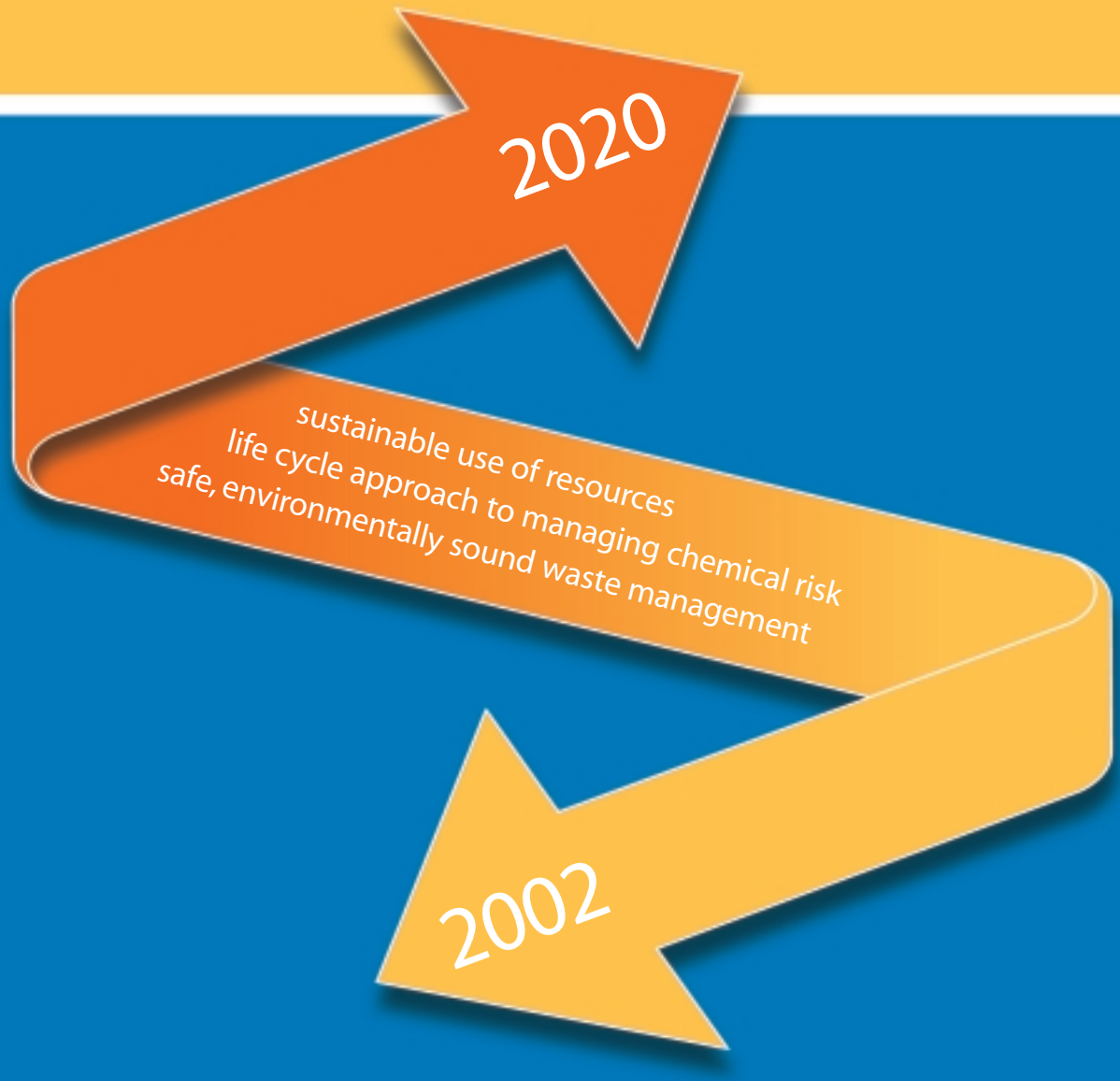
Beyond RCRA

Waste and Materials Management in the Year 2020



EPA United States Environmental Protection Agency

Acknowledgments and Disclaimer

The RCRA Vision Paper was written by the RCRA Vision work group:

- Dave Fagan, Office of Solid Waste, EPA
- Angie Leith, Office of Solid Waste, EPA
- Peggy Harris, California EPA, Department of Toxic Substances Control
- Jennifer Kaduck, Georgia Environmental Protection Division
- John McCarroll, EPA Region 9
- Wayne Naylor, EPA Region 3
- Jeff Scott, EPA Region 9
- Shiela Sevenstar, Cherokee Nation
- Karen Ueno, EPA Region 9

This paper is intended to provoke discussion and facilitate a public dialogue to explore possible directions for the mid- to long-term future of the RCRA program. Even as the ideas presented in this paper remain open to honest reflection, the desired dialogue has already begun. Based on comments received on an earlier draft of the paper, EPA, with its co-regulators in the states and tribal governments, has already identified a number of short-term opportunities to explore in more detail some of the ideas and issues raised here. This dialogue will continue as EPA works with all stakeholders to continue to craft a vision for the RCRA program of the 21st century.

