

National Cooperative Highway Research Program

NCHRP Synthesis 184

Disposal of Roadside Litter Mixtures

A Synthesis of Highway Practice

**Transportation Research Board
National Research Council**

TRANSPORTATION RESEARCH BOARD EXECUTIVE COMMITTEE 1993

Officers

Chairman

A. RAY CHAMBERLAIN, *Executive Director, Colorado Department of Transportation*

Vice Chairman

JOSEPH M. SUSSMAN, JR *East Professor of Engineering, Massachusetts Institute of Technology*

Executive Director

THOMAS B. DEEN, *Transportation Research Board, National Research Council*

Members

KIRK BROWN, *Secretary, Illinois Department of Transportation*

DAVID BURWELL, *President, Rails-to-Trails Conservancy*

L.G. (GARY) BYRD, *Consultant, Alexandria, Virginia*

L. STANLEY CRANE, *former Chairman & CEO of Consolidated Rail Corporation*

RICHARD K. DAVIDSON, *Chairman and CEO, Union Pacific Railroad*

JAMES C. DeLONG, *Director of Aviation, Stapleton International Airport, Denver*

JERRY L. DePOY, *Former Vice President, Properties and Facilities, USAir*

DON C. KELLY, *Secretary and Commissioner of Highways, Kentucky Transportation Cabinet*

ROBERT KOCHANOWSKI, *Executive Director, Southwestern Pennsylvania Regional Planning Commission*

LESTER P. LAMM, *President, Highway Users Federation*

LILLIAN C. LIBURDI, *Director, Port Department, The Port Authority of New York and New Jersey*

ADOLF D. MAY, JR., *Professor and Vice Chair, Institute of Transportation Studies, University of California*

WILLIAM W. MILLAR, *Executive Director, Port Authority of Allegheny County (Past Chairman, 1992)*

CHARLES P. O'LEARY, JR., *Commissioner, New Hampshire Department of Transportation*

JUDE W. P. PATIN, *Secretary, Louisiana Department of Transportation and Development*

NEIL PETERSON, *Former Executive Director, Los Angeles County Metropolitan Transportation Commission*

DARREL RENSINK, *Director, Iowa Department of Transportation*

DELLA M. ROY, *Professor of Materials Science, Pennsylvania State University*

JAMES W. VAN LOBEN SELS, *Director, California Department of Transportation*

C. MICHAEL WALTON, *Ernest H. Cockrell Centennial Chair in Engineering and Chairman, Department of Civil Engineering, The University of Texas at Austin (Past Chairman, 1991)*

FRANKLIN E. WHITE, *Chief Executive Officer, Los Angeles County Metropolitan Transportation Commission*

JULIAN WOLPERT, *Henry G. Bryant Professor of Geography, Public Affairs and Urban Planning,*

Woodrow Wilson School of Public and International Affairs, Princeton University

HOWARD YERUSALIM, *Secretary of Transportation, Pennsylvania Department of Transportation*

ROBERT A. YOUNG III, *President, ABF Freight Systems, Inc.*

Ex Officio Members

MIKE ACOTT, *President, National Asphalt Pavement Association*

ROY A. ALLEN, *Vice President, Research and Test Department, Association of American Railroads*

JOSEPH M. DELBALZO, *Acting Administrator, Federal Aviation Administration, U.S. Department of Transportation*

FRANCIS B. FRANCOIS, *Executive Director, American Association of State Highway and Transportation Officials*

JACK R. GILSTRAP, *Executive Vice President, American Public Transit Association*

THOMAS H. HANNA, *President and CEO, American Automobile Manufacturers Association*

ALBERT J. HERBERGER, *Administrator, Maritime Administration, U.S. Department of Transportation*

S. MARK LINDSEY, *Acting Administrator, Federal Railroad Administration, U.S. Department of Transportation*

ROBERT H. McMANUS, *Acting Administrator, Federal Transit Administration, U.S. Department of Transportation*

ROSE A. McMURRAY, *Acting Administrator, Research and Special Programs Administration, U.S. Department of Transportation*

RODNEY E. SLATER, *Administrator, Federal Highway Administration, U.S. Department of Transportation*

HOWARD M. SMOLKIN, *Acting Administrator, National Highway Traffic Safety Administration, U.S. Department of Transportation*

ARTHUR E. WILLIAMS, *Chief of Engineers and Commander, U.S. Army Corps of Engineers*

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Transportation Research Board Executive Committee Subcommittee for NCHRP

A. RAY CHAMBERLAIN, *Colorado Department of Transportation (Chairman)*

FRANCIS B. FRANCOIS, *American Association of State Highway and Transportation Officials*

WILLIAM W. MILLAR, *Port Authority of Allegheny County*

JOSEPH M. SUSSMAN, JR *East Professor of Engineering, Massachusetts Institute of Technology*

Field of Special Projects

Project Committee SP 20-5

KENNETH C. AFFERTON, *New Jersey Department of Transportation*

JOHN J. HENRY, *Pennsylvania Transportation Institute*

GLORIA J. JEFF, *Michigan Department of Transportation*

EARL SHIRLEY, *California Dept. of Transportation*

JON UNDERWOOD, *Texas Dept. of Transportation*

THOMAS WILLETT, *Federal Highway Administration*

J. RICHARD YOUNG, JR., *Mississippi Department of Transportation*

RICHARD A. McCOMB, *Federal Highway Administration (Liaison)*

ROBERT E. SPICHER, *Transportation Research Board (Liaison)*

TRB Staff for NCHRP Project 20-5

ROBERT E. SKINNER, JR., *Director for Studies and Information Services*

DONNA L. VLASAK, *Senior Program Officer*

LINDA S. MASON, *Editor*

SALLY D. LIFF, *Senior Program Officer*

CHERYL KEITH, *Secretary*

C. MICHAEL WALTON, *University of Texas at Austin*

THOMAS B. DEEN, *Transportation Research Board*

L. GARY BYRD, *Consulting Engineer, Alexandria, Virginia*

Program Staff

ROBERT J. REILLY, *Director, Cooperative Research Programs*

LOUIS M. MacGREGOR, *Program Officer*

FRANK R. McCULLAGH, *Senior Program Officer*

AMIR N. HANNA, *Senior Program Officer*

CRAWFORD F. JENCKS, *Senior Program Officer*

KENNETH S. OPIELA, *Senior Program Officer*

DAN A. ROSEN, *Senior Program Officer*

SCOTT A. SABOL, *Program Officer*

EILEEN P. DELANEY, *Editor*

National Cooperative Highway Research Program

Synthesis of Highway Practice 184

Disposal of Roadside Litter Mixtures

DOROTHY L. ANDRES
Lawrenceville, New Jersey

Topic Panel

JAMES F. CONDRON, *FHWA, Georgia Division*
CHARLES T. EDSON, *New Jersey Department of Transportation*
PAT HAMAN, *U.S. Environmental Protection Agency*
FRANK N. LISLE, *Transportation Research Board*
WAYNE G. McCULLY, *Texas Transportation Institute*
W. CLAYTON ORMSBY, *Federal Highway Administration*
CARL B. WELLS, *Kentucky Transportation Cabinet*
ROSS M. WOLFE, *Michigan Department of Transportation (Retired)*

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

Research Sponsored by the American Association of State
Highway and Transportation Officials in Cooperation with the
Federal Highway Administration

NATIONAL ACADEMY PRESS
Washington, D.C. 1993

Subject Areas
Maintenance

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NOTE: The Transportation Research Board, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

NCHRP SYNTHESIS 184

Project 20-5 FY 1990 (Topic 22-08)

ISSN 0547-5570

ISBN 0-309-05310-2

Library of Congress Catalog Card No. 92-062818

Price \$12.00

NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical committee according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the Federal Government. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

The Transportation Research Board evolved in 1974 from the Highway Research Board, which was established in 1920. The TRB incorporates all former HRB activities and also performs additional functions under a broader scope involving all modes of transportation and the interactions of transportation with society.

Published reports of the

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

are available from:

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Printed in the United States of America

PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

*By Staff
Transportation
Research Board*

This synthesis will be of interest to maintenance managers, maintenance engineers, those responsible for environmental protection and waste management, and others concerned with the removal and disposal of litter from the roadside. Information is presented on the various aspects of the roadside litter problem, including the causes, amounts, costs, and hazards of litter disposal.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

This synthesis describes the state of the practice with respect to the magnitude and character of the roadside litter collection and disposal process. This report of the Transportation Research Board discusses various state practices with regard to roadside litter collection and highlights the volunteer efforts for roadside litter removal, such as Adopt-a-Highway and Keep America Beautiful. The disposal practices followed by state highway

maintenance agencies are described, as are the issues associated with the available landfill disposal sites, incineration, and other disposal methods. Alternative strategies and deterrents to highway litter, such as litter reduction regulations and educational programs are presented, together with suggested strategies for recycling, reuse of materials, and "smart purchase" practices. Recommendations for future research are also included.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

CONTENTS

I	SUMMARY
4	CHAPTER ONE INTRODUCTION Waste Disposal Dilemmas, 4 History of Legislation and Regulations, 6 History of Litter as a Highway Maintenance Problem, 7
10	CHAPTER TWO SURVEY OF HIGHWAY MAINTENANCE ENGINEERS Occurrences and Frequency of Litter, 10 Magnitude of the Litter Problem Today, 10 Maintenance Operations Practices Involving Litter, 17 Disposal Practices, 18 Recycling Practices, 20 Specialized Disposal Problems, 21
29	CHAPTER THREE ENVIRONMENTAL AGENCY COMMENTS ON DISPOSAL OF HIGHWAY LITTER AND ROADSIDE DEBRIS
32	CHAPTER FOUR DETERRENTS TO HIGHWAY LITTER Litter Reduction Regulations, 32 Litter Collection Assistance Programs, 34 Educational and Promotional Campaigns, 36
38	CHAPTER FIVE SELECTED STATE STUDIES Connecticut, 38 Virginia, 38 North Carolina, 39 Tennessee, 40 New Jersey, 40
42	CHAPTER SIX FINDINGS, RESEARCH ON ALTERNATIVE STRATEGIES, AND RECOMMENDATIONS Findings, 42 Alternative Strategies, 42 Recommendations, 44
45	REFERENCES
46	APPENDIX A QUESTIONNAIRE FOR STATE MAINTENANCE ENGINEERS
51	APPENDIX B QUESTIONNAIRE FOR STATE ENVIRONMENTAL AGENCIES

ACKNOWLEDGMENTS

This synthesis was completed by the Transportation Research Board under the supervision of Robert E. Skinner, Jr., Director for Studies and Information Services. The Principal Investigator responsible for conduct of the synthesis was Sally D. Liff, Senior Program Officer. This synthesis was edited by Linda Mason.

Special appreciation is expressed to Dorothy L. Andres, who was responsible for collection of the data and preparation of the report.

Valuable assistance in the preparation of this synthesis was provided by the Topic Panel, consisting of James F. Condron, Highway Engineer, FHWA, Georgia Division; Charles T. Edson, Assistant Commissioner for Construction and Maintenance, New Jersey Department of Transportation; Frank N. Lisle, Engineer of Maintenance, Transportation Research Board; Wayne G. McCully, Range Scientist, Texas Transportation Institute, Texas A&M University; W. Clayton Ormsby, Supervisory Research Chemist, Federal Highway Administration; Carl B. Wells, Roadside Environment, Kentucky Transportation Cabinet, Division of Maintenance; Pat Haman, Environment Protection Specialist, U.S. Environmental Protection Agency; and Ross M. Wolfe, DeWitt, Michigan. Frank R. McCullagh, Senior Program Officer, Transportation Research Board, assisted the NCHRP 20-5 staff and the Topic Panel.

Dr. Edward W. Repa, Director, Technical and Research, National Solid Wastes Management Association, provided technical review and information for this synthesis.

Information on current practice was provided by many highway, environmental, and transportation agencies. Their cooperation and assistance were most helpful.

DISPOSAL OF ROADSIDE LITTER MIXTURES

SUMMARY

Thousands of tons of litter are removed from this nation's highways and roadsides annually. Costs to state maintenance operations alone exceed \$120 million each year, diverting not only money, but valuable time and other resources away from repairing and maintaining a deteriorating highway infrastructure. Not only are millions being spent to collect from the roadsides materials discarded illegally, but continually growing costs are being incurred to dispose of these roadside mixtures. Dwindling landfill capacity, recycling mandates, and high costs for disposal in many areas, coupled with environmental restraints enacted at various governmental levels, have complicated the task of disposal or reuse as an easy low-cost activity.

A survey of the fifty state transportation agencies was conducted to ascertain the current state of the practice in highway maintenance operations regarding the disposal of roadside litter mixtures and debris. Ninety percent of the maintenance units responded, indicating a high level of awareness of the disposal problem. Simultaneously, a separate survey questionnaire was sent to offices in state environmental agencies with responsibility for solid waste management. These agencies were queried for information on environmental constraints regarding roadside debris disposal and were requested to provide recommendations. In addition, the U.S. Environmental Protection Agency (EPA) was contacted with regard to federal laws and the EPA position relative to roadside disposal problems. The National Solid Wastes Management Association also provided information.

The findings of the survey were as follows:

- Litter is viewed by highway maintenance engineers and the public as a major problem along Interstate highways, ramps and interchanges, and primary and secondary roads in urban areas.
- The cost of litter collection and disposal exceeds \$120 million annually.
- An average of 3.3 percent of each state maintenance budget is spent on roadside litter and debris programs annually.
- Litter collection and disposal requires intensive use of maintenance forces at the expense of other activities.
- Formal waste management practices for maintenance operations are not in general use.
- Automated collection equipment for roadside litter is not generally used by state maintenance crews.
- Equipment manufacturers have not yet developed the necessary high-capacity equipment for automated litter collection on highways.
- Current and potential limits to landfill areas are not recognized by some highway maintenance organizations.

- The maintenance unit's role in solving disposal problems is not universally acknowledged except in dealing with specific incidents that affect operations.
- Few states sort roadside litter mixtures or recycle collected materials, and no identifiable trend toward those practices was noted.
- Disposal of road sweepings has been identified as a current or potential problem in most states.
- Safety practices of personnel involved in litter collection and disposal activities are part of maintenance safety training for hazardous materials or are assumed to be common sense measures within general safety practices.
- Police enforcement is not generally recognized as an effective deterrent to the practice of littering.
- State beverage container deposit laws are considered very effective as roadside litter deterrents, as reported by state maintenance and environmental agencies.
- Volunteerism is increasing as an assistance program for roadside litter collection activities.
- Adopt-a-Highway programs are recognized nationally as the most effective volunteer program benefiting road maintenance operations.
- Costs of highway litter removal activities remain high in spite of assistance from volunteer groups.
- Anti-litter education programs and public media campaigns, such as Keep America Beautiful, were identified as very successful approaches to deterring litter.
- No federal funding is available to assist with the problem of highway litter and its disposal, specifically to be used toward anti-litter education or waste reduction programs.
- A general lack of communication between highway maintenance and state environmental agencies impedes cooperation and progress in addressing litter problems.
- The costs of disposing of litter mixtures in order to comply with environmental requirements are not usually considered when regulations are promulgated.
- Highway maintenance disposal problems require that obstacles to cooperation between environmental agencies and highway maintenance staff be overcome.

Environmental issues related to roadside maintenance activities are part of a larger context that will challenge highway maintenance engineers throughout the 1990s. State maintenance engineers in some areas are dealing with problems of disposal caused by insufficient landfills or other disposal sites. While they are concerned with the problem of pollution recognition and how to deal with waste being created currently, they are also looking toward pollution prevention and cleaner technologies in the future. Several alternative strategies are proposed for implementation in highway maintenance operations.

Recognizing environmental activities within maintenance operations units will help change present highway maintenance practices to become proactive. Coordinated efforts of top management of transportation and environmental agencies to resolve mutual problems might include: developing an environmental action plan for waste management specific to road maintenance operations with alternatives to landfill disposal where required by local conditions; fostering waste abatement practices through cautious purchasing of maintenance materials, encouraging reusable containers, and incorporating economic rewards to suppliers who use recycled materials in their products.

Public and private partnerships can instill a sense of ownership at a grass roots level. Encouraging the involvement of civic groups, educational groups, and corporate participants can assist in the control and collection of litter. Volunteerism has proven to be very successful and should receive increased state and federal support.

Transportation agencies share a responsibility for participation and promotion of educational programs on litter prevention and solid waste disposal, recognizing that such programs lead to changes in behavior that will ultimately result in cleaner roadsides.

In recognition of the millions of dollars spent on roadside litter and its disposal, and subsequent costs for compliance with environmental regulations, there is much to be done in the highway maintenance and environmental communities toward communicating and working together to solve mutual problems in a less costly manner.

INTRODUCTION

STATEMENT OF THE PROBLEM

Since the end of World War II, great strides in manufacturing techniques and man-made products have made our everyday tasks easier. As a result of the development of plastics and the creation of modern packaging techniques, ours has become a "throwaway" society. Manufacturers and service providers emphasize shopping and shipping convenience, quick preparation and consumption, and easy disposal for the consumer. Since 1960, the waste generated in the United States attributable to progress in manufacturing processes and packaging has increased more than 200 percent (1). The average American family produces approximately 100 lbs of trash per week (1). The U. S. Environmental Protection Agency (EPA) has estimated that 196 million tons of garbage are generated annually in this country. In 1990, this was a daily average rate of 4.3 lbs per person or more than 1,500 lbs per year. Of this, 67 percent was disposed of in landfills, about 16 percent was combusted, and 17 percent was recycled. Per capita data are given in Table 1 for the United States, Table 2 shows the breakdown of municipal solid waste material (MSW) types, by both weight and volume.

The United States leads the world in dependence on modern packaging techniques to solve many public health, transportation, and food distribution problems. As a result, we lead the way in the production of disposables for waste management in landfills or other means, or to be recovered. The route from point of consumption to final destination, however, is not always direct.

Thousands of tons of litter are removed from this nation's state highway systems at a cost exceeding \$120 million annually, based on a survey conducted for this synthesis. In spite of numerous campaigns, publicity, and appeals to the public for cooperation toward cleaner highways, the problem continues. For highway maintenance engineers, litter-ridden roadsides have become a continually recurring problem with no permanent remedy in sight.

Roadside litter mixtures consist primarily of cardboard, rubber, plastics, glass, aluminum, steel, wood, soil from road sweepings, lumber, dead animals, and paper in all shapes and sizes. Even household garbage and putrescibles are components of these mixtures. The materials collected are the result of machine sweeping, inlet and ditch cleaning, and roadside and rest area refuse collection. A major element of roadside litter collection is the labor intensive activity by highway maintenance workers and volunteers walking along the highways.

The public funds and resources spent on the collection of this material from roadways is only one part of the costly problem. Once collected, the disposal of these materials and mixtures becomes a larger problem. Stringent environmental regulations enacted since the 1970s, coupled with dwindling landfill capacity available for disposal in some areas, are further complicating this once simple and routine maintenance activity. If landfill space is available, it is frequently at great distances from collection points.

TABLE 1
PRODUCTION OF TRASH IN THE U.S. (2)

Year	Pounds of trash, per person per day
1960	2.7
1970	2.8
1980	3.3
1990	4.3
2000	4.5

If disposal involves mixtures of materials, environmental regulations may require separation into various components before becoming acceptable for disposal. Frequently, regulations regarding collection leave the maintenance engineer uncertain and may result in the accumulation of trash collected and "temporarily stored" in scattered areas at maintenance yards while available disposal sites are sought.

WASTE DISPOSAL DILEMMAS

Reduction of Available Landfills

From the late 19th century until World War II, most trash was disposed of at public or private landfills. Open burning was generally permitted at landfills, and small incinerators were operated at diverse and decentralized locations. Incinerators were abandoned at the end of their useful life, placing more pressure on landfills to take up the overflows. With urbanization this changed. The number of landfills decreased, particularly in densely populated areas like the northeast United States; however, they were replaced by larger facilities with relatively little net loss in capacity.

A sanitary landfill is defined by the American Society of Civil Engineers (ASCE) as "a method of disposing of refuse on land without creating nuisances or hazards to public health or safety, by utilizing the principles of engineering to confine the refuse to the smallest practical area, to reduce it to the smallest practical volume, and to cover it with a layer of earth at the conclusion of each day's operation or at more frequent intervals as may be necessary" (2).

Since 1978, more than 70 percent of available sanitary landfills, or over 14,000, have closed in the United States. By 2000, it is expected that an additional one-third of existing landfills will close. These landfill closings are caused by changes in environmental

TABLE 2
VOLUME OF MATERIALS DISCARDED IN MUNICIPAL SOLID WASTES, 1990 (2)

	1990 Discards (mil tons)	Weight (% of MSW total)	Volume (% of MSW total)	Ratio (volume%/ weight %)
Paper & Paperboard	52.4	32.3%	31.9%	1.0
Plastics	15.9	9.8%	21.1%	2.2
Yard trimmings	30.8	19.0%	9.8%	0.5
Ferrous Metals	10.4	6.4%	8.9%	1.4
Rubber & Leather	4.4	2.7%	6.1%	2.2
Textiles	5.3	3.3%	6.4%	1.9
Wood	11.9	7.3%	6.8%	0.9
Food wastes	13.2	8.1%	3.2%	0.4
Other	5.7	3.5%	1.4%	0.4
Aluminum	1.6	1.0%	2.2%	2.1
Glass	<u>10.6</u>	<u>6.5%</u>	<u>2.2%</u>	<u>0.3</u>
TOTALS	162.3	100%	100%	1.0

regulations, such as the Resource Conservation and Recovery Act (RCRA); by facilities becoming filled to designed capacity; and by local objection to location, known as the NIMBY (Not In My Back Yard) syndrome (3). The outcry from the public, which was once restricted to residential areas and suburbs, has now moved outward to protect sites in rural environments. As a result of these disappearing disposal sites, local governments are finding that larger portions of their budgets are being used to pay tipping fees (the dumping cost per cubic yard, ton, or truckload) for waste disposal.

As sites became unavailable for building new landfills because of NIMBY concerns or costs to upgrade facilities to meet new environmental regulations became prohibitive resulting in closings, the Northeast was forced to ship household trash to areas in the South, Midwest, and West where capacity existed, or where landfills were viewed as economic development. At the present time, states cannot prohibit the flow of trash from outside their borders as the courts have ruled it an interference with interstate commerce. Interstate disposal disputes between states such as New Jersey and Indiana were recently resolved by written agreements between the governors to cease previously legitimate shipments and to prosecute illegal trash disposers.

While the U. S. is generating more than 190 million tons of trash annually, it is interesting to note that 3 million tons of garbage in a landfill produces enough methane to meet the energy needs of 18,000 homes for 15 years (4).

Incineration Techniques

Incinerators in use in the 1960s were basically combustion with little or no control on stack emissions and no energy recovery. These became caught up with compliance problems in meeting the strict air quality standards being generated. Many of the older incinerator plants lacked adequate pollution control devices and were forced to close, putting an even heavier burden on landfills (5).

The siting and construction of new incineration facilities presents as much difficulty as finding more available land for landfills. There are basically two types of incineration plants: combustion with energy recovery, (i.e., waste-to-energy) and combustion without energy recovery. A mass-burn plant burns unprocessed, mixed municipal solid waste. A refuse-derived plant burns waste that has been mechanically processed to produce a more homogeneous fuel. Recyclables such as paper, certain plastics, tires, and metals may be extracted from the waste. These materials are considered marketable items for use in other processes.

While initially viewed as a viable alternative to landfills, incineration now often faces opposition. In the early 1970s, fueled by an oil energy crisis, trash was seen as an "urban ore" (2). For a brief period of time, there was great interest in resource recovery technology. Refuse fuel was an idea for solving the immediate energy dilemma and perhaps future heating needs for households. Unfortunately, poorly planned projects plagued with equipment failures, high costs, and again the NIMBY syndrome, discouraged

continued development of waste-to-energy facilities. Costs to construct a state-of-the-art incinerator plant are estimated at \$100,000 per installed ton. Environmentalists saw incinerators as turning garbage into a compact toxic waste or as generating dangerous gases composed of nitrous oxides, dioxins, and furans, and adding to the acid rain problems (5). Corporations that initially considered investing came to see their involvement as a "no win" situation.

Interest and research continues today in incineration technology and it is still viewed as a viable tool to manage waste and ease the world energy shortages. Approximately one-third of household garbage, by weight, is ash when burned. However, the resultant ash is sometimes considered hazardous if heavy metals collect and consolidate, requiring that the ash be treated and placed in specially designed landfills to safely contain any potentially toxic by-products from leaching into adjacent soils and water systems.

In Miami, Dade County built a resource recovery plant at a cost of \$165 million. The plant separates out recyclable products—metals, tires, and glass. After burning the non-recyclables, the remaining ash is removed, mixed with other cementitious materials and converted into concrete building blocks and construction materials. Approximately 160 tons are produced daily. The energy created from burning combustibles is sold as electricity, approximately 50 megawatts, sufficient to provide power to more than 50,000 homes in the Dade County area. In 1986, the plant was able to recover a large portion of operating costs through the income derived from the sale of separated recyclables, sale of ash-derived byproduct construction materials, and sale of electricity (6).

