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## Options for Improving Hazardous Waste Cleanups Using Risk-Based Criteria

Deborah Elcock<sup>1</sup>  
Argonne National Laboratory  
955 L'Enfant Plaza, SW, Suite 6000  
Washington, D.C. 20024

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## INTRODUCTION

Both the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund)<sup>1</sup> and the Resource Conservation and Recovery Act (RCRA)<sup>2</sup> corrective action programs have costly requirements for cleaning up hazardous waste. Cost estimates approach \$150 billion for nonfederal CERCLA cleanups, \$240 billion for nonfederal RCRA corrective actions, and \$300 billion for Department of Energy RCRA and CERCLA remediation activities. Hazardous waste cleanup costs in other countries are unknown, in many countries, cleanup programs are in relatively early stages of development or implementation. Incorporating the idea of risk management (i.e., the use of risk-based health criteria and risk assessments) into legislative and regulatory requirements for hazardous waste cleanup may help contain these costs, while still protecting human health and the environment.

While many legislators and regulated parties champion the increased use of risk assessment, many environmentalists fear that requiring risk assessments will amount to a suspension in regulations and that the environment will suffer accordingly. Beyond the broad risk assessment bills under discussion in Congress, several risk-related actions could be incorporated in specific environmental laws as CERCLA and RCRA, and their related regulations. This paper explores how risk- and technology-based criteria are currently used in the RCRA and CERCLA cleanup programs. It identifies ways in which risk could be further incorporated into RCRA and CERCLA cleanup requirements and the implications of risk-based approaches. The more universal use of risk assessment as embodied in the risk communication and risk improvement bills before Congress is not addressed. Incorporating risk into the laws and regulations governing hazardous waste cleanup will allow the use of the best scientific information available to further the goal of environmental protection in the United States while containing costs, and may help set an example for other countries that may be developing cleanup programs, thereby contributing to enhanced global environmental management.

## FINDINGS

Reviews of the legislative histories of RCRA and CERCLA show little indication that Congress intended risk to be a key factor in providing for the cleanup and management of hazardous waste. EPA has tried, however, to implement risk in many of its regulations. These attempts have typically failed, in favor of technology-based requirements.<sup>3</sup> The public and the Congress have generally preferred technology-based options, but increased exposure to risk concepts and concerns over resources limitations, may be causing public opinion to become more receptive to the concept of risk.

### **Risk in Waste-Related Legislation**

In 1976, Congress passed RCRA to provide a comprehensive hazardous waste management program intended to promote resource conservation and to prevent significant environmental degradation from occurring in the future. There is little explicit consideration of risk in the law, and when it was reauthorized and amended in 1984, the requirements became even more prescriptive. The increased stringency is attributed to Congressional distrust of EPA's ability to effectively implement RCRA, resulting from EPA's perceived lack of progress in writing rules and the influence of environmental groups desiring a comprehensive hazardous waste management statute.<sup>4</sup> Some of the most costly provisions of the Hazardous and Solid Waste Amendments of 1984 (HSWA) include land disposal restrictions (LDRs), minimum technology requirements for land disposal facilities, and corrective

action at treatment, storage, or disposal facilities seeking Subtitle C permits and at interim facilities where there has been a release of hazardous waste into the environment

CERCLA was enacted in 1980 to protect human health and the environment from the dangers of unpermitted or uncontrolled releases of hazardous substances to the environment. Reacting to limited cleanup accomplishments and administrative difficulties during the first 5 years of the Superfund program, Congress added new sections and strengthened others in the Superfund Amendments and Reauthorization Act of 1986. In particular, Congress added cleanup goals and standards, introduced more stringent requirements, and stressed permanent remedies and treatment over containment technologies. The amendments provided remedy selection goals, but did not require EPA to issue specific standards for CERCLA cleanups. Instead, Congress directed EPA to apply legally applicable or relevant and appropriate requirements (ARARs) developed under other federal and state environmental laws to individual CERCLA sites. Many of these ARARs (e.g., effluent limitations guidelines under the Clean Water Act and LDRs under RCRA) are technology-based requirements developed to prevent process wastes from entering the environment; they were not written for managing remediation wastes. As applied to CERCLA cleanups, ARARs can be difficult to identify, and their implementation costs may be high relative to the risk reduction they provide.

None of these legislative provisions incorporates a risk basis, but as discussed below, risk is sometimes considered in the regulations.