This paper could not have been completed without the assistance of the many individuals who kindly volunteered their time and expertise. In particular, the work group wishes to express its appreciation to those who participated in the September 1999 roundtable meeting in Washington, DC that laid much of the groundwork for this project:

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Beyond RCRA:

Waste and Materials Management In the Year 2020

"Looking into the future is a fool's occupation,
but it is the bigger fool who dares not to."
—Voltaire

A Vision of the Future

>> The year is 2020, and America's wasteful ways are a thing of the past. New technologies and a changed economic climate, combined with enlightened government policies and a pronounced shift in societal and corporate attitudes have resulted in dramatic decreases in the volumes and toxicity of industrial wastes generated by the country's industries. Materials that were once considered wastes suitable only for landfilling are now continually reused and recycled, and "industrial ecology" has become the mantra of corporate executives across the nation. Landfills are becoming obsolete—the small volumes of wastes that actually need disposal are carefully managed under an efficient and environmentally protective system that features a mix of economic incentives, voluntary measures, and regulatory controls. Cleanup of most contaminated sites has been largely completed, and thousands of areas once known as brownfields have been put back into productive use.

Generating and managing post-consumer household wastes has undergone a similar transformation. Concern for environmental sustainability has become ingrained as a societal value, as individuals have become much more aware of the environmental consequences of their consumptive choices. These changes in consumer values have prompted shifts in manufacturing techniques and choices, so that manufacturing processes are based on managing resources efficiently, closing the loop of material flows, and designing for the environment. Products contain fewer toxic materials and are designed to last longer. Much less—and less toxic—waste is generated during manufacturing. Manufacturers now take responsibility for their products throughout the product life cycle, and product stewardship,—involving all members of the product chain,—is a standard operating procedure. Household recycling, as well as advances in packaging, product design, and other market-based measures, have reduced household waste generation rates to a small fraction of what they were in the late twentieth century. Virtually all organic wastes, construction and demolition wastes, and other materials formerly managed as part of the municipal solid waste stream are now diverted to beneficial reuse, dramatically reducing the amount of landfill space needed. Far fewer raw materials and fewer toxic chemicals

are used to manufacture consumer products, and consumers are far better informed of the potential risks from toxins in the goods and services that they use.

By the year 2020, a chemically safe environment has also become established legally and culturally as a basic human right. Advancements in telecommunications and information management have created much closer linkages between government agencies, citizens, and businesses, and the resulting flows of information have enabled a more participatory approach to making environmental decisions. These developments have prompted pollution abatement measures that ensure lower income communities no longer bear disproportionately high risks from exposure to industrial chemical emissions.

These gains in waste and materials management have not, of course, been confined to the United States. Heightened concerns over the health of the global environment, combined with an increasingly globalized economic system, have created new institutions and policies to promote environmental sustainability and ensure that wastes and materials are managed wisely worldwide.

What kind of world will we actually inhabit in 2020? Some predict that it will be better than the present—where products and materials will be less toxic and reusable, and where resources will be used more efficiently so that far less waste is produced. Others predict we will experience a bleaker future—where harmful chemicals will be more prevalent throughout our environment and may seriously affect groundwater, drinking water, and food supplies. While we can't know which of these scenarios—or others—will exist in 20 years, considering the future now makes sense if we want a chance to shape it positively. This paper is intended to stimulate a dialogue around this important issue.

Introduction

>> At the turn of the new century, the United States has completed two decades of managing wastes under the federal Resource Conservation and Recovery Act (RCRA). In these past 20 years, waste management practices have improved tremendously. Uncontrolled dumping of hazardous industrial wastes has decreased dramatically, and the number of facilities that handle hazardous wastes has shrunk by half. Municipal solid waste landfills have been upgraded across the country, and unlined hazardous waste landfills and lagoons have almost disappeared from our landscape. Thousands of contaminated sites across the country are being cleaned up to restore land to productive uses and protect ground-water resources. Post-consumer recycling rates have risen dramatically, and many industries have made impressive gains in pollution prevention by reducing the amount and toxicity of wastes they generate.

Despite these impressive achievements, the RCRA program also receives its share of criticism. Critics point to the way the RCRA program identifies materials, particularly byproducts of manufacturing, as "waste," which they argue has a chilling effect on recycling, reuse, reclamation, and energy recovery. Others state that the program continues to focus too much on "end of the pipe" controls, and not enough on earlier interventions targeted at upstream pollution prevention measures. In contrast, some believe that the program has not done enough to require safe management of industrial, municipal, and hazardous wastes.

This paper is not an attempt to document or analyze the strengths and weaknesses of the RCRA program as we know it today. Rather, after two decades of experience with the current system, it is time to look forward to the next 20 years, to begin to examine how the program could and should evolve to meet the challenges and opportunities of the new century. In 1999, the U.S. Environmental Protection Agency (EPA), in concert with state and tribal environmental agencies, formed a small work group to begin to explore the RCRA program's longer-term future. In September 1999, a roundtable meeting of experts from academia, industry, and public interest organizations was convened in Washington, DC to lay the groundwork for this

effort. That meeting provided a number of important insights into future technological, societal, environmental, and economic trends, and how they might affect the future of waste management in this country. The proceedings of the roundtable meeting have been summarized in a separate paper.[1]

In the Fall of 2001, a draft of "Beyond RCRA," also referred to as the RCRA Vision Paper, was made available for public review and comment. Public meetings were held in Washington, DC and in San Francisco, California, and the public was invited to submit written comments. Overall, those who commented expressed support for the RCRA Vision Paper and the value of examining the future shape of the program without being constrained by current legislative and regulatory approaches. At the same time, some individuals made specific suggestions for improvement to the paper or offered their views on the trends and factors that will (or should) shape the RCRA program of the future. These comments have been valuable to the work group in shaping the final version of the Vision Paper and will continue to be important as dialogue on the future of the program continues.[2]

The primary focus of the RCRA Vision Paper is to suggest broad outlines for what the program of the future might look like, and the forces that might shape it unconstrained by the current legal and institutional structure. The work group is not advocating or recommending any particular policies or directions, nor is the paper intended to advance any particular administrative or legislative action.

