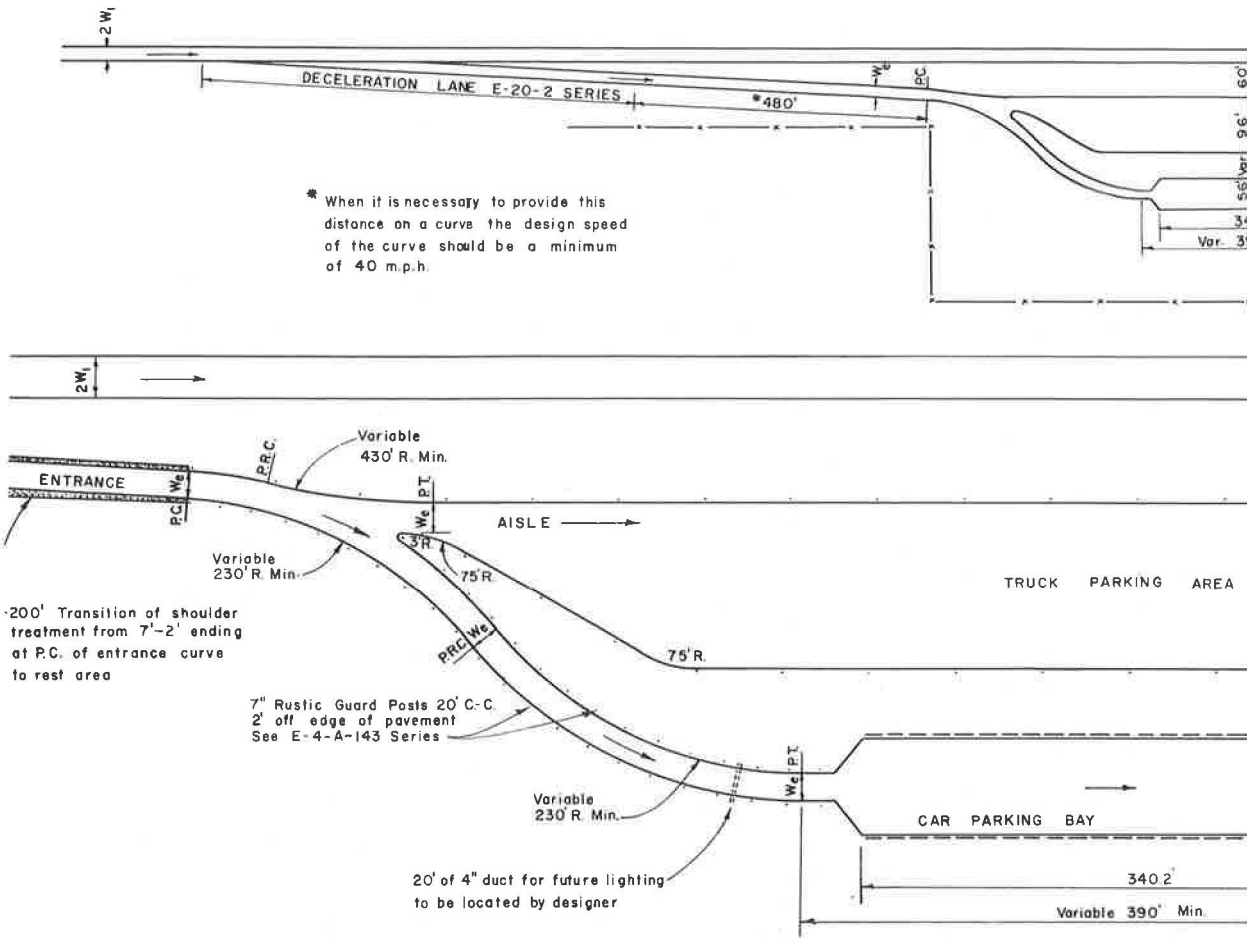
An ample supply of refuse barrels should be provided and appropriately marked to encourage their use.

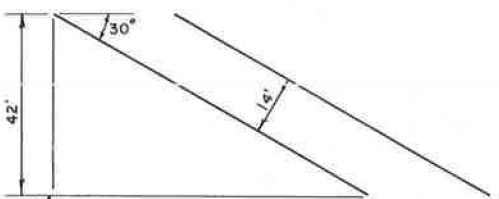
Landscaping the rest area grounds should follow as a final refinement to create a homogenous park-like atmosphere throughout the area. As previously indicated, no attempt should be made to screen the toilet structures.

The main theme of the planting should be one of simplicity, utilizing plant materials for accent purposes and general interest.

Having fulfilled the desirable design considerations, the next concern is for policing the area once it is opened for public use. At the outset it must be emphasized that a high standard of maintenance is mandatory. Neglect begets neglect and mis-use on the part of the public, with the final result being excessive vandalism and loss of respect.

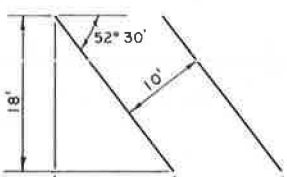
The study, previously referred to, further revealed that 43 percent of the persons who stopped at rest areas used the toilet facilities first. The next most popular service was resting—23 percent; drinking water—20 percent, picnicking—4 percent and 9 percent used telephones, bulletin boards and trash cans. Since almost 50 percent of rest area users stop because of the need for toilet accommodations, the first item of maintenance concerns the attention given these facilities. Regardless of the type provided—pit, chemical, or flush style—there can be no half-way measures insofar as maintenance is concerned. Toilets must be maintained in a continuously high degree of cleanliness. Usage volumes will dictate the degree of maintenance and manpower required to attain a satisfactory standard of sanitation. Design of toilet structures plays an important part in adequate sanitation and ease of maintenance. Buildings must be well ventilated, amply lighted both day and night, and the facilities positioned so that reasonable interior privacy prevails. Interior walls should be finished with varnish impregnated with a material such as clean sand to discourage obscene and disfiguring markings. Insect control should be included as part of installation. Hinged doors should be omitted in favor of stationary screen walls. Floors should be of cement-concrete construction and coated with a sealant material to prevent permanent staining. In flush-type facilities, a design which provides for fixtures attached to walls rather than




TRUCK STALL

Length of truck parking area is the product of the number of stalls desired and 28'.




CAR STALL

Length of car parking bay is the product of the number of stalls desired and 12.6'.

The orientation of the parking areas and the thereto may be changed to fit the location.

A minimum of 24 truck parking stalls shall b of townline 12 north and a minimum of 12 stalls north

When the number of truck parking stalls provid position are less than 24; i.e. 12, they should be situ exit from the rest area.

If the orientation of the rest area is changed, t stalls should be so situated as to keep the length of

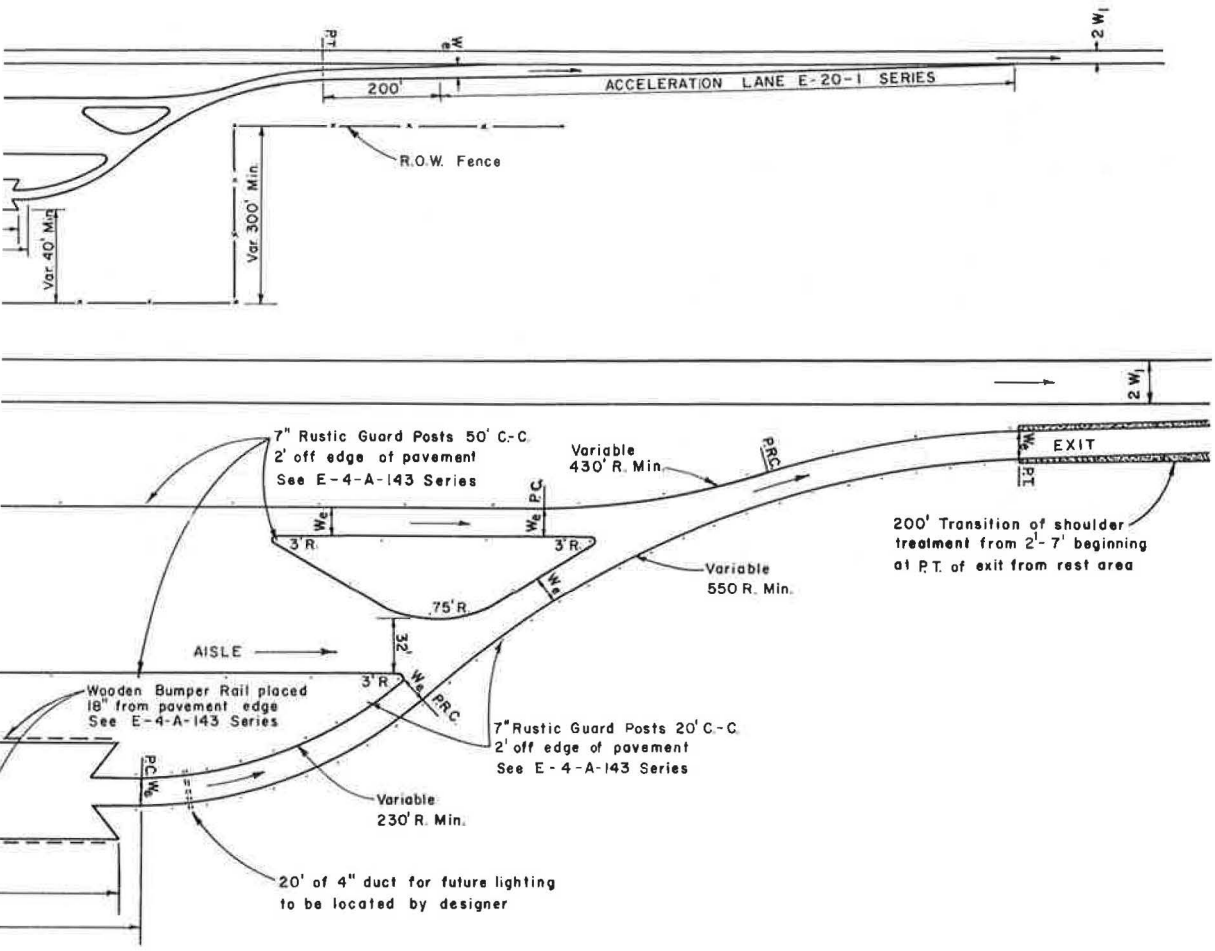
Surface generally to be as follows: 18" subbase, 130 lb. bituminous leveling course, 120 lb. bituminous c

Pavement may be concrete in the event that th included in the contract with the main roadways and bituminous concrete in the contract.

Curves are not to be superelevated.

Use 3' valley ditch where no subase is required. is required, drain with edge drain where outlet is av use minimum ditch to drain subbase on the inside of ea and approaches. Use 3' valley ditch on outside.

Figu




GENERAL NOTES

Use 4' shoulders of native soil or subbase material with top soil surface and seeding.

Information board, telephone booths, well, toilet buildings, and walks to be located as directed by Chief Forester.

Rest area is to be landscaped as directed by Chief Forester.

Allow a lump quantity for top soil and sod for use as directed around information board, telephone booths, well, and toilet buildings.

Provision for outlet for pump overflow to be made as directed by Chief Forester.

Prior to completion of plans, check to determine whether information board, telephone booths, well, or toilet buildings are to be included in the contract.

R.O.W. fence as per standard.

Ramp width ($W_e$), 16' minimum

$W_1$ Normal lane width used on freeways (usually 12')

Pavement marking as directed by Traffic Engineer

A minimum of 54 car parking stalls shall be provided.

MICHIGAN STATE HIGHWAY DEPARTMENT
STANDARD DESIGN GUIDE FOR

# REST AREA

THIS DRAWING TO BE USED AS A GUIDE FOR DESIGNERS

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the floor permits more economical maintenance. Concealed valves are less subject to vandalism. Fixed glass-block windows are likewise desirable in rest area toilet buildings. This, of course, necessitates ample ventilation of the toilet rooms.

Grounds maintenance should include a liberal number of refuse barrels strategically placed. One 50-gal drum should suffice for 3 picnic tables. One or more barrels should be placed within easy reach of the truck-parking area for truckers who add motor oil during their stops.

Wherever possible provisions should be made to water the lawn. As previously mentioned a well-maintained lawn produces a restful relief from eye strain resulting from extended periods of driving.

It would be difficult to attempt to prescribe a specific pattern of maintenance. Under normal conditions, it will be adequate to police a site once during the morning hours and again in late afternoon. This should be considered a minimum and range upward to the assignment of a full-time caretaker. If estimated traffic volumes along the Interstate System prove accurate, it may be assumed that by 1975 the assignment of a full-time attendant will be necessary. At such time, a uniformed attendant should be employed.

Where modern comfort station facilities are available, periodic night-time visitation by law enforcement officers should be provided. Information reveals that 92 percent of the persons interviewed indicated that rest areas should be open 24 hr a day all year.

From the experience to date, rest areas are an essential and integral part of the Interstate System of Highways. The quality of service provided in these areas must be in keeping with the high standards being incorporated into this system of freeway facilities.

# Progress Report on Noise Abatement

WILBUR H. SIMONSON, Chief, Roadside Branch, Bureau of Public Roads

•THIS REPORT has been prepared to show the progress on noise abatement during the period from 1960 to 1962. It is a record of printed information as of January 1963, supplementing information previously published by the Highway Research Board in the reports of the Committee on Roadside Development (HRB Roadside Development 1961, p. 2-4).

The majority of articles published over the past two years relate to airport noise, particularly the jet noise problem in communities where abatement is difficult and costly in comparison to the abatement of highway noise. The noise problem is likely to dominate airport development. Noise control requires early collaboration of airport, government, and local authorities for planning present and future airports and their surroundings. For example, in 1961 in Great Britain, extensions of runways included formation of an earth embankment to shield local residents from engine noise. A considerable number of articles were published in Great Britain and Germany during 1961 and 1962 on measurement of noise emitted by vehicles.

The problem of noise control has now reached a point where it can no longer be ignored in highway planning. In cities and the urban-rural fringe, the Interstate highways carry heavy streams of traffic. In the total concept of urban freeway design, as recommended in the June 1962 Hershey Conference Report on "Freeways in the Urban Setting," basic principles must be considered separately and in relation to one another. They include not only those pertaining to the structural and geometric standards of the freeway itself, but also those pertaining to the amenities which the well-designed freeway offers its users and the residents of the areas it traverses, including those related to social and economic community values.

