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CIRCULAR

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RESEARCH PROBLEM STATEMENTS IN LANDSCAPE AND ENVIRONMENTAL DESIGN

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INTRODUCTION

This circular contains fourteen research problem statements developed by the Committee on Landscape and Environmental Design. The statements were screened by a subcommittee

and the order in which they appear represents the best consensus of priority research needs within the scope of the Committee's activities.

RESEARCH PROBLEM STATEMENTS

PRIORITY LISTING

STATEMENT
NUMBER

NAME OF PROBLEM

- | | |
|----|---|
| 1 | Cost-Effective Roadside Revegetation to Enhance Physical and Psychological Roadway Features |
| 2 | Value of the Psychological Effect of Visual Barriers in Solving Noise Attenuation Problems |
| 3 | Scenic Highway Selection Criteria |
| 4 | Maintenance Costs of Intensively Landscaped Highway Areas |
| 5 | Accommodation of Interests in Roadside Vegetation Management and Outdoor Advertising |
| 6 | Evaluation of Plants for City Streets and Requirements for Healthy Survival |
| 7 | Cost-Effective Analysis of Erosion Control Materials and Techniques |
| 8 | Use of Landscape Plants by Wildlife |
| 9 | Aesthetic Improvement of Railroad and Rail Transit Rights of Way |
| 10 | Effects of Eroded Solids from Highway Construction on Aquatic Communities |
| 11 | Development of Best Management Practices (BMP) for Highway Construction |
| 12 | Nitrogen Fixation with Grasses |
| 13 | Effect of Shoulder Slope Vegetation on Subsurface Drainage of Roadbeds |
| 14 | Soils Ecology for Highway Planting Establishment |

PROBLEM NO. 1

live with native plants and compatible with site conditions.

I. NAME OF PROBLEM - COST-EFFECTIVE ROADSIDE REVEGETATION TO ENHANCE PHYSICAL AND PSYCHOLOGICAL ROADWAY FEATURES

D. Identify those plant communities that meet the following requirements:

- II. THE PROBLEM - Inflation and declining revenues are causing severe cutbacks in transportation construction including roadside development. Proper roadside development and vegetation restoration is a necessary element in transportation systems to enhance physical (operational safety and maintenance) and psychological (buffers and visual relief) features of the roadway system and contiguous communities.
- Restoration of roadside vegetation disturbed during construction is presently done by seeding of grasses and legumes and/or planting of woody vegetation. The vegetation used for revegetation is most often considered exotic and not necessarily compatible with existing environmental conditions or competitive with native vegetation unless certain maintenance measures are undertaken. Maintenance measures include weed control, brush control, mowing and fertilization among others. These actions are normally perpetual and therefore their cumulative costs are high.

1. Compatible with the primary function of transportation facility including operational safety, geometric design features and maintenance of structural integrity.
2. Minimize vegetative litter (breakage and leaf and fruit droppage).
3. Successful competition with native vegetation and invading weeds.
4. Realistic to establish and manage including availability of seeds and plants, propagation methods, seeding and planting methods (without irrigation), natural revegetation, herbicide programs and soil management and costs.
5. Visual qualities.

III. OBJECTIVES

IV. CURRENT ACTIVITIES

- A. Identify and prioritize those roadside development needs which are essential elements in satisfying physical and psychological needs of the motorist and the community.
- B. Develop methods for revegetating roadsides which will satisfy motorist and community needs and which are cost-effective to construct and maintain.
- C. Evaluate methods of revegetating roadsides with plant communities that are competi-

- A. Research in progress: not determined.
- B. Suggested key words: roadside development, vegetation, planting, replanting.
- C. The following reports related to the subject have been published.
 1. Washington State Department of Highways Report FH-WA Highway Research Report 14.1 "Vegetative Cover for Highway Rights of Way," 1973.

2. Washington State Department of Highways Report FH-WA Highway Research Report 14.2 "Vegetative Cover for Highway Rights of Way," 1976.

