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Chairman: Robert E. Tatman, Ohio Department of Transportation

Waste Management in Transportation
The Present and the Future

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In this paper, both current and forward-looking views of waste and waste-related problems confronted by the transportation industry are presented. In the first of the paper's two primary sections, both commonly used and advanced ways in which governments, transportation agencies, and private industry address waste management issues today are described. In the second, the focus is on the future, and such questions as the following are addressed:

- How will waste be utilized and managed in the future?
- How can we integrate the efficient management and minimization of waste into transportation operations and maintenance?
- What statutory and regulatory changes are needed to protect the public while allowing for flexible and commonsense solutions to waste management problems?

WASTE MANAGEMENT: STATE OF THE PRACTICE

Statutory and Regulatory Framework

Waste management within the transportation industry has been and continues to be extensively regulated by federal, state, and local agencies. The primary federal laws, which states had generally copied, are the Resource Conservation and Recovery Act (underground storage tanks fall under a portion of this law) and the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). CERCLA is overdue for reform, but Congress has been unable to agree on how to restructure the statute. In the meantime, many states have been revising their laws, and those laws now look very different from federal law. Laws and regulations governing waste, therefore, are a crazy quilt and are rapidly evolving, and state and federal rules can be in conflict. Unless and until CERCLA is reauthorized, the future holds more confusion.

These laws and regulations affect land acquisition and project implementation because they can create substantial liability for the owner or operator of property contaminated with hazardous substances or petroleum. They affect product use and waste management in operations and can require agency facilities to be remediated. They create pressure for agencies to reuse industrial waste in transportation construction projects beneficially.

The management of wastes and by-products generated by the transportation industry is also heavily regulated. Several states have incurred substantial costs and civil penalties dealing with hazardous substances that were improperly disposed of. However, proper disposal of large volumes of hazardous waste is costly. To avoid these problems, waste

minimization, pollution prevention, and better waste management systems are gaining ground.

Hazardous Materials Found in Rights-of-Way

In 1993, a study initiated under the National Cooperative Highway Research Program concluded that "hazardous wastes are frequently encountered and are potentially present in nearly all DOT projects . . . ." In response to this situation, the transportation industry has created and used many procedural, technical, and cost compensation strategies to enable the cost-effective and timely construction of projects involving environmentally impaired properties. These strategies are grouped and explained below.

Key Technical Strategies

- Property screening and characterization: Most agencies now have programs to fully and accurately identify the types and extent of hazardous materials that will be encountered in transportation improvement projects. This activity typically occurs prior to site acquisition because it is critical to providing the best possible liability protections under environmental due diligence laws and to developing effective hazardous materials remediation, removal, reuse, or recycling plans.
- Risk assessment methodologies: Site-specific risk-based criteria can now be developed and applied in most states so that actual future use and exposures, rather than the ultraconservative risk scenarios of the past, form the basis of hazardous materials management. The development of site-specific assessment enables the remedial approach for a transportation project to be tailored to and evaluated within the specific context of the end use of the construction corridor or project.
- In-place materials management: A secondary advantage of site-specific risk assessment is that it can support a feasibility assessment of managing hazardous materials in place on the basis of a project-specific assessment of the human health risks posed by site conditions and proposed construction activities. The ability to gain concurrence from regulatory agencies to manage hazardous materials within the area of excavation or within the project right-of-way minimizes the cost associated with excavation and off-site disposal or treatment. However, this approach does not eliminate the long-term liability of the department of transportation for the contaminated right-of-way.

Key Cost Compensation Strategies

One of the primary challenges facing the transportation industry in developing environmentally impaired property is associated with compensation for environmental response costs. Several strategies have evolved to assist decision making, to streamline the assessment and cleanup process, and to maximize an agency's potential for recovering response costs.

- Regulatory referral: One avenue is to report an impaired property to federal or state regulatory agencies prior to land acquisition. The uncertain schedule of any regulator-driven cleanup and the potential for success of this approach have proven to be unworkable for all but the most severe instances of contamination.
- Good faith negotiations: It is now common for transportation agencies to have sufficient information generated via investigative efforts to quantify the type of

contamination that is present and the estimated costs of cleanup. The information is now commonly shared with a qualified professional appraiser for consideration in evaluating the property's fair market value. Armed with an accurate and legally defensible valuation approach, agencies can fashion good faith offers that, at a minimum, account for the costs of remediating a subject property.