With the increase in traffic volume, it has been necessary to take measures to control the amount of noise to which people are exposed on or along major arterial highways. The December 1961 Consultant's Report, "Street and Highway Traffic Noise, Washington, D.C.," prepared for the District of Columbia Department of Highways and Traffic, contains data that will be helpful in paving the way for noise control which will be considered a basic requirement of the total area of highway planning and engineering. It is obvious that there is less reaction to highway noise in communities where the source of the noise is unseen. This opens the door for independent roadway design and screen planting which will be included in basic highway planning and design. The consultant's report cited above discusses the aesthetic and psychological impact on the public of landscape design in noise control, including structural features that might be included in the engineering design for noise control. (A preview of this report is on p. 3 of the 1961 Committee Report.)

Noise criteria in residential areas were discussed in "Train Noises and Use of Adjacent Land" by T.F.W. Embleton and G.J. Thiessen, members of the National Research Council of Canada. This timely article was published on page 7 of the Jan.-Feb., 1962 (Vol. 1, No. 1) issue of "Sound—Its Uses and Control," a publication of the Acoustical Society of America. It describes the effect of train noises on the industrial and residential uses of the land adjacent to the railroad right-of-way. Sound pressure levels are given for a variety of train noises at a given distance from the tracks, taking into consideration the effects of the environment such as cuts, barriers of various sorts, trees, etc. Track noise may be reduced to acceptable levels for an urban residential area at a distance of 300 ft from the right-of-way and engine noise at a corresponding distance of 500 ft, if a cut of suitable depth is employed.

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In the city complex, there is more concern with the physical design and development of the highway itself. It is in the city that considerations of urban amenities are added to the design requirements. Here there is concern with the impact of traffic noise on the surrounding area, particularly to dwellers on abutting property. Modern highway planning is not only concerned with the conservation and development of an appropriate highway environment for the motorist, but also for the community. Here highway administrators, locators and designers, and their associates have an overall responsibility to make the completed highway pleasant and agreeable to all concerned. The engineering involved takes on the broad aspect of urban environmental engineering.

Public relations have spurred a re-evaluation of willingness to do something about noise. This is discussed by Howard T. Burris of the Burgess-Manning Company, Dallas, Texas, in the Sept.-Oct., 1962 issue (Vol. 1, No. 5, p. 7) of "Sound." His eye-catching article is titled, "An Approach for Quiet Neighborhood Planning." The author discusses the problem of establishing a satisfactory silencing program for an industrial plant making noise that may annoy neighbors. The treatment takes into account the noise level acceptable to the resident as well as the noise level of the manufacturing equipment.

Appropriate planting of rights-of-way is important as a means of noise abatement. Functional planting for this purpose is one of the elements of design requiring careful consideration. Appropriate planting can help to make the city more attractive and blend the freeway into its urban environment at the same time. A width of 60 ft or more of right-of-way on the outer roadside borders is desirable for buffer planting. Although roadside space for functional planting is limited in urban areas, adequately planted borders lessen the sense of crowding buildings against the roadways, and also insulates adjacent residential and business properties from the noise and fumes of traffic.

On p. 4 of the March-April, 1961 issues of "Noise Control" there is a comprehensive and clear-cut article on "Measurement of Noise" by Lewis S. Goodfriend. This review summarizes the essential requirements and performance characteristics of most types of noise measurement equipment. The environmental conditions under which measurements are made, and an appreciation of the characteristics of the noise being measured are also discussed. Decible notations and use of units in sound measurements are reviewed.

The material presented in this paper outlines the techniques and problems of noise measurement. The references cited by the author should be helpful for the actual planning or design of a test facility or procedure.

Community reaction has brought the challenging problem of noise abatement to engineers responsible for highway development. This requires positive consideration of traffic noise factors in the planning and design of major arterial routes.

A short list of pertinent 1960-62 references follows.

## REFERENCES


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# Mulching Practices and Materials

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•THIS REPORT is essentially an extension of Frank Brant's report made before this Committee at the 40th Annual Meeting of the Highway Research Board and published in the 1961 report of the Committee on Roadside Development. His definition of mulch

TABLE 1

EROSION-CONTROL MATERIALS 1962

| State | Hay or Straw | Wood Cellulose | Soil-Set | Soil-Saver | Other[1] |
|---|---|---|---|---|---|
| Ala. | H | X | X | X | Excelsior |
| Alaska | - | - | - | X | Naturally-occurring materials. |
| Ariz. | S | - | - | - | Now testing various erosion control methods. No materials listed. |
| Ark. | S | X | - | - | |
| Calif. | S | - | - | X | |
| Colo.[2] | - | | | | |
| Conn. | H | X | - | - | Wood cellulose in combination with bran and resins. |
| Del. | S, H | X | X | - | |
| Fla. | S, H | X | X | X | Knitnet; Troyturf; Fiberglass; Ultracheck; Bagasse. |
| Ga. | S | X | X | - | |
| Hawaii | - | - | - | - | Sawdust and wood chips on plant beds. |
| Idaho | S, H | - | - | - | |
| Ill. | S | X | - | X | Mulchnet; Erosionette. |
| Ind.[2] | - | | | | |
| Iowa | S | X | X | - | |
| Kan. | S, H | - | - | - | Glass Fiber around trees and shrubs. |
| Ky. | S | X | - | X | Mulchnet; Erosionette; Knitnet. |
| La. | S | - | X | X | Knitnet |
| Me. | H | X | - | X | |
| Md. | S | X | X | X | |
| Mass. | H | - | - | - | Wood chips |
| Mich. | S, H | X | X | X | Troyturf |
| Minn.[2] | S, H | | | | |
| Miss. | S | X | X | - | |
| Mo. | S | X | - | X | Ultracheck; Paper netting. |
| Mont. | S | - | - | - | |
| Neb. | S, H | X | - | X | |
| Nev.[3] | - | | | | |
| N.H. | H | | | | |
| N.J. | H | X | - | - | 3½-in. layer Salt Hay on plant beds; also licorice stems. |
| N. Mex.[3] | - | | | | |
| N.Y. | S, H | X | - | - | |
| N.C. | S | X | X | X | Troyturf; Glass Fiber; Asphalt; Pitch cobubles. |
| N.D. | S | - | - | - | |
| Ohio[2] | S | | | | |
| Okla. | H | X | - | X | Asphalt emulsion over mulch sod; Ultracheck. |
| Ore. | H | X | - | X | Knitnet |
| Pa. | S, H | X | X | X | Ultracheck |
| R.I. | S, H | - | X | - | |
| S.C. | S | X | X | - | |
| S.D. | H | - | - | - | Mulchnet |
| Tenn.[2] | - | | | | |
| Tex. | S | X | X | - | Asphalt |
| Utah | S | X | - | - | |
| Vt. | H | - | X | - | |
| Va. | S | X | X | - | |
| Wash. | H | X | - | X | |
| W. Va. | S | X | - | - | |
| Wis. | S, H | - | - | - | |
| Wyo. | S | - | - | - | |
| Total | 43 | 27 | 16 | 17 | |

[1]See Appendix for individual State evaluations or comment on "other" and Soil-Saver materials.
[2]No report, 1962.
[3]No mulching.

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will be repeated: "Mulch, as dealt with in this paper, means a surface cover of either organic or inorganic material. Included is the practice of partial incorporation of mulch material into the soil as a means of holding it in place, but excluded is mulch material fully incorporated as a soil amendment. Also excluded is the tillage practice of soil mulch or dust mulch."

The purpose of this report is to follow up on trials of mulching materials and practices made by the States subsequently, and to record their evaluation of trials as an assistance and guide to others in the continuing search for improved methods and results in erosion-control practices. A composite picture of the major materials now in use or under trial, based on reports received from the States, is given in Table 1. Hay or straw is predominant among the materials being employed, and they are the standard control materials used in trials of new materials and methods.

In addition to the exhaustive list of mulching materials and practices presented in the 1961 report, two new items have been reported—bagasse and excelsior. Bagasse would probably be considered a local material, whereas excelsior would have a wider

TABLE 2

WOOD CELLULOSE

| State | Soil | Date | Slope | Exposure | Subsequent Weather | Check Plots | Remarks |
|---|---|---|---|---|---|---|---|
| Ala. | Sand, Clay | July 1961 | 3:1 or flatter | E & W | Rain, 19 days | Hay | Some rilling; no erosion or hay plots. Excellent grass stand all plots. |
| Ark. | - | April 1960 | 3:1 fill, 2:1 to 3:1 cut | - | Normal | Straw | |
| Conn. | Sand | Aug.-Dec. 1961 | 2:1 or steeper fill slopes | E & W | Drought, high evaporation | Hay | Severe test conditions. All treatments were equal to hay as mulch material; all provided adequate erosion control. |
| Del. | | | (No details. See Appendix.) | | | | |
| Fla. | Sand | March 1961 | 2:1 fill | All | Normal Heavy rain May 26 | Hay | Severe wind erosion one Turfiber test section. No significant difference in growth of grass. |
| Ga. | - | Fall 1961 | 1½:1 to 3:1 cut | All | Normal | Straw | Growth better than straw check plot. |
| Ill. | | | (No details.) | | | | Used on critical areas with good results. |
| Iowa | - | Fall 1961 | Various | - | Above normal rainfall | Straw | 4 trials: satisfactory to unsatisfactory. Against erosion not as effective as straw. |
| Ky. | - | Fall 1962 | - | - | - | - | Too early to evaluate results. |
| Me. | Heavy clay, silts, gravel | Aug. 1961 | 2:1 or steeper | N & S | - | - | Excellent catch of grass. Not a satisfactory test for erosion control due to lack of heavy rains. |
| Md. | - | Oct. 31, 1961 | 4:1 fill; 2:1 cut | N & S | - | Straw | By Feb. 1962 Turfiber had given practically no erosion control. Germination was superior on straw-mulched areas. |
| Mich. | Sand | May 1961 | - | - | Extended dry period. | - | Experiment did not prove successful. |
| Miss. | - | - | 3:1 cut | N & S | Excessive rainfall | Straw | Demonstration plots did not give adequate erosion control nor the residual results obtained from straw mulch. |
| Mo. | | | | (No details.) | | | Recent experiment, comments reserved. |
| Neb. | | | | (No details.) | | | Used in maintenance-repair work. Good results. |
| N.J. | - | Sept. 1962 | - | - | - | - | Applied on plant beds at different thicknesses to control weeds. No conclusions. |
| N.Y. | - | Oct. 1962 | - | - | - | - | 40 Ac. application. No evaluation possible (Oct. 11, 1962). |
| N.C. | Clay | Aug. 1962 | 2:1 cut | E | - | Straw | |
| Okla. | Loam | April 1961 | 3:1 cut & fill | N & S | No rain 3 wk then 2¾ in. in 1-day period. | Hay | The 2¾-in. rain caused considerable damage to Turfiber plots, little or none to hay plots. |
| Ore. | Clay | May 1962 | 1½:1 cut | N | Normal | - | Applied 1,000, 1,500, and 2,000 lb per acre rates; 2,000 lb indicates best growth by Dec. Exposed to strong N.W. winds during summer. Approximately 15% mulch displacement by Dec. |
| Pa. | Shale | June-Nov. 1961 | ¾:1 to 1½:1 cuts | N & S | Normal | - | Growth and erosion-control results satisfactory. |
| S.C. | - | Fall 1962 | - | - | - | - | Good stand of grass. Ideal to use near buildings, etc., easy to wash off, leaves no unsightly marks. |
| Tex. | Silty loam | April 1961 | 4:1 cut & fill | - | Normal | - | Erosion control and growth results unsatisfactory. |
| Utah | - | Fall 1962 | - | - | - | - | 5-acre project contracted. No report of results. |
| Va. | - | May 1961 | - | - | - | Straw | Both methods very satisfactory. No significant differences apparent. Specifications require addition of 5 lb annual rye per acre when used by contractor. |
| Wash. | Gravelly | Spring 1961 | 2:1 cut | S & W | - | - | Results inconclusive due to soil conditions. Fall 1962 project in same area, similar conditions, produced good results. |
| W. Va. | | | | (No details.) | | | Included in construction specifications as alternate for straw. |

TABLE 3

SOIL-SET

| State | Soil | Date | Slope | Exposure | Subsequent Weather | Check Plots | Remarks |
|---|---|---|---|---|---|---|---|
| Ala. | Sand, clay | July 1961 | 3:1 or flatter | E & W | Rain, 19 days | Hay | Some rilling; no erosion on hay plots. Excellent stand of grass all plots. |
| Del. | " | Aug.-Sept. 1962 | (No details.) | | | | Stands of grass "remarkable" on 5-ft shoulders of dirt roads. Use eliminates difficulty of movement of straw by traffic next to pavement edge. See appendix. |
| Fla. | Sand | March 1961 | Roadway ditch | " | " | Soil-saver | Material found very susceptible to damage. Not recommended. |
| | Sand | March 1961 | Fill slopes | N, S, E & W | " | " | Test discontinued in Oct.; no evaluation made due to development of volunteer grass. |
| Ga. | " | Fall 1961 | (No details.) | | | | Good results with Bermuda grass on loose and prepared soils, 3:1 slopes. |
| Iowa | " | Fall 1962 | (No details.) | | | | One-half-acre test plot. Too early to determine results. |
| La. | Loessial terrace | April 1961 | 3:1 backslopes, shoulders & foreslopes | N & S | 4.8 in. rain in 30 days | Hay | Application approximately twice normal rate. By 14 June best grass on south slope, equal to hay check plot. Excellent grass on mulch-sodded shoulders. |
| | Loessial terrace | April 1961 | Shoulders, 4:1 foreslopes | N & S | 4.8 in. rain in 30 days | " | Little results from seeding except in ditch. Backslopes had some ripplet-washing with little or no grass sprouting. Recommend further trials. |
| Md. | 2-in. topsoil on A-2 base | May-June 1960 | 2:1 cut | S | Excellent growing weather | Straw | Practically no germination of seeded species. Weed growth flourished presumably from the ammonia in Vulcanol. Other tests also indicate that Vulcanol has practically no mulching qualities, is only fair as a soil stiller and when applied directly on the seed has an inhibiting effect on the seed. (Report date Nov. 11, 1961). |
| Mich. | " | | (No details. See Appendix.) | | | | |
| Miss. | " | 1960-61 | 3:1 cut | N & S | Excessive rainfall | Straw | Demonstration plots did not give adequate erosion control nor the residual results obtained from straw mulch. |
| N.C. | Clay | Aug. 1962 | 2:1 cut | E | | Straw | Report not yet available. |
| Pa. | Silt loam | May-Nov. 1961 | 1½:1 cut | N & S | Normal | Hay | Exhibited good erosion control; hay gave better growth results. |
| R.I. | " | Sept.-Nov. 1961 | 2:1 cut & fill | E & W | Normal | Hay | Prevented erosion as well as hay or straw mulch but latter promoted germination and growth better. |
| S.C. | A-7-6(6) | June 1961 | 2:1 cut | E | Rainfall 50% above normal | Straw | Test section resisted erosion better than check plots; germination slower but caught up with check plot by Oct. |
| Tex. | Sandy loam | Nov. 1961 | 4:1 cut 8:1 fill | N, S, E & W | Normal | No treatment | Material gave little or no protection. Erosion was just as bad as on check areas with no treatment. |
| Vt. | " | Sept. 1961 | 2:1 fill | N | Normal | Hay | Retarded germination, erosion control not as good as check plot. |
| Va. | Sandy loam & clay | Spring 1960 to Fall 1961 | 1½:1 fill 2:1 & 1½:1 cut | All | Normal | Hay | Grase growth unsatisfactory, erosion control satisfactory. |

application. The results of both trials compared favorably with hay or straw controls, and each has the advantage of being free of weed seeds. An interesting adaptation and combination of two old materials, asphalt and mulch sodding, is reported by Oklahoma. No State reported on "Glassroot" trials.