3. Washington State Department of Transportation Report FH-WA Highway Research Report No. 34.1 "Chemical Weed Control in Roadside Vegetation on Highway Rights of Way," 1979.

- V. URGENCY - In view of inflationary trends and declining revenues there is an urgent need to identify and develop more cost-effective methods for roadside vegetative management. The potential for savings in the proper use of re-vegetative science and technology is both immediate and long term.

PROBLEM NO. 2

- I. NAME OF PROBLEM - VALUE OF THE PSYCHOLOGICAL EFFECT OF VISUAL BARRIERS IN SOLVING NOISE ATTENUATION PROBLEMS
- II. THE PROBLEM - There are many instances where fences or plants have been used to provide privacy for abutting dwellings. Although these screens have not reduced the noise any appreciable amount, the affected resident has reported substantial reduction in noise levels. The value of the "out of sight - out of mind" approach to solving the highway noise problem needs to be determined.

III. OBJECTIVES

- A. Determine methods for evaluating the psychological effect of visual screens for transportation noise abatement.
- B. Determine if health is truly protected through the use of visual screens which produce a psychological protection from noise.

IV. CURRENT ACTIVITIES

- A. Research in progress: not determined.
- B. Suggested key words: visual, barriers, screens, noise attenuation, noise barriers, fences, tree screens.
- C. Related research activities: not determined.

- V. URGENCY - If results show that there is real value in providing visual barriers in lieu of more substantial noise barriers there are many places where planting can be used as a cost-effective method for noise attenuation.

PROBLEM NO. 3

- I. NAME OF PROBLEM - SCENIC HIGHWAY SELECTION CRITERIA
- II. THE PROBLEM - Many miles of the nation's highways pass through the most scenic parts of the country. Along with the environmental protection concerns there has developed an increasing interest amongst many groups to identify and designate as scenic certain corridors

possessing unusual visual qualities. Criteria for past selections of scenic highways have been based primarily on individual opinion. There is a rising need for professionally developed criteria for the identification, selection, acquisition and management of scenic highways.

- III. OBJECTIVES - Develop general criteria for the selection, acquisition of control rights and management of scenic highways.

IV. CURRENT ACTIVITIES

- A. Research in progress: not determined.
- B. Suggested key words: scenic highways, scenic roads, scenic easement, parkways, visual, selection criteria.
- C. Related research activity: Although there is no knowledge of a concentrated national approach to solving this problem, several states have addressed themselves to the subject. The State of California has published a guide to scenic roads and the United States Forest Service published a technical bulletin relative to scenic highways.

- V. URGENCY - The Federal Highway Administration on several occasions recognized the desirability for a scenic highway program. This timely study would prepare the various states for such a program in addition to satisfying the need for scenic highway criteria found in other transportation related programs.

PROBLEM NO. 4

- I. NAME OF PROBLEM - MAINTENANCE COSTS OF INTENSIVELY LANDSCAPED HIGHWAY AREAS

- II. THE PROBLEM - Highway agencies often attempt to beautify some areas of the highway system with intensive and expensive landscaping programs. These are sometimes done to placate local citizens or environmental activist groups, or merely because of aesthetic propensities of the landscape unit in the highway agency. Often, however, these areas are subsequently neglected because of the high cost of maintaining them and the investment is then wasted. In fact, the landscaping may hinder the use of conventional equipment to at least keep the area neatly mowed.

One of the factors that may lead to this seeming waste of money is the lack of knowledge about what costs are to be expected in maintaining an intensively landscaped area. The compilation of data would enable highway agencies to make landscape design decisions with some enlightenment about the subsequent maintenance costs. Such information would also be useful background data when soliciting public input about highway landscaping plans.

III. OBJECTIVES

- A. Select a number of landscape conditions that are typical to many highway localities and agencies.
- B. Collect information on the cost to construct and maintain these areas in a satisfactory manner.

- C. Based on the results of A and B and other available data develop long-term maintenance costs for typical highway landscape projects.