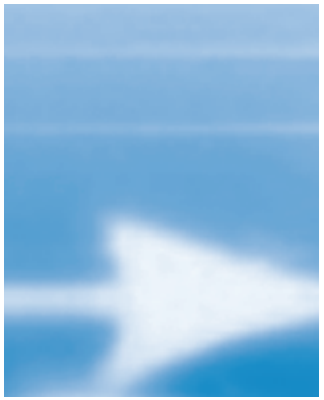
The work group has not attempted to quantify how effective any of the measures discussed in the paper might be, nor to calculate their political feasibility—these are issues for future debate.

The scope of this paper is confined to exploring the future of waste and materials management in the United States, although the work group believes that much of the paper's substance could be relevant to other nations with relatively affluent, industrial economies. In fact, as noted elsewhere in this paper, it is unrealistic in this era of increasing globalization to consider these issues in purely American terms. Many countries have already made great strides in moving forward with some of the ideas outlined in the RCRA Vision Paper; the United States can certainly learn from their experiences. The work group acknowledges, however, that the problems associated with waste and inefficient use of resources in the United States do not receive the same level of attention in those parts of the world where poverty and resource scarcities often overwhelm such concerns.

[1] Copies of the "RCRA Vision Roundtable Meeting Summary" can be obtained by contacting the RCRA Docket at RCRA-Docket@epa.gov or by calling (703) 603-9230; reference RCRA Vision No. F-2001-BRVP-FFFF.

[2] Copies of comments received on the draft RCRA Vision Paper are available from the RCRA Docket (see above).

Trends and Future Directions



>> In developing a vision for the future of RCRA (or whatever its successor program might be called), it was necessary to make certain projections and assumptions as to the future "landscape"—that is, the economic, technological, and societal setting—in which the program might operate in the year 2020. These projections and assumptions have been organized into six broad categories: Resources, Health and Risk, Industry, Information, Globalization, and Society and Governance. The work group recognizes that there is uncertainty about these trends and future directions and that the future will also be shaped by trends we did not recognize, breakthroughs in science and other future events that we cannot predict, and other factors that are currently unknown. However, we do not believe this uncertainty, which is natural and unavoidable, should argue for inaction. Rather, since change is certain, the United States must begin now to anticipate changes and prepare to respond to them. In that context, we believe the RCRA program of the future will be influenced by the following trends and directions:

Resources

- **Pressures on natural resources will continue to increase.** It is relatively safe to assume that worldwide demand for basic resources (e.g., fresh water, minerals, energy sources, fibers, agricultural land) will continue to increase over the next 20 years, as the world's population increases and the global economy continues to expand. It is also likely that a number of areas of the world that now have relatively low living standards will become more prosperous, which will tend to increase demand for goods and services and the basic resources that are used to supply them. It is not assumed that there will be wide-scale shortages of basic resources or commodities in the year 2020. However, it is expected that as worldwide demand for resources mounts, some specific resources might become less abundant and/or more difficult to exploit in the future, which could increase their economic value. Some of these variations in supplies and costs of commodities/materials will likely vary geographically. Increased costs of commodities would likely result in some changes in consumptive behavior, but should also create market pressures to develop substitute materials and/or products.

- **New technologies will change how resources are used and wasted.** Technological advancements will also affect the availability of resources and the way we use them. It is entirely possible, for instance, that a dramatic technological breakthrough could alter—in a positive way—the current balance between resource supplies and demands, and the efficiency with which resources are used. For example, a revolutionary new energy source could realize extraordinary environmental, economic, and social benefits by substantially reducing the use of fossil fuels; however, it seems unwise, at this point, to assume that technological advances will somehow rescue us from having to worry about resource scarcity in the future. It is more likely that the effects of technological change on economic and ecological sustainability over the next few decades will be more mixed, though nevertheless profound.

  The future could bring a variety of changes in resource use—not only in terms of how resources are extracted and used, but also in terms of what materials are considered "waste." For example, new technologies could enable extractive industries (e.g., minerals, petroleum) to become more efficient, and thus less wasteful. This change is already being seen in a number of manufacturing industries, with the prospect of important future advances in energy efficiency, efficient use of materials, and materials substitution. Technology improvements may open new doors to reuse, reclamation, and recycling of materials that are now viewed as wastes, and could increase the safety of disposal practices for wastes that remain. Life spans of some products will likely increase, which could decrease waste volumes. On the other hand, technological innovations could create demands on different types of resources and create new types of wastes, or could produce new consumer products that are popular but resource-intensive. The sheer rate of technological change could result in many products that quickly become obsolete, which could also increase waste generation rates.

- **There will be a need for more sustainable use of resources.** Most people believe that the current trend is toward greater demands on, and consumption of, material resources in this country and elsewhere. While the economic value of some of these resources might increase, the more important (but often hidden) price to be paid may well be an environmental one. Extracting, producing, and using ever-increasing volumes of material resources—most of which are finite—will inevitably have important environmental consequences. Some recent studies have projected that the current global economy cannot be sustained over the long term without severe environmental consequences. The challenge at hand, therefore, is to create a system that enables economic prosperity to co-exist with a healthy global environment, by using less and making more efficient use of the material resources that are consumed.