- Use of appraisal during eminent domain: The approach cited above is perfectly legitimate in support of good faith and private-sector or open-market types of property transfers. However, in the case of a public-sector property taking, it is unclear whether a public agency empowered with eminent domain authority under state statute can consider any or all aspects of environmental impairment in determining the compensation value for the property. Even in favorable and informed jurisdictions, the appraisal of contaminated property in eminent domain is and will likely continue to be a challenge, since risk-based approaches will complicate that process.
- Recovery of costs through litigation: Agencies may consider cost recovery after project completion against parties responsible for the contamination. The barriers confronting an agency in predicting its return on investment through cost recovery litigation (pursuant to CERCLA) are numerous and formidable. Legal questions, complex technical and procedural requirements, and substantial resource requirements are the major barriers that have effectively precluded agencies from recovering costs at this phase of a project.

Environmental Management Systems

Until recently, the transportation industry viewed environmental issues from the standpoint of the project. Resources were devoted to ensure that projects complied with the National Environmental Protection Act, regulations of the Federal Highway Administration (FHWA), and other federal, state, and local environmental laws and regulations. This perspective is changing, and transportation organizations are beginning to look internally to evaluate how they can improve both the environmental performance of their operations and their cost-effectiveness. The private sector is heavily engaged in evaluating and adopting environmental management systems (EMSs) such as ISO 14000 to improve and integrate the environmental aspects of their operations.

Public transportation agencies are in the process of assessing the benefits of EMS programs. FHWA has been investigating and implementing techniques that account for environmental factors in transportation projects. As part of this effort, a number of private- and public-sector organizations were evaluated to identify key management practices and other factors that resulted in enhanced environmental performance. Three state DOTs—those of Arkansas, Minnesota, and Pennsylvania, each with a proven track record of environmental compliance and performance—were chosen as subjects of the study. Each of these transportation agencies has evolved comparable strategies to integrate environmental considerations throughout its organization. Pennsylvania DOT is taking its success to the next logical level by proceeding with the design and implementation of a formal ISO 14001–based EMS program.

In summary, an EMS is viewed as an excellent opportunity to build environmental management into the daily business operations of transportation organizations. Some of the expected benefits include

- Reduced disposal costs,
- Reduced liability costs,
- Fewer permits,
- Fewer inspections,
- Improved worker health and safety, and
- Environmental considerations integrated into corporate decision making.

Waste Management: Its Legacy and Promise

Historical operations and waste management practices at transportation facilities have frequently resulted in adverse impacts on the environment. The emergence of environmental regulations governing management of contaminated sites in the 1980s required transportation agencies to identify environmental impacts and remediate affected sites. Remediation of transportation yards and facilities has involved inventorying, assessing, and addressing cleanup. For instance, disposal of laboratory waste has in some states been improper, and those states are facing sizable cleanup costs and liabilities to those allegedly affected by the contamination.

In the past decade, many transportation agencies have initiated programs to assess and, if necessary, remediate contamination at their respective facilities. In some cases, agencies have taken a wait-and-see approach, acting when compelled to do so by regulators. Organizations with a proactive outlook and a program that would be considered to represent the state of the practice typically apply the following phased approach when remediating their properties and facilities:

- They inventory their facilities,
- They assess past and current operations and waste management practices at those facilities to determine whether the environment has been affected,
- They investigate sites where impacts may have occurred,
- They assess the risk to human health and the environment at properties that are affected,
- They prioritize the actions that need to be taken on the basis of relative risks,
- They identify feasible options for cleaning up contaminated media, and
- They clean up properties using the latest in cost-effective technology.

This process will continue for many more years, since the process of addressing these problems is time-consuming and expensive.

To the extent that hazardous waste generation and hazardous materials usage are minimized at transportation facilities (primarily through EMSs, use of best management practices, and focused pollution prevention programs), the magnitude and extent of future contamination will be ameliorated.

Beneficial Reuse of Industrial By-Products

The transportation sector uses millions of tons of material every year. Some of these materials are used for construction, operation, and maintenance, whereas some are scrap or secondary materials that the transportation sector no longer needs. These volumes do not include materials handled by freight transport. The state of the practice and the future

possibilities concerning transportation materials, therefore, relate to two streams: primary and secondary materials.

Management of secondary materials such as asphalt, concrete, plastics, and paint has traditionally been limited to landfill disposal. Transportation agencies have perceived these obsolete materials as costs, which are especially high in areas with high landfill tipping fees or long transport distances to landfills. Materials that have had a high value at the end of their useful life (such as steel, aluminum, copper, and other metals) have been recycled and reused to a limited extent in other applications (for example, old steel bridge girders have been transported to another site). The key to the success of metals recycling and reuse has been the existence of (*a*) reverse logistics systems (which collect the metals and transport them to processing plants) and (*b*) markets that are ready to absorb the materials (scrap steel, aluminum, and copper have positive resale value and steady demand).