OVERVIEW OF CHANGING ENVIRONMENTAL PHILOSOPHIES AND POLICIES: HISTORY OF LEGISLATION AND REGULATIONS

Most environmentalists attribute the advent of the "Environmental Age" to the celebrated Earth Day of April 22, 1970, but earlier concerns were being voiced in all quarters regarding the problems facing future America. In 1966, a report was released by the National Academy of Sciences (NAS) entitled "Waste Management and Control" (7). It charged the American public with the responsibility for pollution, calling for a bigger role by the federal government to initiate large-scale experimental programs to reduce pollution, assist regional agencies, and initiate research. The report also called for national efforts to stimulate private industry in the reuse and "management of residues," and initiate a grass roots program to build public awareness.

The NAS report stated that the whole United States economy was based on converting natural resources into consumer products, "selling them to the consumer, and then forgetting about them." The study stated further "there are no consumers, only users." The user employs a product, changes it, and then discards it. This discard process creates the residues we are forced to deal with, now of even greater magnitude some quarter of a century later because of population increases.

The problems identified in the NAS report remain with us today. The areas identified as possible deterrents to finding the ultimate solutions have not been resolved more than 25 years later. No one can dictate what degree of cleanliness the environment should achieve; it is a matter of informed choices by the people. "Cleaning up costs money. What price are we willing to pay?" The report recommended that environmental advocacy groups be encouraged

to meet together, share views, and be prepared to establish more temperate views on the "right amount of pollution" (7).

In 1965, Congress passed the first Solid Waste Disposal Act, Public Law 89-272, which was further amended in 1970. This legislation focused attention on solid waste management and charged each state with the responsibility to implement appropriate programs. Regulatory powers were placed within the Bureau of Solid Waste Management, a unit within the United States Public Health Service and the precursor of the Environmental Protection Agency. With regard to considering the problem of highway litter as a solid waste matter, little guidance or attention was provided from these agencies because of the relatively low rate of solid waste generation. While early studies were being performed by state highway departments across the country to quantify the magnitude of litter involved in road maintenance activities, the volumes and weights were not striking enough to capture the attention of these federal offices. This is explainable now since quantities were expressed in low numbers as tons per day, items per mile, or cubic feet. It was understood that the public expected highway networks and rural public land managers, as in state and national parks, to continue to provide safe and aesthetically pleasing facilities as part of their normal operating practices. Each highway department and public works agency at state, county, and municipal levels was left to develop and implement its own controls and solid waste management programs (8).

In 1969, Congress passed the "National Environmental Policy Act of 1969," (NEPA) Public Law 91-90. This established as a national policy that the federal government was to "encourage productive and enjoyable harmony between man and his environment" (9). All federal agencies were mandated to implement this policy in their future programs. The first environmental decade was launched in 1970, with the official birthdate of April 22, 1970—Earth Day. With the passage of the Clean Air Act of 1970, a sense of urgency swept Congress and subsequent federal legislation followed quickly. The Resource Conservation and Recovery Act (RCRA) of 1976, Public Law 94-512, established a program to support work for innovative solid waste management systems, development of resource and recovery systems, waste disposal systems, and provided for technical and financial assistance at the state and local government levels. EPA followed with the promulgation of regulations regarding hazardous and solid waste handling. These were subsequently modified by the passage of the Hazardous and Solid Waste Amendments (HSWA) of 1984, which provided for further land disposal restrictions.

Despite the passage of legislation at the federal level, and the promulgation of local government controls, people still view the environment as more in distress today than 20 years ago. At a recent conference on the environmental agenda for the 1990s, the overall view was that no federal agency can take the responsibility for solving these environmental problems. While changes have occurred with a transfer from a federal responsibility to that of the states, the view more commonly expressed is that "community watchdog organizations, consumer and citizen education campaigns would be more effective than more government regulators" (9).

The passage of the environmental laws propelled one of the most popular movements in our country's history. Advocacies arose in the 1970s and 1980s with conflicting agendas. Although "all were based on protecting the environment, the responsibility for the environment was transferred to the sub-government levels. Fragmentation of responsibility resulted in conflicting priorities.

Conflicting ways to solve the crisis were prevalent. One widely held position was expressed by Sutherland and Parker in *Environmentalists at Law* (9). "Statutes are not enough. However good the intent and however competently they are drafted, statutes are not self-executing; they have to be implemented" (10).

State Programs Initiated in the 1970s and 1980s

A number of states took the initiative in the early 1970s to change the consumerism philosophy of a "throwaway society" to one of "waste not: want not." Several of the northeastern states promoted educational programs inviting public participation. The New Jersey Department of Environmental Protection, one of the first state environmental agencies founded in response to the federal mandate, published a handbook in 1978 titled *Waste Not: Want Not*. It advocated a philosophical return to the attitudes of the early part of the century. As consumers, we were being asked to return to the conservation ethic, which years before, was mandated by our forefather's need for economic security in their daily living. Products and packaging for longer life and reuse were promoted. Broken appliances were to be repaired and food wastes composted (11). Unfortunately, these individual efforts were not supported by a similar effort from the private industrial sector. Industry independently worked to improve packaging techniques, placing consumer products into disposable containers. Packaging of products for longer life and reuse by the consumer was not readily available in the market place. There were some early exceptions. In some of the New England communities, public groups raised small grass roots efforts and encouraged such changes. This was usually at a higher economic cost to the consumer. Any movement for changes from the throwaway society we have become since post World War II has been difficult to put in place before the 1990s.

In the 1970s, several state bills that encouraged refilling and reusing beverage bottles were passed. Michigan was one of the few states that encouraged manufacturers and consumers to use refillable bottles by requiring lower deposit fees (10). During the mid 1970s, bottle bills were passed in Oregon, Michigan, Vermont, and Maine. At that time, bottles of all sizes and shapes, as well as beverage cans, were proliferating along roadsides. Voluntary bottle deposit programs were effective in encouraging recycling. Statewide deposit programs offered consumers incentives to separate out certain types of containers, glass beverage bottles, and aluminum beverage cans.

In the more urbanized states, roadside litter proliferation was recognized as a social problem. However, it was considered a separate concern, not an environmental problem, and certainly not as significant as resolving the landfill capacity dilemma. Recycling became a spin-off solution to deterring roadside litter, as well as a response to the larger problem of conserving landfill space. Voluntary recycling programs became more successful as profitable markets were identified for recycled materials such as aluminum and glass (11).

During the 1980s, the states were contending with developing environmental programs to comply with the federal delegation of responsibility from the legislation of the 1970s. Since the environmental agenda was so large for many of the urbanized states, activity was aimed toward immediate priorities of public safety and health, stopping illegal hazardous waste dumping and cleaning up toxic waste sites from years before.

The environmental agenda for the 1990s includes making recycling a cost-effective disposal management method. Incentives for source reduction should be offered to the manufacturing community to minimize the volume of materials creating this overall waste disposal problem which, unfortunately, finds its way to our roadsides.

HISTORY OF LITTER AS A HIGHWAY MAINTENANCE PROBLEM

Roadside Litter Composition

According to the U.S. Environmental Protection Agency's Solid Waste Management Glossary, litter is "any wantonly discarded material." Highway litter, recognized early as a potentially costly maintenance headache, comes primarily from four sources:

1. Items indiscriminately tossed from car windows;
2. Debris carelessly left by the traveling public in roadside rest areas, parks, and other pull-offs;
3. Household garbage consciously left for pickup by someone else; and
4. Improperly covered or operated vehicles (12).

Contributing Factors

Studies conducted by the Keep America Beautiful (KAB) organization regarding the sources of roadside litter were initially performed in 1968 and subsequently carried out by individual state highway departments. In an attempt to create initial campaigns of public awareness concerning the problem of litter, results were published indicating the following: (13)

- Litter is related to age. For people between the ages of 21 and 35, three times more litter is likely to occur than from an age group of 50 years plus. Comparisons with the ages 35 to 49 indicate the younger group will be more prone to litter at a rate of twice as much.
- Men are more likely to litter than women.
- Smaller household size, such as one- or two-person households, were found to be less likely to litter than five- or more person households.

Prior to the adoption of a state bottle bill in Michigan, studies there found that litter is influenced not only by the number of people in vehicles using the highways, but also by what is available to them in the marketplace as they travel. Fast-food packaging and density of food service locations directly influence the quantity and composition of litter. Highways used as transportation routes from metropolitan areas to landfills have particularly large volumes of litter as a result of debris blowing off uncovered or improperly covered refuse trucks. Traffic volumes in tourist areas with heavier seasonal uses show the results of convenience packaging by yielding more litter (14).

Colorado DOT released statistics on the volume of litter collected along its highways in 1971. They calculated that the litter collected was enough to cover a football field to a depth of 13 ft. There were more than 21 million items collected, or 9.5 pieces per person in Colorado. They found that the amount was directly

related to traffic volume, the number of traffic lanes, and the population of the nearest town (15).

Wyoming's early studies in the Medicine Bow Mountains revealed that areas routinely maintained had significantly lower litter accumulation. The highest accumulations occurred during the summer, which comprised the highest traffic months. The density of litter decreased linearly with the distance from human settlements (16).

Volumes of litter picked up by state highway departments were reported routinely in trade journals, as the impacts on state maintenance activities increased. Twenty-nine states participated in the 1969 Keep America Beautiful study that measured litter volumes along roadways. This study generated the commonly used statistic of anticipated litter quantities of "one cubic yard per mile per month" and "1,300 litter items per mile per month" (16). While ranges varied from roadway types and geographic areas, the magnitude of the problem was unquestionable.

A study of highway litter in Georgia was conducted in 1973, jointly funded by the Georgia Department of Transportation and the FHWA (18). Results coincided with studies in other states—litter quantities were directly related to the classification of highway, average daily traffic density (AADT), and the season of the year. Most studies reported spring and fall to be the heaviest litter accumulation months. However, this could be further related to the period of inactivity of litter collection during winter months, followed by a sudden emphasis when mowing preparations begin in the spring. One of the conclusions of the Georgia study was to initiate vigorous programs of litter collection by highway staff to be coupled with promotional campaigns aimed at drivers and vehicle occupants. An additional recommendation made and adopted later as a major program issue by Keep America Beautiful was to place pressure on manufacturers and distributors of articles that contribute to roadside litter (18).

One of the most complete reports available regarding highway litter problems in the 1970s was done by the Tennessee Technology Institute for the Tennessee Bureau of Highways. They concluded that the volume of litter on Tennessee's highway system in 1973 and 1974 was equivalent to solid wastes generated in a year by a community of more than 10,500 people. At that time, the costs for household trash collection and removal in that size town was \$215,000. The Tennessee Bureau of Highways was then spending 6.5 times this amount in attempting to control litter, spatially and randomly distributed along roadsides. The Tennessee study named "litter" as only part of a maintenance problem, but identified litter collection to be a necessary solid waste management program to be adopted into routine maintenance operations (8).

In 1974, a second national survey of the growing problem was conducted and results published in *Rural and Urban Roads* magazine. It revealed that rural area roadside litter was increasing, while budget dollars available for cleanup were decreasing. At least 38 states reported increased costs for litter-related maintenance programs. Heavy penalties and enforcement were called for, as well as promotion of a public education campaign concerning the problem (19).

The problem was recognized as a national issue for the United States when the Secretary of Transportation issued his 1974 Report to Congress, "Report on the Study of Highway Litter, with Recommendations" (20). In the report, the Secretary gave recognition to the litter studies and litter prevention techniques being promoted by private groups such as Keep America Beautiful, and the indi-

vidual efforts underway by the states through legislated bottle bills, fines, and enforcement. In the 1973 Federal Aid Highway Act, there were specific requests for recommendations for the prevention of litter and cleanup programs on a regular basis. In response to the 1973 mandate, the Secretary submitted the following recommendations:

- Actively support national organizations and encourage federal financial support for research in the area.
- Encourage state job corps and summer youth programs devoted to highway litter.
- Encourage state governments to enact bottle bills and anti-litter laws.
- Encourage states to adopt legislation requiring covered truckloads.
- Fund state-federal research programs to develop litter pickup machines.

Specifically for state maintenance agencies, the Secretary recommended that each state:

- Establish management programs with performance standards to manage the planning and scheduling of litter pickup;
- Expand programs beyond the routine spring and fall cleanups;
- Participate in local recycling programs;
- Expand their public awareness programs;
- Assign organizational units other than maintenance personnel to be responsible for public awareness and anti-litter action programs;
- Where land is still available, plan for adequate and inexpensive disposal sites, with consideration of the landfill for future use.

Unfortunately, little emphasis has been placed on continuing research in the area of litter control since the 1970s by transportation or environmental agencies. The litter problem was classified as a social behavior problem and an educational problem to be solved.

The recommendations of the 1974 Secretary of Transportation included "Almost all litter studies reviewed indicate that the problem can best be fought through public education." Now, years later, his statement is still applicable if modified by the additional phrase "... and the cooperation of all those involved in collection, disposal, and enforcement from within government and in the private sector."

In the interim years, any emphasis on litter prevention programs has relied strictly on support from the private sector and organizations such as Keep America Beautiful. The federal dollars made available to study and challenge the problem are no longer available, generally being targeted toward problems more obviously recognized as true highway problems—safety improvements, deferred maintenance repairs, pavement rehabilitations and increased capacity improvements. However, the public's expectation that a highway be presented to them in an aesthetically pleasing condition remains a recurring demand. The neglected program has resulted in deteriorated roadsides in many of the urban states. With the lack of roadside maintenance over prolonged periods, the deteriorated appearance signals to the public that dumping and littering on the right of way is an acceptable activity. This perception, coupled with a reduction in litter control effort, has caused further increase in trash and litter.

Removal Costs

During early studies, data collection of estimated costs was hampered by nonuniform reporting of data by states, as well as varied information sources. With the later recommendation by the Secretary of Transportation to establish maintenance management standards, reporting of costs by highway departments for these activities became more uniform. In these earlier studies of the 1970s, costs for litter pickup reached as high as \$3 million annually in the states of Texas and Illinois where extensive road networks exist. Reported costs were as high as \$80 per mile in Oregon. Much of the debris was being sent to open dumps at that time, or if sent to sanitary landfills operated by local government agencies, the dumping fees were being waived. This policy has changed in the last twenty years and disposal costs have soared for state DOTs. During 1972 and 1973, the Tennessee DOT was spending seven percent of its maintenance funds, or \$1.73 million for litter disposal (8).

In the Texas study, conducted in conjunction with the FHWA at the Texas Transportation Institute, attempts were made at estimating the costs of litter per ton. Attempts were also made to determine the cost effectiveness and feasibility of using highway litter in highway construction and maintenance projects (21). The Texas study determined that the use of highway litter and debris in large volumes has a negative value. It costs more to collect and process than it is worth at its best use. The overall economics

involved in collection and processing of litter, with technology available in the early 1970s, could not justify its use. The conclusions reached were that the value of collected litter and the frequency necessary to collect it had to be based solely on immeasurable attributes, which were those of good housekeeping and visual improvements, as noted by motorists and the general public.

More recent cost data collected by the Keep America Beautiful organization in 1989 indicates that more than one-half billion tax dollars are spent annually on removing debris from all roads and public areas in the United States. An additional one-half billion dollars in costs are incurred by private property owners (2).

Chapter Two of this synthesis discusses the current annual costs reported by state maintenance engineers of roadside maintenance activities conducted to control, collect, and dispose of litter and debris.

The remainder of the synthesis examines litter collection, separation, recycling, and the disposal techniques currently in use by state highway agencies. Environmental constraints affecting these programs are identified. Scattered research is being conducted in Departments of Transportation around the country and the findings are reported here. Through the survey of highway maintenance departments and study of current practices, this synthesis identifies those areas most affected today and those that are potential trouble sources for highway maintenance engineers in the future. In addition, some alternative methods for litter collection and disposal that have been implemented to meet the environmental challenges in a "dollar-tight" setting are highlighted.

SURVEY OF HIGHWAY MAINTENANCE ENGINEERS

OCCURRENCES AND FREQUENCY OF LITTER

To determine the magnitude of the litter problem along our nation's roadsides, a questionnaire was developed and sent to state maintenance engineers in transportation departments in each of the 50 states. Public works directors in several key cities were contacted as well. The objective of the questionnaire was to survey the states for information on current operational practices in the area of roadside litter collection, road sweeping, inlet and drainage ditch debris, and animal carcass disposal. Comprehensive data were collected on the regulations that could affect the methods for disposing of these solid waste mixtures collected from roadsides during highway maintenance operations. Costs were reported in annual dollars spent, and as a percentage of the overall budget for maintenance operations. Survey data reflect the state of the practice during 1990 and 1991. The magnitude of the problem was reflected in the number of responses received from state maintenance engineers: ninety percent of the questionnaires were completed. Many contained comments and recommendations relative to actual experiences. A copy of the questionnaire is found in Appendix A.

The questionnaire was developed to identify several key activities involved in the collection and disposal of roadside litter and debris. Typically, illegally dumped items are mixtures that could include glass and metal beverage containers, paper, wood, household garbage, metals from vehicles, and rubber tires. In this synthesis, these mixtures are grouped and discussed as general roadside litter. Specialized operations for handling debris collected in street sweeping, inlet and drainage ditch cleaning, and animal carcass removal are examined and treated separately.

Those responsible for road maintenance operations were queried on the magnitude of the litter problem from their viewpoint. The various types of materials considered problematic in roadside debris mixtures were identified with regard to frequency of occurrence, need for separation prior to disposal, and final disposal difficulties. Information on the estimated volumes of litter encountered annually, and on costs incurred to control the problem was gathered.

Specific types of highways and locations were categorized as major generators of litter, intermediate problem areas, or little-to-no problem for state maintenance forces. Of importance was the nature of the surrounding roadside environment as rural or urban. Since available road classification data were limited relative to residential or suburban roadsides, all such roads were classified as non-rural and categorized as urban, except as explained for specific states.

Where Litter Occurs

Forty-five states responded with state-maintained roadway inventories ranging from 2,355 center line miles in New Jersey to

over 76,000 center line miles in California and North Carolina. Where information was available, ramp and interchange miles data were obtained. These ranged from 18 miles in Alaska to 5,100 miles in California. In general, ramp and interchange mileage averaged less than 10 percent of the total road system to be maintained by those states which responded. California's and New Jersey's ramp inventory composed 33 percent and 35 percent of their road inventories respectively. It is generally recognized that ramp areas and marginal roads are litter targets. Litter tends to accumulate on both sides of noise barriers, and is particularly annoying to residents if not collected from the back side of the barrier.

Obviously, miles of maintained roadsides vary greatly with each of the responding state organizations. The assignment of maintenance responsibility differs as many states have several levels of government responsible for roads—towns and municipalities, cities, counties, and state. Other states are responsible for the entire road network contained within the state boundaries, except for that portion contained within cities. Therefore, center line data for states such as North Carolina, Virginia, and Pennsylvania may seem disproportionately large compared to actual geographic areas, due to the fact that the state maintains most of the secondary road system.

The survey characterized the roadway system as rural, suburban, or urban. Residential or suburban areas were classified as non-rural in the final tabulation and combined with urban areas since population density is believed to be a significant factor for potential litter disposal problems. Data on inventory and costs are tabulated in Table 3.

MAGNITUDE OF THE LITTER PROBLEM TODAY

Effects on Maintenance Programs

More than 65 percent of responding states indicated that litter control was a planned work activity or major work generator for their maintenance forces. In fact, it was classified as major work in Arizona, California, Florida, Kentucky, Massachusetts, Minnesota, New Jersey, and Nevada. The remaining states indicated this activity was handled as required—many times during the year or only prior to seasonal mowing operations.

Data on the amounts of litter collected annually were provided by 24 states. The highest figures were recorded in Texas with 27,000 tons collected annually, New Jersey with 22,000 tons, and Illinois with 14,700 tons. California reported its data in volume as 285,000 yd³ as did Colorado, reporting 94,000 yd³. Iowa indicated its annual quantity as 2,000 tons or 10,000 yd³, giving some comparison of the data reported in weight (tons) or volume. This information is summarized in Table 3.

The survey requested information on each state's litter program and the problems related to control of debris, collection and removal from the roadside, and disposal of the debris once collected.

TABLE 3
SURVEY OF STATES: ANNUAL LITTER COSTS AND PHYSICAL INVENTORY

	ANNUAL COST MILLIONS \$	% MAINT. BUDGET	CENTERLINE MILES SYSTEM	% NON-RURAL ROADS	ANNUAL TONS LITTER
ALABAMA	1.168	2.00	NA	15.00	NA
ALASKA	0.200	3.00	5,578	7.50	NA
ARIZONA	1.500	3.00	7,420	3.00	NA
ARKANSAS	1.152	4.00	16,203	NA	23,217
CALIFORNIA	28.000	5.60	18,103	22.00	285,000
COLORADO	3.252	3.20	9,280	15.00	94,414
CONNECTICUT	1.700	2.80	3,712	46.00	1,140
DELAWARE	0.322	2.20	5,098	25.00	NA
FLORIDA	6.500	3.80	36,755	44.00	31,000
GEORGIA	3.590	3.20	20,000	35.00	NA
IDAHO	0.500	1.00	4,954	21.00	1,300
ILLINOIS	6.300	4.00	16,833	56.40	14,700
INDIANA	1.722	3.00	15,650	22.00	NA
IOWA	0.730	1.00	10,110	19.00	2,000
KANSAS	0.344	0.60	NA	NA	NA
KENTUCKY	3.500	3.00	27,365	12.00	NA
LOUISIANA	0.400	0.50	17,300	NA	10,000
MARYLAND	0.400	3.10	5,116	43.70	4,542
MASSACHUSETTS	0.860	NA	12,500	38.00	NA
MICHIGAN	2.700	2.10	11,836	NA	5,000
MINNESOTA	2.000	1.50	12,053	10.00	8,000
MISSISSIPPI	0.920	2.00	10,372	25.00	16,100
MISSOURI	NA	NA	NA	NA	NA
NEBRASKA	NA	NA	9,962	NA	6,500
NEVADA	1.646	5.90	5,529	6.00	NA
NEW HAMPSHIRE	1.000	2.20	4,042	30.00	400
NEW JERSEY	5.500	14.00	2,355	90.00	22,000
NEW YORK	6.000	2.30	14,900	NA	NA
NORTH CAROLINA	1.200	0.40	76,800	8.00	NA
NORTH DAKOTA	NA	NA	7,365	2.70	NA
OHIO	2.870	2.00	19,255	20.00	4,500
OKLAHOMA	3.587	3.50	12,258	8.20	5,000
OREGON	0.480	0.50	7,600	53.00	260
PENNSYLVANIA	5.000	0.70	40,800	18.00	4,600
SOUTH CAROLINA	1.400	1.00	41,280	15.00	1,950
SOUTH DAKOTA	0.200	1.00	7,786	8.00	NA
TENNESSEE	1.300	2.00	13,462	NA	NA
TEXAS	12.000	2.70	76,564	NA	27,000
UTAH	0.837	1.50	5,818	NA	NA
VERMONT	0.650	2.00	3,000	12.00	3,300
VIRGINIA	3.000	1.30	55,727	10.00	NA
WASHINGTON	1.500	2.00	6,998	14.00	NA
WEST VIRGINIA	2.000	1.50	34,036	3.00	2,000
WISCONSIN	NA	NA	11,400	NA	NA
WYOMING	1.200	3.50	7,685	4.00	NA

NA - NOT AVAILABLE

* = CUBIC YARDS

Of the 45 responses received, 33 indicated that control of debris was a problem, 26 indicated collection and removal was a problem, and only 19 responded that disposal of roadside debris was a concern. This information is interesting when compared to the number of responses characterizing litter maintenance programs reported as a routine activity. While only 8 states reported litter as a major work generator, 33 states, or 73 percent, recognized it to be a serious problem for maintenance forces to control and 55 percent reported problems with collection and removal of debris from the roadside. This information is included in Tables 4 and 5.

Costs for Removal of Roadside Litter and Debris

Annual cost figures were made available by 42 of the 45 responding states and represent cost data for survey years 1990 and 1991. Accuracy of the costs is directly dependent on the cost collection practices in each state. Generally, cost information was provided from each state's maintenance management systems. The dollar costs ranged from \$200,000 per year in Alaska and South Dakota to \$28 million in California and \$13 million in Texas. The total costs reported for this activity exceeded \$120 million for the reporting states. Of more importance was the percentage of the annual maintenance budget this cost the state maintenance engineer. This information is provided in Table 6.

A telling comparison of data from the table is that of New Jersey, one of the most densely populated states in the United States, with only 2,355 center line miles in its state maintenance inventory and Nevada, one of the most sparsely populated states, which has 5,500 center line miles; each is spending significant portions of their annual maintenance allocation on the litter problem.

Characterization of Litter Problems By Roadway Type

Another survey question requested that the prevalence of litter be identified according to the type of road system being maintained. Primary and secondary roads are considered to present more opportunity for illegal depositing of debris by passing motorists and adjacent property owners, including commercial establishments. Rural interstate roads and expressways generally offer less opportunity for litter deposits because of the high-speed nature of the roadway and a lack of access to commercial establishments.

Based on earlier litter studies of the 1970s in Tennessee, Colorado, and Georgia, the importance of identifying the population density and nature of activity in the area was noted. Similarly, the opportunity for littering is possible at locations along ramps and interchanges of limited access roads and at intersections with other roads. Both categories attract development of commercial business establishments aimed at the motoring public, such as gas stations and fast-food restaurants. They also tend to serve as vehicle collector areas because they require slower exit speeds.