IV. CURRENT ACTIVITIES

- A. Research in progress: not determined.
- B. Suggested key words: landscaping, landscape design, maintenance costs, roadside maintenance.
- C. Related research activities: There have been a number of studies which address landscaping and vegetation management in rights of way, but none are known to have considered the long-term costs of maintenance.

- V. URGENCY - Recently there has been a tendency to placate the wishes of various activist groups, both national and local, with intensely landscaped projects. Once installed the landscaping is often neglected and does not please anyone, neither the activists nor the highway agency that is required to maintain the landscaped areas. Significant savings on initial construction as well as long-term maintenance costs could be realized if sufficient data were available to make rational decisions.

PROBLEM NO. 5

- I. NAME OF PROBLEM - ACCOMMODATION OF INTERESTS IN ROADSIDE VEGETATION MANAGEMENT AND OUTDOOR ADVERTISING

- II. THE PROBLEM - A conflict of interests and practices exists between the efforts of highway agencies to maintain vegetation along highway rights of way and efforts of outdoor advertising sign owners to maximize the visibility of their signs. Each year substantial numbers of trees and shrubs are removed, often by illegal and unnecessarily destructive methods, for the benefit of roadside advertising. The resulting damage to landscaping, visual environment, erosion, noise abatement and plant and wildlife habitats has reached serious levels in some regions.

Although most states have some laws protecting vegetation on public rights of way, the pattern of protection is diverse and penalties and enforcement procedures generally are poor. Efforts to develop policies and technical guides for accommodation of roadside vegetation and advertising interests are hampered because the environmental, engineering and administrative consequences of the various options have not been identified.

- III. OBJECTIVES - Identify and evaluate the consequences of unauthorized destruction of vegetation on highway rights of way and correlate this information with options for developing legally sound and operationally prudent practices for states regarding the interests in protecting roadside vegetation and in improving billboard visibility.

IV. CURRENT ACTIVITIES

- A. Research in progress: not determined.

- B. Suggested key words: roadside vegetation, outdoor advertising, billboards, motorist information.

- C. Related research activities: The outdoor advertising industry is promoting its interests through contact with FHWA offices in Washington and the field, the AASHTO Maintenance Operating Committee and individual state highway departments.

The Federal Highway Administration has published several memoranda expressing policies favoring preservation of vegetation but authorized states to accede to advertising industry wishes by entering into agreements which turn vegetation control over to industry elements.

Currently the subject of vegetation control policy is on the agenda of the National Advisory Committee on Outdoor Advertising and Motorist Information. This committee is charged with recommending future federal policy on this and other subjects relating to billboard control.

- V. URGENCY - Annual damage to roadside vegetation is substantial and continuing, especially in the eastern, central and southern regions. State-industry agreements for vegetation control have raised serious legal questions and administrative problems. Neither state nor federal agencies can make sound policy or technical decisions until the consequences of current practices and options are evaluated.

PROBLEM NO. 6

- I. NAME OF PROBLEM - EVALUATION OF PLANTS FOR CITY STREETS AND REQUIREMENTS FOR HEALTHY SURVIVAL

- II. THE PROBLEM - Harsh city environment requires special characteristics in trees and special planting methods. There are no dependable guidelines for selection and establishment of street trees which will remain healthy under city conditions.

- III. OBJECTIVES Study of methods, materials and results of street tree planting in city environment. Recommend on regional basis, plant lists and planting methods for establishing trees in adverse city conditions. A synthesis of existing documents should be examined for a possible solution to the problem.

IV. CURRENT ACTIVITIES

- A. Research in progress: not determined.
- B. Suggested key words: plants, planting, urban streets, trees.
- C. Related research activities: No known.

- V. URGENCY - The results of this research could be used to advantage as soon as completed. The possibilities are good that the results will lead to immediate savings related to increased survivability of plantings and reduced maintenance costs.