#### **Risk in Waste-Related Regulations**

The extent to which risk is considered in waste-related regulations varies. Some regulations require formal risk assessments; others are strictly technology-based.

**Risk in CERCLA Regulations.** The implementing regulations for CERCLA cleanups are contained in Volume 40, Code of Federal Regulations (CFR) Part 300 and are known as the National Contingency Plan (NCP). The NCP provides for risk assessment in several areas. The hazard ranking system (HRS), Appendix A to the NCP, assesses the relative risks posed by exposure to contamination at sites in EPA's inventory of hazardous waste sites, but it does not rely on a rigorous risk assessment procedure. The primary function of the HRS is a screening tool to help EPA determine which sites warrant further investigation -- not to set priorities or assist in remedy selection. The NCP requires a detailed, site-specific baseline risk assessment as part of the remedial investigation to determine if remedial action is required. Risk assessment is also used to modify preliminary remediation goals, to assist in remedy selection in the absence of ARARs, and to help determine whether a site is clean enough to be removed from the Superfund list after cleanup is complete. The impact of these risk assessments on cost-effective attainment of health and environmental protection goals may be diminished because the results are often tempered by other requirements such as the preference for permanence.

**Risk in RCRA Regulations.** In 1990, EPA proposed a comprehensive program to implement the statutory requirements for corrective action under RCRA. This program, proposed as 40 CFR Part 264, Subpart S, was detailed in the proposed rule titled *Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities*.<sup>5</sup> Except for two provisions -- those dealing with corrective action management units and temporary units (issued as final in February 1993)-- these regulations have not been issued in final form. EPA plans to repropose much of the

corrective action rule beginning in 1995. In the meantime, States and EPA Regions use the proposed rule as guidance. The proposed corrective action rule reflects EPA's recognition of the importance of risk. The preamble states that the overall goal in corrective action "is, to the extent practicable, to eliminate significant releases from solid waste management units that pose threats to human health and the environment, and to clean up contaminated media to a level consistent with reasonably expected, as well as current uses." The preamble also says that the highest priorities will be assigned to the most environmentally significant facilities and to the most significant problems at specific facilities. In addressing cleanups, the preamble allows the Agency to rely on "conditional" remedies where prompt remedial action can reduce risks to levels acceptable for current uses, or where final cleanup is impracticable.<sup>7</sup> The actual rules, however, provide less flexibility. For example, the default assumptions for conducting risk assessments are conservative and do not reflect site-specific conditions. When regulators enforce corrective action, they may look to the regulations themselves rather than to the preamble. As a result, the facility owner or operator must prove whether a given risk-based approach will meet the requirements of the rule. In addition to the proposed Subpart S rule, other RCRA regulations directly affect corrective action. These include LDRs, minimum technology requirements (which hazardous waste disposal facilities must meet before accepting hazardous waste), and the definition of hazardous waste.

#### **Concerns that Could be Addressed Through Increased Use of Risk**

Several aspects of the CERCLA and RCRA cleanup programs can lead to lengthy cleanup schedules, inconsistent approaches to site investigation and remedy evaluation, and remedies for which costs outweigh the benefits. Many of these concerns could be mitigated, at least in part, through a more explicit consideration of risk.

**Cleanup Requirements.** Although CERCLA does contain the requirement that ARARs under State law, identified in a timely manner by the State, must be considered in a CERCLA action. However, CERCLA does not define which federal requirements are applicable or relevant and appropriate in which circumstances. As a result, EPA and the courts frequently determine which ARARs must be met. This often time-consuming process must be repeated for each site. Because States are not required to pay for the costs of meeting state ARARs, which may be more restrictive than federal ARARs, many potentially responsible parties (PRPs) argue that meeting such state ARARs leads to higher cleanup costs and variability in remedies across different States for comparable sites and risks. Risk-based cleanup criteria, in which the remedy selected is commensurate with the risks posed by the problem, could help alleviate many of these problems.