It is interesting to note that ramps and intersections in urban areas are almost equal as major litter repositories for all types of roadways. Interstate roadsides within urban areas are significantly more problematic than urban secondary roads. This could be the result of collection and control of litter by the adjacent owners and an awareness and pressure on commercial establishments adjacent to the road to maintain their areas in a visually acceptable condition. Comparative information on litter problems at various

locations is given in Tables 7 and 8. The data collected for the individual states are provided in Table 9.

Staffing Roadside Litter Programs

The people officially involved in the collection and disposal of roadside debris for state highway departments vary among the states. While all state maintenance departments have staff involved in this operation, the size of dedicated staff, the support staff involved on an as-needed basis, and the outside personnel involved vary greatly. Only California, Florida, Georgia, Massachusetts, Nebraska, South Carolina, and Vermont reported having road maintenance crews exclusively dedicated to roadside litter activities. In cases where the number of dedicated personnel involved was provided, it was generally between 20 and 40 people.

The majority of states reported that almost all roadway maintenance personnel (75 to 100 percent) were needed when a cleanup operation was scheduled. Any staff not involved were those dedicated to specialty maintenance operations, such as road resurfacing and bridge repairs. Recognizing that the numbers of people involved in litter collection and disposal would vary depending on the size of the roadside system maintained, urban characteristics, and traffic density, the states were requested to supply information identifying the percentages of maintenance forces involved, as well as contracted or outside support received annually for this specific activity. The data are tabulated in Table 4.

Outside staffing support came from several areas: maintenance contracts for litter collection and disposal, convict and prison labor programs, Adopt-a-Highway (ADAH) programs, youth programs, public aid recipients, and other organized volunteer programs for specific events such as Clean Up, Green Up and Clean Community Days. In many cases, the voluntary cleanup events were scheduled as part of Keep America Beautiful (KAB) participation. Eighteen states are officially designated as Keep America Beautiful states (Figure 1), and as such have dedicated staff supporting annually scheduled KAB activities (22).

Texas reported that only 1.6 percent of its maintenance work force, approximately 120 maintenance workers, were involved in their annual litter program as a part-time function in addition to regular duties. More than 60 percent of this activity was accomplished by contracted forces at an annual expense in FY 1990 of \$7.6 million.

Use of convict or prison labor was reported by 27 states. The amount of support ranged from as little as 1 to 5 percent in seven of these states to as high as 80 percent in Georgia. Florida and Maryland use more than 40 percent convict labor support.

By far, the program most acclaimed by DOT maintenance respondents was the Adopt-a-Highway program. At the time of this survey, of the 45 reporting states, 38 have formalized Adopt-a-Highway programs. While many reported the programs to be newly implemented and therefore currently providing small percentages of support to their maintenance operations, most newcomers to the program were enthusiastic with the initial successes observed. A number of states reported that more than 50 percent of their roadside litter programs were dependent on Adopt-a-Highway participants. These were:

Colorado, 80%; Nevada, 60%; Kansas, 70%; North Carolina, 50%; Minnesota, 75%; Tennessee, 50%; Nebraska, 60%; Wyoming, 60%.

TABLE 4
SURVEY OF STATES: LITTER PROGRAMS AND STAFFING

	LITTER ACTIVITY	DEDI- CATED STAFF	MAINT REGU- LAR FORCES	CON- VICT	ADAH	YOUTH	CON- TRACT	OTHER
ALABAMA	PLANNED	NO	80%	15%	5%	0%	0%	0%
ALASKA	AS REQUIRED	NO	25%	0%	0%	10%	5%	60%
ARIZONA	MAJOR/PLANNED	NO	30%	2%	5%	0%	63%	0%
ARKANSAS	PLANNED	NO	89%	0%	10%	0%	1%	0%
CALIFORNIA	MAJOR WORK	YES	0%	16%	20%	0%	0%	64%
COLORADO	AS REQUIRED	NO	2%	1%	80%	0%	0%	0%
CONNECTICUT	PLANNED	NO	80%	18%	2%	0%	0%	0%
DELAWARE	PLANNED	NO	45%	15%	40%	0%	0%	0%
FLORIDA	MAJOR WORK	YES	45%	43%	2%	2%	7%	1%
GEORGIA	AS REQUIRED	NO	10%	80%	10%	0%	0%	0%
IDAHO	AS REQUIRED	NO	39%	6%	40%	1%	7%	7%
ILLINOIS	PLANNED	NO	58%	30%	0%	0%	0%	11%
INDIANA	PLANNED	NO	70%	20%	10%	0%	0%	0%
IOWA	PLANNED	NO	89%	1%	10%	0%	0%	0%
KANSAS	AS REQUIRED	NO	28%	0%	70%	0%	0%	2%
KENTUCKY	MAJOR WORK	NO	57%	20%	2%	0%	20%	1%
LOUISIANA	PLANNED	NO	90%	0%	5%	0%	5%	0%
MARYLAND	AS REQUIRED	NO	26%	44%	30%	0%	0%	0%
MASSACHUSETTS	MAJOR WORK	YES	82%	10%	5%	0%	3%	0%
MICHIGAN	PLANNED	NO	50%	5%	20%	20%	0%	5%
MINNESOTA	MAJOR PLANNED	NO	25%	0%	75%	1%	0%	1%
MISSISSIPPI	AS REQUIRED	NO	50%	10%	40%	0%	0%	0%
MISSOURI	PLANNED	NO	30%	10%	45%	5%	0%	0%
NEBRASKA	AS REQUIRED	YES	30%	5%	60%	0%	0%	5%
NEVADA	MAJOR WORK	NO	30%	5%	60%	5%	0%	0%
NEW HAMPSHIRE	PLANNED	NO	100%	0%	0%	0%	0%	0%
NEW JERSEY	MAJOR WORK	NO	66%	33%	1%	0%	0%	0%
NEW YORK	PLANNED	NO	100%	0%	0%	0%	0%	0%
NORTH CAROLINA	PLANNED	NO	NOT AVAILABLE					
NORTH DAKOTA	AS REQUIRED	NO	70%	0%	30%	0%	0%	0%
OHIO	PLANNED	NO	57%	0%	3%	40%	0%	0%
OKLAHOMA	AS REQUIRED	YES	19%	54%	9%	0%	15%	3%
OREGON	AS REQUIRED	NO	1%	14%	NEW	85%	0%	0%
PENNSYLVANIA	AS REQUIRED	NO	25%	0%	30%	20%	5%	0%
SOUTH CAROLINA	PLANNED	YES	50%	5%	40%	0%	5%	0%
SOUTH DAKOTA	PLANNED	NO	75%	10%	10%	0%	0%	5%
TENNESSEE	PLANNED	NO	20%	10%	50%	0%	10%	0%
TEXAS	AS REQUIRED	NO	20%	0%	20%	0%	60%	0%
UTAH	PLANNED	NO	83%	7%	10%	0%	0%	0%
VERMONT	PLANNED	YES	95%	0%	5%	0%	0%	0%
VIRGINIA	PLANNED	NO	55%	20%	20%	0%	5%	0%
WASHINGTON	PLANNED	NO	50%	10%	20%	10%	10%	0%
WEST VIRGINIA	PLANNED	NO	100%	0%	0%	0%	0%	0%
WISCONSIN	AS REQUIRED	NO	NOT AVAILABLE					
WYOMING	PLANNED	NO	40%	0%	60%	0%	0%	0%

TABLE 5
SURVEY OF STATES: DISPOSAL PRACTICES AND PROBLEM ACTIVITIES

SUFFICIENT LANDFILLS EXIST	5 YEARS	NOW	IS SORTING REQUIRED?	DISPOSAL OF DEBRIS	COLLECTION AND REMOVAL	CONTROL OF DEBRIS	STATE
YES	YES	YES	NO	NO	NO	YES	ALABAMA
		NO (URBAN)	NO	YES	YES	YES	ALASKA
	YES	YES	YES/TIRES	NO	NO	NO	ARIZONA
	NO	NO	YES/TIRES	YES	YES	YES	ARKANSAS
	NO	YES	NO	NO	YES	YES	CALIFORNIA
	NO	NO	NO	YES	YES	YES	COLORADO
	NO	NO	YES	YES	YES	YES	CONNECTICUT
	YES	YES	NO	NO	NO	NO	DELAWARE
	NO	YES	NO	NO	YES	YES	FLORIDA
	NO	NO	NO	YES	YES	YES	GEORGIA
	NO	YES	NO	YES	YES	YES	IDAHIO
	YES	YES	NO	NO	YES	YES	ILLINOIS
	NO	NO	NO	YES	NO	YES	INDIANA
	YES	YES	YES/TIRES	NO	NO	NO	IOWA
	YES	YES	YES/TIRES	NO	NO	YES	KANSAS
	YES	YES	YES/TIRES	NO	YES	YES	KENTUCKY
	YES	N/A	YES	YES	YES	YES	LOUISIANA
	NO	YES	NO	NO	YES	YES	MARYLAND
	NO	NO	NO	NO	NO	NO	MASSACHUSETTS
	NO	NO	NO	YES	YES	YES	MICHIGAN
	NO	NO	YES	YES-URBAN	YES-URBAN	YES-URBAN	MINNESOTA
	NO	YES	NO	YES	YES	YES	MISSISSIPPI
	NO	YES	NO	NO	YES	YES	MISSOURI
	NO	YES	NO	NO	NO	NO	NEBRASKA
	YES	YES	NO	NO	YES	YES	NEVADA
	NO	NO	YES	YES	YES	YES	NEW HAMPSHIRE
	NO	NO	YES	YES	YES	YES	NEW JERSEY
	NO	YES	YES	YES	YES	YES	NEW YORK
	NO	YES	NO	NO	NO	NO	NORTH CAROLINA
	YES	YES	NO	NO	NO	NO	NORTH DAKOTA
	NO	NO	NO	YES	NO	NO	OHIO
	YES	YES	YES	NO	NO	YES	OKLAHOMA
	NO	YES	NO	NO	YES	YES	OREGON
	NO	NO	NO	NO	NO	YES	PENNSYLVANIA
	YES	YES	NO	NO	NO	NO	SOUTH CAROLINA
	YES	YES	NO	NO	NO	NO	SOUTH DAKOTA
	YES	YES	NO	NO	YES	YES	TENNESSEE
	YES	YES	NO	NO	NO	YES	TEXAS
	YES	YES	NO	NO	NO	NO	UTAH
	YES	YES	NO	NO	NO	NO	VERMONT
	YES	YES	NO	NO	YES	YES	VIRGINIA
	YES	YES	NO	YES	YES	YES	WASHINGTON
	YES	YES	NO	YES	YES	YES	WEST VIRGINIA
	NO	NO	YES	YES	YES	YES	WISCONSIN
	YES	YES	NO	YES	YES	YES	WYOMING

TABLE 6
RANKING OF COSTS VERSUS BUDGET IMPACTS FOR SELECTED STATES

State	Annual Cleanup Costs (in millions)	Percent of Maintenance Budget
California	\$28.0	5.6
Texas	\$13.0	2.7
Illinois	\$ 6.3	4.0
New York	\$ 6.0	2.3
New Jersey	\$ 5.5	14.0
Pennsylvania	\$ 5.0	0.7
Nevada	\$ 1.6	5.9

TABLE 7
COMPARISON OF LITTER PROBLEMS ALONG
INTERSTATES AND NONLIMITED ACCESS ROADS

Road Type	States that consider litter a problem	
	Urban Areas	Rural Areas
Interstates		
Major Problem	55.9%	0 %
Intermediate Problem	35.3%	58.8%
Minimal Problem	8.8%	41.2%
Primary/Secondary Roads		
Major Problem	29.4%	0 %
Intermediate Problem	58.8%	58.8%
Minimal Problem	11.8%	41.2%

TABLE 8
COMPARISON OF LITTER PROBLEMS AT
INTERCHANGES, RAMPS, AND INTERSECTIONS

Location	States that Consider Litter a Problem	
	Urban Areas	Rural Areas
Interstate Ramps		
Major Problem	58.8%	11.8%
Intermediate Problem	29.4%	61.7%
Minimal Problem	11.8%	26.5%
Primary/Secondary Ramps & Intersections		
Major Problem	51.5%	15.2%
Intermediate Problem	36.4%	48.5%
Minimal Problem	12.1%	36.3%

Texas, the first Adopt-a-Highway state, is accomplishing 20 percent of its roadside litter collection with Adopt-a-Highway participants.

Other state programs involve more unique participants. In California, 64 percent of the state roadside collection is accomplished

by probationers and welfare recipients. In Oregon, the Summer Youth Program performs roadside cleanups and is presently performing 85 percent of the state maintenance litter collection. Ohio's youth program accomplishes 40 percent of the state workload, while Michigan and Pennsylvania youth forces add 20 percent support to their states' programs. In Illinois, Chicago's Public Aid recipients are responsible for litter collection on state highways in that area, accomplishing 11 percent of the annual litter collection total.

PennDOT reported that their litter program staff includes 90 county-level coordinators who are responsible for overseeing the Adopt-a-Highway and Keep America Beautiful activities in their specific areas.

Litter Management Programs in State Maintenance Organizations

More than 50 percent of the responding states indicated that roadside litter was a planned maintenance activity and 17 percent indicated it was a major work generator. Only 10 states responded affirmatively to the question regarding the existence of a formal policy and program on disposal within their departments. Follow-up discussions with those claiming to have formal programs revealed that several such programs were, in fact, no more than an understanding that collected debris was the responsibility of the district engineer or individual crew supervisor, and disposal was to be in accordance with local governing regulations. Most states reported they had policies and written directions for maintenance forces when unidentified or hazardous materials were to be disposed, but not for routinely encountered roadside debris.

Caltrans has a comprehensive manual of instructions for road maintenance employees encompassing how to handle spills of substances on highway rights of way, containment, identification, notification, immediate actions to be taken, and recommended cleanup actions. Checklists for on-site evaluations prior to initiating any cleanup activity and guidelines for safety and personal protective equipment are available for maintenance workers, and scheduled training sessions held.

The Connecticut DOT is among several that have a formal program of recycling to comply with state government rules for waste stream reduction. It is directed by the Bureau of Administration within the DOT. To comply with the state mandate, the Bureau of Maintenance has written directives regarding the handling and

TABLE 9
SURVEY OF STATES: FREQUENCY OF LITTER OCCURRENCES

	INTERSTATES				PRIMARY AND SECONDARY			
	ROADS		RAMPS		ROADS		RAMPS	
	RURAL	URBAN	RURAL	URBAN	RURAL	URBAN	RURAL	URBAN
ALABAMA	L	I	L	H	I	H	I	H
ALASKA	I	H	L	I	I	H	L	I
ARIZONA	I	H	I	H	I	I	I	H
ARKANSAS	I	I	I	I	I	I	L	I
CALIFORNIA	I	H	L	H	L	I	L	H
COLORADO	I	H	I	I	I	H	I	I
CONNECTICUT	I	H	I	I	I	I	I	I
DELAWARE	I	I	I	I	I	I	I	I
FLORIDA	I	H	I	H	I	I	I	H
GEORGIA	I	I	I	H	L	I	L	I
IDAHO	L	H	L	H	L	I	L	I
ILLINOIS	I	H	I	H	I	H	H	H
INDIANA	L	I	L	I	L	H	L	L
IOWA	L	L	L	L	L	L	L	L
KANSAS	L	I	L	L/H	L	I	L	H
KENTUCKY	I	I	I	I	I	H	I	H
LOUISIANA	I	H	H	H	I	H	H	H
MARYLAND	I	H	I	H	L	I	I	H
MASSACHUSETTS	I	H	I	H	I	H	I	H
MICHIGAN	I	H	I	H	I	H	I	H
MINNESOTA	I	H	I	I	I	H	I	H
MISSISSIPPI	I	I	H	H	I	I	H	H
MISSOURI	L	H	I	H	L	I	I	H
NEBRASKA	I	H	I	H	L	L	L	I
NEVADA	I	H	I	H	I	I	I	I
NEW HAMPSHIRE	I	H	H	H	I	I	H	H
NEW JERSEY	I	H	I	I	I	H	H	H
NEW YORK	I	I	I	I	I	I	I	I
NORTH CAROLINA	I	I	I	I	I	I	I	I
NORTH DAKOTA	L	I	L	I	L	L	L	L
OHIO	L	H	I	H	L	I	L	I
OKLAHOMA	L	H	I	H	L	I	L	H
OREGON	I	H	I	H	I	H	I	H
PENNSYLVANIA	L	H	I	H	L	I	I	H
SOUTH CAROLINA	I	I	I	H	I	H	I	H
SOUTH DAKOTA	L	L	L	L	I	I	L	L
TENNESSEE	I	I	H	H	I	I	I	I
TEXAS	L	I	I	H	I	I	I	H
UTAH	I	H	I	H	L	I	L	I
VERMONT	L	I	L	I	L	I	L	I
VIRGINIA	L	I	I	H	L	I	I	H
WASHINGTON	I	I	I	I	I	I	I	I
WEST VIRGINIA	I	I	L	I	I	H	L	I
WISCONSIN	L	L	L	L	L	L	L	L
WYOMING	L	I	I	H	L	I	I	H

LEGEND

H = HIGH; I = INTERMEDIATE L = LOW

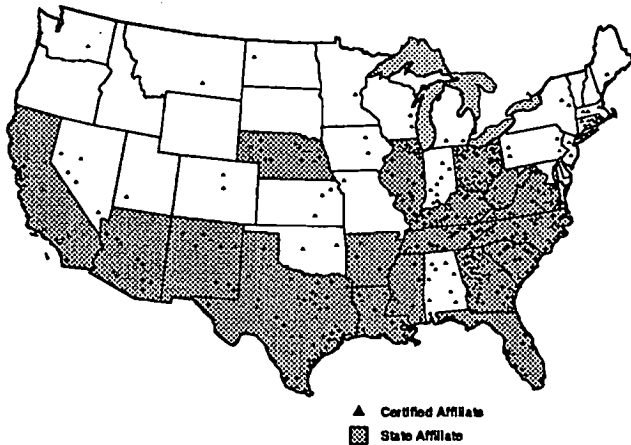


FIGURE 1 States affiliated with Keep America Beautiful.

disposal of glass, metal, newspaper, and cardboard found along roadsides. Instructions have been given to road supervisors that litter items are classified as "contaminated" and to be treated as household garbage. Beverage containers are classified as recyclables and are sorted. Additionally, an Office of Environmental Compliance has been established within construction and maintenance operations to address environmentally sensitive activities at maintenance facilities and garages.

The Pennsylvania Department of Transportation is in the process of implementing a comprehensive waste management strategy. After several years of internal department planning, a consulting firm was engaged to formulate a department strategy to guide decision making involving environmental issues. The plan is to develop waste management policies and procedures for management-level decision making and work activities aimed at a sound environmental awareness strategy. PennDOT recognized that it should take the lead in acknowledging the public perceptions and opinions "which demand protection of human health and environmental awareness." (23) While the plan is broad in scope, there is a specific recognition of areas in maintenance and operations that introduce disposable materials into the solid waste stream. For that portion of the plan involving maintenance operations, it is intended that a comprehensive Maintenance Waste Management Manual be prepared for use by the engineering districts. While hazardous substances handling is a major concern, the storage and handling of materials used in maintenance operations, as well as disposal, will be considered. Such material wastes generated by maintenance activities include traffic paint excesses, bridge paint, and sand blast residual waste products. The broad strategy includes coordinators and trainers to assist engineering districts as well as conduct audits for compliance with the plan.

Within states indicating the existence of formal policies, those having a mandated responsibility for recycling at a state agency level had assigned a level of responsibility within the maintenance organization. Those states that had assigned responsibility for waste disposal, scrap handling, and recycling to an "administrative unit" within the highway agency were working to accomplish written guidelines and directions for their maintenance forces.

TABLE 10
RANKING OF DEBRIS BY DIFFICULTY OF COLLECTION

Debris Type	States identifying as a problem (%)
Rubber Tires	65
Glass	54
Paper/Cardboard	51
Plastics	51
Newspaper	40
Aluminum cans	40
Metal cans	40
Other metal items	38
Lumber/wood	38
Miscellaneous Household and yard trash	3

MAINTENANCE OPERATIONS PRACTICES INVOLVING LITTER

Collection and Separation Practices

The occurrence of litter and debris along roadsides is a fact of life for the highway maintenance engineer. Almost 75 percent of the responding states (i.e., 33) considered the control of amounts of debris along roads a problem. The item most reported as a control problem was rubber tires. When asked to identify the problematic items among choices such as newsprint, cardboard, plastics, glass, aluminum cans, metal cans, other metals, rubber tires, wood, and miscellaneous trash, 65 percent of the states ranked tires as the most difficult control problem. (Hazardous materials are excluded from this synthesis.) The results are given in Table 10.

In addition to control of the amounts of litter along roadsides, the states were asked about collection and removal. More than 55 percent of the states that responded acknowledged these tasks as troublesome or time-consuming actions for maintenance forces. Almost all states reported little or no separation of these commonly found items on site, with the exception of rubber tires. Thirteen states reported collecting tires and separately handling them as a waste material. In most cases, the disposal of rubber tires was not acceptable at approved landfills. Several states indicated they had contracted services to remove waste tires, while others indicated that the waste tires were sold as a scrap material. In several cases, the demand for waste rubber tires had disappeared as the market was glutted. In California, the Department of Transportation and California Waste Management Board are actively working together on uses of crumb rubber, which is being produced from recycled tires and placed into the construction market as a resource. Other commonly found items were generally collected, placed in trucks, and returned to maintenance yards for disposal at landfills. It is likely that implementation of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) will result in more use of recycled rubber tires and other waste products.

Several states are involved in mandated or voluntary recycling operations. Only six states reported separating glass, aluminum, and metal beverage containers on site—Connecticut, Indiana, New Jersey, New York, Massachusetts, and Pennsylvania. Colorado, Delaware, Missouri, and Virginia encouraged Adopt-a-Highway groups to separate and recycle. Rest areas in Illinois and Nebraska were reported to have recycling cans for beverage containers, and

while not queried in the survey, it has been observed that this is also practiced in some other states.

Specialty Equipment for Collection

Two questions in the survey requested information on the use of automated equipment for collecting roadside debris, excluding sweepers, which are discussed later in this chapter. Most surprising was the reported absence of availability of such equipment. New Jersey reported that several automated rakes were purchased for cleaning medians on Interstate highways and more expansive areas located within ramps and interchanges. A mixture of responses for non-use of automated equipment ranged from frequent breakdown, extensive daily maintenance, and serious damage to turf.

Minnesota reported some experience with a modified turf rake pulled with a tractor. Their experiences with automated pickers paralleled New Jersey's with significant dust, picking up too much grass, and equipment breakdowns. Several litter vacuums have been tried but were felt to be too small for their applications of cleaning up paper along fences. Ohio and New Jersey equipment maintenance personnel reported they had retrofit several maintenance trucks for easing roadside pickup operations and provided sorting compartments. In discussions with the Arizona DOT, it was reported that several state maintenance contractors responsible for litter pickup and roadside maintenance in the Phoenix district had automated their operations through equipment modifications. Automated collection equipment removed large pieces of debris from pavements along safety shape concrete barriers and curb followed by street sweepers. Contract operations were complete with the appropriate safety equipment for a moving operation in high speed traffic. No other states reported any innovative applications of equipment that could be useful to others in this activity.

For this synthesis, inquiries regarding collection and separation equipment were sent to more than a dozen manufacturers and distributors of road equipment. The existence of equipment for collection and litter mixtures is published annually in the *Public Works Journal* and displayed at major equipment trade shows. However, it appears that advertised use is not necessarily a proven successful use.

The information sought in the questionnaire was to collect the states' experiences with available products. However, it appears that most equipment purchased and distributed to field operations specifically for automated roadside litter collection purposes has not survived the maintenance supervisor's field testing and appears to have been lost or buried as obsolete or unusable equipment in maintenance yards around the U.S. It appears that the emphasis placed by the Secretary of Transportation in the 1970s on developing automated equipment and practices for litter collection has not yielded any progress at the state maintenance operations level in the 1990s.

DISPOSAL PRACTICES

Disposal of roadside litter was identified by 19 states as a problem associated with this routine activity. These states are indicated in Table 5. Alaska viewed disposal as a problem in their more urban areas where litter proliferates near fast food services and where its nearest landfills are quickly filling to capacity. Kansas shares similar concern in areas near more urbanized centers. Texas

and Oklahoma's disposal problems were primarily associated with discarded rubber tires. Idaho anticipates that disposal will be a problem in the future. Although not presently a day-to-day problem for its maintenance crews, the fact that disposing of such debris takes precious time from routine maintenance operations was recognized.

Obstacles to Disposal of Roadside Litter Mixtures

States were asked about any environmental constraints that do or may affect their state's roadside litter program. This question excluded any handling of materials classified as toxic or potentially hazardous. Another question dealt specifically with the need to sort roadside mixtures prior to disposal because of existing environmental regulations. Environmental constraints directly affecting their programs were noted by eight states. Their reasons were: controlled disposal of tires and batteries in state landfills, closed landfills in areas of disposal for environmental reasons, and insufficient landfills in immediate areas of pickup activities. While approximately 50 percent of the reporting states indicated there were no environmental constraints at the present time, several states, including Ohio, Tennessee, and Florida, were anticipating legislation to impact their programs. In these states, sorting was not a current requirement, but phased-in recycling regulations within the next three to five years would be implemented and could affect their operations.