PROBLEM NO. 7

I. NAME OF PROBLEM - COST-EFFECTIVE ANALYSIS OF EROSION CONTROL MATERIALS AND TECHNIQUES

- II. THE PROBLEM - Effectiveness of various structural and vegetative materials and techniques used for erosion control has not been evaluated in terms of cost of the end results. Nor has any effort been made to develop a value system to assign relative values of effectiveness of the various materials and techniques available either individually or collectively. (NOTE: See Conclusions and Suggested Research, NCHRP Report 220: Erosion Control During Highway Construction.)

Use of the Universal Soil Loss Equation as set forth in NCHRP Report 221: Erosion Control During Highway Construction, Manual on Principles and Practices, is limited at best without such value assignments. Economics of the various alternatives must be considered as well.

- III. OBJECTIVES - To develop cost-effective analyses having a system of relative values assigned for the various materials and techniques of erosion control both individually and in combination thereof.

IV. CURRENT ACTIVITIES

- A. Research in progress: Evaluation of the physical properties of a number of erosion control materials is being conducted by Virginia. Pennsylvania is looking at some of the broader aspects of erosion control techniques, although not specifically at cost-effectiveness of erosion control materials.

- B. Suggested key words: erosion, erosion control, water quality, embankment stabilization, shoulder stabilization.

- C. Related research activities: NCHRP Report 221, Erosion Control During Highway Construction, Manual on Principles and Practices, utilizes a modified universal soil loss equation to enable the designer to predict soil loss under a given set of conditions and to design into the project necessary control features (VM factor).

- V. URGENCY - Implementation of research contained in NCHRP Reports 220 and 221 is dependent upon research as proposed herein. With the ever increasing cost of highway projects and the continuing emphasis placed on water quality, a cost analysis of the various alternatives and combinations thereof is essential.

PROBLEM NO. 8

I. NAME OF PROBLEM - USE OF LANDSCAPE PLANTS BY WILDLIFE

- II. THE PROBLEM - There is a great potential for highway rights of way to support populations of birds and small mammals. The importance of this habitat is greatest in urban and agricultural areas where little natural habitat exists. In urban areas large areas of rights of way are landscaped. In developing a landscape plan usually the wildlife potential is ignored.

- III. OBJECTIVES - To determine the use of selected

landscape plant species to support wildlife. Research will not only consider their use for food and shelter but optimum planting design.

IV. CURRENT ACTIVITIES

- A. Research in progress: not determined.

- B. Suggested key words: wildlife, wildlife habitat, roadside vegetation, plants, plantings.

- C. Related research activities: none known.

- V. URGENCY - Millions of dollars are spent annually in landscaping. Little or no consideration is given to the value of the plants to support wildlife. Proper right of way management should include consideration of this important aspect, especially in light of the importance of highway rights of way as wildlife habitat.

PROBLEM NO. 9

I. NAME OF PROBLEM - AESTHETIC IMPROVEMENT OF RAILROAD AND RAIL TRANSIT RIGHTS OF WAY

- II. THE PROBLEM - The view from passenger trains passing through many urban areas is of deteriorated, rubbish strewn back yards; vacant lots and commercial or industrial areas. Such conditions do not encourage the use of mass transit. Ways to improve the visual quality of the railroad environment should be researched.

III. OBJECTIVES

- A. Determine scope of the problem.

- B. Determine if there are legal means to clean up and otherwise improve deteriorated areas viewed from the train.

- C. Determine how the proposed improvements can be financed.

- D. Determine if enabling legislation is needed.

- E. Determine feasibility of accomplishing the work through local clean-up and fix-up campaigns versus public funding or a combination of both.

IV. CURRENT ACTIVITIES

- A. Research in progress: not determined.

- B. Suggested key words: railroad, aesthetics, visual improvement.

- C. Related research activities: There has been much written about the visual improvement of the highway environment but little or nothing about the railroad environment.

- V. URGENCY - Conserving energy has a high priority. If improving rail transportation is an important energy conservation measure research leading to increased ridership should have a high priority.