Health and Risk

- **More chemicals will bring new risks.** The number and amount of human-made chemicals that are produced, used, and eventually disposed of has dramatically increased over the past several decades. This trend is expected to continue, and it is likely that by the year 2020, advances in chemistry, biology, and other fields will have created tens of thousands of new chemical compounds, many of which will be derived from genetically engineered organisms. While many of these products may represent important improvements, undoubtedly, some of these new substances may have the potential to cause harm to human health and ecological systems. Knowledge of risks posed by new chemicals will likely not keep pace with their development.

- **Health effects of chemicals will be better understood.** It is expected that scientific advances over the next few decades will yield a much deeper understanding of how various chemicals affect humans and other living organisms. It is likely that we will learn some chemicals are more harmful than we now think, while others may be found to be less harmful than is now understood. We will also likely better understand the health effects of chemicals among sub-populations, such as children and the elderly, people with genetically predisposed chemical sensitivities, and people who have had chronic or multiple exposures to chemicals. In addition, much more should be understood about cumulative and synergistic risks to people who are exposed to multiple chemicals over time because of where they live or work. As this information becomes available, communities with particularly high risk burdens will expect government and industry to take action to reduce those risks.

- **Methods for measuring and managing chemical risks will improve.** Techniques for estimating the fate and transport of chemicals in the environment should advance greatly in the next few decades, with corresponding advances in technologies used to detect and analyze (and perhaps characterize the risks of) chemicals in the environment. There will be better understanding of life-cycle risks of some, but not all, chemicals as they are produced, used/reused and disposed of, and it is likely that more examples of potentially harmful chemicals in common consumer goods and services will be identified (recent examples would include lead in gasoline, and mercury in home thermometers). As the public becomes more aware of risks, it might demand more comprehensive and pro-active measures from industry and government to mitigate them, including potential bans on some chemicals.

Industry

- **Industry will consume and waste different types of materials.** Over the next 20 to 30 years, a wide range of new products and materials will be produced by the U.S. economy that

will have important effects on the profile of manufacturing residuals (e.g., wastes, by-products) generated by industry. For instance, there are already many examples of products and industries in which potentially harmful chemicals have been phased out in favor of more benign materials. This trend, which the work group expects will continue, will have many positive environmental effects, including wastes with lower hazard potential. On the other hand, production of some new chemicals and products may result in new, relatively high-risk waste streams. As the industrial base continues to age, as some existing industries evolve over time, and as new industries emerge, the volumes and characteristics of industrial wastes can also be expected to change, for better or for worse. The geographic distribution of waste-generating facilities in this country can also be expected to change in response to a number of different factors.

- **Industry will be more efficient and less wasteful.** Given the assumption that the economic value of certain basic materials and resources may broadly increase over the next few decades (as discussed above), it seems safe to assume that market forces will create greater incentives to use such materials more efficiently. This trend might be manifested in products that contain less expensive substitute materials, or that use less material per unit of production. More valuable materials will also create new incentives to reuse or recycle many products, as well as many wastes and by-products from various manufacturing processes. Technologies for reuse and recycling of materials should also advance in many areas, which could lower the rate at which many such materials are wasted.

  As a general matter, therefore, the capabilities and incentives for U.S. industry to use material resources more efficiently (i.e., less wastefully) will likely increase over time. Many materials now considered wastes will instead be used to produce new materials and products. As this happens, it is likely that current distinctions between wastes and materials (which are in large part regulatory in nature) will become less meaningful. This change could warrant government policies that more effectively promote safe management of wastes. Reducing unnecessary regulatory constraints on more efficient use of materials, might also be necessary.

- **Wastes will still be with us.** Wastes will not disappear by the year 2020. Though industry might become more efficient (i.e. much less wasteful) in producing goods and services, it seems logical to assume that some industrial residuals will continue to have very low potential for productive reuse or recycling and will thus need to be managed as wastes. The work group anticipates, therefore, a continuing need to ensure that wastes are managed safely under some system of controls and/or incentives that is at least analogous to today's hazardous waste regulatory framework.

  Given that wastes (and the need to manage them safely) will exist in the future, the work

group anticipates that waste treatment and disposal technologies will evolve in important ways. Such future technologies could include the use of chemical markers, sensing and monitoring devices, and/or advanced telecommunications systems to allow industry, government, and other interested people to more closely track generation, composition, movement, and ultimate disposition of wastes. Waste treatment technologies should also improve, as should the performance of landfills and other disposal techniques. The concept of disposal as we now know it (i.e., permanent entombment) might also change over time if, for example, new technologies or economic forces emerge that enable recovery of materials from previously landfilled wastes.

Information

- **The information revolution will continue**. Over the next few decades, we will almost certainly continue to see dramatic increases in the amounts of information available to nearly everyone on the planet, and their ability to access and share it. At this point, it hardly seems possible to overestimate the effects that this will have on virtually every aspect of today's society and economy.

- **Industry, individuals, and the environment will benefit from the information revolution.** Advances in information and communications technologies have already begun to transform the way business is conducted in this country, and many of these advances should be environmentally beneficial with respect to waste and materials management. For instance, more efficient information exchange should stimulate the business of buying and trading recyclable materials between companies and industry sectors, which could create much more sophisticated markets for such materials, similar to the commodity markets of today. More information should enhance the ability of consumers to make more environmentally friendly choices for products and services. As a general matter, the work group believes that in the year 2020, faster and more efficient information flows will result in greater awareness and knowledge of environmental issues and concerns on the part of individuals, businesses, and other institutions.