Connecticut and New Jersey require maintenance personnel to sort litter as it is collected or just prior to disposal. Wisconsin and Ohio are among several states presently evaluating this practice on a pilot scale. Results of the state responses relative to sorting, disposal, and environmental regulations that affect typical roadside debris are found in Table 5.

A number of activities directly affect the disposal of materials picked up by maintenance forces or their auxiliary helpers. These are: sorting materials into different piles on site, taking materials back to maintenance facilities to separation bins or other trucks, and transferring to other vehicles for shipment to landfills. Sometimes, it is necessary to stockpile materials that fall into an unclassified category and must be held awaiting approval for disposal at the nearest landfill. These may not have been classified as harmful or toxic, but because of their non-routine nature, become stockpiled until decisions are made between waste management regulators and maintenance managers. This problem has occurred frequently in the Northeastern states, where spills on highways have been contained with sand, swept off of the main pavement, and loaded by a state environmental unit responsible for spills into large containers or drums while awaiting removal. Subsequently, the materials are tested and classified as nontoxic and nonhazardous but left for the state maintenance forces to dispose of. Generally, disposal of these materials becomes more costly as delays are encountered regarding their classifications. Material that has been drummed becomes particularly "questionable or suspect."

Landfill Availability

There is diminishing availability, in some areas, of disposal space as existing landfills reach capacity or are forced to close because they do not meet environmental standards. Development of others is often stymied by local opposition or the "Not In My

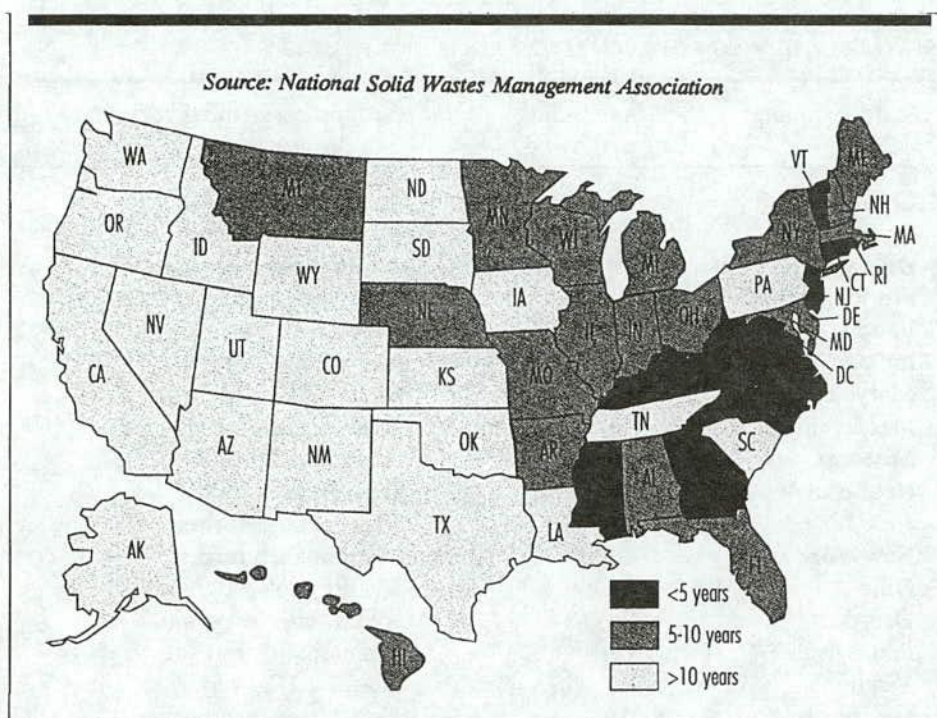


FIGURE 2 Estimated years of remaining U.S. landfill capacity, 1991.

BackYard" (NIMBY) syndrome. The Michigan Department of Natural Resources, in its report on effects of bottle bill legislation in that state, noted that it costs at least \$2 million to build a 100-acre landfill with a capacity of twenty years. Estimated costs do not include potential legal fees should opposition be encountered or special containment construction requirements mandated in those states very actively monitoring groundwater infringements (24).

The U.S. Environmental Protection Agency issued regulations in 1991 that require all landfills to meet minimum national standards for landfill design, operation, and management to protect groundwater from potential contamination resulting from landfill leachates.

Maintenance engineers were asked if there were sufficient landfills in their state that permit disposal of unsorted materials. Twenty-nine state maintenance engineers responded that there were sufficient landfills, yet seven of these qualified their response with comments such as "getting more difficult," "more and more a concern," and "a definite future problem for our state." Tennessee specifically noted the NIMBY syndrome as a problem.

The estimated years of remaining U. S. landfill capacity, based on surveys of the National Solid Wastes Management Association, are depicted in Figure 2. The majority of municipal solid waste landfills available for highway litter are owned by local governments.

In a 1990 study conducted by Rutgers University Graduate Department of Public Administration regarding "Litter Control in New Jersey: Public Perception vs. Public Policy," several states noted that providing sufficient landfill space for public use would

deter litter accumulations along highways as well as the larger problem of illegal dumping.

Environmental Regulations on Disposal

For this synthesis, each of the responsible environmental units in the 50 states was queried regarding the existence of state laws and regulations that control the disposal of solid waste materials usually found along shoulders and roadways and that would prevent disposal in a landfill. Of the 30 responding states, only Connecticut, Maine, Maryland, Minnesota, New Jersey, and South Carolina indicated they had such regulations.

While New Jersey Department of Environmental Protection and Energy (DEPE) indicated affirmatively, it stipulated that state disposal regulations cover litter picked up along roadsides and was subject to control only if picked up as part of its Clean Community Program. This is a local level program only and does not include state maintained roadways or major highways. All other roadside debris was approved and eligible for disposal at public landfills unless specifically restricted items, such as rubber tires, were incorporated in the mixture. Recycling of litter mixtures from roadsides is voluntary at this time.

A number of the environmental units responded that, while there were no specific regulations placed on state maintenance agencies for disposal of roadside litter mixtures, specific discarded items in curbside trash pickup were controlled by solid waste regulations. These states, in the majority, had implemented recycling and source reduction regulations, and at this point had not yet encom-

TABLE 11
STATES PERFORMING ROADSIDE LITTER RECYCLING PRACTICES

State recycling	Is recycling mandated?	Groups performing recycling
Colorado	No	Adopt-a-Highway
Connecticut	Yes	Maintenance forces
Delaware	No	Adopt-a-Highway
Florida	No	Maint. pilot program/ADAH
Illinois	No	Rest areas
Indiana	Yes	Maintenance forces
Maryland	No	Maint. pilot program
Massachusetts	No	Maintenance forces
Missouri	No	Adopt-a-Highway
Nebraska	No	Rest areas
New Jersey	Yes	Maintenance forces
New York	Yes	Maintenance forces
Ohio	No	Maint. pilot program
Oregon	No	Maint. pilot program
Pennsylvania	Yes	Maintenance forces
Virginia	No	Adopt-a-Highway
Wisconsin	Yes	New phase-in program

passed state maintenance operations. The agencies were in the following states:

California	New York
Idaho	North Dakota
Indiana	Ohio
Louisiana	Rhode Island
Massachusetts	Virginia
Mississippi	Wyoming
New Mexico	

It would appear, therefore, that litter mixture disposal problems could affect maintenance operations if communications and coordination between the agencies are not activated in the near future. Information received from both maintenance and natural resources agencies in California indicate cooperative efforts in this area have been formalized for some time.

RECYCLING PRACTICES

There are a number of approaches to accomplishing recycling strategies. These include uniform statewide regulations for sorting and saving specific items, or regulations established at county, city, or such subjurisdiction levels. There are voluntary participation programs, which have been organized by civic groups, and interested industries have provided drop-off collection locations. Florida allows each county to set regulations on the collection approach to be used: drop boxes, curbside collection, buy back centers, multifamily, institutional and commercial collection, and materials recovery facilities. Curbside collection is the most commonly used practice in New Jersey and Connecticut. Curbside recycling is becoming more prevalent in Florida.

Other states that have passed recycling laws have mandated specified percent reductions in solid waste amounts in the total waste stream for a city or county over a specified phase-in period. This recycling strategy has been reported in North Carolina.

State maintenance engineers were asked in Question 9a of the highway maintenance questionnaire if their forces recycled or reused any collected debris. Affirmative responses were received from 17 states. Not all states practicing recycling have mandated recycling regulations but are voluntary participants. Several states are strongly suggesting that their Adopt-a-Highway groups sort and recycle collected litter as shown in Table 11.

No states engaged in recycling efforts have provided dedicated staff for this specific effort. Only Florida, Oregon, and Pennsylvania reported that income was derived from recycling efforts put forth by maintenance forces. The income was returned to maintenance operating funds in Florida and Pennsylvania, but a very minimal sum was realized for the effort. Florida reported its pilot recycling program produced minimal amounts while PennDOT reported they had realized \$509,000 for the recyclables collected by their maintenance forces. They are presently working out agreements with their rest area operators to return funds gained through recycling to maintenance operating accounts.

Connecticut and Pennsylvania reported a significant improvement of their roadsides since recycling was required. New York reported its maintenance forces experienced a negative impact as landfills became more restrictive as to what they would accept from their roadside collection operations. Recyclable items varied within each county jurisdiction and roadside debris was not mandated for recycling. Curbside recycling requires a commitment from each household with the expectation that there may be financial rewards to be gained through reduced property taxes or trash collection fees. The immediate rewards are not as obvious as derived by individuals on returning a beverage container in a "bottle

bill" state. This may be a reason for observed increases in beverage containers along roadsides in some of those areas where curbside recycling is mandated.

Personal Safety Practices

There has been concern about the potentially dangerous items that are found along roadsides. Along with distasteful putrescibles of household garbage, other dangerous or flammable materials are being dropped off by unscrupulous waste haulers or citizens. Legal disposal sites are becoming less accessible and it is costly to dispose of items such as biological or medical wastes and household or industrial chemicals.

Of the 45 responding states, 18 states indicated they had no formal policy or procedures established for their maintenance personnel involved in litter pickup activities when encountering or in handling items that could affect personal safety. While 24 states answered yes, it appeared that the precautions indicated in more than half were part of Hazardous Material Training Programs or Right to Know programs. A number of these states indicated that only rubber gloves or protective gloves were provided to their maintenance workers, Adopt-a-Highway volunteers, and rest area personnel responsible for emptying trash barrels.

States such as New York, South Carolina, and Ohio issue "grabbers" or pickup devices to their forces to avoid injury from such materials. Oregon indicated that if such items are found by their Youth Litter Patrols, the items are "flagged" and disposed of by trained maintenance personnel into bio-hazard containers. Connecticut provided one of its internal publications for maintenance personnel, namely the *Safety Topic of the Week*, which specifically deals with litter. In very simple language, it presents a procedure to help persons involved in litter disposal recognize basic pitfalls and avoid personal injury through good safety practices.

It appears that incorporating specific litter pickup precautions, such as developed by Connecticut DOT, and information presented in mandated training programs on handling hazardous materials should satisfactorily address labor group concerns. Scheduled periodic reviews of such precautions could be handled as in California, where Tailgate Safety Sessions are held in each crew every ten days.

SPECIALIZED DISPOSAL PROBLEMS

Sweeping

The cleaning of roadways in urban areas, particularly city streets, is a required scheduled activity for the more densely populated states. Loose gravel and other debris must be swept from pavement surfaces and along gutter lines. Where there are closed drainage systems, it is particularly important to keep the accumulation of dirt and loose road particles from significant buildup, which eventually could lead to clogged catch basins, storm sewers, and underdrains. Regular cleaning of high-volume, high-speed highways is a safety necessity.

There is a colorful history attached to street sweeping practices. Public awareness of cleanliness, comfort, and hygiene made street cleaning a major political issue in the period preceding World War I. John Murphy produced the first automated street sweeper, an Elgin Model A, in 1913. By 1920, steel-fitted gutter brooms, water

spray systems, and collection hoppers were common features on the automated device. The removal of particulates from the pavement went through technological growth paralleling the auto industry. Broom sweepers could remove 20 percent of the total solids routinely found along urban curbsides, but coupled with vacuum devices, more than 70 percent solids were being picked up. Unfortunately, the remaining debris were small particles, which were dispersed into the adjacent roadside atmosphere, creating concerns about air pollution (25).

Environmental Concerns

Along with maintenance questions on how these particulates could be picked up faster and more efficiently, problems became larger as the quantities increased and disposal of these materials became an environmental concern. Cities such as Newark, New Jersey found that a typical day's sweeping would yield 1.2 tons of debris from 6.5 curbmiles. In 1987, it cost the city of Newark \$94/curb mile to perform this work with their forces and to dispose of the material. Private contracting was initiated and costs dropped to \$44 to \$51/day with greater productivity. Debris collected averaged between 2.7 and 2.9 tons/day. An additional benefit was that the better maintained equipment was able to clean 15 curbmiles per day. Each private contractor was required to dispose of these materials. An allotment of \$75/day was provided for disposal costs (27).

While the philosophy of health and hygiene from the early 1900s continued with the practice of sweeping, it became clearer that the real benefits are improved aesthetics, preventive maintenance for enclosed drainage systems, and enhanced pavement safety on high-speed, high-density highways.

In 1978, results of a study conducted in Sweden were released. This study revealed a connection between heavy metal fallout from atmospheric pollution into stormwater runoff. It was proposed that pollutants in runoff could be reduced by reducing the local pollutant sources, which were deposited on surface debris in streets. It was postulated that the sweeping of streets may improve the quality of stormwater. The report indicated that the sweeping of a street in Sweden removed 57 percent of suspended solids and between 31 and 57 percent of the heavy metals deposited on street surfaces (26).

The link between health and improved well-being of the environment as a result of street sweeping was studied by the EPA and FHWA. In 1978 and 1979, the EPA initiated and funded a study of non-point pollution abatement through improved street cleaning practices. The study was conducted in four separate phases with results published at the conclusion of each phase. This research continued for 15 years within the FHWA in response to the requirements of the federal Clean Water Act. This act required that federal agencies work with state and local governments to develop comprehensive solutions to prevent, reduce, and eliminate pollution. Debris collected along highways was considered a major contributor to pollution via runoff water. In response to the growing awareness that highway runoff was a potential threat to the environment, the FHWA initiated a study to identify, quantify, and analyze effects of constituents from highway surfaces in receiving waters (28). The common constituents of highway runoff waters and their primary sources were published by the FHWA in 1984 in *Sources and Migration of Highway Pollutants*. Information from this study is contained in Table 12 (28).

TABLE 12
HIGHWAY RUNOFF CONSTITUENTS AND THEIR PRIMARY SOURCES

Constituents	Primary Sources
Particulate	Pavement wear, vehicles, atmosphere, maintenance
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer applications
Lead	Leaded gasoline (auto exhaust), tire wear (lead oxide filler material), lubricating oil and grease, bearing wear
Zinc	Tire wear (filler material), motor oil (stabilizing additive), grease
Iron	Auto body rust, steel highway structures (guard rails, etc.), moving engine parts
Copper	Metal plating, bearing and bushing wear, moving engine parts, brake lining wear, fungicides and insecticides
Cadmium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline (exhaust), lubricating oil, metal plating, bushing wear, brake lining wear, asphalt paving
Manganese	Moving engine parts
Cyanide	Anticaking compounds (ferric ferrocyanide, sodium ferrocyanide, yellow prussiate of soda) used to keep deicing salt granular
Sodium/calcium, chloride	Deicing salts
Sulphate	Roadway beds, fuel, deicing salts
Petroleum	Spills, leaks or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate
PCB	Spraying of highway rights-of-way, background atmospheric deposition, PCB catalyst in synthetic tires

Source: FHWA Report RD-84/058 (1984)

Studies indicated that troublesome heavy metals and nutrients adhered to particles 45 microns or smaller. The Clean Water Act of 1987 required that heavy metals contained in roadside debris be "picked up" to improve stormwater runoff quality. More than \$3 million was spent by the EPA and FHWA testing sweeping equipment to see if street sweeping would clean up pollutants. Studies revealed that pollutant solids were apt to be higher in areas where confined curbs kept them trapped and then readily available for pickup by water runoff from the pavement. Uncurbed areas allowed these typical pollutants to be freely dispersed. The study

revealed that street cleaning, catch basins, porous pavements, and filtration devices for sediment control were ineffective practices.

The FHWA has taken the position that street sweepers are not effective in removing highway pollutants. The EPA and FHWA are in agreement that materials routinely found in road sweepings are not present in quantities sufficient to create environmental concern. Most state agencies appear to be in accord, based on survey results.

While equipment has been developed to remove particles down to 63 microns, the majority of the heavy metals contained in the

TABLE 13
ANNUAL QUANTITY OF SWEEPINGS

State/City	Quantity in Tons
Portland, OR	50,000
Oregon	50,000
Massachusetts	30,000
Arkansas	28,000
Nevada	18,700
New Hampshire	15,000
Maryland	14,000
Idaho	13,700
Pennsylvania	12,400
Iowa	10,000
Newark, NJ	3,827
Nebraska	1,500
Alaska	50

material are 45 microns or smaller (29). Unfortunately, some controversy continues relative to disposal of this material and several environmental agencies and highway groups have initiated studies within their states before reuse is permitted. The particulates being collected by currently available street sweepers are not within the size identified. However, controls are being applied concerning disposal of these materials, apparently on a "what if" basis.

While collection of roadside sweepings appears not to be a major concern, disposal of sweepings remains a problem in many states where this is a common maintenance activity. Also, the use of sweeping materials as fill or as a substitute fine aggregate is controlled in some states. Testing of leachate is required and pre-approval necessary before being permitted in public landfills or used for shoulder or erosion areas, especially near watersheds or wetlands. While testing is primarily to ascertain the presence of hazardous materials resulting from spills and the quantity of heavy metals, if the materials are not permitted to collect along curblines to any depth, the chances are very low that their quantities will be significant. Research has been reported in Massachusetts and Washington where they are attempting to put sweepings and screened inlet debris to beneficial use with the preapproval of state environmental agencies.

Current Disposal Practices for Sweepings

All states responded to questions related to the disposal of street sweepings. Estimated quantities of such debris varied among those who record such data—from 50 tons per year reported in Alaska to 50,000 tons per year in Portland, Oregon. These estimates are presented in Table 13.

A number of the respondents indicated knowledge of environmental regulations in their states associated with disposal or reuse of street sweepings. Colorado, Connecticut, Iowa, Louisiana, Maryland, and New Jersey reported that the material must be clean, meaning free of any hazardous materials, prior to reuse or disposal in a public landfill. Nevada indicated that sweepings must be free of any hydrocarbons before disposal in landfills. In Michi-

TABLE 14
DISPOSAL COSTS FOR SWEEPINGS

State/City	Cost per Ton
Connecticut	\$ 7
Iowa	\$ 25 to \$35
Maryland	\$ 30 to \$70
Massachusetts	\$ 50
Michigan	\$ 40
Nebraska	\$ 10
Nevada	\$ 4
New Jersey	\$100
Newark, NJ	\$108
Portland, OR	\$ 68
Pennsylvania	\$ 15
Washington	\$ 55

gan the sweepings must be tested before disposal at preapproved sites. Virginia and New Hampshire replied that disposal in designated wetland areas was prohibited by state environmental regulations. This was probably true for other states but either not known by the maintenance staff completing the questionnaire or overlooked; however, none of the state environmental or natural resource agencies reported this prohibition in their responses. Nine states reported that disposal was more of a problem for maintenance forces responsible for urban areas. Cost data on the disposal of sweepings are given in Table 14.

Twenty-three states responded that sweeping activities were contracted out to private companies, particularly in urban areas. Most of those states using contract services included disposal costs in the final contract with disposal primarily at landfills or preapproved sites. Only Connecticut indicated that final disposal was the responsibility of state maintenance forces; landfills in Connecticut are using sweepings as a surface cover in their daily operations.

Twenty-four states are able to use street sweeping materials, once cleaned of any litter particles. The uses include clean fill material for low areas in the roadside right-of-way, as fill in barrow pits, for shoulder build up, to flatten and protect slopes, to fill washouts, and as a general road fill. Several states reported using clean stockpiled material as an abrasive in snow and ice operations. Massachusetts has done research on reuse of sweepings and found the particles were too rounded to be an effective abrasive. New Jersey indicated it was presently evaluating equipment for precleaning and screening stockpiled sweepings to be used as a fill for routine shoulder repairs. Disposal of sweepings in New Jersey is averaging more than \$100 per ton if taken to landfills. State survey results are summarized in Table 15.

Drainage and Inlet Debris

In all reporting states, routine maintenance activities include keeping water courses free from accumulations of obstructions, dirt, debris, and unwanted vegetation. Clean outs are usually scheduled prior to anticipated seasonal rains or onset of winter weather conditions. Open drainage systems commonly used in the rural

TABLE 15
SURVEY OF STATES: ROAD SWEEPINGS AND DISPOSAL

STATES	DISPOSAL SITES	USES	ENVIRONMENTAL CONSTRAINTS	REGULATIONS	CONTRACTS
ALABAMA	LANDFILLS	NONE	NO	N/A	YES
ALASKA	STOCKPILE	FILL	NO	N/A	YES
ARIZONA	LANDFILLS	NONE	NO	NO	NO
ARKANSAS	LANDFILLS	SNOW/ICE ABRASIVES	NO	NO	NO
CALIFORNIA	LANDFILL (95%)	SHOULDER FILL	NO	N/A	YES
COLORADO	LANDFILL	NONE	URBAN AREAS	YES	NO
CONNECTICUT	APPROVED SITES	YES	URBAN AREAS	YES	STATE
DELAWARE	LANDFILLS	NONE	N/A	N/A	NO
FLORIDA	LANDFILLS	FILL BORROW PITS	NO	N/A	LF
GEORGIA	LANDFILLS	NO	NO	N/A	LF
HAWAII					
IDAHO	STOCKPILES	SHOULDER FILL,SAND	NO	NO	STOCK
ILLINOIS	LANDFILL	NONE	NO	NO	LF
INDIANA	LANDFILLS	NONE	NO	NO	LF
IOWA	LANDFILL	ROADFILL	YES	NO	NO
KANSAS	USED	SHOULDER DITCH	NO	N/A	NO
KENTUCKY	LANDFILL	NO	NO	N/A	LF
LOUISIANA	LANDFILL	NO	URBAN	URBAN	NO
MAINE					
MARYLAND	LANDFILL	NO	CLEAN	URBAN	YES
MASSACHUSETTS	USED	FILL/ PLANTING BORROW	NOT YET	N/A	NO
MICHIGAN	LANDFILL	CLEAN FILL	MUST TEST	URBAN	YES
MINNESOTA	USED/ STATE ROW	CLEAN FILL	YES/ NO SALT	URBAN	YES
MISSISSIPPI	LANDFILL	NO	AVAIL. LF	N/A	LF
MISSOURI	LANDFILL	NO	NO	NO	NO
MONTANA					
NEBRASKA	LANDFILL	NO	APP. LF	URBAN	NO
NEVADA	STOCKPILE	SHOULDER FILL	HCs	URBAN	NO
NEW HAMPSHIRE	USED	FILL,SHOULDERS,ICE CONTROL	YES	WETLANDS	NO
NEW JERSEY	LANDFILL	CLEAN FILL	CLEAN	N/A	CONTR
NEW MEXICO					
NEW YORK	STATE PROP	FLATTEN SLOPE,FILL	YES	N/A	NO
NORTH CAROLINA	LANDFILL /USED	ROADFILL, SLOPES	NO	N/A	NO

TABLE 15 (Continued)

STATES	DISPOSAL SITES	USES	ENVIRONMENTAL CONSTRAINTS	REGULATIONS	CONTRACTS
NORTH DAKOTA	STATE PROP/LF	SAND	NO	N/A	CONTR
OHIO	LANDFILL	NO	NO	N/A	CONTR
OKLAHOMA	USED/ STATE ROW	FILL, ERODED AREAS	NO	NO	YES
OREGON	USED	SHOULDER SLOPES	NOT YET	N/A	CONTR
PENN- SYLVANIA	LANDFILL	ROADFILL/ SHOULDER	NO	NO	CONTR
RHODE ISLAND					
SOUTH CAROLINA	LANDFILL	WASHOUTS	CLEAN	N/A	NO
SOUTH DAKOTA	LANDFILL	NO	NO	N/A	NO
TENNESSEE	LANDFILL	NO	NO	N/A	LF
TEXAS	LANDFILL	NO	NO	N/A	LF
UTAH	USED	SLOPES/ SHOULDER	NO	URBAN	NO
VERMONT	N/A	N/A	WETLANDS	N/A	N/A
VIRGINIA	LANDFILL	NO	NO	NO	10%
WASHINGTON	STATE PROP	SHOULDER WINTER SAND	YES	URBAN	NO
WEST VIRGINIA	LANDFILL	NO	YES	URBAN	NO
WISCONSIN	N/A	N/A	N/A	N/A	NO
WYOMING	USED	SNOW/ICE CONTROL	NO	N/A	NO
N/A = NO ANSWER	LF = LANDFILL				

areas of highways in the United States include gutters, shoulder inlets, side drains, diversion ditches, roadside ditches, culverts, and silt basins. Usually materials removed from these drainage facilities are taken to the farthest points of the adjacent right-of-way and graded to support the existing open system. Materials removed generally are composed of silt, dirt, and unwanted vegetation, with occasional more typical roadside litter items. Maintenance of closed drainage systems presents a more varied mixture of disposables. Catch basins located within gutters and along curbsides, inlets, underdrains and other closed underground storm water systems, particularly in the densely populated areas, reveal all types of unusual items for maintenance crews. Reported items range from illegally discarded medical waste, drug paraphernalia, aborted fetuses, and even golf clubs. Disposal of such materials has been reported to require unique solutions.