PROBLEM NO. 10

I. NAME OF PROBLEM - EFFECTS OF ERODED SOLIDS FROM HIGHWAY CONSTRUCTION ON AQUATIC COMMUNITIES

II. THE PROBLEM - During most highway construction projects one or two streams are crossed or are near the limits of the construction activities. Even with the latest erosion and sediment control devices being used on the construction project sediment still enters the stream. The effects and the tolerable limits of this sediment as suspended and bedload material on various aquatic communities (flora and fauna) have not been determined.

III. OBJECTIVES

- A. Determine the amount of bedload material the flora and fauna of a stream can tolerate above ambient conditions without having any adverse effects.
- B. Determine the amount of suspended solids the flora and fauna of a stream can tolerate above ambient conditions without having any adverse effects.

IV. CURRENT ACTIVITIES

- A. Research in progress: not determined.
- B. Suggested key words: erosion, aquatic communities, flora, fauna, suspended solids, bedload.
- C. Related research activities: Several federal and state agencies have considered setting suspended solids limits on non-point pollution sources such as highway construction but have refrained from doing so since the effects of various amounts of suspended solids on aquatic communities have not been determined.

V. URGENCY - This study is of high priority since regulatory agencies would like to set bedload or suspended solids limits on non-point sources. However, they have no idea what effects various amounts of suspended solids or bedload material have on different aquatic communities.

PROBLEM NO. 11

I. NAME OF PROBLEM - DEVELOPMENT OF BEST MANAGEMENT PRACTICES (BMP) FOR HIGHWAY CONSTRUCTION

II. THE PROBLEM - Provisions of the Federal Water Pollution Control Act of 1972 and the Clean Water Act of 1977 require the control of non-point source (NPS) pollution through best management practices (BMP). Resource agencies have begun implementing this legislation by cooperative development of BMP's with development agencies and other concerned parties. A conspicuous lack of quantitative data exists on the environmental impacts of some highway construction activities. This fact makes development of BMP's for transportation agencies particularly difficult.

III. OBJECTIVES - Conduct a literature search and generate a sufficient data base to evaluate environmental impacts of different construction techniques available for a given construction activity. Suggestions include: a quantita-

tive evaluation of construction parameters affecting water quality and aquatic habitat due to placement of fill in lakes and streams; stream crossing techniques and their effect on the riparian ecosystem; and techniques to prevent or control sediment runoff in fragile granitic soils during and after construction.

IV. CURRENT ACTIVITIES

- A. Research in progress: not determined.
- B. Suggested key words: environmental impact, construction, water quality, sedimentation, ecosystem, aquatic habitat.
- C. Related research activities: The following activities have been conducted.
 1. Qualitative assessments of sediment control provided by U.S. DOT (BMP for Erosion and Sediment Control) and U.S. EPA (Methods to Control Fine-Grained Sediments Resulting from Construction Activity).
 2. Quantitative assessments of water quality impacts resulting from construction of small sized bridge structures. Methods of abutment construction evaluated are: spread footing, driven pile and drilled caisson. These data have been generated by Idaho Transportation Department and are presently being evaluated.

V. URGENCY - In most states compliance with BMP's will assure a transportation agency's compliance with state water quality standards. The obvious benefits gained include: protection of environmental quality, increased public acceptance of transportation projects, a decrease in conflict between resource and transportation agencies and expedient completion of a project due to decreased environmental delays.

PROBLEM NO. 12

I. NAME OF PROBLEM - NITROGEN FIXATION WITH GRASSES

II. THE PROBLEM - Due to sensitivity to many weed control chemicals and other factors legumes for roadside seed mixtures tend to be short lived. Over a period of several years roadside grasses become nitrogen deficient. Ammonium nitrate fertilizers used to provide nitrogen for grasses requires large quantities of natural gas to produce and are becoming increasingly expensive. Natural processes for supplying nitrogen to roadside vegetation are highly desirable.

III. OBJECTIVES - To develop a specie or species of grasses suitable for roadside use that have the capabilities of nitrogen fixation.