ARARs, *per se*, are not used in RCRA cleanups, but the use of action levels and media cleanup standards, coupled with the requirement that a corrective measure comply with all applicable waste management standards, produces similar results. Action levels are media-specific contaminant concentrations, which, if exceeded, will trigger a requirement for a corrective measures study (CMS) and are based on an assessment of the risks associated with exposure. Action levels are not final cleanup levels, but they can be used as "target" cleanup standards for purposes of evaluating remedial alternatives during the CMS. Media cleanup standards are the contaminant concentrations that an implemented corrective measure must achieve. Media cleanup standards are established based on an evaluation of several site-specific factors, including land use, the effectiveness of the selected corrective measures, and direct, indirect, and multiple contaminant exposure. However, the application of action levels might not consider risk in a realistic fashion. This is because, like ARARs, action levels are often standards issued under other laws, and because they assume

unconditional use of a facility. To help ensure that action levels accomplish their intended purpose, they could be designed to reflect plausible or most likely scenarios. If an action level is exceeded, a site-specific risk assessment could be conducted, thereby providing the risk manager or regulator with a realistic distribution of the actual risks.

**Exposure Assumptions.** In the CERCLA remedy selection process, risk assessments are conducted for contaminants when ARARs do not exist. Risk estimates are based on "reasonable maximum exposures," which represent exposures well above average, yet still within the range of possible exposures. While such conservative assumptions can protect human health and the environment, many argue that the costs for remedies selected on the basis of such assumptions could be used to mitigate potentially greater hazards. Another concern with the current approach is the preference for permanent treatments. Some treatments thought to be permanent when prescribed may not be permanent in practice. This is especially true with pump and treat technologies for groundwater treatment. In many cases, existing groundwater cleanup goals cannot be attained in reasonable time frames (decades) with current technologies. In RCRA corrective actions, action levels may be calculated in cases where existing standards do not exist. The calculations are based on a set of conservative exposure assumptions specified in the proposed rule.<sup>8</sup> These assumptions significantly overestimate real exposures. For example, four of the five sets of exposure assumptions assume that the individual at risk is exposed for 24 hours per day, 365 days per year, for 70 years, implying that the person never changes residences, never works outside the home, never takes a vacation, and is always at the point of maximum exposure for 70 years. Compounding this conservatism is that these worst-case assumptions are cumulative. Although each conservative assumption may be individually plausible, the probability that all worst-case assumptions will occur simultaneously is remote. Overly conservative and compounded exposure assumptions can lead regulators to derive excessively stringent action levels and to make inappropriate decisions about the level of corrective action required at a site. The use of "most likely" exposure assumptions could be used to develop action levels when site-specific data are unavailable. Action levels could still be used, but the risk basis would help produce more realistic decisions.

**Slow Cleanup Progress.** Critics of the Superfund process often point to slow cleanup progress. The Congressional Budget Office (CBO) recently analyzed the duration of Superfund cleanups and concluded that the average time between proposed listing on the National Priorities List (NPL) and completion of principal cleanup work is at least 12 years, and probably closer to 13 to 15 years.<sup>9</sup> EPA acknowledges that since the start of the program in 1980, fewer than 20 percent of the sites have completed principal cleanup work. Reasons for the slow progress include resource constraints, problems with achieving the required degree of remediation, coordination problems among agencies, nature of the contamination, complexity of the site, and enforcement problems. Standardized, risk-based remedies and combined cleanup phases based on risk could help speed the cleanup process.

The RCRA corrective action program is also proceeding slowly and the General Accounting Office (GAO) attributes the slow progress to several factors.<sup>10</sup> The number of facilities requiring corrective action is growing as new wastes are regulated and as EPA identifies illegally operating hazardous waste activities. Other factors include limited EPA and contractor resources, the lengthy and complex nature of the investigation process, and inadequate RCRA facility investigation and CMS submissions. The GAO also points out that the longer it takes for corrective action to be completed at a facility, the greater the likelihood that the owner will be unable to maintain the cleanup effort, or that he may go out of business. EPA, in its 1990 RCRA Implementation Study (RIS), acknowledged

the enormity of the corrective action workload and recommended that efforts to assess contamination at facilities be accelerated. To maximize efficient use of resources, the RIS suggested that EPA rank all facilities based on potential environmental risks and benefits, stabilize the risks (stop the spread of contamination) until final corrective action can be taken, and develop a method for providing different levels of oversight to facilities that pose different risks.<sup>11</sup> Implementation of these recommendations has recently begun, but because the program is relatively new, the effectiveness of the concept remains unproven.<sup>12</sup>