As discussed in the previous section on sweepings, the potential threat to the environment from highway water runoff along paved and unpaved roadways was researched in studies initiated by the FHWA (28). After 15 years of research, it was found that pollutant loadings from highway drainage systems were negligible. While higher concentrations of these materials were found initially in the areas adjacent to the roadway systems, they were subsequently

removed by runoff waters. The FHWA and Environmental Protection Agency are in accord on the nonthreatening potential contained in highway drainage systems, unless due to illegal dumping or hazardous spills. The results of the final phase of the Water Quality Study indicated that common maintenance practices "that are ineffective in reducing pollutant loads include street cleaning, catch basins, porous pavements, and filtration devices for sediment control" (28).

The Final Report on Highway Water Quality contained a recommendation for an effective way to reduce pollutants in highway runoff waters through litter control (28). This may become an important environmental concern for maintenance operations as more emphasis is placed on wetlands mitigation policies and protection of natural wetlands.

Forty-nine states reported that their maintenance forces were routinely removing inlet or ditch debris. The material was left on-site or taken to state property in thirty-three responding states. Precautions were required to keep from silting or dumping into wetlands areas. Twenty-nine of these states also disposed of materials in public landfills.

Approximately one-third of the reporting states indicated an awareness of environmental regulations in their states affecting

the disposal or reuse of the removed materials. Random testing and composition checks are required in Massachusetts and Pennsylvania. New Hampshire, South Carolina, and Oregon were particularly concerned with reuse near streams and wetlands or in watershed areas. Disposal problems were identified in Colorado, Connecticut, Idaho, Maryland, New Jersey, and Washington.

Colorado reported that some of its inlet facilities were tested for contaminated materials after heavy metals exceeded allowable limits. Connecticut reported that its disposal problems are associated with contaminated materials, decreasing disposal sites and longer hauling distances to those accepting the materials. The ability to dump materials cleaned out of ditches in Idaho is subject to regulations covering wetlands, rivers and streams, and U.S. Forest Service rules. Maryland reported that it buries any silty material and does not reuse it. New Jersey reported the material was often contaminated and any reuse was cautious. Any reusable materials were separated from litter and non-soil materials.

A number of states reported the expected off-site use of the materials once separated from non-soil materials. Such uses were primarily as a clean fill for roads and shoulder repairs, erosion control in washout areas and slopes. However, Iowa reported the material used as a compost along the right of way. New Hampshire recommended screening the material and using it as humus, while Vermont noted that the material "makes a good slope dressing as it will stick well and grow vegetation readily." The use of wastewater sludge from ditches was reported in 1986 along Alaska's right-of-way as beneficial to plant growth and providing bank stabilization. Its use was considered as a waste disposal resource, but public reaction was reportedly negative. Nine states indicated the use of contracted forces for drainage and inlet cleanout. Detailed information is compiled in Table 16.

Animal Carcasses

One of the most unpleasant tasks faced by a maintenance worker is the removal of dead animals from the roadway or shoulder. *The*

AASHTO Maintenance Manual (30) addresses this problem as follows: "The remains of dead animals killed by motor vehicles should be removed from the roadway and buried as soon as possible after being reported or observed. Some states require reporting to police or wildlife authorities." The task is more complicated when dealing with removal and disposal within the confined roadway of an urban expressway or places where traffic density and motorist oversight is ever present.

Sixty percent of the states responded that the removal of dead animals from roadways and roadsides is a problem for their agencies. Thirteen states indicated the responsibility for disposal was assigned to state agencies such as Fish and Game, Game Conservation, Parks, or units within that state's natural resources or environmental protection agencies. In some cases, a local government was responsible for animal control units. Table 17 shows the costs in work hours and dollars incurred by selected states in disposal of animal carcasses.

More than half of the states have regulations and laws controlling the disposal of dead animals. New Hampshire, Nevada, and Vermont require a record of any identification if present and notification of owners. In Oregon, disposal of carcasses in any landfills is prohibited, while in Idaho this activity is restricted to specified landfills not near housing or water sites. Laws in Alaska permit salvaging meat from larger animals hit along the roadways. California reported that unpermitted burials were subject to fines.

Whenever possible, the usual method of disposal for state maintenance forces was to bury the carcass on site, or adjacent to the roadway or pulled back into the forest. Most states reported those carcasses taken off-site for disposal were buried on other state properties or taken to landfills permitting such disposal. Larger carcasses were reportedly taken to rendering plants in eleven states, usually by contracted services or other governing units. Specific information by state is given in Table 18.

TABLE 17
ANNUAL COSTS FOR DISPOSAL OF ANIMAL CARCASSES

State	Annual cost (\$)	Work hours
New York	2,600,000	236,000
Virginia	1,750,000	100,000
California	1,200,000	4,137
Texas	1,000,000	58,000
Nebraska	325,000	8,350
Iowa	280,000	*
Wisconsin	250,000	Contract
Kentucky	200,000	*
Ohio	180,000	*
Pennsylvania	175,000	7,000
New Hampshire	70,000	5,000
Utah	70,000	3,000
New Jersey	65,000	Contract
Arkansas	58,000	*
Vermont	51,000	2,028

* No data received

TABLE 16
SURVEY OF STATES: DRAINAGE AND INLET DEBRIS

	ROUTINE ACTIVITY	DISPOSAL SITE	OFF-SITE USES	CONTRACTS %	DISPOSAL PROBLEMS	ENVIRON REGS	DISPOSAL COSTS
ALABAMA	YES	STATE PROP.,LF	NONE	10-20%	NO	NO	\$10.00/TON
ALASKA	YES	STATE PROP.,LF	ROADFILL	NO	NO	NO	N/A
ARIZONA	YES	LANDFILL	NONE	NO	NO	NO	
ARKANSAS	YES	STATE PROP.	ERODED SLOPES	5%	NO	NO	\$1.4M ANNUALLY
CALIFORNIA	YES	STATE PROP.	FILL MATERIAL	1%	NO	NO	
COLORADO	YES	STATE PROP.,LF	NONE	NO	YES	CONTAMINANTS	
CONNECTICUT	YES	STATE PROP.,LF	FILL MATERIAL	NO	YES	WETLANDS	
DELAWARE	YES	STATE PROP.,LF	NO	NO	URBAN	NO	
FLORIDA	YES	STATE PROP.,LF	SHOULDER FILL	N/A	N/A	NO	
GEORGIA	YES	LANDFILL	NONE	NO	NO	N/A	
IDAHO	YES	STATE/OTHER	SHOULDERS & TURNOUTS	NO	WETLANDS	YES	\$27,000 ANNUALLY
ILLINOIS	YES	STATE PROP.	EROSION FILL	NO	NO	NO	\$3.48M ANNUALLY
INDIANA	YES	STATE PROP./LF	EROSION FILL	1%	NO	NO	
IOWA	YES	STATE PROP.	FILL & COMPOST	NO	NO	YES	\$1.6M ANNUALLY
KANSAS	YES	STATE PROP.,LF	SHOULDER FILL	NO	NO	LOCAL REGS	
KENTUCKY	NO	N/A	RANDOM FILL	5%	NO	NO	
LOUISIANA	YES	STATE PROP.,LF	N/A	NO	NO	NO	
MARYLAND	YES	STATE PROP.,LF	NONE	NO	IF SILTY	SILT	2.23M ANNUALLY
MASSACHUSETTS	YES	CONTRACT REMOVAL	N/A	100%	N/A	TESTING	
MICHIGAN	YES	LANDFILL	STOCKPILE/ ABRASIVES	YES	HAULING	TESTING	
MINNESOTA	YES	STATE PROP./LF	FILL,COMPOST, TOPSOIL	NO	NO	NO	N/A
MISSISSIPPI	YES	STATE PROP.,LF	NONE	NO	NO	NO	
MISSOURI	YES	LANDFILL	NONE	NO	NO	NO	
NEBRASKA	YES	LANDFILL	WASHOUT FILL	NO	NO	NO	
NEVADA	NO	STATE PROP.,LF	SLOPE FILL	NO	NO	NO	
NEW HAMPSHIRE	YES	STATE PROP.	SLOPES/HUMUS	NO	NO	WETLANDS	
NEW JERSEY	YES	STATE PROP.	FILL AFTER CLEANUP	NO	"CLEAN"	CONTAMINANTS	
NEW YORK	NO	STATE PROP.,LF	FILL	NO	NO	NO	
NORTH CAROLINA	YES	STATE PROP.,LF	FILL/PUBLIC DISTRIB	NO	NO	NO	
NORTH DAKOTA	NO	NO INFORMATION PROVIDED					
OHIO	YES	STATE PROP.	FILL MATERIAL	NO	NO	NO	
OKLAHOMA	YES	LANDFILL	NO	NO	NO	NO	
OREGON	YES	STATE PROP.	SHOULDER FILL	YES	NO	STREAM PERMITS	
PENNSYLVANIA	YES	STATE PROP.	EMBANKMENTS, ROADFILL	40%	NO	COMPOSITION	
SOUTH CAROLINA	YES	STATE PROP.,LF	FILL MATERIAL	NO	NO	WETLANDS	
SOUTH DAKOTA	YES	LANDFILL	NONE	NO	NO	NO	
TENNESSEE	YES	STATE PROP.	NONE	NO	NO	NO	
TEXAS	YES	STATE PROP.,LF	FILL MATERIAL	YES	NO	NO	
UTAH	YES	STATE PROP.	SLOPE, ROADFILL	NO	NO	NO	
VERMONT	YES	STATE PROP.,LF	SLOPE DRESSING	NO	NO	WATER AREAS	
VIRGINIA	YES	LANDFILL	NONE	NO	URBAN	NO	\$200000 ANNUALLY
WASHINGTON	YES	STATE PROP.,LF	SHOULDERS/FILL	NO	APPVD SITES	WETLANDS	2.5M ANNUALLY
WEST VIRGINIA	YES	STATE PROP.	YES	YES	APPVD SITES	YES	N/A
WISCONSIN	YES	STATE PROP.,LF	FILL MATERIAL	NO	NO	NO	N/A
WYOMING	YES	LANDFILL	NO	NO	NO		N/A

LF = LANDFILLS N/A = NO ANSWER

TABLE 18
SURVEY OF STATES: DISPOSAL OF ANIMAL CARCASSES

	PROBLEM ACTIVITY	REGULATIONS ON DISPOSAL	METHODS OF DISPOSAL	DISPOSAL CONTRACTS
ALABAMA	YES	NO	BURIED ON SITE, RENDER PLANTS	NO
ALASKA	NO	NO/MEAT SALVAGED	PULLED BACK, LANDFILLS	NO
ARIZONA	NO	YES	ON SITE, OFF SITE, FOREST, BURNING	YES
ARKANSAS	YES	NO	BURIED ON SITE, LAND FILLS	NO
CALIFORNIA	NO	YES/FINES	BURIED ONSITE, OFF SITE	YES ANIMAL CONTROL
COLORADO	YES	YES	PULLED BACK	NO
CONNECTICUT	YES	N/A	BURIED ON SITE, OFF SITE	NO
DELAWARE	NO	NO	BURIED ON SITE, OFF SITE, LANDFILL	NO
FLORIDA	YES	NO	BURIED ON SITE, OFF SITE	NO
GEORGIA	YES	YES	BURIED ON SITE, OFF SITE, L.F.	NO
IDAHO	YES	YES/BURIAL SITE	BURIED ON SITE, OFF SITE	NO
ILLINOIS	NO	NO	BURIED ON SITE, OFF SITE	NO
INDIANA	NO	YES	BURIED ON SITE, OFF SITE	NO
IOWA	YES	YES	BURIED ON SITE	YES RENDER PLANT
KANSAS	YES	N/A	BURIED ON SITE, OFF SITE, L.F.	YES RENDER PLANT
KENTUCKY	NO	NO	BURIED ON SITE, OFF SITE, LF, RENDER	NO
LOUISIANA	NO	NO	BURIED OFF SITE, PULLED BACK	NO
MARYLAND	YES	YES/BURIAL SITE	ON SITE, OFF SITE, L.F., RENDER	NO
MASSACHUSETTS	NO	NO	BURIED OFF SITE	NO
MICHIGAN	YES	YES	OFF SITE, FOREST, RENDER PLANT	YES RENDER PLANT
MINNESOTA	YES	YES/LOCAL REGS	ON SITE, OFF SITE, FOREST, RENDER PLANT	
MISSISSIPPI	NO	NO	OFF SITE, FOREST, LANDFILL	NO
MISSOURI	YES	NO	ON SITE	NO
NEBRASKA	YES	NO	ON SITE, FOREST	NO
NEVADA	YES	YES/I.D.NOTICE	OFF SITE, LANDFILL	NO
NEW HAMPSHIRE	YES	YES/I.D.NOTICE	ON SITE, OFF SITE, FOREST, L.F.	NO
NEW JERSEY	YES	NO	ON SITE, RENDERING PLANT	YES DEER PICKUP
NEW YORK	YES	YES	ON SITE, OFF SITE, FOREST, L.F.	NO
NORTH CAROLINA	NO	YES-LARGE ANIMALS	ON SITE, LANDFILL	NO
NORTH DAKOTA	YES	NO	PULLED BACK, RENDERING PLANT	NO
OHIO	YES	YES	LANDFILL, RENDERING PLANT	NO
OKLAHOMA	YES	NO	LANDFILL	NO
OREGON	NO	YES/NO L.F.	ON SITE, OFF SITE, RENDER PLANT	NO
PENNSYLVANIA	YES	YES	OFF SITE, RENDERING PLANT	YES/SPCA
SOUTH CAROLINA	NO	N/A	ON SITE, OFF SITE, FOREST	NO
SOUTH DAKOTA	NO	NO	LANDFILL, RENDERING PLANT	NO
TENNESSEE	NO	NO	ON SITE, OFF SITE	NO
TEXAS	YES	YES/L.F.DISPOSAL	ON SITE, OFF SITE, LANDFILL	NO
UTAH	YES	YES RECORDS	LANDFILL, RENDERING PLANT	YES
VERMONT	NO	YES-DEER, MOOSE	ON SITE	NO
VIRGINIA	YES	NO	ON SITE, OFF SITE	NO
WASHINGTON	YES	YES/BURIAL SITE	ON SITE, OFF SITE, FOREST	
WEST VIRGINIA	YES	YES	ON SITE, OFF SITE, FOREST, LANDFILL	
WISCONSIN	YES	YES	OFF SITE, RENDERING PLANT	YES/NATURAL RESOURCES
WYOMING	YES	YES/BURIAL SITES	ON SITE, OFF SITE, FOREST, LANDFILL	NO

LF =LANDFILL

N/A = NO ANSWER PROVIDED

CHAPTER THREE

ENVIRONMENTAL AGENCY COMMENTS ON DISPOSAL OF HIGHWAY LITTER AND ROADSIDE DEBRIS

A questionnaire was developed for response by those state agencies responsible for regulating and controlling solid waste disposal within their states, such as Environmental Protection, Environmental Quality, Ecology, and Land and Natural Resources. Most states have established a Division of Solid Waste Management or similarly named subunit with responsibility for waste disposal, as a result of federal requirements from the U.S. Environmental Protection Agency (EPA). Thirty-two state agencies responded to the questionnaire. Appendix B is a copy of the questionnaire.

Under the federal Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments of 1984 (HSWA), state and local governments are required to control and regulate municipal solid wastes. The EPA regulates hazardous landfill sites after identification by state agencies and provides subsequent funding and control of cleanup operations. The Clean Water Act (Public Law 92-500) established a comprehensive national water quality program. Amendments in 1977 required federal agencies to work with state and local governments to prevent, reduce, and eliminate water pollution.

The survey requested general responses from the states relative to any environmental constraints that exist as a result of federal or state laws and that could affect routine roadside maintenance and the disposal and reuse of collected materials. The letter forwarded with the questionnaire identified the usual components of the litter mixtures collected from roadways, including those mixtures accumulated from street sweeping and inlet and drainage ditch cleanups. Materials resulting from hazardous spills or illegal dumping and categorized as toxic were specifically excluded. The state environmental agencies were requested to give their recommendations for alternative disposal methods for use by highway agencies. A reply was also invited regarding communications and interagency cooperation between the state environmental office and the highway maintenance office on the mutual problem of litter, debris, and waste disposal.

A number of state agencies forwarded copies of the state solid waste laws and regulations, but very few identified the way that state highway units would be affected by such regulations. There was a recognition in several responses that street sweepings and inlet and drainage debris had to be cautiously handled because of the potential for hazardous contents—high hydrocarbon contents and possible heavy metal concentrations. Also, disposal of roadside debris within wetlands and classified watershed areas was a concern raised by several state agencies.

Seven agencies indicated there were rules in their states controlling the solid wastes that are commonly found along roadways. These were Connecticut, Maine, Maryland, Minnesota, New Jersey, South Carolina, and Wisconsin. In most cases, the applicable regulations were those requiring separation of recyclable beverage containers. In Connecticut, all other roadside litter items were

classified as “contaminated” and not subject to state recycling laws.

None of the commonly found litter materials, i.e., newspaper, cardboard, glass, plastics, tires, and aluminum, derived from highway maintenance operations were identified as being of concern to environmental agencies, except where recycling is mandated. The exception was rubber tires and the need to keep these out of landfills. Any concern was voiced as a need to comply with “existing solid waste disposal regulations.”

One question asked if the agency worked with and coordinated its regulatory efforts with other state agencies involved in disposal of roadside waste, recycling, and material reuse. A follow-up question asked if communications were opened prior to enactment. Of the 31 responses received, 19 indicated there was interagency coordination, 10 reported no coordination among agencies, and two cited coordination after regulations were issued. There was no indication that consideration was given to costs incurred as a result of regulating solid waste disposal, recycling, or reuse. Many responses indicated the lack of a sense of interagency understanding or sensitivity. Comments in response to this question included the following:

- “This questionnaire relates primarily to another agency’s operations.”
- Mutual participation in the Adopt-a-Mile, Keep America Beautiful (Alabama and New Mexico) and State “Pals” program. (Alabama)
- Exchanges of information between the DOT and Waste Management Board on reuse of construction and maintenance materials. (California and Massachusetts)
- Participation on the Governor’s Litter Task Force. (South Carolina)
- Formation of an Office of Litter Prevention and Recycling with goals to increase awareness of litter and improve extent of enforcement of state’s litter laws, as well as coordinate state-wide litter pickups and encourage recycling among road crews in several pilot programs. (Ohio)
- Assistance with implementing state recycling programs, particularly within state government agencies. (Maryland, Connecticut, and Florida)
- Coordination regarding litter volumes to evaluate effectiveness of “bottle bills.” (Michigan)
- Providing educational programs on anti-litter in conjunction with DOT staff.
- Formation of “Oscar,” a program focusing on anti-litter education, responsible for coordinating litter clean up along roadways using convict labor. (Rhode Island)

With few exceptions, most coordination efforts were noted as oc-

curing after regulations had been issued by the state environmental agency.

Several environmental agencies noted that they have worked with state DOTs for the reuse and recycling of highway construction materials. These states included California, Washington, Florida, and Massachusetts. A separate synthesis is being prepared on this subject as NCHRP Project 20-5:Topic 22-10 *Use of Waste Materials and By-Products in Highway Construction*.

The environmental agencies were asked to give their view or rating of the success of any programs dealing with roadside litter.

- California believes that the state beverage container recycling and litter reduction legislation significantly reduced the beverage container component of litter.
- Michigan reported that the bottle deposit bill was proven effective, and that the newly implemented recycling bill is unproven as yet.
- Virginia, Wisconsin, and Minnesota declared Adopt-a-Highway programs successful in their states.
- New Jersey believes its Clean Community Program is controlling litter and debris on roadways and public areas within the local government level of participation.
- Minnesota's experience was that prevention-type campaigns were ineffective.
- Ohio felt that the goals of its Office of Litter Prevention, to integrate litter law enforcement as a valid police function as a means to improve the enforceability of Ohio's litter laws, would establish enforcement as an effective deterrent to littering.
- Oregon reported that recycling problems result from resistance: "It is mandatory that recycling services be provided to people; but it is not mandatory that people use the service."

When asked about their concerns relating to materials found along roadsides and how they should be handled, the following pertinent responses were received:

- Aesthetics, an eyesore
- Detrimental to tourism
- Land and water pollutants
- Degradation of public lands
- Contamination of stormwater runoff due to salts, oils, and heavy metals
- Contributes to hazardous materials on roadsides

Solving and handling such roadside concerns should be accomplished through:

- More enforcement
- More recycling programs
- More volunteerism
- More signage along roadsides supporting Adopt-a-Highway and volunteer groups
- More use of convict labor and alternative sentencing

The final two questions dealt with recommendations that could be of assistance to highway agencies in performing their roadside maintenance activities in a cost-effective manner, and in identifying any research that may be on-going relative to the roadside waste disposal problem. Along with encouraging more sorting on site by road crews and recycling in those states where not yet mandated, the need for finding more markets for recycled products

was noted. Knowledge of any research in this area was sparse except for a notation by Delaware and Maryland regarding reuse and markets for recycled tires. The Massachusetts environmental agency is working with the Public Works Department on the reuse of street sweepings. In general, the responses received from state environmental units appeared to promote a desire for stricter conformance with environmental regulations by highway maintenance organizations. These agencies did not acknowledge a responsibility to provide advisory assistance to other state agencies.

The environmental agencies generally did not consider roadside debris a disposal problem, and in some cases, saw no need for compliance with existing solid waste regulations or clean water requirements. This may have been due to the level of staff assigned to respond to the questionnaire and a lack of experience in the "world" the agency regulates. What this does point out is the need for improved dialogue between state agencies before regulations are promulgated and frequent communications after adoption. There is a strong need for coordination within environmental units regarding the cross-impacts one regulatory program has on another. Mandated recycling does reduce waste stream collection, and should ease the pressure on waning landfill space, but it does not automatically create markets for collected items. Unfortunately, it often causes a glut, particularly if a thorough market analysis has not been done, as has occurred with old newspapers, green glass, and rubber tires. The passage of mandatory recycling regulations without a consumer value placed on the item, such as beverage containers in "bottle bill" states, makes no impact as to the place of disposal for the "litterer." Without some individual monetary benefit, penalty, or recognition for behavior modification, the roadside becomes as good a trash container as the curbside recycling container. Charging weekly trash collection fees on households, because of reduced landfill capacity, longer hauling distances, and higher tipping fees may be an incentive for illegal dumping of household trash on public property and roadsides. A solution at one government level may become a spoiler for another waste management strategy.

Discussions were conducted with various offices in EPA regarding their concerns with roadside litter mixtures and typical roadside debris that would find its way into public landfills. The Office of Solid Waste and the Office of Public Affairs reported that the agency has no law or regulation involving roadside litter or debris at the present time, and no federal guidelines have been distributed to the states that would affect the disposal of such materials by state or municipal road maintenance forces. Any regulations or requirements affecting roadside litter, sweepings, and inlet cleanout materials are state or local mandates.

In 1991, the EPA issued new rules affecting municipal solid waste landfills. These regulations will affect the operation of privately and publicly operated landfills at the state and local level. These rules become fully effective in October 1993. The rules will affect the operation of the class of facilities that accepts household waste materials and other solid waste, e.g., commercial, institutional, and nonhazardous industrial wastes co-disposed with household waste. Their purpose is primarily to protect the environment from potentially hazardous discharges emanating from landfills and entering adjacent ground water or surface water systems. It is anticipated by EPA that compliance with these rules will affect the cost of sanitary landfill operations, as many older landfills are replaced with newer more carefully designed and managed facilities. If, as a result, there are any cost increases, they will probably be passed on to the "disposer." It is up to the states to

control what goes into a municipal landfill. The EPA's role is that of protection.

According to the Office of Public Affairs, the EPA is moving forward in its mission from a regulatory and remedial action role toward prevention. The future focus will be pollution prevention. The EPA has an initiative to minimize waste in the future. They

strongly support source reduction practices and waste stream reduction goals at the local government level. EPA will be working toward more public outreach to accomplish these goals. At the present time, EPA sponsors educational programs for grade schools to raise an awareness of the environment and to suggest practices that will protect our ecosystem.

CHAPTER FOUR

DETERRENTS TO HIGHWAY LITTER**LITTER REDUCTION REGULATIONS****Law Enforcement**

The control of roadside litter through law enforcement programs has had a questionable success rate. Almost every government jurisdiction has litter or trash laws on their books, from states to small towns, although the success of these programs is negligible. The many signs posting fines for littering and illegal dumping along highways are ignored by many people because the risk of being caught and prosecuted is low. Other potential consequences of their acts, both social and environmental, also fail to prevent this behavior.