IV. CURRENT ACTIVITIES

- A. Research in progress: Some work is being done in developing an algae for the purpose of nitrogen fixation as indicated in the 1975 July issue of National Geographic. Also some work is being done by the State University, Leyden, the Netherlands,

entitled, "The Biology of Nitrogen Fixation." A researcher in Brazil is doing greenhouse work with grasses that have nitrogen fixation capabilities.

- B. Suggested key words: legumes, grasses, nitrogen, nitrogen fixation.
- C. Related Research activities: There is considerable interest and activity in this process amongst other disciplines.
- V. URGENCY - This proposal is considered highly important to reduce the cost of roadside maintenance and dependence on petroleum products for a source of nitrogen. Natural processes for supplying nitrogen to roadside vegetation are highly desirable.

PROBLEM NO. 13

- I. NAME OF PROBLEM - EFFECT OF SHOULDER SLOPE VEGETATION ON SUBSURFACE DRAINAGE OF ROADBEDS
- II. THE PROBLEM - The shoulder slope of roadways is the interface between the roadbed foundation and the surrounding land forms. Obstruction of the drainage pattern through this interface increases moisture content of the roadbed foundation, which, in turn, endangers the structural integrity of the roadway. In order to reduce the chance for drainage obstruction the present practice is to eradicate vegetation on shoulder slopes with herbicides. This has resulted in extensive herbicide programs which are costly, cause potential erosion and water pollution, and degrade visual quality of a highway facility.
- III. OBJECTIVES - Analyze the effects of vegetated roadway shoulder slopes on the drainage of the roadbed and, thereby, overall structural integrity of the pavement structure. Develop design, construction and maintenance procedures that are cost-effective, preserve the quality of the roadbed foundation, and are less detrimental to water quality and visual quality of the facility.
- IV. CURRENT ACTIVITIES
 - A. Research in progress: None known.
 - B. Suggested key words: roadside vegetation, subsurface drainage, shoulder slopes.
 - C. Related research activities: None known.
- V. URGENCY - Increased cost of petroleum-derived products such as fuel, fertilizers and herbicides are increasing roadside construction and maintenance costs. Improved vegetative practices for roadway slopes hold promise for savings in maintenance costs and reduction in roadway structure damage.

PROBLEM NO. 14

- I. NAME OF PROBLEM - SOILS ECOLOGY FOR HIGHWAY PLANTING ESTABLISHMENT
- II. THE PROBLEM - Highway construction activities have altered natural pH, moisture and temperature regimes of the various soil types within right of way planting sites. The degree and measurement of alteration from that cataloged

in the National Cooperative Soil Survey is unknown. Since basic soils and environmental data are fundamental to the successful establishment of stable shrub communities for open space management there is a need for better correlation of plant species propagation and establishment within given soil boundaries.

- III. OBJECTIVES - To collect and catalog seasonal moisture, temperature and pH data on soil mapping units within our interstate highway right of way. This would be the first phase of a two-phase study of induced secondary plant succession. The second phase would be trial seedling plantings for soil suitability, the results of which to be utilized as a predictor element for site specific, controlled vegetation.
- IV. CURRENT ACTIVITIES
 - A. Research in progress: Maine Department of Transportation is presently working on propagation and establishment techniques in conjunction with their landscape nursery program. Activities now under way include woody plant seed germination and cuttings under glass and field beds. Seedling containers, specialty fertilizers, herbaceous sod mats and species evaluation are also currently being studied in the nursery and on roadside.
 - B. Suggested key words: soil reaction, catena, regime, soil mapping unit, soil horizon, subsoil, solum.
 - C. Related research activities: None known.
- V. URGENCY - Revenue shortfall problems and pesticide environmental/health issues are seriously affecting the quality of functional roadsides. Low cost successful establishment of controlled form plant communities is a cost-effective vegetation management alternative. Research findings can be directly implemented into a large scale on-going plant succession program.