With respect to mulches used on plant beds, two States are experimenting with wood cellulose to control weeds. Kansas reports the use of glass fibers for the same purpose. The results of these trials are not yet available.

Reports from several States disclose an increase in the use or trial of three materials in the last two years. Reports on wood cellulose (primarily Turfiber) increased from 11 to 26, on "Soil-Set" from 11 to 16, and "Soil-Saver" from 12 to 17. These totals are smaller than those published by manufacturers of the products. State evaluations of wood cellulose and Soil-Set are summarized in Tables 2 and 3. The results reported vary widely.

The use of Soil-Saver is reported most generally for drainage channel stabilization. There may be some significance in that several States used Soil-Saver as the control or check for comparison with performance of other materials. State evaluations of Soil-Saver are included in the Appendix and contain valuable information to those planning trials of this material.

## CONCLUSIONS

As stated in the previous report, "There is no trend apparent toward major changes in mulching practices or materials." A review of the material presented in the 1961 report and in this follow-up report show that many factors enter into the choice and

success of erosion-control materials and practices. The availability, cost of materials, cost of application, and the variables of soil, slope, weather, to mention but a few, point to the conclusion that there is no single all-inclusive best material. The increased number of trials of new materials show that the problem is being approached with an open mind.

Practical evaluations of the results of tests on new mulching materials by experienced personnel are invaluable, but there is a demonstrated need for testing erosion-control materials and practices on a more thorough and scientific research basis to reach reliable, fair conclusions.

## *Appendix*

### SUPPLEMENTAL INFORMATION

Alabama

Mulch tests were planned and carried out in cooperation with Auburn University Agricultural Experiment Station, Dr. Dana Sturkie, Agronomist, and manufacturers of the following products: Turfiber, Soil-Set, Soil-Saver and excelsior. An abstract of the report follows: Mulches of hay, excelsior, Turfiber, Soil-Set and Soil-Saver were tested on back slopes seeded July 6, 1961. All mulches were beneficial in preventing erosion. Hay, excelsior and Soil-Saver were somewhat superior to Turfiber and Soil-Set for preventing erosion at the rates tested. Thorough preparation of the land and mixing of lime and fertilizer with the soil was essential in maintaining a stand of plants. Mulching on unprepared land would not maintain a stand of plants.

Excelsior broadcast by hand, rate 4,000 lb per acre, should be cut short and wide (18 in. fine cut difficult to apply uniformly; 6 in. wide cut easily applied). Excelsior has no weeds. Hay and excelsior were evident on Sept. 13; Turfiber and Soil-Set were not.

Alaska

Present plans provide for slope treatment with naturally occurring material, jute mesh and seeding. This work, although confined to the more pronounced areas of silt composed terrain, will eventually include other material also affected by erosion.

California

Two small experimental installations were made of jute-mesh material. Installation in San Jose, made in February, is now badly decomposed. Ivy was planted through the mesh, and good growth was obtained. The rapid decompositon of the mesh was probably due to the constant watering required to keep the ivy growing. Even though the mesh is decomposed, the slope suffered no damage during heavy rain on October 12 and 13. The remains of the mesh plus the partial cover provided by the ivy plus the surface compaction obtained by constant sprinkling probably all contributed to the result. This particular installation showed a saving over the previously used straw and wire mesh. However, it requires a smoother, more evenly graded surface than the straw and wire mesh treatment. The staples must be long enough to go through the cultivated soil and anchor firmly into the uncultivated soil beneath. It appears to be satisfactory where mechanical protection is not required for more than 8 to 10 months. For overall protection straw and seed rolled into the soil, or straw and wire mesh on the surface followed by planting is the most satisfactory.

Connecticut

See detailed report in 1962 Committee on Roadside Development, Highway Research Board.

Delaware

Specification calls for mulching to be as follows: Hay, straw, or other approved

materials. This covers a broad category of material but it was intentionally done. Most mulching in recent years has been straw. For three reasons this has gotten to be impractical: (a) straw is becoming hard to obtain; (b) after a heavy rain straw clogs up catch basins, pipe, etc.; and (c) the wind will often blow the mulch from the backslopes so that seed will not catch.

In the past two or three months, excellent results were obtained with a material called Soil-Set. Turfiber has also been used.

Either of these is much better than straw mulch. Soil-Set has been used on approximately 40 miles of bituminous surface (dirt shoulders) road for seeding and mulching. Stands of grass have been remarkable, particularly on backslopes and shoulders and close to the edges of the pavement where traffic would normally blow straw over into the ditch line; the Soil-Set seems to have held these 5-ft shoulders from washing until growth of grass or settlement has taken place. This is believed to be an excellent material to use for this type of work but it must be applied at the proper rate.

Florida

Bagasse is the fibrous residue of sugar cane after the juice has been extracted. It is being used as a mulch in horticultural nurseries and as litter in the poultry industry. Test used bagasse at rates of 1, 2 and 3 tons per acre with hay at 3 tons per acre as control check. Due to short fibers, the bagasse was raked into the top 3 to 4 in. of soil, the hay cut into the top 4 in. with shovels. From the results of this project it appears that bagasse will perform as well as the standard State Road Deparment mulch. The fact that bagasse has short 2 to 3 in. long fibers and might not provide a good mechanical anchorage does not seem to be a problem. Bagasse reputedly does not decompose as fast as hay mulch.

Evaluation of ditch erosion control materials:

1. Ultracheck.—Will perform satisfactorily in preventing erosion, but due to the thickness of the material it is difficult for grass to penetrate through. Grass will not grow until the material erodes away.
2. Soil-Saver.—Has shown the most promising performance in this test both with respect to erosion control and germination of the seed.
3. Troyturf.—Results of test are inconclusive due to the severe washing conditions it was exposed to in the Kings Road installation. In the West 8th Street installation it was buried under a layer of soil and could not be evaluated.
4. Soil-Set.—Very susceptible to damage and any break in the membrane may result in the complete failure of the installation.
5. Fiberglass.—Evaluation not complete—Fiberglass preventing erosion but preventing germination to date.
6. Knitnet.—Performance was equal to Soil-Saver.

Illinois

Turfiber, Erosionette over straw, and Soil-Saver have been used over critical areas with good results.

Kansas

At present high density fiberglass mat is used around trees and shrubs instead of hay mulch. Tree planting specifications call for placing 2 in. of hay mulch over an 8-ft diameter area around each tree and also over each shrub bed. Cultivation of the areas is required prior to placing mulch. The idea is that glass fiber mat will reduce or eliminate the need for hand cultivation of plants and shrub beds to remove the weeds. Use of glass fiber mat is limited until the results of field application experience are obtained. It is also planned to experiment with jute blankets or other materials that may become available for this type of weed and moisture control.

Kentucky

Excellent results using jute matting were obtained. In side ditches, one width is

used but in medians 2 widths are usually used. Soil preparation is the usual discing and harrowing, followed by raking to remove large stones, clods, etc., that would prevent close contact of the jute mesh with the ground. Cost of the material varied, from about $0.35 to $0.52 per sq yd in place.

Louisiana

At Leesville, jute mesh was applied with hand labor in 3 percent grade ditch. The soil was sandy loam. In spring 1960, the soil was prepared for ordinary seeding methods. Jute mesh showed very good possibilities of checking erosion. Material needs good smooth grade and careful fastening to ground. Price about $0.37 per sq yd in place.

At Hammond, jute mesh was applied with hand labor to 3:1 slopes on overpass. Soil varied from sandy loam to clay loam. Fall 1961, overpass slopes were eroded badly and were repaired by maintenance forces. Slopes were seeded with normal methods and jute mesh applied. Checked erosion satisfactorily; good seed germination. Also, jute mesh needs to be rolled after installation.

At Hineston, spring 1962, a 2 percent ditch grade was seeded normally with several grasses. Knitnet was rolled out by hand labor and secured with pins. It was cheaper than jute mesh. Fair erosion-control material, light in weight. Some shrinkage after material is wet. More testing is needed.

Maine

Jute matting in drainageways continues to be satisfactory. A paper fiber mesh tried as a substitute for jute seemed stiff and had a tendency to bridge.

Maryland

Jute is the standard method for establishing vegetation in drainage channels.

Massachusetts

Very good success with the use of wood chip mulch for erosion control on slopes, inducement of natural growth on slopes, protection of plant material, including individual trees, abutment plantings, beds of shrubs, groups of trees and as a mulch on slopes prior to the planting of seedling pines and other evergreens, natural growth sods, low bush Blueberry sods, Bearberry sods, Sweetfern sods, Bittersweet, Woodbine, Multiflora and Creeping Roses as well as two-year lining out stock.

Wood chip mulch is far superior to hay for use around plant material. On slopes where wood chip mulch is used no loam is required, helping to offset the cost. Massachusetts is trying to take large areas out of grass mowing by mulching and planting. The initial cost is not the most important point involved in roadside development. The steadily increasing cost of maintenance and the many acres of grass to be maintained annually are the important factors. These must be taken out of mowing by planting.

Michigan

Turfiber, Troyturf, Soil-Set, and jute mesh material all have their good points, but with the exception of the jute mesh material they are rather expensive when compared with grass sod. Large quantities of heavy jute net material are being used as a substitute for sod. It is very highly thought of for use on rather steep slopes in combination with seeding. One advantage over sodding is that it can be applied to an area immediately after fine grading operations, whereas, if sod is used, the time of year must be considered. The cost of heavy jute mesh material applied is approximately $0.35 per sq yd which, with the addition of seeding costs, makes it somewhat comparable to sodding, except for the previously noted advantage. Satisfactory sod sources are becoming more and more difficult to find.

In summary, sod has the advantage of giving immediate slope protection but has a drawback in the time element. Mulch net material is highly satisfactory, particularly on steeper slopes and as a substitute for sod. Straw or hay mulch will always remain

an important device for stabilizing soils disturbed by highway construction projects.

Minnesota

Some of the newer materials were placed in test plots this fall, but it is still too early to determine the results of these experimental plots. Due to the low cost of area sodding in Minnesota, an average cost of $0.3865 per sq yd, which includes six weeks maintenance period with watering, is cheaper than using the new mulching materials now on the market. (From 1961 Report.)

Missouri

During the past two years (1961-62), more than 1,000,000 sq yd of (Type I) jute netting have been used, primarily in accord with the standard design for new construction. This material has been and is being used on all types of soils encountered in the State including loess, sand and clay. The jute should provide protection for a period of 12 to 24 months, which is sufficient time to establish a good grass turf. Its use has been limited to the more critical areas on slopes and ditches where difficulty was experienced in establishing turf with old procedures. For design purposes, in loess soil a Manning's 'n' of 0.020 and a maximum velocity (ft/sec) of 4 were selected for this material. In clay soils a Manning's n of 0.020 and a maximum velocity of 5 are used. In the construction procedure for the above soils, check slots are required within 100 ft on slopes of 4 percent or less. On slopes of 4 percent or more check slots must be spaced within each 50 ft. The material must be applied in the direction of the flow of water and lap joints lapped not less than 4 in. The netting is to be placed immediately after the seeding operation and firmly embedded in the soil by rolling which usually requires watering. The netting is held in place with 6-in. No. 11 U-shaped staples. There has been less experience in sand; however, on one project 24-in. staples and check slots on slopes 4 percent or less each 20 ft and on slopes of 4 percent or more each 10 ft were required. The costs for this material in place has ranged $0.25 to $0.45 per sq yd. In general, the results have been highly satisfactory with proper application, particularly in median ditches where much difficulty with straw mulch was experienced in the past. Jute netting work has compared favorably with sodding.

Limited quantities of paper netting were used under similar construction procedures as jute netting. The selected Manning's n for this material is 0.026 and the maximum velocity is 4 (ft/sec). Discretion must be used in applying this material with respect to location, soil type, abrasive action, growing season, etc. Generally, results with this material have ranged from highly satisfactory to unsatisfactory. Effectiveness is more erratic than jute netting but superior to straw mulch. It has not held up in V-shaped ditches but has looked good in flat-bottom ditches and medians. The major factor has been the cost in place which ranges from $0.30 to $0.35 per sq yd.

Glass fiber blanket as a ditch liner is rather new. Several experiments have been conducted using it in different ways. This work is inconclusive, but it has brought to light some interesting points.

1. The 1-in.-thick blanket with nominal weight of 28 g per sq ft used as a ditch liner with seed has not been too successful. Stiff stem grasses will penetrate the mat satisfactorily, but the liner does not sufficiently offset the eroding action of running water prior to turf establishment to justify cost. The material with necessary pins cost $0.57 per sq yd. This material is classified as less effective than netting material.
2. There have been both apparent successes and failures with the ½-in.-thick glass blanket impregnated with 2 gal asphalt per sq yd. (The Manning's 'n' for the material is estimated at 0.016 and the maximum velocity (ft/sec) at 8 in. in loess soil.) Most failures tend to occur where abrasive action takes place in association with increasing velocities. At a recent installation in a sand area it has prompted some of the following comments: (a) The material has proven so far to be adequate for protection of berms and ditches on relatively flat areas; (b) On medians where grade exceeds 4.5 percent the material is beginning to fracture around pins at bottom of grade; (c) For ditch-erosion control a small amount of scouring by gravel will quickly damage the material to the extent that it comes apart and actually floats off; and (d) During hot weather, equipment cannot pass over this material without fracturing it.

The contract cost of glass fiber blanket in place is approximately $2.50 to $3.00 per sq yd. The extended use of this material seems questionable due to both results and cost.