Globalization

- **The global economy will be more highly integrated.** The trend toward an increasingly globalized economic system is also likely to have important effects on the future of waste and materials management. Freer movement of money and materials could result, as many now predict, in a much more integrated world economic system, as well as higher levels of prosperity and consumption in many countries. Increased global demand for material goods and services would create the need for more capacity in manufacturing and extractive industries, which are likely to become more globally dispersed. The environmental impacts of these industrial activities worldwide also, presumably, would increase, though this could have both positive and negative environmental consequences for the United States and other parts of the world.

- **Environmental protections will need to be more internationalized.** The worldwide environmental consequences of freer trade and international monetary policies have recently become the focus of a highly visible public debate, particularly in the United States and Europe. This debate may go on for many years. In any case, this issue may be particularly relevant to environmental concerns regarding waste and materials management, in part because potentially hazardous materials and wastes can be easily moved between those countries that have strict environmental protections and those that do not. Therefore, if new approaches to waste and materials management in the United States are to be successful, they will likely need to be harmonized with, if not integrated into, a more global system for instituting and maintaining environmental protections.

Society and Government

- **People will have more influence in environmental decisions.** Recent years have seen important changes in the relationships between individuals, industry, and government regarding waste management issues, particularly at the local level. Much of this has been driven by increased awareness and environmental activism on the part of individuals and grassroots community groups; as people become more aware of chemical risks, they naturally demand further protections. By the year 2020, it is expected that continued developments in information and telecommunications technologies will have created much stronger links between people and the government institutions that serve them. One result of this trend may be that individuals will be empowered to more directly and effectively influence government decisions on environmental issues that are local, regional, or even global in nature.

  One result of greater public involvement in environmental decisions would hopefully be to focus increased attention and resources on environmental problems that to date have not been adequately addressed by government or industry. One example might be a concerted effort to upgrade waste management practices on Native American lands and at remote settlements in Alaska, where the environmental realities of waste disposal are still often harsh. Another example could be actions to further reduce exposure to harmful chemicals in communities that bear disproportionate risks from nearby sources of pollutants.

- **The size and cultural diversity of the United States population will continue to increase and will affect environmental decision-making.** The environmental justice movement has framed environmental protection, including patterns of impacts, as a civil rights issue. Others have framed environmental health more broadly as a human rights issue. These efforts will likely continue, and the right to live in a relatively clean environment will continue to gain currency in this country as a basic civil right and a human right, through both laws and societal attitudes. This trend will likely influence the siting and operation of future manufacturing and waste management facilities.

Goals

>> As originally conceived, RCRA was designed primarily as a system of controls over the management of wastes in this country, with two fundamental mandates: protect human health and the environment, and conserve resources. To achieve these mandates, EPA and the states (and to a lesser extent, tribes) were provided with two primary tools: broad authority to regulate management of wastes, and broad authority to enforce RCRA's regulatory and statutory provisions. The statute, however, limited the scope of the regulatory program to certain types of wastes and certain types of regulatory mechanisms (e.g., permits, land disposal restrictions). RCRA was also designed to fit within the existing framework of media-specific environmental laws (e.g., Clean Water Act, Clean Air Act). Thus, Congress by design limited the scope of the program and its goals, and provided EPA and the states with a set of specific tools for implementing the program.

The work group believes that the original broad mandates of RCRA remain valid, and will be valid in the year 2020. However, we now have two decades of experience with federal, state and tribal regulation of waste management in this country, and the work group can see that the "landscape" of waste management will change dramatically over the next 20 years. It therefore makes sense at this time to examine how waste and materials management should evolve in this country to meet future challenges and opportunities, while building on the elements of the current program that have been most successful. In doing so, it is necessary to redefine the specific goals that will guide such a future program, and examine new tools and strategies to achieve those goals.

The following discussion describes three goals that could form the foundation of a new system for waste and materials management in the year 2020. For each goal, the work group also suggests some tools and strategies that might be effective in making such a new system work. Ultimately, of course, decisions regarding the specific shape and scope of a future system, and its legal underpinnings, will likely need to be made through the legislative process.

Goal #1: Reduce waste and increase the efficient and sustainable use of resources.

As discussed previously, over the next few decades it is likely that the human population of the planet will continue to rise, as will the material aspirations of large numbers of people in many parts of the world. Many believe that the resulting increased demand for resources cannot be sustained[3] without wide-scale degradation of the global environment, unless those resources are used with much greater efficiency than they are today. This goal is centered around two objectives that call for using resources more efficiently.

The first objective is to reduce the overall volumes of all wastes that need to be disposed of in this country, regardless of source or composition. This includes wastes currently captured by municipal solid waste programs and hazardous waste programs, whether produced by individuals or industry. Some would argue, in fact, that "zero waste" should be the goal. Even today, some companies and local governments have adopted a zero waste goal, with impressive results. While zero waste is not realistic in a literal sense, the work group believes a future waste reduction program could achieve more than it would otherwise by setting its aspirations high, and explicitly focusing on reducing waste as much as possible, even approaching zero.

The second objective is to reduce the amounts of materials used to make products or perform services. Increasing the useful life of products would contribute to this objective, as would increasing rates of reuse/recycling of materials and products. A key aspect of achieving this objective would be production processes that gear their design, use, and reuse capabilities to minimize raw material inputs, extend product life spans, and maximize the ease and frequency of subsequent product disassembly, recycling, and/or transformation for further productive use. Such continuous utilization processes (from "cradle-to-cradle") are critical both to reducing waste and increasing the sustainable use of resources. Important techniques are already emerging and being implemented in selected instances, such as designing for the environment, life cycle planning/design/assessment, product-stewardship and product take-back campaigns, and other industrial ecology initiatives.