At the time that public awareness was being aroused about highway litter in the 1970s, a number of studies were conducted relative to the effects of litter fines. One of the most complete studies was conducted for Keep America Beautiful, Inc. (KAB). In 1971, a questionnaire survey was sent to the membership of the International Association of Chiefs of Police throughout the United States to determine police practices with respect to litter control. Survey responses indicated that the major impediment to litter control through law enforcement was that litterers were hard to catch in the act, and apprehension had to be based on actual observation. Police officers saw this enforcement activity as less important than other duties, and resented perceived public apathy. The officers felt that increased public interest in the environment would create a better climate for enforcement. The specific recommendations made for improved litter enforcement were:

- Increase public education via news media, radio, bumper stickers, car trash bags, etc.
- Substitute cleanup sentences for fines.
- Raise fines and publicize consequences.
- Enable special civilian auxiliary groups (litter squads) to report observed littering offenses (31).

A study conducted in Tennessee in 1971/1972 went further and recommended that the costs for highway litter cleanups and disposal be identified to change the attitudes of the public. For example, publicity to decrease public apathy concerning litter should include factual data as to:

- The number of law officers who could be funded by the cleanup cost.
- The number of court personnel who could be hired to handle the backlog of legal work with these equivalent dollars. (This technique may motivate court officials to convict and punish those who break litter laws.)
- The number of miles of road that could be paved or the number of hours that could have been spent on bridge repairs in a state.

- The cost of the program annually expressed in terms of gas tax reductions (18).

As a result of these studies and forthcoming recommendations, a number of programs have been implemented. Perhaps the most successful has been the public information and education programs promoted through organizations such as Keep America Beautiful to increase public interest in reducing litter.

The recommendation to raise fines has been implemented and more raises are likely due to inflation and the need to increase revenues. However, once legislated, the anticipated increase in revenues has not been realized.

Based on the results of the 1991 survey of state maintenance divisions for this synthesis, current information regarding fines and arrests for litter violations are not being summarized and made available to the state maintenance engineers by law enforcement agencies in most cases. The questionnaire sent to the 50 state maintenance engineers contained several questions relative to law enforcement of anti-litter laws. All responding states indicated there were anti-litter laws in their respective states which were enacted to control illegal dumping along state highways. In response to the question regarding maximum fines, Missouri and Nevada indicated the maximum fine was \$2,000. Alaska, California, Colorado, Massachusetts, South Carolina, and Texas reported state litter fines at \$1,000. The average fine, as reported by twelve states was \$500. Results of the questions on law enforcement are found in Table 19.

Less than 10 percent of the states felt that anti-litter laws were an effective deterrent to illegal disposal of items on state roadsides. Comments were received from more than 90 percent of the respondents concerning this method of litter deterrence. The responses ranged from "unsuccessful, minimal, rarely enforced, questionable, enforcement lax," to a very simple, "NO."

No state maintenance engineer reported knowledge of any collected fines being returned as a dedicated funding source to maintain clean roadways.

Tennessee reported increased efforts and some success with the use of eight special "Litter Troopers" assigned to patrolling problem areas. Unfortunately, this program was a victim of cost cutting in 1991. Tennessee officials reported that 812 citations were issued in 1990. In 1989, 24 persons were reported jailed for littering. Not only did the assigned Highway Patrol Litter Troopers investigate and arrest violators, they also participated in education programs at grade schools. This was reported to be a popular effort among school children in Tennessee.

South Carolina indicated some dissatisfaction with their program, and had recently increased litter fines to \$1,000. New Jersey reported the ineffectiveness of their law enforcement program by noting they are recording 10 tons of litter per center line mile annually and no known arrests. Comments received regarding the reasons for ineffectiveness parroted the earlier study performed for

Keep America Beautiful, Inc. Prosecution requires eye witnesses or investigations at dump sites, and apprehensions usually must occur during the act. Witnesses are reluctant to appear at a trial for this type of misdemeanor, and prosecution and law enforcement are not simple programs.

The Ohio Department of Natural Resources (DNR) responded to the questionnaire on Environmental Concerns and Roadside Litter by forwarding a copy of its agency progress report. In 1982, the Law Enforcement Assistance Program was enacted and responsibility for litter enforcement laws was transferred to the DNR. The program goals were to integrate litter law enforcement as a valid police function of enforcement agencies in Ohio; to establish an effective deterrent to littering; and to ensure and improve the enforceability of Ohio's litter control laws and ordinances. Since 1982, the Division of Litter Prevention and Recycling in the DNR has provided \$7.45 million in assistance programs, educational training, media events, and funding for police officers and sheriff's deputies to work as anti-litter enforcers during off-duty hours. The Ohio DNR reports "Since the program began ten years ago, 21,000 litter arrests have been made through programs funded by this Division." Arrests were reported for littering from motor vehicles, roadside dumping, and vehicles hauling uncovered loads. Until the 1989/1990 pilot program was initiated, litter enforcement was the responsibility of local government enforcement. The reported activity for the pilot program in 15 cooperating counties in Ohio resulted in 170 litter citations during the first year. The Division of Litter Prevention and Recycling in Ohio recommends that local collection crews be funded through enforcement programs such as theirs. Also, local crews would have a familiarity with local guidelines on the disposal of litter collected and the availability of sites in their areas.

State Bottle Bills

Michigan passed one of the first bottle bills in the United States in November 1976 and it became effective in December 1978. The state law required that "all beer and soft drink containers must be of the returnable type and carry a refundable deposit" (13). The first deposit was set at 10 cents per can or bottle. The Michigan DOT analysis of litter over a three-year period indicated substantial reductions after the legislation was passed. The Michigan DOT performed its first followup roadside litter study in 1979. In its final report, results indicated that the bottle bill was effective in controlling the illegal disposal of such containers along state highways. The study confirmed that "the beverage container legislation was a primary factor responsible for the litter decreases" (13).

In a report provided by the Michigan Department of Natural Resources (DNR) dated May 1989, the bottle bill is credited with diverting 6 to 8 percent of all solid waste from Michigan's waste stream annually. Their calculations estimate that more than 6 million tons have been kept out of Michigan landfills since the bottle bill enactment. The Michigan DNR has estimated that a 100-acre landfill, constructed with a 20-year life expectancy, costs more than \$2 million to build. Controversy still encircles the real successes of the program. It is not without critics within the beverage distribution industry who have had to adjust their operations, claiming such revisions to be costly (24).

Other positive effects of the Michigan experience have been continued reductions in beverage containers in roadside litter. In 1986, soda and beer containers composed only 4 percent of col-

lected litter. General litter continued to be reduced in 1986 and was 38 percent less than during the period prior to the bill enactment.

However, Michigan DNR acknowledges that consumers are returning fewer bottles today than in 1979. The reasons are economics. A dime is not worth as much as it was in 1979. There is less motivation to return beverage bottles to distribution areas. There is less motivation to collect those littered containers for such a small profit. Recognizing that further steps may be required, the DNR is prompting beverage manufacturers to reuse their containers (24).

Reported research conducted by Putnam, Hayes, and Bartlett in 1988 "Evaluation and Effect of the Bottle Bill on Massachusetts' Wholesalers of Malt Beverages" for the wholesale beverage industry quantified the costs associated with mandatory bottle deposits at a gross cost for collection and processing in a range of 1.0 to 1.6 cents per container.

In 1978, Maine passed a bottle bill in an effort to reduce roadside litter. Analysis of roadside litter was performed prior to enactment of the law, and subsequently in the fall seasons in 1978 and 1979. The findings revealed that total litter was reduced by 15 percent in 1978 and another 10 percent in 1979. Overall, the reduction attributed directly to the bottle bill was estimated at 55 percent in 1978 and 56 percent in 1979 (32).

Eleven states responded affirmatively to the question regarding the existence of beverage container deposit requirements in their states. These states are Arkansas, California, Connecticut, Delaware, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont. All agencies responding for these states agreed that the effects of such legislation were positive. Fewer cans and bottles were being found along roadsides in their states as a direct result. Survey data on state bottle bills are contained in Table 19.

Recycling Laws and Practices

The possibility of using road maintenance forces for recycling programs to battle highway litter disposal problems was initially reported in the Tennessee Technical Institute study (18) and found not to be an economically acceptable alternative. Gallaway in the Texas study (21) concurred, as did Graves in the Georgia study (17). During the 1970s, there were not the grass roots efforts in place that gradually came into being in the late 1980s. Voluntary recycling occurred in heavily populated areas of more urbanized states as landfills became scarcer and dumping costs escalated. In the 1970s, the onus of responsibility to resolve this problem, as seen by the highway maintenance engineer, was to be placed on the generator of consumer litter by-products. Because of the areas of distribution and the volumes collected, the possibility for litter separation and on-site recycling by road maintenance personnel was seen as cost prohibitive. The appeal for public participation as well as industry self-control to resolve the problem was implicit in each of the earlier state studies. At this time, there was little emphasis on using recycled materials in the new product market.

Again, the responsibility for positive action was to be transferred to "someone else." This message was fortunately picked up and fostered to its current status by environmental groups such as Keep America Beautiful, Inc., with offshoot Clean Community Programs, Adopt-a-Highway groups, and environmentally active private citizen groups. In some cases, the success of these programs has been hindered by environmental regulations covering the operation of approved recycling centers and businesses.

TABLE 19
SUMMARY OF STATES: DETERRENTS TO HIGHWAY
LITTER

RESPONDING STATE	LAW ENFORCEMENT & FINES	BOTTLE BILLS	RECYCLING
ALABAMA	500	NO	NO
ALASKA	1000	NO	NO
ARIZONA	500	YES	NO
ARKANSAS	300	YES	NO
CALIFORNIA	1000	YES	NO
COLORADO	1000	NO	NO
CONNECTICUT	250	YES	YES‡
DELAWARE	NA	NO	NO
FLORIDA	500	NO	NO
GEORGIA	300	NO	NO
IDAHO	300	NO	NO
ILLINOIS	500	NO	NO
INDIANA	100	NO	YES‡
IOWA	100	YES	YES
KANSAS	NA	NA	NO
KENTUCKY	500	NO	NO
LOUISIANA	100	NO	NO
MARYLAND	100	NO	NO
MASSACHUSETTS	1000	YES	YES
MICHIGAN	500	YES	NO
MINNESOTA	400	NO	YES
MISSISSIPPI	50	NO	NO
MISSOURI	2000	NO	YES
NEBRASKA	200	NO	NO
NEVADA	2000	NO	NO
NEW HAMPSHIRE	250	NO	NO
NEW JERSEY	200	NO	YES‡
NEW YORK	100	YES	YES‡
NORTH CAROLINA	500	NO	YES
NORTH DAKOTA	NA	NO	NO
OHIO	500	NO	NO
OKLAHOMA	1000	NO	NO
OREGON	500	YES	NO
PENNSYLVANIA	300	NO	YES‡
SOUTH CAROLINA	1000	NO	NO
SOUTH DAKOTA	200	NO	NO
TENNESSEE	500	NO	NO
TEXAS	1000	NO	NO
UTAH	100	NO	NO
VERMONT	500	YES	NO
VIRGINIA	500	NO	NO
WASHINGTON	NA	NO	YES
WEST VIRGINIA	2000	NO	NO
WISCONSIN	200	NO	YES‡
WYOMING	100	NO	NO

‡ = State mandated NA = No answer

Instead of working together, recycling has been viewed as a competitor in the marketplace with cogeneration and incineration plants. Major financial investment went into construction of refuse burning plants and cogeneration facilities in the late 1970s and 1980s. Recycling programs, other than voluntary efforts, were not being encouraged and markets for recyclable materials were scarce. This was prior to the public outcry, particularly voiced in the more densely populated states, from those who were concerned about adverse environmental effects of incineration plants, which were proliferating as a result of insufficient landfill space and escalating trash removal costs. The common plea from opponents on both sides of the issue was to "get rid of the garbage and not move it through one more machine" (5). Others fought the establishment of recycling locations and viewed them as degrading the environment even more. The public ferment against environmental pollution and proposed solutions was a "no win" dilemma for many government entities who sought to solve "this waste management program which has gone wrong" (2). While other methods for reducing environmental pollution have not progressed as rapidly, recycling has been accomplished successfully for a number of items when markets exist for the products.

LITTER COLLECTION ASSISTANCE PROGRAMS

Adopt-a-Highway Programs

The success of Adopt-a-Highway (ADAH) programs has bounded forward in times of lean maintenance budgets. ADAH began in East Texas in 1985; spearheaded by the success there, the programs being instituted in most states parallel those early efforts. Through an informal communication network set up among Adopt-a-Highway staff in several of the originating states, there is constant contact, cooperation, and active fostering of increased volunteer efforts for clean roadsides and public lands across the country. The ADAH program has had significant growth since the 1991 questionnaire was circulated to state maintenance engineers. Generally, two-mile sections of highway or specific areas such as intersections, are adopted for at least one year by civic groups, student groups, employee and military associations, family groups, or garden clubs. Figure 3 shows members of a Civitan Club in New Jersey beginning a cleanup project.

Some states require that adoption be a two-year commitment. Groups are responsible for litter and debris removal within their assigned sections. Some states, such as Missouri and North Carolina, have extended the litter control activity to include mowing and beautification projects. Groups are usually given extensive safety training prior to initiating their cleanup work and are provided with gloves and reflectorized safety vests. Specially identified trash bags are sometimes provided and pickup of collected debris is performed by state maintenance staff. Pickup schedules vary, some states require a minimum number of pickups per year while others stipulate specific time periods as part of the "adoption requirements." In all cases, recognition is given to the ADAH groups in the form of signs, located at each end of the adopted sections, which identify the participating groups. Figure 4 shows that ADAH signs in Virginia not only recognize sponsors, but offer a challenge to other community residents to participate.

Texas reports that litter was increasing at a rate of 15 to 20 percent annually at the time its program was started with an annual cost of \$24 million for litter collection in 1985. Since the ADAH



FIGURE 3 Adopt-A-Highway activities in Camden, New Jersey.

program has been implemented, visible roadside litter has decreased by 60 percent. More than \$43 million in free radio and television time has been given to the campaign. With more than 1,500 participating groups, the program has been expanded to roadside beautification projects. As part of the "Great Texas Clean Up-Green Up Campaign," wildflowers have been planted on more than 3,000 miles of highways.

"Don't Lay That Trash on Oklahoma" followed as a \$500,000 anti-litter media campaign for the Oklahoma DOT, Turnpike Authority, and Oklahoma Health Department. Volunteer groups adopted designated, two-mile sections of Oklahoma roadways. Signing, safety training, supplies, and trash bags were provided. The media effort used radio spots, billboards, trash barrels, identification slogans, bumper stickers and litter bags and targeted all Oklahomans. This revolutionary approach started in the mid 1980s and has moved into 37 states as reported in the questionnaire to state maintenance engineers. The program benefits all. For the ADAH group, a sense of pride and satisfaction are derived from the results of a cleanup day, and motorists are reminded of the litter problem as they drive by an Adopt-a-Highway sign and see a clean roadside. The state maintenance engineer sees assistance with controlling a problem that never should have occurred in the first place. The public is the biggest winner as litter amounts are reduced and the regenerating characteristics of litter-in-place are removed (33).

The success of these programs has not been without a learning period and some costly initial ventures. The more cost-effective programs evolved from solutions of problems in earlier programs. In Texas, there are uniform statewide rules on pickup schedules, stipulated time requirements, guidelines for and supervision of minors, safety protection, and education. In order to cut down on overtime requirements for its own highway personnel, Texas required that groups obtain their supplies during the work week (34). Texas and Oklahoma ADAH staff have been instrumental in sharing their experiences with other states.

Missouri reported that, by the end of 1989, more than 3,000 groups had adopted 4,500 miles of state highways (35). In 1991, Missouri's program had increased to 5,000 groups covering 7,300 roadside miles.

In Tennessee, the ADAH program began in October 1989.



FIGURE 4 Roadside sign to recognize ADAH sponsor in Virginia.

Within two years the program had more than 1,620 groups signed up with 22,000 volunteers who are responsible for cleaning litter from 30 percent of the Tennessee state highway system. During the first year's activity, more than 1,000 tons of litter were collected by the ADAH groups. As an unexpected bonus, it was found that ADAH activities had decreased the roadside litter expenditures for maintenance forces from \$3 million to just below \$2 million for the year. The Tennessee ADAH program has an aggressive recruitment program, with public service television and radio support. The participation of Tennessee's nationally known music community has helped spread the program throughout the state. However, the program effort has not stopped at recruitment. Adopt-a-Highway groups are recognized for their efforts and reports of individual group accomplishments are frequently publicized in local newspapers. Tennessee DOT officials feel that grass roots "networking" between ADAH groups and local highway maintenance personnel is most important for continued success of the program. The planning and public relations activities for the ADAH program is centrally administered in the DOT's Maintenance Division, Highway Beautification Section. Actual daily operation, group recruitment, evaluation, pickup scheduling and monitoring is performed at the district-county supervisor level. One major advantage observed with the Tennessee program is that all the major anti-litter programs are administered and funding monitored in a central office housed in the maintenance division.

North Carolina's Adopt-a-Highway program has been in existence since 1987. More than 6,000 groups have been recruited to clean up North Carolina's roadside system, which exceeds 76,880 center line miles. At present, there are 15,000 miles in the ADAH inventory. ADAH groups are strongly encouraged to sort and recycle the litter and debris picked up in assigned sections at least twice a year. North Carolina admits that groups, particularly those with corporate or commercial sponsorship, are getting great adver-

tising. However, they feel that the positive impact gained on roadside improvement and the sense of civic goodwill derived from this voluntary participation makes it one of North Carolina's most cost-effective endeavors.

A number of states that have not yet initiated these programs on a full scale are planning to incorporate them within the next few years. The reason for the apparent reluctance has generally been expressed as a fear of the "legal problems they will generate." In some states not yet using volunteer programs for support, maintenance engineers have been reluctant to participate in the program without a formalized agreement protecting them and their staffs from tort liability suits. Because of the proven success of the ADAH program across the nation, more of these states are now joining the ranks and accepting volunteerism as a way to alleviate major program cutbacks due to state fiscal crunches. There are legal mechanisms to accomplish protection from liability claims. Unless negligence is proven, such protection is given by written agreements with individual groups waiving liability or state use permits issued for presence within the state's right-of-way. Ideally, state legislation should be enacted recognizing the ADAH program and establishing parameters for responsibility.

The Adopt-a-Highway program development and success rate has become a contest among some states. The prestige of having the most roadsides committed to ADAH is seen as a reflection of state pride through these volunteer efforts. In a few cases, the anticipated roadside improvement was not accomplished because of lack of a mechanism to measure visual improvement in the quality of the roadside. There was no followup report after a "no show" or poor performance by a group, no rescinding of permits or agreements and a disposition for not carefully screening participants prior to inclusion in the program.

While the ADAH program is working in most states, it is, in reality, a short-term or partial answer to the litter and trash problems. The longer term solution is judged to be a continuing education program, starting at the elementary school level, and coupled with frequent media announcements to reach the general public. Those states using such volunteer efforts are indicated in Table 4.

Figure 5 identifies states where state maintenance forces are heavily supported in litter collection activities by volunteer groups. In these states, at least one-third of all litter collected is being accomplished by volunteers. The use of convict labor is excluded.

EDUCATIONAL AND PROMOTIONAL CAMPAIGNS

The need to create a public awareness of the problems caused by littering and trashing the nation's roadsides has been addressed by a number of state highway departments, some as part of state Adopt-a-Highway programs, some as Keep America Beautiful participants, and others as ad-hoc efforts in response to the problem as it became a huge budget and staffing burden.

The Tennessee DOT sponsors a litter prevention curriculum for all kindergarten to grade six schools in the state. The popular grade school video program uses "Mr. Frogge and the Frog Pond" to teach children of the harm created by littering. Efforts are aimed at changing attitudes about littering. Tennessee DOT is a certified Keep America Beautiful participant and has won the Keep America Beautiful State Award for several years. Much of their roadside maintenance cleanup activity has been reduced as a result of the anti-litter projects and participation of Keep America Beautiful certified communities within their state. "Pretty Please—Clean

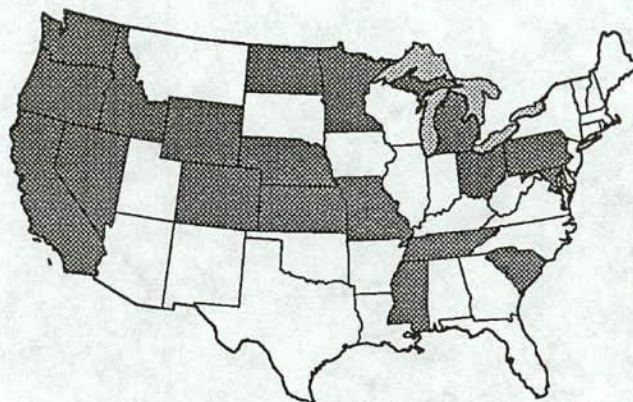


FIGURE 5 At least one-third of litter collected by volunteers in shaded states.

Tennessee Now" is the current campaign receiving much media and civic support statewide.

The "Don't Mess With Texas" campaign was a proactive advertising effort designed with three goals:

- To raise public awareness of the litter problem,
- To solicit change in behavioral patterns, and
- To teach appropriate disposal methods.

Texas has added an educational component to the program, "Spread the Word . . . Not the Waste," which is a curriculum for students in grades seven and eight. Figure 6 shows a combined advertising effort relating "Don't Mess with Texas" and ADAH. California is publicizing its program "Care for California" with signs at state worksites. Maryland has signed areas along its state roadways, "Keep the Free State Litter Free." Mississippi State Highway Department participates in a "Litter Quitter Program," providing staff to visit elementary schools, make presentations at group functions, and provide media service announcements.

Oklahoma's major media effort "Don't Lay That Trash on Oklahoma," coupled with the educational component of its Adopt-a-Highway program, resulted in a 63 percent reduction in roadside litter within three years of initiation. Assigning a beautification coordinator from within the Office of Public Affairs to work with its maintenance organization and be responsible for the effort, the program now has "1,600 volunteer groups who form a partnership of pride that has dramatically improved the appearance of our roadside."

Minnesota DOT has similarly assigned dedicated staff from within the organization as a highway beautification program. While promotion of the Adopt-a-Highway program is one effort being used as a public education device, the Minnesota Office of Waste Management has recognized waste education as a primary program goal calling for the creation and distribution of kindergarten through grade eight curricula. In 1990, the program was field tested with third graders, and because of the sound, positive results, materials and efforts were expanded to all Minnesota schools in 1991.

Keep America Beautiful, Inc.

As discussed previously, studies of the tendency to litter have disclosed definite trends regarding who litters and why. Littering



FIGURE 6 "Darryl the Barrel" joins forces with the ADAH symbol to discourage litter in Texas.

is caused by people without a sense of ownership toward that which they leave scarred. The attitude that littering on public property is of no consequence is a behavioral trait that can be modified through behavior-oriented education programs, especially when introduced early in childhood development. The Keep America Beautiful organization is a national nonprofit organization that sees its role as public education in efforts for litter prevention, improving waste handling practices in U.S. communities, and identifying alternatives for handling solid waste—such as source reduction, recycling, waste to energy, sanitary landfills, and composting techniques. This group, started in the early 1950s, remains the primary method of involving people and influencing their attitudes toward their environment through anti-litter and waste management practices.

Keep America Beautiful's primary resource is its network of community group members across the United States wanting to improve the visual quality of their environment. The organization is dedicated to providing educational programs and nontechnical materials for every age on litter prevention and solid waste management. They are not a lobbying group and have removed themselves from serving specific advocacies or sponsoring legislation. Membership comprises more than 485 communities and 18 state

affiliates who have been informed through a five-step education program and certified as to their progress through actual results in reduction of litter in their areas. Group members come from local government, local business and civic groups, and the community at large. It is an organization founded on participation that believes in a public-private partnership and that education at the primary level is much more effective than governmental mandates and enforcement. They believe in community involvement and a commitment toward specific programs aimed to improve individual communities and not through application of blanket regulations. The philosophy of the KAB organization has emanated from the early research on litter occurrences along roadsides in the United States, which attempted to quantify the amounts of litter, identify where it most frequently occurs, determine who is usually responsible, and show the effects of enforcement and fines for deterring such behavior characteristics.

The organization has support from major corporate membership across the U.S. as well as a National Advisory Council composed of government agencies and national civic and professional organizations. The Federal Highway Administration is represented on this council. (Figure 1 displays Keep America Beautiful Inc. participation in the United States.) (22)

There are other organizations formed through government efforts to address anti-litter and waste management problems in states. New Jersey's Clean Communities program, which is housed in the Office of Solid Waste Management, is one such program, functioning primarily as a grant applications and awards program funded by state revenues from the beverage wholesale industry in New Jersey. Funds are distributed to local government for active participation in identified community cleanup projects. Unfortunately, the program does not yet have a strong educational component, nor has it identified a broader responsibility to recognize litter along its state highways as an aspect of community projects.

Vermont has an organization called Vermont Green Up, Inc., which springs to life annually on May 1st when civic organizations clean up Vermont's roadsides and public lands.

A few of the early corporate or industry sponsored groups continue to operate in specific geographical areas, such as the "Pitch In" container campaign sponsored by Anheuser Busch. However, these groups continue as a response from particular industries that produce or distribute consumer products that lead to roadside litter. They provide for trash receptacles and routine cleanups. As a general effect on litter, they are not educating or promoting a sense of ownership for combatting litter or behavior modification at a national level.