3. The ½-inch-thick glass blanket heavy-duty weight (57 g per sq ft) impregnated with 2 gal of asphalt and covered with chips, estimated at 20 lb per sq yd has not been used in construction as yet. Approximately one year ago, a maintenance installation was made. The liner was placed in a 5 ft flat-bottom ditch 340 ft in length on a 7 percent grade. The soil type was Memphis silt loam in the C horizon with a texture of clay loam. This installation was completed at an estimated cost of $1.50 per sq yd. The material has been subjected to the passage of routine maintenance equipment with no apparent damage. The experiment to date has been very successful in all respects, but what will happen in the future is only a guess. It is estimated that it will withstand maximum velocities of 12 ft/sec. This material has merits within limitations for substitution with concrete; however, further experimentation is needed.

Nebraska

Either native hay or straw is presently used as mulch on new right-of-way seeding. Both seem quite adequate in most areas. Present specifications call for jute mesh as waterway or slope protection. Jute mesh and Turfiber have been used experimentally in maintenance repair work. Results with Turfiber were very good, but the jute mesh rotted out quickly and there was considerable erosion under the mesh. Straw mulch has been used with fair results. The best results have been obtained by filling the deep washes with clay soil and top dressing it with barnyard manure from local commercial cattle feedlots. In small washes, the manure is used for the entire fill. Some erosion was controlled with check dams of this material built at 25- to 50-ft intervals. Manure that has been piled up for several years and is well rotted worked best.

New Jersey

Salt hay mulch has been used for planting areas at a cost of approximately $0.07 to $0.08 per sq yd when applied in a 3½-in. layer. This method has not been too satisfactory for controlling weeds. Wood chips are now being placed 4 in. thick on new plantings at a cost of $0.34 to $0.40 per sq yd. Wood chips have been doing a good job in controlling weed growth. For new plantings, a mulch of licorice stems has been used in a 4 in. layer, and the results have been excellent. Licorice mulch is not flammable; it contains 93 percent organic matter, and costs $6.00 to $9.00 per ton delievered to the project.

An experimental mulching of plant material with wood cellulose (Turfiber), was recently conducted, and it was applied at different thicknesses to determine whether it controls weeds. It has been in place only one month; therefore, results are inconclusive.

North Carolina

Use of asphalt alone has been dropped from the recent schedule as being unsatisfactory, at least in clay soils. In sandier soils, it probably will be tried again. Troyturf also has been dropped, principally because of cost. It gave good erosion control and quick germination but requires a very careful maintenance program to accomplish thorough establishment. It would be considered only for very special situations. In addition, plots have recently been installed including Turfiber, Soil-Saver, Knitnet No. 346, two materials from the Pextile Corporation of America, and sodium silicate. Glassroot is also scheduled for trial, but no report on this extensive list of trials is available. Final evaluation of fish solubles is also unavailable.

Oklahoma

Asphalt emulsion over mulch sodding was used on 3:1 fill slopes, facing both north and south. The length of slopes (toe to top) was variable, ranging from about 15 ft to more than 100 ft. The western project was composed of fine sand, on which no topsoil had been applied. The soil series was not determined. Soils on the other two projects

were composed of 4 to 5 in. of fine sandy loam topsoil, which had been replaced on sandy fill material obtained from Stephenville series.

The Bermuda mulch sod consisted of a mixture of surface soil and Bermuda roots, which had been excavated together. The material was spread about 4 in. deep over the slopes, then compacted. The asphalt mulch was a high-viscosity medium-set emulsified asphalt. One part of the emulsion was mixed with three parts water before application. Slopes were reshaped where necessary. Weeds were destroyed by disking if present.

The slopes were watered by sprinkling. The mulch sodding was applied and compacted, then watered thoroughly. Fertilizer was applied before placing the sod, then again on top of the sod. The fertilizer was incorporated by sprinkling. The water-asphalt mixture was then applied over the sodding, at the rate of 1.2 gal per sq yd. This amounted to 0.3 gal of residual asphalt per sq yd.

In general, results were good. However, several factors tended to keep results from being better:

1. The weather during the work period was very hot, dry and often windy, not suitable for sodding work.
2. Such weather made it very difficult, if not impossible, to properly water the slopes before and after application of sod.
3. Lack of coordination resulted in considerable delay between application of sod and application of asphalt. As a result, the sod was often much too dry when the asphalt was applied.
4. The sodding was done late in the summer, which left a very short growing season for the grass.

In spite of the adverse factors, results were much better than on similar areas where sodding was applied without an asphalt mulch cover. The grass started to grow sooner, grew faster, retained a dark green color, and continued to grow long after the unmulched grass had ceased to grow and had gone dormant.

The western project received some very hard rains a short time after the asphalt mulch was applied. These rains may have dumped 6 to 8 in. of water on the area in less than 12 hr. The mulched areas eroded rather badly in some instances. The erosion, however, was much less than on similar but unmulched areas. It is believed that asphalt mulch will be very effective in promoting the growth of Bermuda sod in areas normally deficient in moisture during much of the growing season. Results indicate that success with this method will require thorough watering (soaking) of the soils before application of sod, thorough watering of the sod immediately following application, and application of asphalt over the sod immediately following the watering.

Ultracheck was used in a road ditch on Interstate 35, a few miles north of Oklahoma City. Before the test, the ditch had tended to erode and was requiring frequent maintenance. (The material tested was 1 in. thick.)

The road ditch was reshaped, a good seedbed was prepared, fertilizer was worked into the soil, then both warm and cool season grass seeds were broadcast over the area. Strips of blanket, secured with wire pins, were then laid across the ditch, overlapping so that water could not run under the strips. The installation was about 100 ft long. The work was performed during late summer.

The seeded area was longer than the area treated with Ultracheck. No seedlings emerged through the glass blanket, but a good stand emerged on the uncovered area. When evaluated this summer, no erosion had occurred. The glass blanket however had become ragged in appearance, the pins were working out, the wind had turned up the seams, and a vehicle had left the road and run over part of the blanket causing considerable damage. In general, the area was not eroding, but the material did not have a good appearance and did not seem to have characteristics that would result in long time protection of a road ditch.

Soil-Saver was used as part of an erosion-control project on Interstate 40, about 27 mi southeast of Oklahoma City. The area treated consisted of 2:1 cut slopes, some facing west and some facing south. The slopes ranged from about 30 to 60 ft in length (toe to top). The contract price was $0.35 per sq yd, in place. Area covered was about 11,000 sq yd.

The soils were composed of parent material and substrata, probably of the Dougherty series. Texture ranged from sandy loam to sandy clay. The soils were extremely erosive. Fertility was extremely low.

The soils were reshaped and covered with 4 in. of good soil which contained Bermuda roots (Bermuda mulch sod). Fertilizer of 12-12-12 grade was applied at the rate of 100 lb per 1,000 sq yd. Jute mesh was then applied over the mulch sod, in vertical strips which overlapped four inches. The jute mesh was secured in place with U-shaped No. 8 wire pins. The sod was watered for a 30-day period, as needed.

Growth was satisfactory; unfortunately check plots were not constructed. It is thought that it would have been impossible to hold mulch sod on these slopes without the jute mesh cover. During the process of reshaping, some of the areas became steeper than 2:1, probably approaching 1:1 or 1½:1. Later during the summer, these slopes collected enough moisture to cause sloughing. The jute mesh did not pull loose from the top but broke at the top of each slide. With this exception, there were no major failures.

Based entirely on this one project, the material is expected to be very useful when used as a cover over mulch sod on highly-erosive soils, 2:1 or flatter. This project was carried out during the spring of 1961.

Oregon

Jute was used as ditch lining in sand material in late Sept. and early Oct. of 1962. RC-250 asphalt binder coarse was used on the roadway and was sprayed over jute at approximately 0.25 gal per sq yd. No erosion or failure, germination showed by December 14. This material is standard for drainage channel erosion.

One contractor is placing wood cellulose on the plant bed to control weeds and erosion. State forces have also used this material in a dry state and wet down in the second operation. It is too early to evaluate this method of application.

Knitnet, regular and heavy, has been used successfully to hold down straw under extreme wind conditions on the southern Oregon coast.

South Dakota

Mulchnet was applied over native hay with satisfactory results.

Texas

An extensive experimental project on establishment of turf will be conducted through the Texas Transportation Institute regarding methods and procedures.

Wyoming

It was found that SC-2 asphalt, 0.2 gallon per sq yd, on sand, was subject to wind erosion. It was observed that straw mulching has produced the best stand of grass, however, the asphalt cover has resulted in grass growth in areas where it would not grow otherwise and the asphalt cover has reduced the erosion in these areas, resulting in a saving to maintenance.

# Control of Soil Subject to Wind Erosion

WILMER W. STEINER, Plant Materials Technician, Soil Conservation Service, Upper Darby, Pennsylvania

•EROSION by wind is a particularly serious problem on light soils and pure sands. These soils usually lack cohesiveness except when they are moist. As they have low water-holding capability, they dry rapidly and begin moving early in periods of high-velocity winds. It is important, then, to take special precautions to provide prompt protection for disturbed soils susceptible to wind erosion. Failure to do so may result in heavy soil loss, damage to plant cover, and unwanted depositions on highway rights-of-way and adjacent crop fields or other property susceptible to damage of this sort.

On heavier soils, temporary wind-erosion control may be gained by employing tillage methods that bring clods to the surface. However, these clods soon weather down to erodible particles. Regardless of soil type, permanent control of wind erosion requires that the soil surface be protected by a cover of living plants or by dead vegetation continuously replenished. Surface protection may be gained by employing one or more soil-conserving practices such as stubble-mulching, cover-cropping, strip-cropping, windbreaks, establishment or permanent herbaceous or woody plant cover, and mulching. The proven practices of major interest and value for highway use are mulching, establishing permanent plant cover, and cover cropping.

## MULCHES

The use of mulch offers immediate protection against wind erosion. Wheat straw or hay applied at the rate of 1½ to 2 tons per acre, and anchored properly, is effective on soils and pure sand. Even if permanent species are to be established, mulch should be applied as soon as the land is prepared, either before or right after seedings or plantings are made. In addition to its soil-stilling value, mulch promotes conditions in the seedbed favorable to the germination and establishment of the permanent species adapted to the problem soils of the various regions.

There are a number of practical methods of anchoring mulch against wind movement. Where the site permits machinery to run over the land, mulch can be anchored cheaply by using a tractor-drawn mulch-anchoring tool. This device is made of notched coulters on an axle mounted under a frame which holds varying weights of ballast. The ballast weight is varied according to soil type and condition so that the mulch is partially poked into the soil. The method is very practical and effective and is being used widely on watershed and other stabilization projects.

Another well-known method of anchoring mulch is through the use of asphalt emulsion applied simultaneously, or sprayed over the mulch after it has been placed. In areas of severe wind velocities, larger quantities of emulsion may be needed to prevent movement. The chief value of this method is that it can be used on terrain too steep or too small to permit the use of tractor-drawn machinery.

Mulch may also be anchored securely on certain areas where it is not feasible to use the methods just described. There are several open-mesh fabrics of twine and paper which are effective for holding mulch and can be stapled over critical areas. For example, "Mulch-Net" and similar materials can be used on areas difficult to access at crests of slopes, or in cuts where wind velocities may roll back asphalted mulches.

Industrial firms are developing and testing chemical-mulching and soil-binding materials which show promise for stilling soil and sand subject to wind erosion. Chem-

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Figure 1. An anchoring tool being used effectively to tie down mulch on a watershed project.

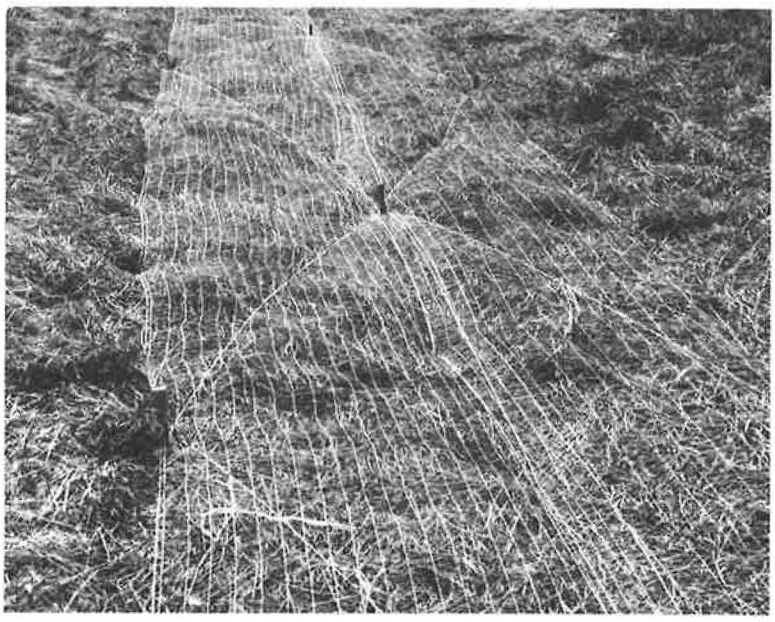

Figure 2. Pegs hold paper netting in place over mulch. Staples and stapling guns can be used to fasten netting instead of driven stakes and twine.

**icals are used to bind soil particles together so as to prevent wind movement. These materials are said to be non-toxic to plants, and when applied properly, they will hold the soil while vegetation becomes established. As these chemical materials become**

more widely tested and their range of use and adaptability become known, they may become valuable tools for those concerned with wind-erosion control.

