CHAPTER NINE

NONFEDERAL PROGRAMS FOR INFRASTRUCTURE MATERIALS RESEARCH

INTRODUCTION

Nonfederal infrastructure research and development is supported and conducted by both public and private entities. Within the public sector, States, counties, municipalities, regional agencies, and quasi-governmental bodies, such as water districts and turnpike or port authorities, fund R&D projects on materials for public works. Within the private sector, materials research is conducted by investor-owned utilities; universities and other research groups; trade and professional associations; engineering, consulting, and construction firms; materials suppliers; and product and equipment manufacturers,

This chapter discusses the types and amount of nonfederal funding of materials research by major infrastructure category: highways, roads, bridges, and tunnels; sewers and wastewater treatment systems; water supply and treatment systems; and water resources projects, including waterways, ports, dams, locks, canals, and irrigation systems. It should be noted, however, that some research is relevant to more than one type of infrastructure, particularly in concrete and cement research.

Reliable estimates of total nonfederal spending on either materials-related or general infrastructure R&D are generally lacking. No single group collects data on all public and private infrastructure areas. What estimates of nonfederal infrastructure-related R&D exist were developed for individual reports, such as the estimates derived for the National Materials

Advisory Board's study of R&D in the cement and concrete industries, and the Transportation Research Board's estimates of highway research.[41]

Based on published estimates of nonfederal governmental spending and on interviews with industry associations, OTA estimates that between $18 million and !$25 million is spent annually on nonfederal materials R&D for public works, primarily for highways and bridges (see table 9-1).[42] This level of investment in R&D is very low compared with the tens of billions of dollars spent annually on infrastructure construction, maintenance, repair, and rehabilitation.

Nonfederal support for public works R&D also has been declining steadily. Although some new trade associations and university research institutes have been created recently (see below and in chapter eight), the overall level of R&D funding is still very low compared with identified research needs. Moreover, continuity of funding remains a problem for some private research institutes, which are increasingly dependent on Federal grants and contracts as a primary means of support.

HIGHWAYS. ROADS. AND BRIDGES

Research on materials used in the construction, maintenance, and repair of the nation's highways, roads, bridges, and tunnels receives around $11 million to $15 million annually, or almost two-thirds of nonfederal R&D. The primary materials of interest here are cement, concrete, asphalt, steel and other structural and reinforcing materials, protective coatings, sand, gravel, surface treatments, de-icing substances, and geotextiles.

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41 National Materials Advisory Board, ConCrete Durability: A Multibillion-Dollar Opportunity, NMAB-437 (1987), estimated R&D expenses at 0.3 percent of sales for cement producers and 0.1 percent of sales for concrete producers. The Transportation Research Board, supra note 29, estimated R&D spending for the highway construction and equipment industry at 0.15 percent of sales. These R&D investments are among the lowest of any U.S. industries.

42 This total generally excludes Federal grants and contract funds. Federally-funded '&Dby nonfederal entities is included in the totals for the source agencies.

Table 9-1

ESTIMATED ANNUAL NONFEDERAL INFRASTUCTURE MATERIALS

RESEARCH AND DEVELOPMENT EXPENDITURES

Infrastructure	Millions of Dollars
Highways, Roads, and Bridges	11,6 - 15.2
Municipal Sewers and Wastewater Treatment	3.0 - 5.0
Warter supply and Treatment	1.1
water Resources, Waterways, and Ports	0,1 - 0.5
General Materials Research	2.0 - 3.0
TOTAL	17.8 - 24.8

Highway materials R&D is the most coordinated area of nonfederal infrastructure materials research. The integrated structure of the programs overseen by the American Association of State Highway and Transportation Officials (AASHTO), the National Cooperative Highway Research Program, the Federally Coordinated Program of Highway Research & Development, and the materials industry institutes provides mechanisms for joint research and diffusion of results. Moreover, the technical expertise and research framework underwritten by the Federal Highway program make the limited amount of State-funded research more effective.

Nonfederal Government R&D

Construction, maintenance and rehabilitation of highways, streets and bridges is primarily a governmental function carried out by States, counties, and municipalities. The modest research programs of nonfederal governments generally are directed at solving local infrastructure problems and at evaluating and testing commercially available products for local use.

According to the Transportation Research Board (TRB), States annually spend about $10 million of their own funds on *afl* highway research. Assuming that State-funded *materials* research is approximately the same portion of State-funded R&D as in Federal-State cooperative research programs (see chapter eight), OTA estimates that States spend about $2 million annually on highway materials-related projects. State highway departments typically have one or more professionals on staff with responsibility for materials engineering and research.

The TRB and the American Public Works Association (APWA) report that some larger county or city public works or roads departments also support independent research on paving materials and corrosion. The TRB estimates that cities and other local government units spend $1 million to $2 million annually on highway research. Materials-related research is probably no more than $100,000-$200,000 of this.