A wave of new interest on the part of cities and local government to clean up their communities has resulted in television and radio appeals for citizens to cooperate with cleanup campaigns and make their neighborhoods a nice place in which to live and play.

CHAPTER FIVE

SELECTED STATE STUDIES

Five states were visited for an in-depth study of state maintenance activities concerning roadside litter and disposal. Selection of states was restricted to the older and urbanized eastern states and several southern states experiencing rapid population growth. The selection does not mean the problem of litter and its disposal is restricted to this geographic area; clearly, this is a nationwide problem influenced by behavior of people in all states.

CONNECTICUT

Connecticut is one of the northeast states experiencing litter disposal problems. The lack of landfill areas or suitable state property to take maintenance disposals is serious now and getting more severe. ConnDOT trucks are required to haul disposal loads longer distances to state approved locations or travel to private or government landfills, paying tipping fees of \$65 to \$75 per ton.

"Ideally, it would be nice to place it [litter] in dumpsters and let others pick it up and take it away," states the Connecticut maintenance manager. "We recognize that such an approach is unrealistic as it would increase costs for yard dumpsters, and ultimate tipping fee costs would impact our maintenance operations budget even more."

Connecticut presently spends \$1.7 million annually for its litter program or 2.8 percent of its total maintenance budget. Other than "recyclables," litter is bagged, placed on state trucks and driven to approved public landfills in the locality. Municipal landfills will only accept locally generated litter and trash from DOT trucks. Some maintenance crews hold bagged trash until sufficient load sizes are accumulated.

Litter collection is a planned maintenance activity and is scheduled by maintenance supervision according to anticipated litter to be generated. Presently, 80 percent of litter collection is performed by maintenance crews, while convict labor accomplishes 18 percent. The remainder is accomplished by "Workfare" participants in two of the major cities. ConnDOT has not enlisted the assistance of Adopt-A-Highway. Officials consider the traffic density too high to be sufficiently safe for volunteer activity. The concern of state liability for participants is prevalent among state highway agencies.

An Office of Environmental Compliance was recently established in the Bureau of Highways to deal with environmental problems that directly impact the activities of construction, maintenance, and design. One engineer has been assigned to deal with maintenance problems of an environmental nature, including coordinating and responding to the ConnDEP on complaints. To date, that unit has assisted maintenance operations as follows:

- Developed a site-specific risk management plan for each maintenance facility. It includes wetlands and areas that are environmentally sensitive for dumping or disposal operations.

- Located salt intrusion areas from winter operations and initiated corrective procedures.
- Mapped out state property dumpsites, which were internally reviewed for environmental compliance. As yet, the duration of usability has not been determined.
- Identified all federal and state laws and regulations on environmental issues that could impact maintenance operations.
- Assumed responsibility for coordinating contacts and communications with the DEP on any maintenance-related issues and incidents.

Connecticut has a beverage container deposit law, as well as mandatory curbside recycling. Compliance is designated at the local government level, but a state government agency is responsible for formulating environmental recycling plans. The recycling regulations are aimed at reduction of materials in the waste stream because of present landfill shortages. The state law is not aimed at roadside aesthetics, as litter is not considered an environmental problem. One action of major consequence to DOT maintenance operations was the acceptance by DEP that most common litter items found along state roads were "contaminated" and therefore exempt from recycling. Because of the separate beverage container deposit law, cans and bottles do not commonly remain along roadsides for long. A return of five cents per container is considered a profitable resource in this state.

Sweepings are usually disposed within state property provided no watersheds exist in the area. When taken to public landfills, sweepings are used as clean cover material. The use of sweepings was tried as a possible winter abrasive in Connecticut. However, problems were encountered due to extreme moisture absorption by the "fines." Attempts to correct this problem by blending with clean sand were still unsuccessful. Seed-contaminated sweepings, occurring from grass collection along curbsides during mowing operations, sprouted in stockpiles and fouled sand and salt spreaders.

The Connecticut DEP's concerns were primarily with disposal within wetland areas. While they indicated there was some coordination with state agencies prior to environmental regulations being promulgated, they felt cooperation was more forthcoming after the recent recycling legislation. The DEP felt more positive results would be derived by using more publicity on recycling and litter control through highway signage.

VIRGINIA

Virginia's maintenance operations are typical of a rural state becoming more and more urbanized. This is particularly true in the northeast section of the state which includes the Washington, D. C. metropolitan area. With urban sprawl now joining Richmond, Virginia and Washington, D.C. as a commuter corridor, an increase

in litter along the major corridor roadways has been observed by highway maintenance staff, especially at ramps and interchanges. Roadside maintenance, and particularly litter collection, has been given a low priority in recent years because of limited funding, resulting in cuts in maintenance programs. In 1990, litter collection and disposal cost \$3 million, representing 1.3 percent of the maintenance budget.

Virginia DOT (VDOT) has a decentralized maintenance operation. There are approximately 4,500 maintenance employees responsible for maintaining almost 55,800 center line miles of roadway. Most of the secondary roads are also maintained by state maintenance forces. The state road system is approximately 89 percent rural environment.

Disposal is not a problem in Virginia in general, except for the northeast metropolitan district. Landfill area is becoming scarce in this section of the state, heavily populated with suburban developments. The problem has not become a major one as it is still possible to dispose of the roadside debris via contract haulers, although at a higher cost. While the metropolitan district has its disposal problems, more rural western Virginia is experiencing an increasing problem with disposal of animal carcasses since deer herds are thriving in that area. VDOT has continued to bury on-site and off-site, handling the activity with maintenance forces.

Coordination between transportation and the state Department of Waste Management is reported as minimal. The environmental unit is concerned that maintenance disposals are within state waste management regulations. The Department of Waste Management (DWM) sees its role with litter and disposal programs as providing the public with educational information and the DOT's role as performing roadside cleanups. However, in 1990 the DWM proposed to the Virginia legislature a litter control program to assist public works through increased volunteer efforts (36).

Recycling is a voluntary activity in Virginia. VDOT maintenance forces are not required to separate and recycle roadside debris. State regulations for recycling are aimed at reducing the solid waste stream by 25 percent by 1995. There are recycling drop-off sites for aluminum, glass, paper, and plastics for voluntary participation. One of the major drawbacks to a larger recycling effort has been the lack of markets for selected items, with the exception of aluminum.

Maintenance forces participate in roughly 55 percent of litter collection. The use of convict labor is restricted to rural areas and accomplishes 20 percent pickup as well as performing cleanouts. This is becoming a scarce and costly resource available to VDOT. Reimbursement for convict labor is presently taken from maintenance activity funds at a charge of \$1.50/day/convict.

The most promise for assistance in litter activity has become the Adopt-a-Highway Program. In existence in Virginia for three years, Adopt-a-Highway groups now number more than 5,000 and cover about 12,000 miles of the state's roadways. More than 41,000 people are involved. Groups are signed up in the maintenance districts, and participation approved through written agreements. Cleanup work is scheduled at least four times per year, typically for 2-mile sections or at ramps and intersections. The program relies on interaction between the Adopt-a-Highway group and the maintenance resident engineer. Signing up groups has become a competitive issue among residencies, with roadside miles of Adopt-a-Highway sections reported monthly. District offices are required to provide safety vests, equipment, and training to the groups. The scheduling of a pickup is coordinated with the local maintenance yard, which provides for bag pickup on the day

of the activity. Virginia pays its forces overtime to support this activity on weekends. Two identification signs are provided for each group, located at the termini of the assigned section. VDOT pre-signs each area with triangular flip identification signs, which are displayed during the collection activity and serve to advise the public that litter collection by the Adopt-a-Highway group is underway in the area. This also serves as a safety message to motorists. As the program has proven to be successful, there are now numerous ramps being adopted along the Interstate system.

While Virginia is just beginning to realize some disposal site problems, the focus of attention is on collection of litter along the roadways through volunteer efforts, recognizing that significant savings are being realized. Disposal problems and landfill shortages have not yet become major maintenance issues.

NORTH CAROLINA

The North Carolina DOT strongly supports its maintenance roadside aesthetics programs. Landscape activities, wildflower plantings, and roadside cleanup campaigns are important activities in North Carolina. With its maintenance budget getting tighter, North Carolina is heavily dependent on its well-established volunteer litter pickup program. North Carolina DOT has 76,800 center line miles, including secondary roads, to maintain in its road system, the largest in the United States. Most of the state is rural, with an urban/suburban roadway system estimated at 25 percent.

Roadside litter control is a planned activity in North Carolina, and officials say that the control, collection, and disposal of litter and debris present no major problem at this time. Approximately 50 percent of litter pickup is being accomplished by the 6,000 Adopt-a-Highway groups in the state on more than 12,000 miles of roadway. There are also Community Outreach Programs sponsored twice a year for roadside cleanup. North Carolina is a Keep America Beautiful state with a number of local affiliates.

Convict labor from minimum custody institutions do perform litter pickup and other landscape activities. However, the Department of Transportation subsidizes the Corrections Department for this program with \$4.5 million annually. Community service sentences to roadside cleanup activities are not viewed as successful.

Disposal of roadside litter and debris is primarily at state approved landfills. At the present time, there are sufficient landfills and there is sufficient space for the creation of new landfills in the state. A Solid Waste Section in North Carolina's environmental agency is responsible for regulating disposal of waste materials. Currently, there are no specific restrictions for typical maintenance collected debris. The amount of interfacing required between highway and environmental agencies has been limited to occasional wetlands dumping reports and silting effects.

Recycling in North Carolina is presently a voluntary program. The state recently passed solid waste reduction regulations which will require a 25 percent reduction in total solid waste, administered for compliance at the county level. Pilot programs instituted for voluntary curbside recycling in several well-populated areas are presently struggling with progressively higher collection costs or cancellation of programs because of the lack of markets for paper and beverage container recyclables.

Litter costs for North Carolina are \$1.2 million annually, which represents only 0.4 percent of the maintenance budget. This figure excludes the line item budgeted amount given to the Corrections Department and is quite low for the road inventory maintained,

primarily due to its volunteer collection programs and low disposal costs.

TENNESSEE

Tennessee Department of Transportation, particularly the maintenance division, is representative of an organization recognizing the value of education and volunteerism as an anti-litter deterrent. The state-maintained road inventory is 13,462 center line miles. Annual litter and debris disposal costs represent less than 2 percent of the maintenance budget. According to state maintenance staff, total litter costs have been reduced by more than \$1 million in the past two years because of the success of the Adopt-a-Highway program initiated in late 1989. More than 1,000 tons of litter were collected in the first year. The Tennessee volunteer programs have been discussed in Chapter Four.

Environmental regulations are now being generated more frequently. Tennessee's Solid Waste Management Act of 1991 mandates a reduction of 25 percent in the total solid waste stream by 1995. At present, there is limited interaction between the Department of Transportation and the Department of Health, Environment, and Conservation on matters relating to roadside litter and disposal activities.

Voluntary recycling is practiced in a number of communities in Tennessee. Several counties in the Nashville area participate in "pilot" curbside collection programs. Collection sites and recyclable material markets are receiving support from industry, although more markets are required. The maintenance division is reusing and recycling products used in maintenance, with more pressure being placed on the recycling of construction materials on road projects. The slogan to "Reduce, Reuse, and Recycle" has been adopted.

While large vacant land areas exist within the state boundaries, more than 60 percent of its population is located in areas lacking sufficient public landfill space. As a result, most solid waste must be transported outside county limits. Additionally, while there is sufficient undeveloped land in Tennessee, residents near proposed landfill sites typically have voiced strong opposition. It is anticipated that many existing landfills in the state will be required to close in the next few years, primarily due to requirements of the Resource Conservation and Recovery Act (RCRA) Subtitle D criteria.

Tennessee DOT is responsible for administering several state anti-litter programs. While the Adopt-a-Highway program is relatively new, it has maintained a very aggressive education and public campaign against littering. Its roots go back to the 1970s with the "Tennessee Trash Program." The Litter Grant Bill, passed in 1981, generates \$2.5 million annually from the malt beverage and soft drink industry. These funds are distributed to eligible counties and used for anti-litter seminars, public school programs, and litter law enforcement programs. Responsibility for overseeing these programs is assigned to the maintenance division, highway beautification section, which has very effectively managed teams of volunteers.

One of Tennessee's most successful anti-litter enforcement programs was its Litter Trooper Program, recently cut because of budgetary problems. Eight state troopers were assigned to investigate illegal dumping and enforce litter laws. In addition, they were provided with anti-litter publicity items and went out to public

schools with their message for children in kindergarten through grade six.

Tennessee is a national award winner of the Keep America Beautiful organization. Many of the counties and larger cities in Tennessee are Keep America Beautiful affiliates as well as "Clean Tennessee" participants. With such a large volunteer program participating in roadside litter collection and control, the positive effects are very visible to travelers along Tennessee roadways.

NEW JERSEY

Serious disposal problems are confronting maintenance operations at the New Jersey Department of Transportation (NJDOT). The problems are due to external factors, many of which are outside the ability of transportation officials to resolve. New Jersey is one of the most densely populated states in the nation. State maintenance operations are responsible for 2,355 center line miles and an additional 1,000 miles of ramps and interchanges. Ninety percent of state maintained roads are located in urbanized areas with heavy suburban surroundings.

As of June 1991, the annual cost for removal of roadside litter and debris and ultimate disposal was \$5.5 million. This figure represented 14 percent of the maintenance operations budget. Tipping costs at local landfills have increased each year. Disposal of debris from maintenance yards reached \$120 per ton in 1991. In addition to the issues of high costs, trash generated within one county cannot be disposed of in another county. This has created some headaches for state maintenance supervisors who have roads crossing several county boundaries.

This state has a most serious landfill shortage. Approved landfills decreased from 335 to 10 from 1977 to 1992. There are strong voices in opposition to recycling companies, refuse-recycling plants, and cogeneration facilities operating in "our back yards." Interest in environmental issues is widespread among the citizens because of the past publicity on hazardous waste sites being discovered, poor air quality in the metropolitan industrial areas, and ocean water pollution. In response to the pollution problems encountered in the state, the New Jersey Department of Environmental Protection and Energy (NJDEPE) is one of the most active in the United States. This large state agency has been very active in promulgation of regulations to clean up past contamination and counter future offenses.

New Jersey has mandated curbside recycling in all 21 counties. While each county has determined its annual waste stream reduction goals, a 60 percent recycling goal has been established for the state.

This highly regulated environmental atmosphere affects the daily activities of state maintenance crews. Components of litter must be sorted and separated for recycling according to county regulations. Convict labor crews are required to sort materials at time of pickup in some road sections, while others sort after pickup. Paper is not being recycled in most instances but is treated as contaminated trash.

Litter accumulation quantities remain quite high along New Jersey's roadways. In 1990, it was reported that 22,000 tons of litter and debris were discarded. Reduced maintenance budgets in the last few years have afforded less attention to litter collection activities resulting in higher accumulations. The use of state prison labor has increased over the past five years, and convict crews now accomplish 33 percent of litter pickup. In the fall of 1991, New

Jersey DOT attempted to recruit civic groups for a pilot Adopt-a-Highway program at the state fair. Initial recruitment campaigns were only marginally successful until outdoor advertising billboards were donated to display recruitment messages. Since then, participants for the new ADAH program have been volunteering in ever increasing numbers.

New Jersey has a Clean Communities Program, administered by NJDEPE, Solid Waste Management Division and funded with revenues collected from glass, plastics, and metal beverage container distributors. This is primarily a local and county government

grant program whose goals are to clean up neighborhoods, local properties, public lands, and parks, but does not include Interstate highways and roadways maintained by NJDOT.

While there is no formal waste management plan for maintenance operations, some staff members are assigned to coordinate with NJDEPE. The staff act in an ad hoc fashion, primarily reacting to resolve DEPE complaints and citations, although they hope for a more pro-active role and interdepartmental cooperation in the future.

FINDINGS, RESEARCH ON ALTERNATIVE STRATEGIES, AND RECOMMENDATIONS

The current practices of state maintenance forces in dealing with the collection and disposal of litter and debris collected from roadsides are summarized in this chapter. The findings have been compiled from information received from questionnaires sent to state highway maintenance and state environmental units in fifty states, from site visits to six states, and from a literature search. There is a wealth of information to be found in current publications relative to solid waste disposal, waste stream reduction practices, and current trends for protecting our land. With so much general information available, the focus of the synthesis is on road maintenance related waste disposal problems and potential solutions. In this chapter, strategies applicable to road maintenance operations are presented as possible solutions, as are recommendations that address the broader issue of cooperative efforts between highway and environmental agencies to accomplish mutual goals.

FINDINGS

The following are the general findings with regard to current practice:

- Litter occurrences are viewed by maintenance engineers and the public as major problems along Interstate, primary and secondary highways, and ramps and interchanges in urban areas.
- The cost of litter collection and disposal exceeds \$120 million annually.
- An average of 3.3 percent of each state maintenance budget is spent on roadside litter and debris programs annually.
- Litter collection and disposal require intensive use of maintenance forces at the expense of other activities.
- Formal waste management practices for maintenance operations are not in general use.
- Automated collection equipment for roadside litter is not generally used by state maintenance crews.
- Equipment manufacturers have not yet developed the necessary high-capacity equipment for automated litter collection on highways.
- Current and potential limits to landfill areas are not recognized by some highway maintenance organizations.
- The maintenance unit's role in solving disposal problems is not universally acknowledged except in dealing with specific incidents that affect operations.
- Few states sort roadside litter mixtures or recycle collected materials, and no identifiable trend toward those practices was noted.
- Disposal of sweepings has been identified as a current or potential problem in most states.
- Safety practices of personnel involved in litter collection and disposal activities are part of Maintenance Safety Training for

Hazardous Materials or are assumed to be common sense measures within general safety practices.

- Police enforcement is not generally recognized as an effective deterrent to the practice of littering.
- State bottle bills are considered very effective as roadside litter deterrents, as reported by state maintenance and environmental agencies.
- Volunteerism is increasing as an assistance program for roadside litter collection activities.
- Adopt-a-Highway programs are recognized nationally as the most effective volunteer program benefiting road maintenance operations.
- Costs of highway litter removal activities remain high, in spite of assistance from volunteer groups.
- Anti-litter education programs and public media campaigns, such as Keep America Beautiful Inc., were identified as very successful approaches to deterring litter.
- No federal funding is available to assist with the problems of highway litter and litter disposal, anti-litter education, or waste reduction programs.
- A general lack of communication between highway maintenance and state environmental agencies impedes progress and cooperation.
- The costs of disposing of litter mixtures to comply with environmental requirements are not usually considered when regulations are promulgated.
- Highway maintenance disposal problems require that obstacles to cooperation between environmental agencies and highway maintenance staff be overcome.

ALTERNATIVE STRATEGIES

The environmental issues for the 1990s must be considered part of a larger context. Some state maintenance engineers must deal not only with problems of disposal caused by abandoned, filled, and insufficient landfills, they face mounting problems with pollution recognition and abatement which can only increase unless sufficient resources are focused on prevention through developing cleaner technologies. An ad-hoc approach has been used and the underlying causes have not been clearly identified before plans for action were set out.

The coordinated efforts of academia and government research are being focused on reducing source pollutants—for example, recycling antifreeze, refrigerants, lead batteries, and automotive degreasers. If the trend of the 1990s is for source reduction, more incentives must be offered to the consumer, to the manufacturer, and to the distributor. Source reduction involves minimizing the volume or toxicity of materials used in products that wind up in the waste stream. In addition, disincentives may be directed toward

consumers, distributors, and manufacturers to reduce source pollutants. For example, assessing variable costs for waste collection, or for disposal, based on negative environmental impacts could make ecologically sound decisions more attractive economically.

Waste Stream Reduction

Emphasis on waste reduction as opposed to waste management is the preferred strategy called for by today's environmental leaders. Several of the responding state environmental agencies indicated that their state waste management strategy was to legislate a reduction in solid waste by established targets per year. Most reduction targets are set to be accomplished within five years. Some measures to reduce the volume of the waste stream are noted below.

- Precycling is a strategy of conscientiously reducing wastes before a consumer purchases a product. For example, selecting food and necessities in minimal packaging.
- Purchasing policies for highway maintenance and construction products that encourage bidders to deliver products made of recyclable materials. Encourage the delivery of materials in returnable and reusable containers and eliminate one-way refuse. Inform state purchasing departments of these goals and policies. Federal procurement guidelines were included in the most recent regulations for compliance with the Resources Conservation and Recovery Act. Disincentives such as including costs for removal and disposal of certain materials in the price of certain products could be instituted.
- Examining maintenance operations for recycling potential and implementing the practice wherever possible can be beneficial. Recycling can be a cost-effective disposal method even if collection costs are higher than recovered assets from the sale of the recycled materials.

Research on Reuse of Materials from Roadside Litter Mixtures and Debris

In the Texas study by Gallaway (21), alternatives to disposal of highway waste materials and litter were proposed. Mechanisms that would provide a monetary return as well as reduce damage to the environment were sought. The study concluded that such practices could only be attempted in large urban areas and waste products must be combined with other materials from the area because even in their best use, it was stated that highway litter mixes will always have a negative value. The costs to collect and process litter mixtures exceed the worth of the mixture in its best use. As postulated in the Texas study, "The overall economics of collection and processing . . . cannot be justified based on the value of litter. The value must be based on benefits to the motorist and viewed as "good housekeeping" and not on the value of the collected litter" (21).

The use of "clean" sweepings and inlet debris is an area where ad-hoc research results could be accumulated and formally studied. Reports of individual states indicate there is a potential use as a landcover when mixed with humus, sludge, and other waste products. The soil farming work which is being done in Washington state indicates that materials categorized as contaminated, such as sweepings, are usable after aging reduces the contaminants.

Through the use of bio-degrading agents, the processes may be speeded up. Composting methods should be encouraged, particularly where vegetative items are still allowed to be routinely disposed of on state lands or public landfills.

Research in Disposal of Roadside Litter Products

Information received for ongoing research in the area of disposal of roadside litter mixtures is relatively sparse. The Washington State DOT (WSDOT) reports that the disposal of highway sweepings and sludge removed from catch basins is becoming a major problem. Because sites for disposal of such materials are becoming scarce, WSDOT is currently sponsoring research at the Washington State University Transportation Center (TRAC) to test materials stockpiled in WSDOT maintenance yards from road sweepings, vacuum cleanout sludges, and ditch spoils. These materials had typically been disposed of at maintenance sites and public landfills, or used as a backfill material. The potential for contamination from toxic heavy metals, pesticides, salts, and total petroleum hydrocarbons (TPH) has initiated research for cost-effective methods of treating and safely disposing of them.

The researchers at Washington TRAC are studying the effects of weathering on contaminants in waste piles, "soil farming," and chemical reaction techniques to reduce the total petroleum hydrocarbons in contaminated sweepings and sludge. They reported in 1992 that samples tested for TPH yields concentrations in the following ranges:

Road sweepings	50-4600 ppm
Vacuum cleanout sludges	500-7800 ppm
Ditch spoils	200-2500 ppm

As reported in the Washington TRAC Research Review, several states use TPH as a determining factor for toxicity and subsequent cleanup action if the TPH concentration is 100 ppm or higher. It has been found that TPH concentrations are reduced as stockpiles age and weather.

Other work is going on within state DOTs where sweepings and dried catch basin sludge are screened and reused if total petroleum contaminants and heavy metals are absent.

In Massachusetts, state environmental agency staff are reportedly working with state public works staff on beneficial uses of street sweepings. Presently, the Massachusetts Department of Public Works reports it has been using sweepings as a daily cover in landfills, and has mixed it with well-graded gravel or loam for use as an approved fill material on land enclosed within ramps and interchanges ("bowl areas"). This has been done after testing for contaminants is completed and found to be within EPA guidelines.

There is considerable ongoing research and development on solid waste disposal items within corporate laboratories, particularly those companies manufacturing materials used in the auto industry. Auto parts with metal and plastic components, when subjected to normal wear and tear, degrade and find their way into roadside residues, curb sweepings, and inlet components. Unfortunately, until reduction or elimination of these degradation by-products is accomplished within the manufacturing process, or state environmental agencies modify inconsistent regulations, state maintenance organizations will continue to pay premium dollars for disposal of this non-point source contaminated material.

Education

Continual reinforcement of and education in the consequences of littering and use of proper disposal methods can eventually modify unacceptable behavior traits. Volunteerism should continue to be encouraged but, this too, requires state and federal government support.

RECOMMENDATIONS

Several recommendations for research and other activities can be drawn from the information in this synthesis.

- Classifying environmentally related problems as part of road maintenance practices may be the first step in addressing the problem of roadside litter. Maintenance operations have historically been performed in a reactionary manner. Ingenuity and "horse-sense" are used to solve daily problems not covered in maintenance management manuals. Through training seminars, specifically relating environmental concerns with daily maintenance practices, necessary modifications can be made in procedures and perceptions.

- Cooperative efforts of top management in highway administrative units as well as maintenance units in dealing with environmental problems could change attitudes toward highways, with an acceptance of responsibility to enhance and improve environmental conditions as part of the fulfillment of highway maintenance goals.