Whenever markets and reverse logistics systems are found for high-volume transportation materials, recycling will take place without outside intervention. For example, asphalt pavements are increasingly recycled on site into new pavements, as well as in off-site asphalt plants. In contrast, old concrete is not being recycled at a large scale because of a lack of market demand. The existence of standards—or at least the lack of regulatory obstacles—also stipulates the use of secondary materials for new applications.

WASTE MANAGEMENT: LOOK TO THE FUTURE

Statutory and Regulatory Framework: Reliance on Local Decision Making and Sustainable Development Concepts

There are several strong trends associated with the evolution of waste management statutes and regulations. The significant changes include the following:

- Emphasis on federal controls is being reduced, with a concurrent increase in state engagement.
- Alternative liability schemes that move from strict and joint liability to proportionate share liability are being formulated.
- States are increasingly adopting risk-based cleanup standards.
- The federal government is getting out of the business of remediating contaminated sites.
- Federal, state, and local governments are offering incentives for meeting or exceeding strict compliance with regulations.
- The adoption of EMSs will reduce the need for existing command-and-control regulatory systems.
- Life-cycle thinking in laws and regulations, materials selection, and facility/infrastructure design will promote sustainable transportation systems.

Management of Contaminated Materials Within Right-of-Way Limits: Applying New Technologies, Regulatory Frameworks, and Environmental Data Management

The key topics likely to affect the foreseeable future with regard to hazardous materials in rights-of-way have already been identified, including cost recovery, brownfields acquisition and redevelopment, regulatory evolution, and the reuse or recycling of hazardous materials. With the exception of the inherently difficult issue of cost recovery, the future is likely to hold continuing research, education, and improvements on each of these fronts. Like

private-sector development, the incorporation of brownfields into rights-of-way will become more and more accepted and understood as not only a good sustainable development practice, but also a cost-saving practice. In cases where forward-thinking policies are not yet backed by strong and detailed regulations or by adequate financial or legal incentives, success stories and political and socioeconomic pressures should help motivate lawmakers to promulgate appropriate requirements and to alleviate financial or legal hurdles. Likewise, it is hoped that better legal precedents will be set so that the potential for liability is more consistently decided, thus helping administrators to predict and manage risks.

Science and technology will also continue to evolve and improve in such a way that potential risks to the public or the environment can be better quantified and shown to be manageable without the need for avoidance or the expenditure of unreasonable levels of public resources—for example, the acceptability of in-place remedies such as natural attenuation.

In addition, the use of environmental database management systems coupled with geographic information systems will be an integral aspect of waste management practices. These tools will provide

- Communication and information access to different stakeholders;
- Reduction of project costs through reduction in efforts required for data analysis, entry, and maintenance;
- Improved quality control and efficiency of deliverables; and
- Support of an informed decision-making process through integrated data availability.

EMSs: Moving Toward a Total Systems Approach

To integrate efficient management and minimization of waste into the transportation organization's operations and maintenance, an all-inclusive assessment of its activities, products, and policies needs to be performed to determine levels of interaction and effects on the environment and human health. The results of such evaluations will be used to develop EMSs for the operations and maintenance of transportation agencies, not just for specific projects or programs. The EMS will be used not only as a monitoring and compliance tool but also as a way to achieve or improve on a particular level of environmental performance.

To ensure the effectiveness of the EMS, transportation agencies will need to regularly review and evaluate information such as the results of audits, corrective actions, current and proposed legislation, results of monitoring, and complaints. These reviews will allow transportation agencies to look at their operations and systems and ensure that they are and will remain suitable and effective.

An EMS should not be developed as an add-on program. Its usefulness will depend on the consistent, systematic control of operations, procedures, products, or services that can have a significant effect on the environment. Although an EMS is obviously concerned with environmental performance, effective management of the total transportation agency is the ultimate goal.

Waste Management: Minimizing Waste Generation and Understanding Risk

Because the entire environmental field is only a few decades old, the state of the practice in waste management and site remediation changes at a high rate. The trends are noticeable on several fronts:

- To the extent that hazardous waste generation is minimized, the need for future cleanups will be minimized; thus, pollution prevention initiatives and revisions to operations and waste management practices that minimize environmental impacts are increasingly important.
- Cleanups based on controlling human health risks from contaminants (rather than cleaning up to pristine conditions) allow for more flexible and cost-effective remedies.
- A subset of risk-based cleanup is the voluntary action programs being instituted by many states across the country. These voluntary programs factor future use considerations into the cleanup decision-making process. Contaminated sites that (because of their future uses) will not allow contact with contaminants (e.g., because the contaminated area will be buried beneath a parking lot) are allowed to leave substantial concentrations of hazardous constituents behind.