Quasi-governmental agencies, such as those that administer Statewide tollways or interstate bridges and tunnels, also maintain research programs. For example, the New Jersey Turnpike Authority has contracted with the Asphalt Institute to assess the reasons for the sudden

"rutting" of asphalt pavement on large sections of the turnpike. The Port Authority of New York and New Jersey research program also includes a materials group, but OTA was unable to obtain specific project descriptions within the timeframe of this survey. Estimates of how much such agencies spend on R&D also were not available. Generally, their research is funded out of revenues and user fees which are not subject to the same political exigencies as State and local government research budgets.

Professional and Trade Associations

A significant share of nonfederal highway materials R&D is supported and coordinated through professional organizations, trade associations, and their affiliated research foundations. However, the primary emphases of these groups is on member services, publications, standards development, and technology diffusion.

The largest share of nonfederal materials R&D for roads and bridges comes from technical societies and trade associations representing materials producers and suppliers. These include: the Asphalt Institute, the National Asphalt Pavement Association (NAPA) and its Research Foundation, the Portland Cement Association, the American Concrete Institute, and the Steel Structures Painting Council. Most industry trade associations have small staffs and very modest research budgets, but the Asphalt Institute, NAPA, and PCA support a total of $2 million per year in research on the characteristics, performance, and evaluation of materials. Materials-related work in iron and steel, other structural and reinforcing materials, and coatings and other anti-corrosives probably also is on the order of no more than $ 1 -!$2 million annually.

Associations of government transportation officials and agencies provide a forum for identification of research needs and priorities and coordinated research efforts, but provide little direct funding for R&D, The two major groups in this area are AASHTO, which represents State officials, and the American Public Works Association (A PWA), which represents State and local governments. Almost all of AASHTO materials research is funded through contracts from States or Federal government agencies. The APWA Research Foundation has a total annual

R&D budget of between $100,000 and $500,000. The primary focus is improving transportation management and maintenance through professional educational and research programs for its members, although it has sponsored some materials-related contract research.

The National Governors' Association, National League of Cities, National Conference of Mayors, National Association of Counties, and National Conference of State Legislatures all have transportation subcommittees and occasionally underwrite research efforts on behalf of their members, but fund very little materials research.

Universities and Other Research Centers

Many universities have materials or highway transportation research centers. There are no independent estimates of the level of funding for research carried out in materials science and civil engineering programs, but the major source is the Federal government--either directly through contracts and grants or indirectly from State agencies, HP&R funds, or NCHRP contracts. Therefore, the amount spent on research is reflected in those budgets (see chapter eight). At some public institutions, there may be additional funding of research centers by State legislatures. For example, the State of Alabama is providing $600,000 to help support the National Center for Asphalt Research, which is jointly sponsored by Auburn University and the NAPA Research Foundation.

Materials Manufacturers and Suppliers

Many materials manufacturers and suppliers maintain R&D departments. According to industry representatives, the asphalt, cement, and concrete industries combined probably spend a total of $6-$8 million annually on R&D, in addition to that sponsored by industry research groups, such as the Asphalt Institute. Industry expenditures for materials R&D are significantly lower now than they were six years ago. According to the National Materials Advisory Board, many private cement and concrete companies have closed their research laboratories. There is no estimate of the private R&D budgets for other materials manufacturers and suppliers, but the

TRB and other sources estimate that average R&D expenditures in the transportation segment are about 0.15 percent of sales.[43]

SEWERS AND WASTEWATER TREATMENT SYSTEMS

Sewers and wastewater treatment systems use a wide range of construction materials and manufactured products: sewer pipes (concrete, masonry, plastic, iron, steel), seals, liners, gaskets, and pumps in sewer collection systems; and screens, filters, membranes, liners, pipes, pumps, additives, and monitors for treatment plants. Materials are not a major consideration in waste water treatment processes, but are an important cost component of sewer and treatment plant construction and maintenance.

Nonfederal research efforts in sewers and wastewater treatment systems have been underwritten by local governments and sewage authorities; professional and trade associations; engineering, consulting, and construction firms; and equipment and materials manufacturers. Large municipal sanitary districts sponsor a lot of R&D, but their efforts are largely problem-oriented or focused on evaluation of commercial products, rather than on materials development. The Metropolitan Sanitary District of Greater Chicago, the Los Angeles County Sanitary District, and Seattle Metro funded a total of about $3.5 million in support of R&D in 1983,[44] OTA was unable to find more recent estimates of the level of research funded by local agencies.