## SEEDING AND PLANTING PERMANENT SPECIES

As indicated, mulches should usually be used to protect permanent seedings or plantings on soils subject to wind erosion in the same manner as on other critical areas. Without mulching, even the best adapted species may fail to establish because of sudden drying or blowing away. Under ideal season and moisture conditions, permanent species may become well established and then fail because of injury by the abrasive action of windblown particles. However, under these conditions, permanent species planted without mulch may be protected from soil movement and abrasion during their vulnerable

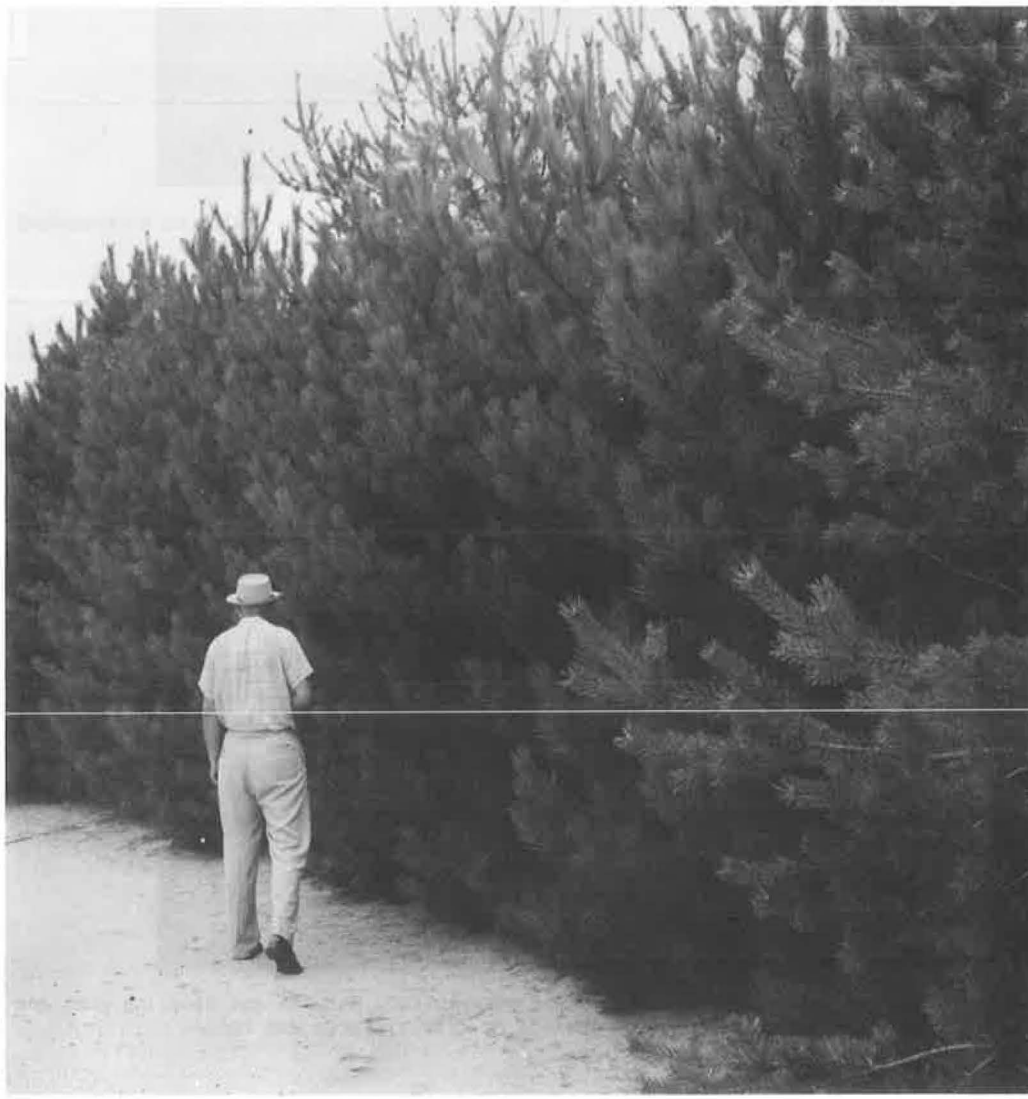

Figure 3. Red and Scotch pine provide effective permanent cover on sandblows in the Northwest. They grow well if the seedlings are protected from sandblasting until well established.

Figure 4. Annual cover crops provide residues which are used to protect seedings of permanent species on land subject to wind erosion.

period by seeding narrow strips of a fast and tall-growing temporary species. Wheat and rye are effective for fall and winter and sudangrass or sorgham will do well in the spring and summer seasons. Plant 8- to 10-ft wide bands of these species between permanent seedings on strips 20 to 50 ft in width. When the temporary species in the bands approach maturity, but before the seed is ripe, they can be worked partially into the ground (trashy cultivation), and the areas can then be seeded to permanent species. Plantings for temporary windbreak purposes should always be placed as close as possible to right angles in the direction of prevailing winds.

In most regions there are available species of plants that have been proven to be effective permanent stabilizers on most soils. However, on areas of sandblows, dunes, and hydraulic fills, the choice of species is much more limited and the need for stilling techniques is a great deal more critical. Well-anchored mulch again is the top choice for stilling sand, tempering seedbed conditions, and preventing sandblasting when permanent herbaceous species are to be established.

Woody plants may often be the best choice for permanent cover on sands. However, they too need protection from blasting and deposition. In addition to mulching with hay or straw, there are other ways to protect new plantings or trees and shrubs. The placing of brush over the area to be planted will reduce sandblowing, provide partial shade, and protect the interplanted seedlings. Another effective technique is to plant a pioneering sand-loving species such as American beachgrass. When the beachgrass is established it can be interplanted with adaptable woody species. The beachgrass will decline, after a few years of site stability, but by then the woody plants will no longer need protection and will be ready to assume dominance over the area.

## COVER CROPS

Annual cover-crops offer a solution to wind-erosion problems in certain instances. They can be used temporarily to stabilize disturbed areas which would otherwise lie bare until brought to final grade and permanently treated. However, they may be used during their season of growth to protect finished graded areas, after which their residues can be used in place for protecting permanent seedings. Cover-crop species


Figure 5. The windbreak in the background is supplemented with perennial sand-stilling species of grass to control a northeastern sandblow problem area.

used for these purposes should germinate rapidly and be fast-growing. Wheat and rye have these qualities for fall sowing and winter cover. Sudangrass and sorghums are among the best for spring sowing and summer growth. Their maximum erosion control and residue-producing values will be realized if they are sown on well-fertilized sites during periods of of ample moisture.

If winter or summer annuals such as rye and sudangrass are used temporarily to protect a site and produce residues for permanent seeding protection, the cover crop should be mowed to a 6 to 8-in. height just before maturity. The permanent species can then be seeded into the remaining stubble and fallen mulch. In areas of severe wind erosion, it may be necessary to anchor the residue with a coulter machine in the same manner as with applied mulch.

## WINDBREAKS

Although windbreaks are primarily used to reduce wind velocities on large areas such as cultivated fields and around homesteads, they have similar value for protecting smaller areas. Windbreaks reduce the drying effects of wind on grassed areas and plantings of woody species. They can also be used as living snow fences or to control depositions of wind-driven soil. Each section of the country has suitable species available which can be used in establishing effective windbreaks tailored to local needs. Many of the species have supplemental wildlife food and cover and aesthetic values. Generally, windbreaks are not cure-alls for wind-erosion problems, but they should be used to supplement other appropriate practices.

The effectiveness of any barrier depends on such factors as wind velocity and direction, and the shape, width, density, height, and interval of the barrier. When the wind blows at right angles to an average tree windbreak the velocity adjacent to the barrier is reduced 70 to 80 percent. At a distance equal to 20 times the height of the windbreak, the velocity on the leeward side is reduced by 20 percent. Little or no protection is afforded at distances greater than 20 times the height of the windbreak.

Because of wide variations of soil and climate encountered nationally, no attempt is made here to list permanent herbaceous and woody species used for controlling wind erosion. Use should be made of species which are locally adapted and which will provide long-lived, erosion-resistant cover under practical treatment. Highway technicians probably know of species suited to local conditions. If not, information concerning them is available from State agricultural experiment stations, county agricultural extension agents, and Soil Conservation Service offices.

## COMMUNITY EFFORT

The most successful results in dealing with wind-erosion problems are obtained when groups of people combine their efforts and recourses and take action on a community level. Individual efforts may be effective for a limited area, however, soil blown from nearly untreated areas can vitiate such efforts and reduce visibility for the motorist, smother established plantings, and clog highways with depositions that are hazardous and expensive to remove.

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# Common Sense Turf Management on Today's Highways

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•THIRTY years ago it would have been difficult to find a highway engineer who would agree that grass or turf could contribute a necessary function to the the highway right-of-way. Today it would be difficult to find one would disagree with the idea that turf is here to stay.

Establishing and maintaining turf on roadsides is big business. It deserves to be. Turf-type vegetative ground covers have contributed more to the control of erosion on roadside areas than all other plant associations combined, and have provided an effective medium for maintaining a sense of orderliness on the modern highway right-of-way. Turf values will become increasingly important as modern highway systems such as the Interstate System and tollways are expanded.

Unfortunately, the management of turf on roadsides has not been given the same professional attention as the establishment phase. It would be difficult to find two States that employ the same standards with reference to turf management. In fact, adjacent county maintenance organizations in the same State frequently pursue different policies to accomplish what might appropriately be termed "turf mismanagement." During the past 25 years, specifications for seeding, sodding and mulching have been developed that provide excellent controls for these operations under every conceivable condition. However, similar standards to provide controls for managing the resulting turf are conspicuous by their almost complete absence.

For the purposes of this presentation, the turf management categories to be discussed will be limited to mowing and the use of herbicides. Fertilizers and soil amendments will be bypassed with a comment made by R. E. Blaser, the agronomist from Virginia: "Need for fertilization should be based on the condition of the turf." Erosion-resistant stands of grasses will persist for five to ten or more years on the fertile soils in the Midwestern States, if properly managed with respect to mowing and broadleaf weed-control.

B. J. Butler and R. R. Yoerger of the University of Illinois reported in 1962 that 3,500,000 acres were mowed along State highways. It has been estimated that completion of the Interstate System will add another 1,000,000 acres. Considering the fact that these many acres of roadside are being added to the maintenance engineer's responsibility without a corresponding increase in his budget, it is almost inconceivable that so little has been done to develop management standards. It would be interesting and perhaps somewhat embarrassing to analyze the reason for this obvious lack of maintenance know-how. Could it be that landscape engineers and architects have been too busy helping designers, drawing plans, and writing specifications for new work? Who should be doing the planning and promoting the procedures needed to bring the roadside turf management problem into proper perspective?

A modern, 4-lane, divided highway right-of-way contains about 25 acres of roadside per mile. With a 40-ft wide strip of turf in the median and an equal area immediately adjacent to the outside edges of the roadways, there are 9.7 acres of critical area per mile of highway. On the Ohio Turnpike, these areas are mowed an average of 11 times a year, at a cost of approximately $2.15 per mowing per acre. Butler and Yoerger reported last year that four States spent an average of $10.21 per acre for roadside mowing which, of course, would not be limited to the critical, centrally-located areas which lend themselves to gang equipment and production-line methods.

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So the figures are not comparable, but, considering the millions of acres, that $10.21 per acre is a soul-stirring figure.

Also included in the University of Illinois report was an estimate that hand-mowing in 37 States was still being done on 100,000 acres. Imagine the millions of dollars wasted on this operation. Workmen on the Ohio Turnpike are not permitted to do any hand-mowing. It is not necessary because better results can be obtained much cheaper with other methods.

How can the pampered and perhaps uncontrolled equivalents of golf course greens on many acres of roadside turf be justified? Why some engineers and administrators cling to the idea that slope areas and fence-line areas must be mowed as frequently and as closely as the turf areas adjacent to the roadways has always been a mystery. Mowing to achieve a lawn or fairway appearance from fence-line to fence-line through rural and forested countryside belongs in the luxury category, and besides, it cannot be justified aesthetically. Strangely, such practices evoke favorable comments for the reason that they create a neat appearance. Such high-class, city-park type mowing is not within the capacity of the maintenance engineer's budget. Even from an appearance standpoint such practices cannot be justified. Many of the roadside areas within the right-of-way should be managed to achieve a natural effect, thus making them an integral part of the adjoining countryside. The picture of mile after mile of neatly maintained turf areas resembling lawns and fairways is neither distinctive nor indicative of the character of the natural environment of the State or locality the motorist views.

The basic elements of a common sense mowing program are as follows:

1. It is not necessary to mow every acre of roadside vegetation in order to maintain properly the right-of-way of a modern highway.
2. The mowing program must be planned. Roadside areas should be arranged in categories and a vegetation management program prepared to fit the needs. Cultural practices and land-use patterns along the right-of-way should dictate the roadside treatment. As a general rule it should not be necessary to mow the following locations: slope areas 2.5:1 and steeper; roadsides adjacent to natural woodland and swamp areas; and areas in agricultural sections with dense uniform stands of desirable species of grasses and legumes beyond ditch lines.
3. There must be a reason, a justification, for mowing the various areas comprising the roadside.

It is encouraging to report that evidence of positive action to develop control policies for turf management is making a belated appearance. In Feb. 1962, the highway maintenance standards subcommittee of the American Association of State Highway Officials distributed a paper recommending standards for roadside mowing. Unfortunately, this document does not entirely clarify the big question: "Where to mow?" It states, in part, "Where mowing is required..." and that is rather non-specific terminology.

Some States, notably Massachusetts and Michigan, have already initiated programs to reduce mowing frequency on certain areas, and to eliminate mowing entirely on specific roadside areas. Michigan is developing contour mowing as an answer to the expensive and artificial appearing "fence-to-fence" mowing practice still followed along thousands of miles of modern highways. A somewhat different solution to the mowing problem is being sought in Massachusetts by establishing woody species of ground cover and encouraging volunteer growth to occupy roadside areas in locations where safety and other basic highway functions will not be jeopardized. These departures from traditional maintenance concepts are being made primarily to improve the status of the maintenance budget. It should be noted, however, that better looking roadsides will accrue, like the other "bests" in life, as a free reward.

Turf management along roadsides today cannot be accomplished economically without the use of selective herbicides and sterilants. Weed-control chemicals can effectively augment a mowing program and actually improve the quality of the turf.

The problem of controlling and eradicating vegetation beneath the guardrail is still very expensive for those organizations that persist in employing manual-mowing methods. During 1957, guardrail areas along the Ohio Turnpike were mowed for the

last time with hand-guided sickle bars. The cost per mowing per mile of guardrail was $17.50. Three mowings were required for minimum control. So $52.50 per mile was spent to accomplish a result less satisfactory than that now being achieved with sterilants and non-selective herbicides for approximately $40.00 per mile per year, and that includes the treatment of an average of 45 sign and reflector post areas per mile. The use of chemicals, therefore, represents a savings of at least $12.50 per mile of guardrail, plus a dividend of clean areas around posts. An additional plus value attributable to spraying is man-hours released for other more productive maintenance operations—an important consideration in an organization where experienced, high-quality labor is difficult to obtain.

When broadleaf weeds such as dock, Queen Anne's lace, and chicory became unduly aggressive and prominent in the median and other areas immediately adjacent to the roadways, a 2, 4-D treatment was initiated. Within a year the population of offending species was reduced to an acceptable minimum at a cost of $5.25 per acre per year for three applications. During 1962 only two applications were considered necessary, and the cost was reduced to $3.50 per acre—just a little more than the cost of one mowing.

In the non-mow, spray areas adjacent to agricultural lands, a similar treatment with 2, 4-D is used. On these fence-line and interchange island areas the same number of applications and the same quantities of chemical are used, but the cost is $5.25 per acre for two applications, or $7.85 for three. This program has been the major factor in the struggle of Ohio Turnpike Commission forces to maintain dense stands of weed-free turf in non-mow areas. It is important to remember that these areas are not generally adaptable to gang-reel mowing equipment, hence the mowing costs eliminated are appreciable.