Creating a system truly oriented towards efficient use of resources could also require fundamental changes in the waste versus non-waste regulatory construct embedded in the current RCRA system so that materials now considered wastes would be seen, whenever possible, as commodities with potential uses. One approach to making such a system work would be to identify materials as "wastes" only when they are clearly destined for disposal; until then, all potentially hazardous materials would be subject to similar management controls/incentives based on their risk potential rather than on designation

[3] The concept of sustainability addresses many issues, such as land use and species protection, which may only indirectly relate to waste or materials management. This goal would address the issue of sustainability only as it relates to material resources that potentially may be discarded as wastes.

as a waste—that is "materials management" rather than "waste management." Reducing distinctions between wastes and materials could dramatically improve recycling and reuse rates and, therefore, make great contributions towards conservation of resources. A materials management system rather than a "wait until it has been designated as waste" management system implies a revamping of RCRA Subtitles C and D. However, any effort to diminish the distinctions between what are now considered "wastes" (particularly wastes now identified as hazardous) and "materials" must not ignore legitimate needs to protect humans and the environment from risks posed by hazardous chemicals.

An important concern, for example, would be ensuring that reused and recycled materials and products are safe, and do not contain unacceptable amounts of potentially harmful substances ("toxics along for the ride"). With respect to materials currently classified as wastes but destined for reuse or recycling, this has been and remains one of the most difficult challenges of the current RCRA program; making it work more effectively in a future materials management system would likely require development of more sophisticated risk assessment techniques than are currently available, and/or establishing contaminant limits on a product-by-product, or industry-by-industry, basis.

Tools and Strategies:

- **Economic tools may be most effective.** In a market economy, decisions involving which resources are used, what they are used for, how efficiently they are used, and ultimately how they become waste, are primarily driven by economic forces. Thus, the most effective tools for achieving this goal are likely to be those that use economic incentives to promote more efficient resource use and thus minimize waste generation. Specific tools could include waste generation fees or surcharges on consumption of certain resources, or credits or rebates to reward resource use efficiencies or purchase of goods and services that rely on recycled materials. With many of these tools, revenues could be generated and invested in specific ways that might help achieve this goal, such as developing more efficient design techniques, better recycling technologies, and/or developing markets for recycled products or materials. Achieving this goal might also include implementing measures to reduce current economic incentives and subsidies that encourage the use of virgin raw materials; taking steps to create economic incentives for recycling and reuse; and using renewable resources. Government might also play a role through government purchasing programs that increase demand for goods, services, and products that are produced sustainably.

- **Informational and technical innovations may also be effective.** Informational tools, such as investments in public education to enhance awareness of resource use/sustainability issues, could be an important part of meeting this goal. This trend could involve labeling of consumer products (e.g., some type of sustainability rating), media-based public

service campaigns, Internet resources, and other approaches. In addition, development and investment in more resource-efficient technologies could be stimulated by government policies; these might be developed through NASA-style direct investments in hardware, or other targeted, government-funded research and development initiatives.

- **New regulatory strategies might be needed.** Many traditional environmental regulatory mechanisms (e.g., pollutant emission limits) would likely be less effective than other tools in helping to meet this goal, since such controls would only marginally affect the economics of resource use/reuse. Regulatory mechanisms that could more directly affect resource use/reuse would likely be necessary. Many of these mechanisms are already being explored as part of current pollution prevention programs. For example, one such approach might be a system of "extended product responsibility," under which proper stewardship of products at the end of their life cycles would be the responsibility of the manufacturers, retailers, local governments, and/or other appropriate entities, analogous to the producer responsibility programs already in place in several European countries. Other regulatory approaches could include prohibitions on disposal or mandated recycling of certain types of post-consumer and/or industrial wastes. In addition, quasi-regulatory approaches that might be effective could include greater reliance on corporate environmental management systems (e.g., ISO 14001), third-party certification systems, industry-specific standard practices or methods, local government or community-based oversight, performance standards, or other approaches.

Goal #2: Prevent exposures to humans and ecosystems from the use of hazardous chemicals.

Hazardous chemicals are and will continue to be features of our everyday lives. While some of these chemicals have resulted in significant benefits for society, exposures to materials that contain hazardous chemicals can present risks to people and the environment. These risks can occur at any point in a chemical's life cycle, regardless of whether it is considered a product, raw material, or waste. If distinctions between wastes and materials become less important in the future (as suggested by Goal #1), the need to control risks from hazardous chemicals and materials throughout their life cycles could become a critical feature of the future program. A truly integrated waste/materials management system would therefore need to appropriately address risks from chemicals as they are produced, transported, and used in product manufacture, as those products are used and reused, and if and when the products ultimately become wastes with unwanted harmful properties. The system would also need to address production and manufacturing wastes and byproducts.

Hazardous chemicals (such as dioxins) that do not have commercial uses, but that can be created as an unintended byproduct of other manufacturing or production processes (or waste treatment processes), also must be addressed. As discussed below, a regulatory program similar to the current RCRA Subtitle C system would almost certainly be unworkable for the purpose of the type of integrated waste/materials management system that would be necessary to address all these elements in a seamless way.

At the present time, managing risks from potentially harmful chemicals in the United States is accomplished through a patchwork of federal, state and local regulatory controls, voluntary industry standards, liability incentives, public education efforts, and emergency response services. In many respects, this current system works reasonably well. There are, however, inherent gaps and inconsistencies regarding which chemicals and which types of exposures are addressed, under what circumstances, and what types of risk mitigation measures are employed. We believe that a more coherent and consistent system for identifying, reducing, and controlling chemical risks could benefit human and environmental health, and could be advantageous to industry in many ways as well.