The American Public Works Association, Association of State and InterState Water Pollution Control officials, Association of Municipal Sewerage Agencies, the Water Pollution Control Federation, and the American Society of Civil Engineers are among the major technical groups involved in wastewater treatment. They probably spend a total of $1 m. llion to S2 mil-

43 Transportation Research Board, supra, note 29, at p.1.

44 American public Works Association, Defining the Role Of Federal and pri ‘a te Sec ‘or Activities in Solving Mun ici Dal Environmental Problems, Workshop Proceedings prepared for EPA, August 11-13, 1983.

lion annually on research on wastewater systems management and identification of research needs. A significant portion of these funds come from contracts with EPA and with local water and sewer utilities. The Water and Wastewater Equipment Manufacturers Association represents many wastewater equipment suppliers. They were unable to provide estimates of either total sales or R&D expenditures for their members.

University research centers also conduct some research on various aspects of sewers and wastewater treatment with Federal funds from sources such as EPA and NSF.

Municipal wastewater treatment systems have made significant progress in dealing with conventional pollutants, but now face new pollution control requirements and increasing demands on their systems. This will present new challenges in repairing and replacing aging systems, and in upgrading and expanding facilities to meet Federal regulations and to deal with changes in inflow characteristics from residential-commercial toxic wastes. Rehabilitation of sewers to control infiltration still remains a significant problem.

WATER SUPPLY AND TREATMENT SYSTEMS

A total of about $14 billion was spent for construction, operation, maintenance, and repair of drinking water supply and delivery systems in 1984, primarily by local governments and water utilities. The major cost components are the underground pipe plus excavation and placement. Materials and products include: pipes (concrete, plastic, ceramic, masonry, iron, lead, steel, copper), pipe foundations and liners; seals, pumps and treatment equipment; nondestructive evaluation techniques; and technologies for inplace repair, maintenance, and rehabilitation. Materials-related research areas include the mechanics of internal and external corrosion, the long-term performance of system materials, maintenance requirements and technologies, rehabilitation technologies, failure prediction, and the effects of materials and water additive? on water quality and system life.

Nonfederal R&D on materials for water supply systems is primarily conducted by local water utilities, professional and trade associations, engineering, consulting and construction

companies, and equipment and supply manufacturers. State agencies' R&D efforts are generally aimed at the health effects of pollutants and identifying the source of contaminants.

Large public and private water utilities fund some R&D which focuses on solving local water system problems or on evaluating available technology for local use. Any openness to innovation in water supply technology that might be fostered by local financial responsibility for water systems is countered by the strong emphasis placed on the reliability of those systems.

Two professional organizations sponsor and coordinate a large share of nonfederal water supply R&D by local water utilities: the American Water Works Association Research Foundation (A WWARF), and the American Public Works Association (A PWA).[45] The AWWARF Research Foundation supports approximately !$ 1 million annually in R&D on materials-related aspects of water systems; current efforts focus on corrosion and rehabilitation of water lines. APWA support for water systems research is probably under $100,000 per year. Its most recent research emphasis is on system management, but some past projects have included materials components. Neither group **could** provide dollar estimates of the R&D activities of their members, but noted that many of the large municipal water systems and investor-owned water utilities sponsor extensive research efforts, including some materials R&D. Examples include utilities in Los Angeles, San Francisco, Chicago, the District of Columbia, Atlanta, St. Louis, Boston, and New York City.

The construction and engineering firms that design and build water systems do little independent R&D, according to a representative of an industry association. There is probably some private investment in new materials-oriented technologies for repair and rehabilitation, but these figures are likely to be proprietary.

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[45] AWWARF was founded as a separate research entity by the American Water Works Association, which represents public and private utilities that supply about 60 percent of the drinking water in the U.S. and Canada. Congress provided $3 million in FY84-FY86, through EPA, as "seed" money for AWWARF. The foundation is now funded by subscription fees paid by member water utilities.

WATER RESOURCES PROJECTS

Water resources projects--waterways, ports, dams, locks, irrigation and flood control facilities, reservoirs, and other multipurpose facilities--probably receive the lowest level of non-federal R&D support because of the high level of Federal responsibility. Also, the primary materials and products of interest --concrete, stone, aggregate, pipes, coatings, geotextiles, membranes, liners, filters, and structural and reinforcing metals and substances--are shared with other infrastructure types. The special materials-related problems in water resources include channel erosion and infill, embankment stabilization, and corrosion and deterioration of locks, dams, pilings, and other structures. OTA was able to identify about $100,000 in annual non-federal expenditures on materials R&D for water resources projects.

There are a number of municipal agencies and quasi-governmental authorities that administer ports and waterways, and there are some privately-owned dams and flood control facilities associated with industrial or recreation developments and electric power projects. Some of these nonfederal entities undoubtedly sponsor some materials research, but the level of funding is not known.

Many of the larger trade and professional organizations have divisions that are dedicated to advancing design, engineering, and materials in construction and maintenance of water resources projects. However, their work generally draws on generic research by materials suppliers, and on work by architecture/engineering and construction firms.