Several States have had encouraging experiences with MH 30 as a turf-growth inhibitor. This chemical is comparatively expensive, however, and if a mowing program for critical roadside areas (median and other areas inside primary ditch lines) is conducted economically, it will cost about the same as mechanical mowing. These comments are based on data obtained in connection with the establishment of plots along the Ohio Turnpike. Mowing the critical areas 11 times with tractor-drawn tandem-reel mowers cost about the same as a combination of 1.3 gal of MH 30 per acre, plus three mowings which were considered necessary to produce an equivalent appearance. Employing rotary sickle-bar or hammer-knife type mowing equipment on critical areas would, of course, result in much higher costs per acre than the combination chemical inhibitor plus mowing treatment. Limited experience with MH 30 indicates that haphazard use will not produce effective results. It must be applied carefully at the proper time and in proper amounts.

As soon as consistently uniform and predictable results can be expected by the maintenance engineer, and the economy factor satisfactorily established, the use of chemical growth inhibitors will be accepted generally as a valuable tool for management to add to its assets.

Reference has already been made to different types of mowing equipment and their adaptability to various roadside areas. Obviously, an effective and economical mowing program cannot be developed without properly relating the mowing machine to the character of the area to be mowed. The University of Illinois study reported that a sickle bar averaged 0.68 acres per hour as compared to the 0.75 acres per hour cut with a rotary mower. Reel-type mowers averaged 2.7 acres per hour which is 3.6 times the potential of the average rotary. During the past three years average output on the Ohio Turnpike with tandem-reel mowers was 3.75 acres per hour, or 1.4 times the national average.

One of the problems associated with a turf management policy that excludes certain roadside areas from mowing is fire originating within the right-of-way as a result of carelessly discarded burning butts. A build-up of dead and dry grass and other vegetation in non-mow and non-spray areas can support a fire that will seriously damage sensitive species. If not controlled promptly, such fires can spread to adjacent property and cause extensive damage and strained public relations.

Policy makers on the Ohio Turnpike staff believe that the economies and aesthetics represented by these areas far outweigh the minor damage caused by a comparatively small number of fires which were promptly extinguished.

Another aspect of the fire problem pertains to those areas of well-established turf between the primary ditch line and right-of-way fence adjacent to cultivated lands. Here the damage is restricted to roadside areas, and results mainly in a deterioration of sensitive species which may lead to an invasion of broadleaf weeds. If fire in these areas is a serious concern, it can be practically eliminated by mowing once a year. In the humid temperate and north temperate zones, this mowing should be done in late summer or early fall with a hammer-knife type mower that will effectively chop and distribute the mowings, thus eliminating an expensive hay-removal operation. Careful mowing in early fall with the proper equipment will be followed with a regrowth of new grass that will be fire-resistant until snow flies, and will not be a serious hazard in the spring since most of the inflammable material will have disappeared.

Another method which might serve the same purpose at less expense would be an application of MH 30 in the spring season. Retarding growth would eliminate a major portion of the seed stems and the longer leaf shoots, thereby preventing an accumulation of quantities of inflammable material.

The frequency of fires and extent of damage in a particular section or State should govern the decision to mow or not mow roadside areas of this type. They are not being mowed along the Ohio Turnpike.

An effective roadside turf management program can be accomplished by preparing a plan which includes the following elements:

1. Zoning of the right-of-way into the several categories of mow and non-mow areas to meet the specific requirements.
2. Use of herbicides as a supplementary tool to mowing in order to eliminate weed species and encourage desirable grasses. This can save numerous mowings, promote good public relations, and, particularly in the critical areas, add appreciably to the effectiveness of the mowing operation.
3. Application of sterilants to eliminate vegetation and the need for hand mowing around post areas and beneath guardrails.
4. Use of mowing equipment best suited to the character of the roadside area being maintained.
5. An effective method to implement instructions and directives so that district, division and county personnel will initiate and conduct operations in a uniform manner.

# Advantages and Disadvantages of Sewage Sludge as a Mulching Material

RUSSELL K. OLSEN, Division of Operations and Maintenance, National Park Service

Mulching practices, although somewhat disputed in detail, are fairly well recognized in general. Differences of opinion invariably exist on the material to be used. Of the many available materials, this discussion will point to certain guidelines for the use of sludge available at low cost in park and roadside development and maintenance programs across the country. Research has shown that the improper use of such materials can be costly as well as detrimental, whereas proper and judicious use of these materials may reduce costs and visibly improve treated areas.

•MOST people are aware of the magnitude of the National Park Service, having heard how many areas are administered, operated, and maintained. So that this figure does not become repetitious, it may be expressed in another way: there are 7,820 mi of roads, 8,929 mi of trails, 8,728 buildings, and numerous statues, monuments, structures and quarters. These facilities are on a small portion of over 25,000,000 acres with climatic conditions ranging from subtropical to arctic. There are pure wilderness areas as well as formal gardens. In the Washington Metropolitan Area alone there are 738 separate units.

Looking at these totals from a grounds-maintenance standpoint, and considering the amount of seeding, sodding, and planting that must be renewed and cared for each year, in addition to new developments, the totals are somewhat staggering. Mulch materials can run into considerable sums of money.

When talking about mulching and a mulch, it is defined as anything spread over the surface of the soil to protect soil or roots from heat or cold, and/or improve soil conditions. In the broadest sense, mulching materials include numerous kinds of plant and animal products and by-products, various manufactured materials, and a few natural inorganic substances.

This discussion will be limited to the uses of night-soil or more commonly, sludges. Some forms of sludge are potentially available in many communities, in fact, in nearly every community of more than a few thousand. Many probably have no opinion concerning its use. Frankly, this is about how the Park Service felt, but then someone said, "Let's use sludge, it's free." With these sage words, it was decided to try this by-product of a sewage system. In fact, before realizing it, the Service went overboard.

Basically there are two kinds of sludge available, activated and digested. Activated is processed by aerating the sewage and processing it with heavy industrial equipment. It is an expensive operation. Milorganite, produced by the Milwaukee Sewage Commission is an example of activated sludge. It is good, if one likes organic fertilizers and can afford them. However, the use of activated sludge is somewhat analogous to "a champagne appetite on a beer pocketbook" and is not for park or highway department use.

Digested sludges are most commonly available. They are the end-products of a sedimentation system where anaerobic-bacterial digestion is allowed to take place for 10 to 14 days. In Washington, D. C., a rotary-vacuum filter is then used to remove

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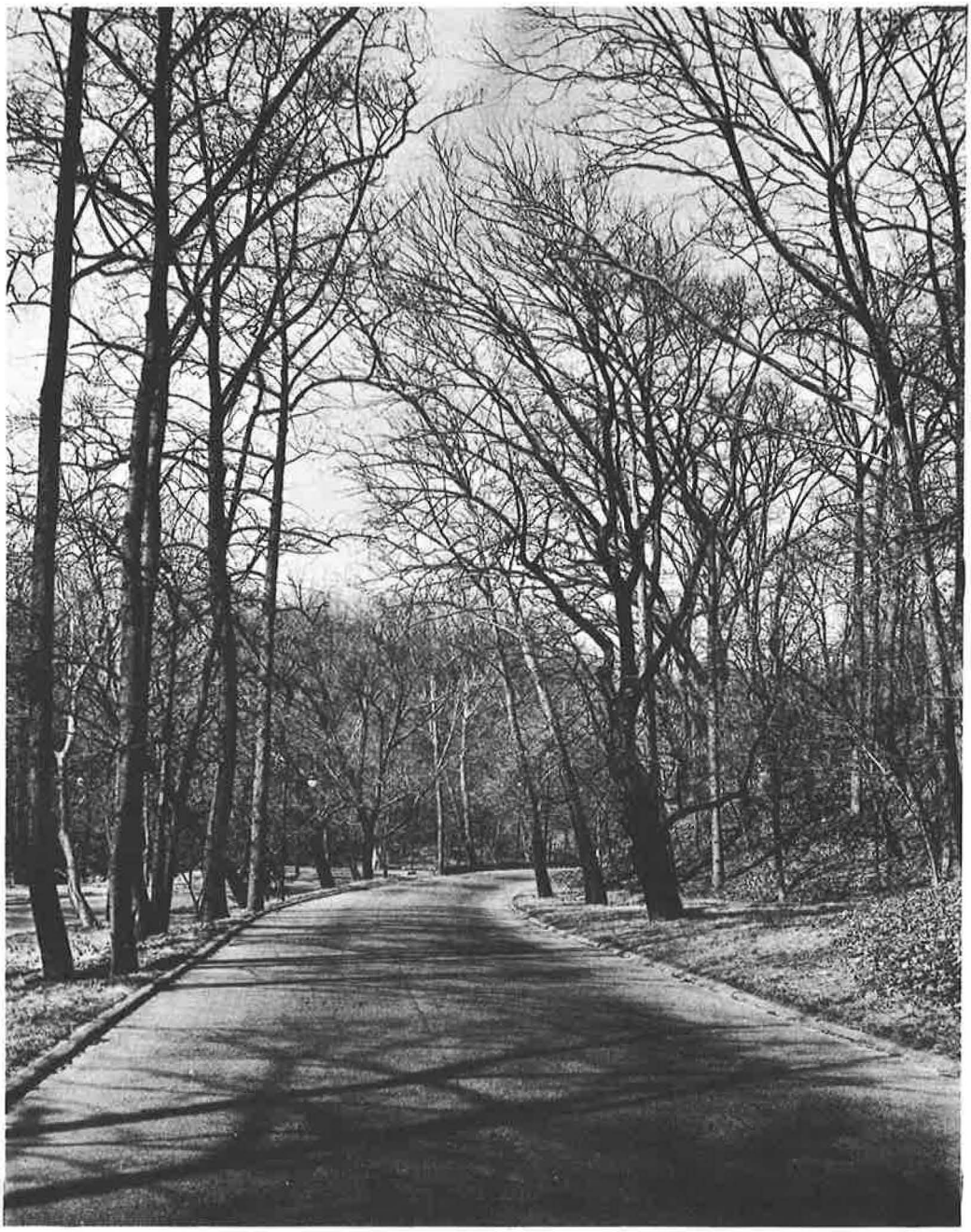

Figure 1. Typical area on Rock Creek Parkway for sludge application.

the moisture. Digested sludge is little better than a low-grade mineral fertilizer, not even on a par with horse manure. It is primarily a soil conditioner. Sometimes it is used as a conditioner for mixed fertilizers, as a mulch for horticultural plants, and on turf areas. The nitrogen content essentially fixes its value as a fertilizer. However, the relatively low-nutrient content of sewage sludge will not permit it to compete with other nitrogen fertilizers.

Figure 2. Typical area on Rock Creek Parkway for sludge application.

After deciding to utilize this free material, it was used in the National Capital Region somewhat indiscriminately. At the same time, it was decided that some kind of an evaluation was necessary. This was a case of a maintenance organization attempting to evaluate a material already in use.

A true research organization would set up methods, materials, and locations, and apply statistical evaluation methods. However, a semblance of a program was set up. The material was primary digested sludge obtained for the cost of hauling it from the treatment plant. The chemical analysis of this material showed 2.06% nitrogen, 1.44% phosphoric acid ($P_2O_5$) and 0.14% acid soluble potassium ($K_2O$). The pH reaction was 6.0 and the total ash was 56.2%. The sludge was available as 100% sludge, or 50% sludge and 50% topsoil. The material could be obtained shredded or unshredded.

The five statue mounds in Lafayette Park, and various minor reservations and selected areas of Rock Creek and Potomac Parkway were used for evaluation purposes. Of primary concern were: whether or not the sludge had any beneficial effect on the soil; what reaction it had on growth; what reaction it had on germination; and what reaction it had on longevity of stand.

The sludge was applied on the turf and reconstruction areas at three different rates: ¼ to ½ in., 1 in., and 2 to 3 in. deep. It was applied at 3 to 4 in. as a mulch around crepe myrtles on Shoreham Hill along the Rock Creek Parkway. No lime or fertilizer was used with the shrubbery mulch. Approximately 15 to 20 lb of 10-6-4 fertilizer per 1,000 sq ft was applied on one-half the turf areas treated. On one-half of the areas treated, 50% sludge and 50% top soil was applied; on the other half, 100% sludge.

In some areas it was applied as a top-dressing or a mulch, and in the other areas it was worked into the soil. On all areas not planted with shrubs, bluegrass, redtop and creeping fescue seed were sown.

Figure 3. Minor park reservation in the District of Columbia showing tillage practice for sludge incorporated into the soil.

Evaluation was based on visual inspections made at weekly intervals, and by turning a shovelful of the soil for visual and touch examinations. There was no appreciable difference between the sludge-and-topsoil mixture and the 100% sludge.

Where the crepe myrtles were mulched, moisture retention was good and the shrubs bloomed well. However, the weed growth, consisting mostly of tomato plants, was extremely hard to control.

The ¼- to 1-in. mulch on the turf areas was relatively effective. The grasses appeared to increase in growth and in depth of color. On the areas treated with additional fertilizer, the grasses appeared to persist longer and have a longer period of good growth.

The mulches deeper than 1 in., regardless of whether or not fertilizer had been added, eliminated existing grass, and new growth which persisted through the seedling stage was also killed. Apparently, this resulted from nitrogen burn and the ash content of the sludge.

The results were best where the sludge was worked into the soil as a soil conditioner. Grass germinated evenly with good color and was persistent. It was apparent that the lighter the soil, the greater the benefit.

The results show that sludge has value as a light top-dressing for turf areas, and it is valuable as a soil conditioner worked into the soil, or as an ingredient of artificial topsoil.

Does the National Park Service still recommend the use of sludges? The answer, in general, is no. Three reasons are as follows: the tomato plants that grew in the

Figure 4. Lafayette statue in Lafayette Square— an area where sludge was applied.

mulch were expensive to eliminate; the excessive ash in the sludge is deleterious when used as a mulch; and the odor is obnoxious, not only to the workman but also to the public. The last was an important factor that has not been previously mentioned. Public opinion alone was enough for the Service to change its mind. The odor from the sludge damaged public relations to the extent that it nullified any usefulness that the material may have had. The only place sludge could be recommended is as a soil amendment in locations well removed from heavy public use.

If sludge is recommended for use as more than an ingredient of artificial topsoil, it should be remembered that despite its low cost, it may prove to be very expensive from a public relations standpoint.

## ACKNOWLEDGMENT

The photographs are by Abbie Rowe, courtesy of the National Park Service.