- Communications are needed at the highest management levels in transportation and environmental agencies, strongly calling for cooperation and coordination of efforts to work together. Once commitments are voiced as major policy decisions between the two agencies, staff seminars and training can ensue to present the problems to be resolved through open discussion and sharing of mutual concerns.

- Assigned staff dedicated to the job of making maintenance and environmental goals match through daily work practices would help to budget resources. Support from the public relations office can be useful to maintenance staff, serving as their voice to the public for assistance with public volunteer programs for litter deterrent and collection assistance, and to communicate the need for clean and safe roadsides.

- An environmental plan for waste management, to include waste reduction practices, developed with the participation and input of state maintenance and environmental agencies could help build consensus and allocate resources. Such a plan might include:

Identification of all federal and state environmental regulations affecting typical field operations that involve disposal of materials collected by or generated within maintenance activities. Where applicable, local regulations should be recognized for appropriate units involved.

Identification of all state property disposal sites, assuring approval for use and compliance with environmental wetlands re-

quirements. These should be site specific. Anticipated usable life of these locations should be estimated, as well as plans of action to extend the longevity of existing disposal sites.

Planning within maintenance operations for use of alternative strategies to landfill disposal, such as separation of collected trash components that are uncontaminated and can be recycled in accordance with state solid waste regulations, voluntarily recycled as a salvageable scrap, or reused in maintenance or construction activities. Some states have found uses for sweepings and ditch and inlet materials, as winter abrasives, clean fill, and fertile surface covers.

Fostering waste abatement practices through cautious purchasing of maintenance materials, encouraging reusable containers, and incorporating economic rewards to suppliers who use recycled materials in their products.

- Public and private partnerships can encourage a sense of ownership at the community level. Civic groups, educational groups, and corporate participants should be encouraged to assist in the control and collection of litter. Adopt-a-Highway, Adopt-a-Ramp, and Clean Communities projects properly involve state highway maintenance staff. When state highways are considered a community responsibility, roadsides can take on the look of ownership and care.

- Departments of Transportation share a responsibility for participation and promotion of educational programs on anti-litter and solid waste disposal. Educational programs on litter prevention lead to behavior modifications, which will ultimately result in cleaner roadsides. Eighteen states currently participate in programs such as Keep America Beautiful. While it is unlikely that FHWA or EPA can provide financial support for this activity under current legislation, some assistance in a financial and advisory capacity could aid those states where litter proliferation is seriously downgrading the appearance of roadsides, and where states are definitely not maintaining their roadsides in a clean, neat, and forgiving manner as called for in AASHTO Standards.

These recommendations could best be assured of success if participation at the national level were available. While it is optimistic to anticipate change immediately, consideration should be given to a joint AASHTO/EPA/FHWA funded effort to recognize the disposal of roadside litter as not only a "maintenance" problem but as a shared waste management problem. These agencies might consider funding research to address the reuse of materials, recycling of waste materials, and smart purchasing practices in maintenance operations. Special funding could be provided to each state DOT for anti-litter education and public media programs to raise public awareness of smart waste management practices involving our nation's roadsides.

In recognition of the millions of dollars spent on roadside litter and its disposal, and subsequent costs for compliance with environmental regulations, establishing offices of environmental coordination within state government, as well as at EPA and FHWA, would help to communicate and work to solve mutual problems in a less costly manner.

REFERENCES

1. Earth Works Group, *50 Simple Things You Can Do To Save The Earth*, Earthworks Press, Berkley, California (1989).
2. Small, W.E., *Third Pollution: The National Problem Of Solid Waste Disposal*, Praeger Publishers, New York (1971).
3. U.S. Environmental Protection Agency, "Characterization of Municipal Solid Waste in the United States: 1992 Update," Executive Summary (1992).
4. Wilcox, C., and J. Bushey, *Trash*, Carolrhoda Books, Minneapolis (1988).
5. Long, R. E., editor, *The Problem Of Waste Disposal, The Reference Shelf*, Vol.60, No.5, H.W.Wilson Co., New York (1989).
6. Pringle, L., *Throwing Things Away*, Crowell, New York (1986).
7. National Research Council, *Waste Management and Control: A Report to the Federal Council for Science and Technology*, National Academy of Sciences Report (1966).
8. Cannella, A. A. and A. A. Friedman, *Management of Solid Wastes Incident to Highway Construction and Maintenance: Final Report*, Tennessee Technical University, Cookeville (February 1974).
9. Vig, N. J., and M. E. Kraft, *Environmental Policy In The 1990's: Toward A New Agenda*, CQ Press, Washington D.C. (1990).
10. Borrelli, P., *Crossroads: Environmental Priorities For The Future*, Island Press, Washington, D.C. (1988).
11. Andress, Carole, *Waste Not, Want Not: State And Federal Roles On Source Reduction And Recycling Of Solid Waste*, Northeast-Midwest Institute (U.S.) (1989).
12. Clark, J. E., *An Anti-Litter Campaign Reduces Maintenance*, Roadside Development Commission Reports Highway Research Board, National Research Council, Washington, D.C. (1959) pp 45/49.
13. Public Opinion Surveys, Inc., *Who Litters—and Why: Summary of Survey Findings Concerning Litter Awareness and Concern About the Problem of Litter*, KAB Inc., N.Y. (November 1968).
14. O'Toole, M. L., *Roadside Litter Study: Final Report*, Michigan DOT Maintenance Division (December 1979).
15. Milliken, J. G. and C. A. Briner, S. K. Downing, E. F. Jaekel, *Litter in Colorado: An Analysis of Litter on Highways and Public Recreation Areas*, Denver Research Institute (June 1973) 60pp.
16. Mason, M. L., *Composition and Incident of Roadside Litter in the Medicine Bow Mountains, Wyoming*, *In Transportation Research Record 805*, Transportation Research Board, National Research Council, Washington, D.C. (1981).
17. Keep America Beautiful, Inc. *A National Study of Roadside Litter*, Research Triangle Park, Maryland (October 1969).
18. Graves, R. A., III, and R.E. Bowling, *Highway Litter in Georgia*, Georgia DOT (January 1974) 92pp.
19. *Rural and Urban Roads*, "Litter Mounts While Budgets Get Slashed," (February 1974).
20. U.S. Department of Transportation, *Report on the Study of Highway Litter with Recommendations*, Report of the Secretary of Transportation to the U.S. Congress Committee on Public Works, Document 93-336 (July 16, 1974).
21. Gallaway, B. M., *Final Report: Feasibility on Using Solid Wastes in Highway Construction and Maintenance*, Texas Transportation Institute, College Station (December 1971) 272 pp.
22. Keep America Beautiful Inc., *1990 Annual Review*, Stamford, Connecticut (1991).
23. *Proposed Waste Management Strategy*, Pennsylvania Department of Transportation, Harrisburg (August 1990).
24. Michigan Department of Natural Resources, *The Bottle Bill*, (May 1989) 15 pp.
25. Duncan, M., R. Jain, S.C. Yung, and R. Patterson, *Performance Evaluation of an Improved Street Sweeper*, Air Pollution Technology, Inc., San Diego, California (March 1985).
26. Malmquist, P. A., *Atmospheric Fallout and Street Cleaning: Effects on Storm Water*, Chalmers University of Technology, Goeteborg, Sweden (1978).
27. Sudol, F. and A. Zach, "Urban Recycling Problems and Solutions," *Public Works*, Vol. 119 (July 1988) pp. 63/67.
28. Smith, D. and B. Lord, *Highway Water Quality Control: Summary of 15 Years of Research In Transportation Research Record No. 1279*, Transportation Research Board, National Research Council, Washington, D.C. (1990).
29. *Better Roads*, "Can a Curb and Gutter Unit Clean up Pollutants?" Vol. 58, No. 1 (February 1988) pp. 19/23.
30. American Association of State Highway and Transportation Officials, *AASHTO Maintenance Manual*, Washington, D.C. (1987).
31. Schmidt, J. H., *A National Survey of Litter Enforcement: A Summary Prepared for Keep America Beautiful, Inc.*, International Association of Chiefs of Police (September 1971).
32. Jacobs, K. M., *Roadside Litter Study*, Maine DOT, Materials and Research Division (Oct. 1979).
33. *A Look at What Some States are Doing: "Don't Lay That Trash on Oklahoma," AASHTO Quarterly*, Vol. 67, No. 4 (Oct.1988).
34. Clark, J. D., "Adopt-a-Highway: A New Source of Pride for Americans," *Transportation Builder*, Vol.1, No. 1 (1989) pp. 14/16.
35. Nelson, K., "Missouri Improves Its Roadside Management Program," *Public Works Journal*, Vol. 121, No.3 (March 1990) pp. 52/53.
36. Lassiter, R. A. Jr., *Virginia's Litter Control Program: Public Works Through Volunteerism*, Virginia Department of Waste Management (1990).

APPENDIX A

QUESTIONNAIRE FOR STATE MAINTENANCE ENGINEERS

DOROTHY L. ANDRES - CONSULTANT
HIGHWAY MAINTENANCE PROGRAMS

TO: CHIEFS OF MAINTENANCE

RE: SURVEY QUESTIONNAIRE - NCHRP PROJECT 20-5:TOPIC 22-08
"DISPOSAL OF ROADSIDE LITTER MIXTURES"

The management of maintenance operations has changed greatly within the past two decades. While it has always been a stated maintenance objective to keep our roadsides free of litter and debris and to maintain our roadways in a neat, clean, and attractive manner, the task was one always controlled by available funding and competition with repair, safety, and preservation-type activities. In most cases, funding restraints continue and the task to maintain our roadsides are now complicated with stringent environmental regulations which affect the disposal and reuse of materials collected along our roadsides. The search for more cost effective removal and collection techniques is now complicated by few allowable disposal methods available for these litter mixtures.

As a former Chief of Maintenance in New Jersey, I am well aware of how this minimally funded program gets tremendous public scrutiny, and at times "steals" significant amounts of your attention from key maintenance activities. There has been no recent survey of the current State of Practice regarding how Highway Maintenance Departments are coping with this problem. Your help is requested in providing some information on how you and your maintenance forces have coped with and hopefully solved some of these problems. Any information you are able to provide will be shared with associates in other States through this Synthesis study, "Disposal of Roadside Litter Mixtures."

I thank you for your assistance with this study, with hopes that sharing your information may be of some assistance to your fellow Maintenance engineers.

Best Regards,

Dorothy L. Andres
Dot Andres

NCHRP PROJECT 20-5:TOPIC 22-08
QUESTIONNAIRE
"DISPOSAL OF ROADSIDE LITTER MIXTURES"

NAME OF AGENCY- _____
LOCATION- _____

OVERVIEW OF ROADSIDE LITTER PROBLEMS OF YOUR AGENCY

1. Please provide the following information regarding the physical inventory required to be maintained by your State or Agency:

_____ Total Center Line Miles
_____ Total Ramp and Interchange Miles
_____ Percent, Rural type surroundings
_____ Percent, Suburban or Residential type
_____ Percent, Urban or Commercial Type

2. Please identify how you would characterize the types of roadways where you have experienced roadside litter and debris problems:

Type Road	Major Problem	Intermediate	Minimal
Interstate & Limited Access Highways			
Rural	_____	_____	_____
Urban	_____	_____	_____
Interstate & L.A./Ramps & Interchanges			
Rural	_____	_____	_____
Urban	_____	_____	_____
Land Service Highways (Primary & Secondary Roads)			
Rural	_____	_____	_____
Urban	_____	_____	_____
Intersections, Ramps, & Jughandles			
Rural	_____	_____	_____
Urban	_____	_____	_____

3. As a routine Maintenance activity, how would you describe litter and roadside debris as an activity for your Maintenance forces?

It is _____ A Major Work generator _____ No Problem
_____ A Planned Activity _____ Handled as Required
_____ Infrequent, requires little attention

4. What is the estimated annual cost for the removal of roadside litter and debris by your Maintenance forces?

\$ _____ Annually _____ % of Total Maintenance Budget

5. Do you have dedicated maintenance staff for litter/debris pickup?

_____ Yes _____ No

6. How many Maintenance staff are involved in your annual program for collection and disposal of roadside debris?

What percentage is this of your Maintenance force? _____

7. What is the estimated tonnage of roadside debris removed from your roadways? _____

8. List types of forces used in roadside refuse cleanup programs and an estimated percent of total refuse picked up by each:

	%
Regular Maintenance forces	_____
Special temporary crews (Youth)	_____
Convict Labor	_____
Adopt-a-Highway	_____
Other Volunteer	_____
Contract	_____
Other (Explain)	_____

9. Considering Roadside Litter Removal as a routine maintenance activity, does your Maintenance Unit have problems associated with the following tasks:

Control of Amount of Debris along roads?	_____ Yes _____ No
Collection and Removal of Debris?	_____ Yes _____ No
Disposal of Roadside Debris	_____ Yes _____ No

Comments: _____

9a. Do you Recycle or Reuse any Collected Debris? If yes, identify types and amounts. _____ Yes _____ No

Comments: _____

10. Does your Agency have a formal policy and program for

2

disposing of Roadside litter and debris? _____. If yes, what unit in what unit in your organization is responsible for administering the program? _____

(Please provide a copy of policy if available.)

11. Are there environmental regulations which require you to SORT such debris? _____ YES _____ NO

12. Are there sufficient Landfills in your State which permit disposal of UNSORTED materials? _____ Yes _____ No

12a. Is there adequate space available for future landfills? _____ Yes _____ No

Comments: _____

13. Are you aware of any environmental constraints in your State/City which affect, or could affect your Roadside Litter Program? Comments: _____

14. Does Your State have Recycling Laws and Regulations? _____ YES _____ NO. List those items which must be recycled.

a. If recycling is performed by your Maintenance forces, please provide the following information relative to costs of the program:

Items	Estimated Tonnage	Annual Recycling Costs
_____	_____	_____
_____	_____	_____
_____	_____	_____

b. Have you dedicated staff to carry out your recycling activities, other than litter pick up efforts? _____ Yes _____ No. If yes, how many? _____

c. Is there any income derived from recycling efforts of your Maintenance forces? _____ Yes _____ No. If yes, how much? _____

d. Is the money returned to your Maintenance operating fund? _____ Yes _____ No

3

e. Are any recycling efforts contracted out by your State/Agency?
 Yes No

g. Has there been any impact or significant improvement of your roadsides since recycling was initiated? Yes No
 Comments: _____

Roadside Litter Collection, Recycling, and Disposal Activities

15. Normal Roadside Litter is generally comprised of paper, plastics, metals, wood, rubber and organic/inorganic mixtures. Please identify which of the following items in these categories are generally found in your area, which are a collection problem, if any are sorted out and separated on site, and if any are required by state laws to be recycled:

Item	Maintenance Problem		ON Site Separation		Recycling Required	
	Yes	No	Yes	No	Yes	No
Paper/cardboard	_____	_____	_____	_____	_____	_____
Newsprint	_____	_____	_____	_____	_____	_____
Plastics	_____	_____	_____	_____	_____	_____
Glass	_____	_____	_____	_____	_____	_____
Aluminum Cans	_____	_____	_____	_____	_____	_____
Other Metal Cans	_____	_____	_____	_____	_____	_____
Misc. Metals	_____	_____	_____	_____	_____	_____
Rubber Tires	_____	_____	_____	_____	_____	_____
Lumber, wood	_____	_____	_____	_____	_____	_____
Other (Identify)	_____	_____	_____	_____	_____	_____

a. If any of the above items require separation prior to disposal, is it done at the local Maintenance Yard? Yes No
 Please identify items: _____

16. Recognizing that roadsides are convenient targets for illegal dumping of all types of items, i.e. medical syringes, paints, and solvents, etc., have you established any safety precautions or programs for your workers for their personal safety? _____
 If yes, please describe: _____

17. Do you have any automated collection equipment for collecting roadside debris? Yes No.
 a. If commercially available, identify manufacturer and equipment type _____
 b. Have your forces retrofit other equipment for collection and separation activities? Yes No
 Please identify _____

c. Are they available for inspection or are photographs available? Yes No (Please enclose photos if available)

18. Have there been any "innovative uses of equipment" which you would like to describe and could be useful to other Highway agencies? _____

19. Are you willing to coordinate a site visit to one of your facilities using innovative road waste management techniques? Yes No

Litter Control Programs in your State

20. Does your State have Anti-Litter laws controlling illegal dumping along highways? Yes No

a. What is the maximum fine? _____
 How much money is collected annually? _____
 Is it a dedicated source of funds to maintain a clean roadside? _____

b. What agency or jurisdiction is responsible for enforcement and collection of fines? _____

c. How successful is this type of litter prevention? Please Comment. _____

21. Does your State have an ADOPT-A-HIGHWAY Program? ☐ Yes ☐ No
or similar volunteer program? ☐ Yes ☐ No

a. If yes, is it considered successful from a Maintenance perspective? Comments: _____

b. Which unit or office in your Agency is responsible for administering the program? ☐ Maintenance
☐ Public Information
☐ Other (Identify) _____

22. Does your State have a Beverage Container Deposit Law? ☐ Yes ☐ No

a. If yes, list types of containers controlled. _____

b. What impact has the deposit law had on roadside litter? _____

23. In addition to recycling and beverage container laws, are there any other laws in your State which have a positive or negative impact on roadside refuse? _____

24. From a maintenance perspective, do you have solutions to litter or waste problems which could assist other agencies? Comments: _____

25. Do you have any recommendations for research on the disposal of Roadside Mixtures? Comments: _____

26. Are you aware of any current literature or research in this area? _____

DISPOSAL OF ROAD SWEEPINGS

27. What is the estimated volume of debris collected by your road sweeping activity? _____ tons

a. How do you presently dispose of your road sweepings? _____

b. Are you able to re-use or put to beneficial use any of this material? _____
If yes, Please Describe _____

c. Are there any environmental constraints associated with the re-use or disposal of this material in your State? _____

d. If there are regulations, are they more of a problem for your Maintenance forces in urban or suburban areas? _____

e. Do you contract out any sweeping activities? ☐ Yes ☐ No
Is disposal of the sweepings the responsibility of the private contractor? _____
If known, where are they disposed? _____

f. Can you give an estimated cost per ton for disposal of such materials by your Agency? _____

DEBRIS ASSOCIATED WITH INLET AND DITCH CLEANING

28. Are your Maintenance forces routinely required to remove inlet or ditch debris from the work site? ☐ Yes ☐ No.

a. If Yes, is it taken to _____
☐ State or GOVT Property
☐ Public landfill
☐ Disposed by Contract
☐ Other

b. Is the material ever re-used off site? ☐ Yes ☐ No
Describe: _____

c. Have you any comments on Innovative or Beneficial uses of this material? _____

d. Is removal or disposal ever contracted out? ____ Yes ____ No
If yes, what is the percentage? _____

e. Are there any disposal problems of such materials for your forces? ____ Yes ____ No
Comments: _____

f. Can you provide estimated costs for the off site removal and disposal of such debris in your State?
\$ _____ Annually _____ Hours
_____ Tons

g. Are there any environmental regulations which control your methods of disposal or reuse of such materials? ____ Yes ____ No
Please explain _____

CARCASSES (DEAD ANIMALS)

29. Is the removal and disposal of dead animals from roadways and roadsides considered a problem for your Agency? ____ Yes ____ No

a. Are there other Agencies responsible for removal of carcasses, other than your Maintenance forces? ____ Yes ____ No
If yes, please identify _____

b. Do you have laws and regulations in your State controlling the Disposal of Dead Animals? ____ Yes ____ No
Please provide brief synopsis, if yes: _____

c. If handled by State maintenance forces what are the usual methods of disposal followed?
_____ Buried on site
_____ Buried Off site
_____ Pulled back into Forest
_____ Public Landfills
_____ Rendering Plants
_____ Other Methods (Explain) _____

d. Have you ever contracted out animal pickup and disposal to animal control agencies or private contractors? _____
If yes, explain _____

e. What is the estimated annual cost of this activity for your Forces? _____ \$per Year _____ Hours per Year.

30. Your additional comments are welcome and would be of great assistance to the success of this project. Please include them on a separate page. For example:

a. What are your thoughts on better or different ways of handling any of the above items?

b. Recognizing the existence of varied environmental rules and controls, what are your suggestions for new or expanded uses for such disposed materials?

THANK YOU FOR YOUR TIME AND ASSISTANCE IN COMPLETING THIS REPORT!

NAME & TITLE OF PERSON COMPLETING QUESTIONNAIRE _____
TELEPHONE NUMBER _____

Please return to: Dorothy L. Andres -NCHRP Study
Highway Maintenance Programs
28 Springwood Drive
Lawrenceville, New Jersey 08648

APPENDIX B

QUESTIONNAIRE FOR STATE ENVIRONMENTAL AGENCIES

NCHRP PROJECT 20 -5:TOPIC 22-08
DISPOSAL OF ROADSIDE LITTER MIXTURES
(NON-HAZARDOUS MATERIALS)

QUESTIONNAIRE FOR STATE ENVIRONMENTAL AGENCY

Thousands of tons of litter and debris are removed from roadways annually. This litter mixture includes dirt, rubber, plastics, glass, aluminum, steel, wood, and paper in all sizes and shapes. Along with the typical debris found on the road, highway maintenance activities involving machine sweeping, storm drain cleaning, and open ditch cleaning result in a complex mixture of the above materials. Environmental regulations greatly vary in the States which affect the disposal of these materials by State or Local Government road maintenance forces. This NCHRP study is examining the methods of collection, separation, recycling, and disposal techniques being utilized by Road Maintenance forces. This litter and debris does not include waste materials resulting from hazardous material spills or illegal dumping or categorized as toxic for which other removal techniques are recognized as necessary.

The following questions are being asked of State Environmental Protection Agencies to assess the extent and variety of environmental constraints which exist and affect a routine roadside maintenance activity, particularly related to disposal and reuse of such materials as identified above. Acknowledging the need for environmental constraints at a national and local level, it is intended through this study to identify and make recommendations for alternative methods for use by highway agencies.

NAME OF AGENCY _____
LOCATION _____

PLEASE PLACE COMMENTS ON SEPARATE PAPER IF SPACE PROVIDED IS NOT SUFFICIENT.

1. Does your State have laws and /or regulations which control the disposal of solid waste materials usually found along shoulders of roadways and adjacent roadsides which would prevent disposal to a landfill or public trash site?
_____ Yes _____ No

2. Does your State have mandatory recycling laws?
_____ Yes _____ No

2a. If no, is recycling anticipated within the next five years?
Please Comment: _____

2b. If recycling is mandated, is control of each item uniform across the State or is it controlled by sub-jurisdictions in the State? i.e. Counties, cities, towns, etc.
Comment: _____

3. Does your State have a Beverage Container Deposit Law?
_____ Yes _____ No

3a. If yes, please comment on the impact that the deposit law had on roadside litter. _____

4. Please identify which of the following materials are currently regulated :

Material	Disposal Controlled	Recycling Required	Other
NewsPaper	_____	_____	_____
Paper/Cardboard	_____	_____	_____
Glass	_____	_____	_____
Plastics	_____	_____	_____
Rubber Tires	_____	_____	_____
Aluminum	_____	_____	_____
Steel	_____	_____	_____

-CONTINUED-

	Disposal Controlled	Recycling Required	Other
Wood & lumber	_____	_____	_____
Street sweepings	_____	_____	_____
Drainage inlet & Ditch mixtures	_____	_____	_____
Animal carcasses	_____	_____	_____

5. Has your Agency worked with and coordinated its regulatory efforts with other State agencies, such as Transportation in the area of roadside litter control, disposal methods, and/or recycling and reuse? Yes No
Please comment: _____

5a. Was this done prior to regulations being enacted or after?
Please Comment: _____

6. If your State Agency has regulations for any of the roadside litter items listed, how would you rate the success of the program? Please explain and comment on the Program _____

7. What are your environmental concerns relating to these materials found along roadsides? _____

8. How would you handle materials of this nature? _____

9. What recommendations do you have to make relative to this topic which could be of assistance to highways agencies in performing this maintenance activity in a cost-effective manner?
Please Comment: _____

10. Are you aware of any current research being conducted in this area? Please provide References: _____

Thank you for your time and assistance in completing this survey. Any additional information you would like to provide is appreciated.

NAME OF PERSON COMPLETING QUESTIONNAIRE _____
TITLE _____

PLEASE RETURN TO: DOROTHY L. ANDRES
HIGHWAY MAINTENANCE PROGRAMS
28 SPRINGWOOD DRIVE
LAWRENCEVILLE, NEW JERSEY 08648

THE TRANSPORTATION RESEARCH BOARD is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. It evolved in 1974 from the Highway Research Board, which was established in 1920. The TRB incorporates all former HRB activities and also performs additional functions under a broader scope involving all modes of transportation and the interactions of transportation with society. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 270 committees, task forces, and panels composed of more than 3,300 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, the Association of American Railroads, the National Highway Traffic Safety Administration, and other organizations and individuals interested in the development of transportation.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Robert M. White is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Bruce Alberts and Dr. Robert M. White are chairman and vice chairman, respectively, of the National Research Council.

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

NON-PROFIT ORG.
U.S. POSTAGE
PAID
WASHINGTON, D.C.
PERMIT NO. 8970

ADDRESS CORRECTION REQUESTED

000021-05
Robert M Smith
Research & Asst Matls Engr
Idaho Transportation Dept
3311 W State St
P.O. Box 7129
Boise, ID 83707-1129