An integrated waste/materials management system would need to address both wastes and materials, and products that are potentially hazardous but clearly are not wastes. Currently, potentially hazardous materials and products that are not wastes are subject to regulation under the Toxic Substances Control Act (TSCA). An integrated waste/materials management system, therefore, could require integrating the functions of what are now two separate and distinct Congressionally mandated programs. A new, broader system of incentives, controls, and functions would likely need to assume a new legal and programmatic identity, rather than being grafted onto either RCRA or TSCA. Such consolidation (which might not necessarily be limited to RCRA and TSCA) could also have the advantage of greater consistency and administrative efficiency for both industry and government.

Tools and Strategies:

- **More information could be a powerful tool.** Informational tools (perhaps combined with other tools) might be the most effective way to reduce risks from chemicals in consumer products and other commonly used materials. More information on potential risks could influence the consumptive choices and behaviors of individuals, which could create powerful market incentives to make lower-risk products, in much the same way that nutritional labels on food packaging have greatly enhanced our ability to make informed dietary choices. Better tracking and communication of material life cycles could allow governments and consumers to more easily examine the long-term implications of their choices and account for true life-cycle costs.

- **Utilize the potential of economic incentives and technical innovations.** Economic incentives and/or disincentives might be effective in furthering this goal, by, for example, making it more costly for manufacturers to use certain high-risk chemicals, or encouraging development and use of less harmful materials. Liability schemes are another type of tool that could provide strong incentives for industry to manage chemicals safely, as could certain types of insurance instruments. Risks from the use of hazardous chemicals could also be mitigated by technological advances, such as through development of less hazardous substitute chemicals or improved chemical handling techniques and equipment, or the use of alternative, renewable resources. Public/private partnerships that focus on product design and technology development and transfer could contribute to this evolution.

- **Some regulatory controls would be needed.** Some traditional environmental regulatory controls would almost certainly be necessary to ensure safe products and safe handling of hazardous chemicals by industry. Such controls might address siting of facilities, transportation and storage of hazardous materials, limits on hazardous chemical content of certain products, or outright bans on very high-risk chemicals. The work group believes, however, that any such system of regulatory controls would need to be less complex and more performance-based than the current hazardous waste regulatory system.

Goal #3: Manage wastes and clean up chemical releases in a safe, environmentally sound manner

As discussed under Goals 1 and 2, a fully realized transition from a RCRA-style waste management program to a broader waste/materials management system has the potential for substantially reducing the volumes and toxicity of wastes generated by the nation's businesses and households. Even so, as discussed previously, it is almost certain that two to three decades from now some wastes will still be with us. Ideally, of course, all wastes would be used and reused in a continuous cycle, in much the same way natural ecological systems work. Unfortunately, U.S. industry and consumers are not yet as efficient as nature at materials use and are unlikely to become so fully within the next few decades. Although the types, volumes, and composition of wastes will change over the next few decades, we must assume a continued need for waste disposal capacity, as well as some type of waste management system that ensures adequate protections for human and ecological health.

In fashioning an effective waste management program as part of a broader waste prevention and materials management system, one of the important issues that would need to be addressed is how and at what point in a material's life cycle would the material be considered a waste. As discussed previously, one approach

could be to classify a material as a waste at the point where it is clearly destined for disposal, such as when it is shipped to a facility to be landfilled. Because, under an integrated materials management system, all hazardous materials would be subject to essentially the same controls/incentives, the concept of waste management would be reduced (from the current RCRA program) to controls over the transportation, landfill design, operation and monitoring, and any required treatment of wastes prior to disposal in landfills.

Under an integrated waste/materials management system, the current "cradle-to-grave" approach to waste management would be supplanted by programs under which materials that are now considered wastes would instead be presumed to be valuable materials, unless and until their useful life is expended (however that may be determined), resulting in a "retirement-to-grave" rather than "cradle-to-grave" system. The main features of a future waste management program, particularly for high-risk wastes, would likely evolve from the more successful elements of the current RCRA program.

A major emphasis of the current RCRA program involves protection of ground water and other environmental media from contamination, by both prevention measures (e.g., unit design standards and monitoring requirements) and cleanup of past releases. Preventing future releases would obviously remain a key objective of a future waste management program. By the year 2020, cleanup of existing contamination problems at RCRA-regulated facilities will hopefully largely be complete, though some long-term remediation work may still be ongoing, and some mechanism for addressing releases that may occur in the future will presumably be needed. Opportunities may also remain to further revitalize idled or under used properties, currently called brownfields, and therefore to increase conservation of open spaces and greenfields. This cleanup function of the current RCRA program could be retained in a future waste management system, or could become the responsibility of one or more other federal or state cleanup programs.

Tools and Strategies:

- **Some regulatory controls would likely be necessary.** Under an integrated waste/materials management system, the materials that would be considered wastes would primarily be those that are lowest in value and least amenable to reuse/recycling. Because these "wastes" would have negative value to those who generate them, there would be a clear incentive to dispose of them as inexpensively as possible. This at least implies the need for a system of government-administered controls to ensure protective management, disposal, and long-term care, particularly for those wastes which have the highest relative risk potential. As stated previously, a future regulatory system should be able to effectively protect public health and prevent mismanagement of wastes, while being less complex and

more performance-based than the current RCRA Subtitle C system.