# Photogrammetry and Photographic Interpretation In Landscape Development

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•BASICALLY, photographs taken from an airplane are translated into accurate and detailed topographic maps or are used by the designer to gain less formalized data which is relevant to the design process, but not ordinarily incorporated into map form. These techniques—photogrammetry and photo interpretation—are, in any event, far too complex to be condensed into a necessarily brief discourse. Therefore, remarks will be confined to an examination of the application of these techniques to the practice of engineering or landscape architecture, with specific reference to highway and park design.

The choice between photogrammetry and the more classic survey methods is almost entirely a matter of comparative economics and considerations of season. Either procedure can be employed to achieve maps of similar scope and accuracy. Let there be no mistake, there is still a choice between these two methods. Today, almost 20 yr after the bomb dropped on Hiroshima ushered in the atomic age, America is still using, as well as building, new power plants that use water and coal as sources of energy. High-flying aircraft, cameras, photogrammetric plotters and tellurometers are dramatic tools, but they have not replaced levels, transits, plane tables, chains or rods—despite the fact that the basic principles of photogrammetry and photo interpretation were demonstrated and used over 100 yr ago.

Photo-survey methods, like atomic energy, advanced enormously under the impetus of World War II and in the years after the war. Proponents of the technique, either as a result of spontaneous enthusiasm or because they stood to profit therefrom, sold photo-survey methods as the end all and be all of engineering mapping. The technique is tremendously valuable, but has limitations.

It would be desirable, but unfortunately, it is not possible to apply one simple formula in determining when photogrammetry is applicable to the solution of a given survey problem. Far too many elements influence the propriety of choice in a particular case. Frequently, the only wise course is to obtain alternate proposals for both ground and air surveys, or else write very explicit specifications as to the character of the finished map, and then permit the contractor to select his own methods. Where a public agency is to perform the work, and both methods are available, it is not as easy to arrive at a simple choice based on economics. In such a case it is probable that the choice would be made largely on the basis of schedules and availability of equipment.

The elements which influence economic considerations are as follows:

1. Location of Survey Area. —The accessibility of the site, the time and cost of getting to it and the availability of housing for field parties can be an important factor in the total cost of a survey. Obviously, the cost mapping of an inaccessible plateau can best be done by aerial methods.
2. Size of Survey Area. —In general, small areas can best be done by ground methods. The cost of a plane and crew waiting for suitable weather, taking off and flying to and from the survey site, is as great for 10 acres as for a 1,000. Further, the proper setting-up of the photographs and establishing the so-called stereo model in the plotter, is another major fixed-cost element which is the same whether all or part of the entire overlapping area of the photographs is to be mapped.

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3. Character of Terrain. —The more rugged the terrain to be surveyed, the greater the economic advantage of using photogrammetric methods. It is just as easy (in fact, easier) to contour a steep slope as a flat one in a photogrammetric plotter. On the other hand, everyone is familiar with the difficulties and costs of sectioning steep terrain.

4. Character of Vegetative Cover. —Dense, evergreen vegetation cannot be satisfactorily penetrated by the camera's lens. If the percentage and distribution of conifers are such that it will require considerable ground-survey time to fill in the gaps in the photogrammetric map, it might have been just as cheap, if not cheaper, to do the job on the ground in the first place. Conversely, it is often possible to interpolate in the areas of dense cover with no significant loss of accuracy.

5. Scale of Mappings. —The smaller the scale of the map required and the larger the contour interval, the greater the economy in photogrammetric methods. No matter what the scale of the map, it takes the surveyor on the ground the same length of time to walk a mile. The eye of the technician, using the photogrammetric plotter, traverses the terrain at a speed related to the scale of the photos. For maps of a scale of 1 in. = 200 ft or smaller, and a contour interval of 5-ft or more, ground methods could not possibly compete economically with photogrammetry.

6. Season of Survey. —In climates subject to heavy snowfall where there is a significant amount of deciduous cover, the seasons for air photography are brief snatches of the spring and fall. Miss the season and one may be delayed as much as 6 months. Ground survey may then be the only answer. However, photos taken on one brief, clear autumn day can be measured at leisure in a warm plotting room while the wind and snow rages over the survey site. Field work can become inefficient when the hands, faces, and feet of surveyors are subject to excessive cold.

7. Character of Detail Required. —During the recent Cuban crisis, a favorite saying described the ability of a photo interpreter to read the headline of a newspaper which a man held 60,000 ft below. This sort of thing does not apply in ordinary engineering photogrammetric work. Neither does the camera penetrate the earth's surface. In urban areas where underground utilities, overhead wires, curbs, steps, low walls and inconspicuous fences may be significant details, a great deal of ground survey is needed—often so much that it becomes more economical to use ground survey in the first place. So, despite the raves of the enthusiasts, where the tolerances for meeting existing pavement and other structures are small, the accuracy of photogrammetry is less than ideal.

Where mapping is concerned, the choice between photogrammetry and ground survey methods must be made on the basis of economics and adaptability of time schedules. The required information can, with very few exceptions, be obtained by either method.

It is in the use of photographs taken for mapping purposes, or of others taken at the same time, at different scales or with special types of films, that the real dividends in aerial mapping methods are realized. In the early stages of a survey it is usually impossible to anticipate all the information that may be needed during the design process. To map all of the information which might ultimately be wanted could be hopelessly expensive. As a result, the designer is frequently forced to make field trips, or to request supplemental survey data, no matter how good the map he has to work with. However, when mapping is based on air photos, an infinite amount of data has been captured permanently, and is readily available to the designer through photographic interpretation.

Photogrammetry is a highly technical procedure requiring elaborate, expensive equipment and highly-trained technicians. Photo interpretation, however, is essentially a very simple practice, no more complex than the act of observing commonly-used types of photographs and simply by looking with a critical mind, deriving from them certain types of information.

Photo interpretation is not an esoteric practice. It involves relatively simple techniques which are readily applicable, although only on the basis of certain types of experience. Essentially, it is possible to express all the basic techniques and the required experience in terms of the need, to be able to recognize what one is looking for. For example, one could observe a red oak for 20 years without recognizing the tree as a red oak unless having a standard of identification: height, spread, shape, branching habit, foliage, etc. Similarly, the only way one can hope to identify an object in an

aerial photo is by knowing, or by being able to visualize or imagine what it would look like in a vertical aerial photo. This can be accomplished only by study or experience.

In the fields of geology, forestry, agriculture, soil identification, and military operations, photographic interpretation can be considered a science. The special applications of photo interpretation in these fields are of such significance that the training of specialist interpreters has been both necessary and feasible. However, there is no need for such specialists in the field of landscape design, unless the photogrammetrist who serves by preparing maps from the photos is considered to be such a specialist.

Too much emphasis on the technical aspects of photo interpretation often serves only to scare off those who stand to benefit the most. The tools of the photo interpreter in landscape practice consist only of a simple stereoscope, a scale, and a magnifying glass. Perhaps a set of parallax wedges, if one wishes to measure slopes, may be added to the basic set of tools. However, they are seldom needed.

By far the most valuable tool is the stereoscope. With this, and a pair of overlapping photos of the project area, the designer has a three-dimensional model of the site available. Every stream, rock, bush and tree is there for his examination. It is amazing how often designers fail to keep air photos constantly at hand to make stereoscopic surveillance of the project site during the course of their work. There is no substitute for the intimate familiarity with the site which can thus be gained. No matter how complete and how accurate their surveys are, the use of aerial photos involves a continuous process of conscious translation—a rectangle on a map may signify a flat concrete platform or a ten-story building. No symbol can convey the difference. A note on the map is necessary to explain this difference and the designer must visualize the significance of the note. In the stereoscopic model the structure can be seen in three dimensions and thus give an incalculably more effective feeling of its character and size.

It would be impossible to attempt to be comprehensive about the special applications of photo interpretation to this field. Those who have not used a stereoscope to study a project site should get one at the earliest opportunity and try it. Any more specific suggestions as to special uses might prompt the inference that no other applications existed.

Instead, a few projects will be examined which are currently under design and in which photogrammetry was used as the survey method. The reasons for using photogrammetry will be indicated and the use of photographs to supplement the photogrammetry during the design process will be outlined.

One project involves the relocation of a State highway in the Finger Lakes region of New York. The general site for the highway parallels the lake shore, separated from the lake only by a continuous row of small summer residences which perch perilously on the slope between the highway and the lake. On the other side of the highway are steep, rocky slopes. The plans must show innumerable front steps, driveways and retaining walls.

A general route selction was made by the cognizant State agency on the basis of photogrammetric maps produced at a scale of 1 in. = 200 ft, with a 5-ft contour interval. (Maps of this scale are almost invariably produced by photogrammetric methods.) Scheduling of the project planning was such that the basic route location was determined late in autumn. Detailed planning was to be started immediately after determining the route location. Thus, if ground surveys had been selected as the basis for mapping, it would have been necessary to do the field survey either under intolerable snow conditions or the project would have had to be delayed for several months pending suitable weather.

The project area was actually photographed before the final route was selected. The effective width of the photographic band obtained was almost 2,000 ft, more than ample to allow for any variations which might have developed in the route-selection process. Actual mapping from the photographs was delayed until the route location had established the precise corridor for which it was necessary to develop topographic detail. This photogrammetric mapping was performed during the winter months when field work might might have been difficult or impossible.

Another consideration in choosing photogrammetry for this project was the character of the terrain—the steep hillside overlooking the lake. If conventional ground methods

had been used the cross-section parties would have had to be roped together like mountain climbers. In spite of the fact that the numerous houses with retaining walls, steps, etc., had to be individually mapped from the ground, photogrammetry was considerably less expensive for this project than surface-survey methods exclusively would have been.

Another project is located at Rockland Lake State Park, also in New York. This planning job for the Palisades Interstate Park Commission, included access roads, two swimming pool complexes, bathhouses, parking fields, a golf course, ski development, and picnic areas. Three stages of photogrammetry have been or will be used in the design of this project.

As in the highway just discussed, basic planning was done at a scale of 1 in. = 200 ft on photogrammetric maps which had been prepared for the entire county in which the project lies and which were available at nominal cost. The plans produced at this scale were in the nature of land-use studies rather than comprehensive preliminary plans. The accuracy of the maps was adequate to permit the determination of what type of development was feasible and what the general location and scope of parking fields, general alignment of roads, location of main features, etc., might be.

When the general scope of the project was fixed on the basis of these 1 in. = 200 ft maps, new photographs of the project area were obtained. During a single flight, photographs suitable for producing both 1 in. = 100 ft maps with a 2-ft contour interval and 1 in. = 40 ft maps with a 1-ft contour interval, were taken. One in. = 100 ft maps were prepared for the entire project area, and on them complete preliminary plans for the project were developed. These plans defined the scope and character of all significant elements in the project and established controlling grades and dimensions. These same maps were also the basis for detailed contract plans for much of the golf course, picnic area, and ski area development.

For those features which required larger scale planning—the swimming pool and surrounding areas, parking fields and access roads—1 in. = 40 ft maps were prepared. These, of course, covered only a small part of the total park area.

It is obvious that it would have been prohibitively expensive to make surveys of the entire area by ground methods at any scale, particularly since only a relatively small portion of the total park area was ultimately to be developed. Photogrammetry was the only feasible approach. The development of the larger scale maps—1 in. = 40 ft—by air methods would not ordinarily have shown as favorable an economic ratio as for the smaller scale maps, but because the photos had been obtained at the same time as those for the smaller scale mapping, and because the same ground control was used for both phases of the mapping, the method used resulted in worthwhile savings.

To have attempted to map each tree, rock, and shrub, which might ultimately have been of interest in the design of the golf course or the picnic area, would have been prohibitively expensive. However, the designers had the photographs constantly available and were able to obtain, stereoscopically, additional relevant topographic information.

Another example also involved a large State park in a very rugged area in the Helderbergs, near Albany. Complete stereoscopic photography of the park lands was obtained, and by a combination of field examinations and intensive stereoscopic examination of the photographs, a basic land-use pattern for the park was developed. The major part of the park area was to be developed for picnic purposes and the major construction item was access roads. Basic data were obtained by conventional ground survey methods but, for reasons of economy, the survey areas were limited to the immediate environs of the road construction. The designer then prepared detailed plans from the ground survey data supplemented with information derived from stereoscopic examination of the photographs.

Finally, actual construction is one of the most neglected areas for the application of photo interpretation. Frequent and systematic air photography of progress at a construction site could provide a continuing check on the adaptation of plans to field conditions and provide a record of inestimable value. This is a possibility which might well engage the attention of commercial air photographers and permit the productive use of planes and cameras at seasons when they cannot economically justify their existence.

# Principles of Making Turf Mixtures for Roadside Seedings

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•HIGHWAY SEEDINGS made up of a mixture of several species are used because the chance of obtaining a good sod is improved. Mixtures should be reasonably simple. A species should be used in a mixture only if it makes a contribution for establishment, or for maintaining a desirable perennial sod along roadsides.

## VARIABLE MICROCLIMATE

One reason for using more than one species in a mixture, is that germination, growth and sod survival among turf grasses and legumes differ with sods and the microclimate in the seedling community. For example, bluegrass and redtop respond quite differently with season of sowing. The excellent emergence and growth of redtop in mid-August as compared with bluegrass is attributable to rather high temperatures and comparatively low moisture. On the other hand, a bluegrass-redtop mixture seeded in mid-September produced a bluegrass-dominant sod. This occurred because of the better germination and seedling growth of bluegrass under the low temperature and more favorable moisture in September. These data have direct application to highway seedings, as temperature and moisture status cannot be predicted because of variations in seeding dates, slope exposure, soil conditions and climate. More significantly, just after seeding when germination and growth processes begin, the seedlings encounter an interplay of all the unpredictable environmental factors simultaneously. Some turf plants respond in germination and growth to variable environmental conditions more favorably than others; hence, it is desirable to include the best-adapted variety of a number of species. It should be stressed that there is little excuse for including more than two to four turf species in a mixture.

It is not wise to make rigid seedings' specifications for seeding contractors, because the time of the year when seedings are made cannot be foretold. Certain species such as Bermuda grass and Sericea lespedeza fail except for winter and spring seedings. Mixtures should be altered for season of seeding, since microclimate, soil, and biotic factors vary with season.

In many areas, it would be desirable to change seeding mixtures for a given seeding contract depending on the specific date of seeding and microclimate differences resulting from steepness and direction of slope exposure.