Because the future uses of many transportation facilities (and transportation projects yet to be built) are well known, the number of options in the management of contaminated transportation facilities is likely to increase. Remediations may take advantage of inherent restrictions on contact with contaminants associated with urban settings, commercial or industrial properties, or transportation rights-of-way to manage contaminated media more cost-effectively.

As the number of options for site management increases because of increasing numbers of regulatory frameworks (state voluntary programs and new risk-based approaches), the need for an effective exchange of ideas and research into these options will increase. An active Committee on Waste Management in Transportation will promote the effective interchange of ideas, strategies, and remedial approaches that will allow state transportation agencies to make cost-effective use of the increasingly diverse knowledge base applicable to transportation facility remediation.

Beneficial Reuse of Industrial By-Products: Call for Integration and Education

To save economic and environmental costs, transportation material utilization also has the goals of pollution prevention, dematerialization, waste minimization, reduction of nonrenewable and renewable resource consumption, and reduction of the environmental and human health effects of materials use. Some actions to implement these goals in construction, operation, and maintenance have led to environmentally beneficial practices such as removal of lead from paint. However, most of these goals are still vaguely defined, and action plans are missing. To facilitate their introduction into the profession on a wide scale, the following needs and trends are identified:

- The environmental implications of using transportation materials need to be systematically assessed and analyzed. Research needs to be conducted about the benefits and costs of recycling and reusing specific secondary materials. This could be achieved with life-cycle environmental and cost analysis. Whereas the benefits might be apparent for some

materials, they may be hidden for others because of a lack of systems view. For example, the environmental benefits of recycling some materials may outweigh their current market costs.

- Once the environmental impacts are assessed, the environmental footprint of the materials should be minimized by improving the processes associated with their manufacture and use. The technical performance of materials should not be compromised in this process.
- It is anticipated that pollution prevention will gain in importance in the economy and society. Many commonly used materials (e.g., paper, steel, aluminum) have been subject to an environmental audit by the government and the public. The transportation industry needs to be prepared for this trend.
- Decision makers, designers, and material procurers in the transportation industry need to be informed and educated about the environmental impacts of their material choices. This will require easy-to-use, transparent, yet comprehensive guidelines, methods, and computer-based design and management tools.
- Education is needed to increase public awareness and trust and to relieve fears about use of certain materials. These materials must no longer be viewed as waste, with its negative connotations, but as resources. One common misconception is that industrial by-products are all excessively dirty or contaminated. Some materials that are perceived to be toxic are not any worse than currently used materials, and they may be better.
- An updated comprehensive national survey of secondary materials use, such as that conducted by FHWA in 1993, is needed to determine current and anticipate future trends.
- Transportation professionals need to initiate work on incorporating secondary materials into standards and codes. Regulations should not specify the origin of transportation materials but should simply be based on performance characteristics.
- It is anticipated that the government will increasingly favor secondary materials in federally funded transportation projects. An example of a similar action is the Environmental Protection Agency's proposed rule for procurement of products containing recovered materials that include, for example, railroad grade crossing surfaces and flowable fill.
- Markets and reverse logistics systems will be needed to allow for large-scale recycling and reuse of transportation materials if that emerges as a social goal.

Emerging Issues Entering the 21st Century

In addition to the trends identified above, many emerging issues face the transportation industry as we enter the 21st century. Some of those associated with waste and waste management are the following:

- Sustainability: The transportation industry will be expected to examine all aspects of its policies, procedures, operations, resource use, and community relations to begin lessening its effect on natural and human systems now and for future generations. Pollution prevention (including materials substitution) and life-cycle thinking will be important tools in measuring the performance of individual transportation organizations.
- Smart growth: The issue of urban sprawl is reaching critical mass at both the grassroots and the national political levels. Improving and increasing the density of transportation systems in urban areas will require the use of environmentally impaired

properties. The use of technologies and approaches described herein, and new ones as well, will be needed to meet the increasing demands of urban transportation systems.

- The many, the connected: Widespread, rapid, and easy access to information will transform how the transportation industry addresses waste management issues. Community groups and informed citizens will have access to detailed information concerning the generation and management of waste associated with transportation organizations, systems, and projects. How the industry responds to issues will be determined to a much greater degree by public consensus and sentiment than by regulatory drivers or government command-and-control programs.

The new millennium will certainly see the continued evolution of waste management in transportation. A major challenge to transportation professionals will be to move the process of waste management more into the mainstream of the transportation mission. If the transportation industry can address waste management proactively at all levels (i.e., planning, construction, operations, and maintenance), then waste management will more likely be viewed as a tool rather than a liability to the core missions of building and maintaining the transportation system.

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