Regulatory controls will also likely continue to be necessary to ensure cleanup. Even if in 20 years remedies are in place at most contaminated sites, it is unlikely that these remedies will have resulted in complete destruction or removal of all contamination. Even now, many of the remedies put in place during cleanups rely at least in part on forms of containment to reduce opportunities for exposure to contaminants. Provisions will be needed to ensure continued protection from residual contamination through operation and maintenance of remedial systems and institutional controls. Contingencies will be needed to ensure discovery and cleanup of releases of hazardous materials that may occur in the future—including the inevitable releases that will occur from present-day landfills and other waste management facilities, especially when opportunities exist to redevelop properties through cleanup.

- **Other tools could lessen the need for regulation.** Economic incentives such as surcharges on waste generation or disposal might be used to encourage waste minimization, and resulting revenues could be used to develop waste treatment and recycling technologies. Other fiscal policies, such as tax credits for companies that reduce waste generation, incentives to cleanup and redevelop idled or under used contaminated properties, or a requirement that companies maintain certain types of insurance, could also be effective incentives.

Information tools could also work. For example, public disclosure (e.g., on the Internet) of facilities' waste generation and management practices could create pressure on companies to manage wastes safely. Advanced information and communications tools could also enhance government oversight capabilities over waste management activities.

It is also entirely possible that future technologies could make waste treatment much more effective and/or less expensive than today. In the next 20 years, we will also presumably have much more information on the long-term performance of landfill containment systems, which could lead to significant improvements in waste disposal techniques.

Conclusions

>> It is certain that in 2020 waste and materials management will have changed considerably from today, no doubt in many ways that are impossible to anticipate at this time. The work group believes that the current system for waste management in the United States, and perhaps other environmental regulatory programs that were developed in the 1970s, will also need to change in important ways if we are to meet the environmental challenges of the coming decades.

The work group acknowledges the likelihood that some of the trends and directions articulated in this paper will ultimately be proved wrong, and that the future of waste and materials management two decades from now will be influenced by many forces that the work group has not anticipated. This uncertainty is expected and does not argue for inaction. The United States must begin to move towards the future now—and the work group believes that the fundamental goals of a future waste and materials management system, as described in the preceding section of this paper, will likely remain valid 20 years from now, despite uncertainties.

The work group believes that sustainability is a critical environmental, economic, and quality of life issue that this country and others will need to confront over the next decades. Since the United States is by far the world's largest consumer of goods and services, it has the responsibility to act with serious purpose to use resources more efficiently and work toward a more sustainable national and global economy. The work group believes that developing new approaches for conserving resources, reducing the amount of toxic materials in society and the toxicity of materials that remain, and managing wastes properly can and should be an important part of responding to this challenge of making a more sustainable world. Promoting resource conservation along with economic growth will need the full range of innovative tools we can collectively devise.

Many of the ideas presented in this paper suggest the need to create a more comprehensive system for waste and materials management, in ways that go well beyond the scope of the current RCRA program. For example, controlling risks of chemicals throughout their life cycles

(e.g., before and after they become wastes) under a single, unified system would obviously be a major departure from how the RCRA and TSCA programs currently operate. It might also require integrating other programs and authorities, including some that are not currently administered by EPA. The work group recognizes that creating such a comprehensive or "holistic" system for wastes and materials would be a complex undertaking. The work group is certain, though, that these are ideas well worth exploring. It might be that this effort could eventually become part of an even larger effort to create a single, unified program for all environmental media that the federal government, states, and tribes now implement under various statutes.

Those who commented on the draft RCRA Vision Paper generally supported the goal of reducing the amount of waste generated and changing the ways in which society identifies materials as wastes; however, comments were mixed over the idea of an integrated waste/materials management system. Some commentary expressed strong concern over the paper's examination of such a system. These comments tended to advocate for reform of particular elements of the current RCRA program and the ways in which it identifies and regulates "wastes" destined for reclamation, recycling, or other reuse, rather than consideration of a new system, arguing that these reforms alone would accomplish increased rates of recycling and reuse and that "materials management" was not appropriate or needed under RCRA. In contrast, some of those who provided comments asserted that the paper does not adequately emphasize the issues and benefits associated with materials management approaches. These comments tended to emphasize the need for initiatives to reduce the amounts of raw materials (especially toxic chemicals) used to produce goods and services, and increase consumer knowledge about manufacturing processes and product composition to inform consumptive choices. Some also discussed the need for life-cycle analysis, the benefits of increased product responsibility through product stewardship and related initiatives, and other non-waste-oriented techniques that might be used to encourage more sustainable behaviors.

The work group recognizes that these are controversial issues. However, the work group also recognizes that potentially harmful chemicals can enter the environment throughout the materials life cycle: from the extraction of raw materials, to the production of goods, to the use of those goods, to the management of the resulting waste. At this point in time, waste disposal probably represents only a small part of the source of exposure to harmful chemicals. If we want to reduce the volume of materials used in creating a sustainable lifestyle and reduce the amount of toxic chemicals in the environment, the work group believes that society needs to focus on materials management, as well as proper waste disposal. How to create the proper set of economic incentives, share accurate information to inform choices, control and restrict improper practices, and measure the environmental benefits of such a system will be the

major challenges facing those who are interested in pursuing the goals outlined in this paper.

The work group encourages readers to join the dialogue surrounding the primary question this paper has explored: how can appropriate policies regarding resource conservation, materials management, and the proper disposal of wastes (which will hopefully be smaller in volume and less potentially harmful) emerge to meet the challenges of the next quarter century?

United States Environmental Protection Agency
Office of Solid Waste
(xxxx-M)
Ariel Rios Building
1200 Pennsylvania Avenue, NW.
Washington, DC 20460

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