## EMERGENCE AND SEEDLING GROWTH

A second reason for using several turf species in a mixed seeding is that some very desirable perennial species are slow to establish even under very favorable conditions (Table 1). Ky. 31 fescue seedlings, 51 days after seeding, were 5 times the size of bluegrass. Italian ryegrass seedlings were 25 times larger than bluegrass. The rate of emergence and seedling growth among species may be classified in categories from very agressive to non-agressive. Cereal crops that are often used as companion grasses and which also occur naturally in straw, grow much faster than ryegrass. Crown vetch and Sericea lespedeza, very desirable legumes where adapted, have exceedingly poor seedling vigor. When using species that are slow to make a sod, it is necessary to use companion grasses in the mixtures in order to control erosion while slow growers get established. Companion grasses also have a moderating effect on soil temperature;

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TABLE 1

GROWTH RATE OF SEEDLINGS AS SHOWN BY PLANT WEIGHTS 51 DAYS AFTER SEEDING UNDER A FAVORABLE ENVIRONMENT

| Seedlings | Weight (grams) | Relative Weight |
|---|---|---|
| Grasses: | | |
| Italian ryegrass | 2.70 | 500 |
| Perennial ryegrass | 1.51 | 364 |
| Ky. 31 fescue | 0.54 | 100 |
| Redtop | 0.15 | 28 |
| Bluegrass | 0.11 | 20 |
| Red fescue | 0.25 | 46 |
| Legumes: | | |
| Red clover | 1.17 | 214 |
| Ladino clover | 0.42 | 78 |
| White clover | 0.32 | 59 |

TABLE 2

RATE OF OBTAINING SOD COVER FROM SPECIES AND MIXTURES SEEDED ON US 11 NEAR DUBLIN IN SEPTEMBER 1958[1]

| No. | Mixture (lb/acre) | Sod Cover March 1955 | Sod Conditions 1960 |
|---|---|---|---|
| 1. | Ky. bluegrass-60 | 44 | Excellent |
| 2. | Redtop-60 | 54 | Sparse, poor |
| 3. | Creeping red fescue-60 | 61 | Sparse, fair |
| 4. | Ky. 31 fesue-60 | 66 | Excellent |
| 5. | Perennial ryegrass-60 | 80 | Very poor |
| 6. | Ky. bluegrass-45, white clover-5, redtop-10 | 35 | Excellent |
| 7. | Creeping red fescue-25, Ky. bluegrass-30, white clover-5 | 51 | Excellent |
| 8. | Perennial ryegrass-10, Ky. bluegrass-45, white clover-5 | 56 | Excellent |
| 9. | Ky. 31 fescue-25, Ky. bluegrass-35 | 64 | Excellent |
| 10. | Ky. 31 fescue-55, Ladino clover-2, white clover-3 | 65 | Excellent |
| 11. | Ky. 31 fescue-20, Ky. bluegrass-35, white clover-4, and Ladino clover-1 | 66 | Excellent |
| Average | | 60.2 | |

[1]The experiment was established on a 4:1 northerly exposed, cool slope on limestone soil, fertilized with a 10-10-10 fertilizer at 800 lb per acre in 1954, and refertilized in 1958 at the rate of 400 lb per acre.

the insulating qualities of the sod formed by quick-growing grasses reduce the loss of radiant energy during the night and limit soil temperature increases during the day. The moderating effect of temperature in the seedling environment may also improve soil moisture because of a decrease in transpo-evaporation.

Data from an experiment along US 11 show that the most rapid initial sod cover was generally obtained from turf species or mixtures with the best seedling vigor (compare

TABLE 3

GROWTH RATE OF SEEDLINGS AS SHOWN BY PLANT WEIGHTS 51 DAYS AFTER SEEDING[1]

| Mixture | Weight (grams) | Relative Weight |
|---|---|---|
| Italian ryegrass | 2.70 | 100 |
| Ky. bluegrass | 0.11 | 4 |
| White clover | 0.32 | 12 |
| Redtop | 0.15 | 6 |

[1]Ryegrass strongly dominant in sod, depending on seeding rate.

Tables 1 and 2). The percent of soil covered with sod in March after a September seeding of five species was: 80% for perennial ryegrass; 66% for Ky. 31 fescue; 61% for creeping red fescue; 54% for redtop; and 44% for bluegrass. Adding a turf species with aggressive seedling growth to one with slow seedling growth resulting in faster sod establishment. However, the permanent sod cover, six years after seeding, was unsatisfactory for redtop, red fescue and perennial ryegrass. These grasses are not hardy perennials because they are not adapted to the moisture, temperature, and disease complex in most Virginia environments. Any seeding with Ky. 31 fescue or bluegrass produced a desirable perennial sod cover.

## SEEDLING COMPETITION IN MIXTURES

Mixtures should be simple and turf species with aggressive seedlings should be used sparingly or omitted. As seeds germinate, a dynamic environment is created where species with aggressive seedlings crowd out the non-aggressive seedlings because of competition for light, moisture, and nutrients. Turf plants with aggressive seedlings become dominant in a sod (Table 3). With slow-growing plants such as bluegrass, light seeding rates of aggressive grasses are usually desirable to aid in erosion control. Heavy seeding rates usually inhibit the establishment of the perennial sod-forming species, and are therefore harmful. Annual cereal grains in unthreshed straw often exterminate desirable sod-forming plants. When the small-grain plants die, the soil begins to erode or slough due to moisture accumulation and attendant supersaturation.

Mixtures with Ky. 31 fescue should not include aggressive companion grasses, except for out-of-season seedings. Ky. 31 fescue is easy to establish because of its wide adaptation and good seedling vigor.

## ESTABLISHING LEGUMES WITH POOR SEEDLING VIGOR

Low soil nitrogen is a major problem in maintaining grass sods. Ureaformaldehyde is the only source of nitrogen that has a rather long-lasting effect because of its slow release through soil microbes. Hardy perennial legumes do not depend on fertilizer or organic nitrogen, because they fix atmospheric nitrogen. In Virginia, Sericea lespedeza is widely adapted and it appears that crown vetch grows satisfactorily in the mountainous regions, and on the cooler slope sites. Both of these legumes have poor seedling vigor; hence, seeding mixtures and fertility practices must be carefully manipulated to get good stands.

Sericea lespedeza establishment was studied in an experiment on a steep, sunny slop on Interstate 81. High nitrogen fertilization and liberal grass seedings caused a tenfold reduction in Sericea plant stands and a fivefold reduction in the size of Sericea (Table 4). Thus, the establishment of Sericea, and the resultant sod cover was excellent with limited nitrogen and a low grass-seeding rate, intermediate for high grass-seeding rates with low nitrogen, and a near failure with liberal nitrogen and liberal grass seedings. Ky. 31 fescue and redtop seedlings grew 7 to 9 times faster than Sericea with low nitrogen, and 14 to 16 times faster than Sericea with high nitrogen fertilization.

TABLE 4

SERICEA LESPEDEZA[1], INTERSTATE 81 NEAR PULASKI, SEEDED IN MARCH, 1956, DATA FOR 1961

| Companion Grasses | Nitrogen (lb/acre) | Plants/Sq Ft June | Wt. of 100 Plants June | Sod Cover Sept. |
|---|---|---|---|---|
| Ky. 31 fescue 15 lb | 20 | 63 | 145 | 43 |
| | 120 | 24 | 85 | 13 |
| Ky. 31 fescue 60 lb | 20 | 60 | 121 | 35 |
| and redtop 10 lb | 120 | 6 | 28 | 4 |

[1] Sericea was seeded at 75 lb per acre, 2:1 slope.

TABLE 5

SEEDLING PLANTS AND SUBSEQUENT COVER OF CROWN VETCH WITH TWO MIXTURES WITH AND WITHOUT LIME—INTERSTATE 81, PULASKI

| Mixture (lb/acre)[1] | Seedling Plants (per sq ft) May 13, 1962 | | Ground Cover (%) Nov. 13, 1962 | |
|---|---|---|---|---|
| | No Lime | Lime | No Lime | Lime |
| Ky. 31 fescue 10, redtop ½ | 10 | 19 | 1.3 | 13.3 |
| Ky. 31 fescue 60, redtop 1 | 9 | 12 | 1.2 | 10.2 |
| Average | 9.5 | 15.5 | 1.2 | 11.7 |

[1] 75 lb of Sericea was included with both mixtures; 4-20-10 fertilizer was applied at the rate of 1,000 lb per acre; experiment located on a 2:1 slope.

After Sericea seedlings are established, the plants become aggressive with respect to companion plants because the tall, erect growth reduces the light intensity at the lower levels where grasses grow.

Crown vetch establishment is often inhibited because of competition during seedling development. High nitrogen fertilization and liberal grass seedings exterminate many of the slow-growing crown vetch seedlings, thus, low seeding rates of companion grass and low application rates of nitrogen fertilizer encourage better populations of crown vetch.

Liming and the seeding rate of companion grasses influence crown vetch establishment (Table 5). There were 9.5 plants per sq ft on unlimed soil as compared with 15.5 plants where lime was applied at 2 tons per acre. Crown vetch ground cover the year after seeding was about 10 times better on limed soil than on unlimed soil. Heavy seeding of a grass mixture reduced the crown vetch ground cover, but the difference was minor because the nitrogen fertilizer rates were low. The tall, erect growth of Sericea in the second year reduced the growth of crown vetch. Sericea made excellent growth on this sunny slope.

## SOIL FERTILITY AND PLANT ADAPTATION

It has been pointed out (1) that turf species used for roadside seedings differ in response to soil fertility and lime. Turf species can be selected for high or low fertility sites; but this is shortsighted since species such as redtop, that tolerate comparatively low fertility and high soil acidity, are not hardy perennials. Thus, it is wise to test soils and provide adequate fertility before making seedings. Sufficient lime and fertility

TABLE 6

INFLUENCE OF LIME AND PHOSPHORUS IN ESTABLISHMENT, COMPOSITION, AND MAINTENANCE OF SOD COVER (US 360, AMELIA—1:1 SLOPES)

| Date of Fertilizer Application, (lb/acre)[1] | | Percent Sod Cover in Oct., 1962 | | | | | |
|---|---|---|---|---|---|---|---|
| | | All Vegetation | | Ky. 31 Fescue | | Weeds | |
| 1,000 March 1959 | 500 Sept. 1959 | Lime | No Lime | Lime | No Lime | Lime | No Lime |
| A 10-5-10 | 10-0-10 | 63 | 38 | 40 | 3 | 3 | 15 |
| B 10-5-10 | 10-5-10 | 70 | 48 | 49 | 6 | 5 | 10 |
| C 10-10-10 | 10-0-10 | 75 | 48 | 48 | 3 | 3 | 7 |
| D 10-10-10 | 10-10-10 | 68 | 65 | 45 | 15 | 3 | 12 |
| E 10-20-10 | 10-0-10 | 80 | 58 | 58 | 8 | 2 | 11 |
| F 10-20-10 | 10-20-10 | 80 | 50 | 53 | 13 | 2 | 12 |
| G 10-40-10 | 10-0-10 | 75 | 55 | 53 | 24 | 1 | 9 |
| H 10-40-10 | 10-40-10 | 83 | 60 | 55 | 28 | 2 | 9 |
| Average | | 74.2 | 52.7 | 50.1 | 12.5 | 2.6 | 10.6 |

[1]Experiment was established in March 1959. Fertilizer application in September 1959 was for maintenance.

TABLE 7

Ca, Mg, P, pH AND ORGANIC MATTER CONTENT OF SOIL FOLLOWING APPLICATIONS OF LIME AND FERTILIZER (US 360, AMELIA, 1:1 SLOPES)

| Date of Fertilizer Application (lb/acre)[1] | | Soil Sampled, October 1962 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Soil Acidity (pH) | | Calcium, CaO (lb/acre) | | Mg, MgO (lb/acre) | | Phosphorus, $P_2O_5$ (lb/acre) | Organic Matter (%) |
| 1,000 March 1959 | 500 Sept. 1959 | Lime | No Lime | Lime | No Lime | Lime | No Lime | | |
| A 10-5-10 | 10-0-10 | 6.0 | 4.3 | 1,650 | 55 | 365 | 56 | 21 | 1.2 |
| B 10-5-10 | 10-5-10 | 6.3 | 4.3 | 2,438 | 20 | 365 | 28 | 25 | 1.2 |
| C 10-10-10 | 10-0-10 | 6.0 | 4.3 | 2,563 | 20 | 347 | 62 | 51 | 1.2 |
| D 10-10-10 | 10-10-10 | 6.1 | 4.6 | 4,500[2] | 120 | 374 | 58 | 60 | 1.1 |
| E 10-20-10 | 10-0-10 | 6.5 | 4.2 | 4,500 | 45 | 369 | 48 | 130 | 1.3 |
| F 10-20-10 | 10-20-10 | 6.3 | 4.4 | 4,500 | 60 | 379 | 46 | 174 | 1.2 |
| G 10-40-10 | 10-0-10 | 6.7 | 4.2 | 4,500 | 223 | 389 | 68 | 304 | 1.3 |
| H 10-40-10 | 10-40-10 | 6.5 | 4.3 | 4,500 | 378 | 352 | 46 | 381 | 1.2 |
| Average | | 6.3 | 4.3 | 3,643 | 115.1 | 367.5 | 51.5 | 143.2 | 1.2 |

[1]Experiment was established in March 1959. Fertilizer application in September 1959 was for maintenance.
[2]Exceeds 4,500 lb per acre.

generally stimulate rapid sod establishment and also improve the soil in later years, thus reducing maintenance problems (Tables 6 and 7). Liming improved the growth of all turf species and the total sod cover with all rates of phosphorus fertilization, however, the largest response occurred for Ky. 31 fescue which produced a 50.1% sod cover with lime as compared to 12.5% when lime was omitted. There were about one-fourth as many weeds on the limed soil as on the unlimed soil; the growth of desirable grasses crowded out most of the weeds. Sod cover was generally increased as the rate of phosphorus was raised to a 10-20-10 ratio.

A fertilizer-lime program should consider the residual build up of soil nutrients resulting from applications made for establishment, thereby reducing fertilizer costs for sod maintenance. The use of lime and phosphorus for sod establishment increased the soil calcium from 30 to several hundredfold three years after making the applications (Table 7). Dolomitic agricultural lime also caused an average sevenfold increase in soil magnesium. Residual phosphorus in the soil increased as the rate of phosphorus application increased. These residual fertilizer nutrients in the soil leach slowly or not at all, thus, they improve sod cover and lessen future maintenance problems.

Other soil analyses show that grass growth is limited by nitrogen as shown by the low content of organic matter. High levels of calcium, phosphorus and magnesium during the period of establishment represent a maintenance boon as only nitrogen will need to be applied for continued thrift of the sod cover. Ureaformaldehyde nitrogen used for establishment may have an effective nitrogen carry-over for more than one year.

## MAINTENANCE PRACTICES

Specifications of seeding mixtures should consider maintenance management. For example, Sericea lespedeza and crown vetch should not be used on sites that will be mowed more than twice annually. Frequent mowing has converted such legume dominant sods to grassy sods.

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## REFERENCE

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