**Management and Cleanup of Low-Hazard Wastes.** The RCRA Subtitle C program was originally designed to prevent hazardous wastes from entering the environment. It did so by identifying materials, which, if mismanaged, could threaten human health or the environment; permitting facilities handling such materials, and minimizing threats by requiring treatment prior to disposal. Designed for process wastes, these requirements still apply to remediation wastes generated during corrective action. Corrective action wastes can include contaminated media, contaminated sludges, and contaminated debris. Many of these wastes are high in volume, but low in concentration of hazardous constituents, and pose low levels of environmental risk. However, they often qualify as hazardous wastes because of the EPA regulations that define hazardous waste. In 1980, EPA published regulations implementing RCRA provisions for identifying characteristics of hazardous waste and for listing specific wastes as hazardous. EPA also included provisions to close what it believed were potentially major loopholes in the Subtitle C waste management system.<sup>13</sup> In the "mixture" rule, EPA provided that a mixture of solid waste and one or more listed hazardous wastes must be managed as hazardous until "delisted." In the "derived-from" rule, EPA stated that any solid waste generated from the treatment, storage, or disposal of a listed hazardous waste remains a hazardous waste unless or until it is delisted. In the "contained-in" principle, which is an EPA interpretation of the "derived-from" rule, any debris that contains a listed waste must be managed as a hazardous waste until it no longer contains that waste. The "contained-in" principle also is applied as a policy to contaminated media. EPA has acknowledged the disparity between the potential risks a material poses and the degree of regulatory control over the material, and suggested that low-risk wastes not be subject to full Subtitle C regulation.<sup>14</sup> In 1992, EPA took a major step toward defining a continuum of control for waste management by proposing a rule that would have tailored waste management requirements to the risk posed by the waste. It proposed two options. The first approach would have established risk-based concentration thresholds below which listed wastes would no longer be subject to all Subtitle C requirements. The second approach would have virtually eliminated the listing process, substituting instead a system that would have identified all hazardous wastes based on characteristics. In addition, EPA proposed that wastes within certain concentration ranges would be contingently exempt from Subtitle C if certain waste management practices were followed. However, because of the number of negative comments and lack of support from the States, EPA withdrew the proposal.

Still trying address the problems associated with hazardous waste identification and attempting to meet a Congressionally imposed deadline of October 1, 1994 for revising the "mixture" and "derived-from" rules, EPA established the Hazardous Waste Identification Dialogue group in January 1993. That group, representing industry, environmental groups and regulatory agencies, was charged with assisting EPA decide how to revise the criteria for identifying wastes to be regulated as hazardous under Subtitle C. After a year and a half, the group was unable to reach consensus and was disbanded. EPA missed the October 1 deadline, and is now planning to propose an identification rule for contaminated media by the fall of 1995 and issue a final rule by late 1996.

EPA has, however, taken positive steps towards improving management of low-risk remediation wastes. The proposed Subpart S regulations contained one very important provision, the requirements for establishing corrective action management units (CAMUs). The CAMU provisions were intended to reduce or eliminate certain waste management requirements (i.e., the land disposal restrictions) of the current hazardous waste management regulations which, when applied to remediation wastes, often impeded the selection and implement reliable, protective, and cost-effective remedies. The final CAMU and TU regulations (promulgated February 16, 1993) provide regulatory flexibility in the selection and implementation of protective, reliable, and cost-effective remedies during RCRA corrective action using risk-based evaluations as part of the approval process. The net result is that the use of CAMUs may reduce the cost and/or enhance the environmental effectiveness of remedies when compared to the requirements of the full Subtitle C program. For example, a regulated unit that would otherwise be capped with the untreated waste left in place could be incorporated into a CAMU, the waste excavated, treated to reduce the toxicity, mobility, or volume of the contaminants, and the treatment residues returned to the unit without having to meet the often burdensome requirements of the LDR. In this way, closure of the unit using the CAMU approach would provide a greater degree of long-term effectiveness and protection, hence a greatly reduced risk.

**Use of Cleanup Technologies.** HSWA prohibited the land disposal of nearly all untreated hazardous wastes. For wastes subject to LDRs, HSWA required EPA to promulgate regulations that would "substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized."<sup>14</sup> EPA considered both risk- and technology-based approaches for meeting this requirement. In January 1986, it proposed risk-based rules, which would not have barred untreated wastes from landfills, but would have required any toxic leachates from these wastes into the surrounding areas to be in concentrations that posed no threat to human health and the environment. Industry argued that the rule was based on overly conservative assumptions and would impose unnecessary and costly restrictions.<sup>16</sup> At the same time, environmental groups and some EPA staff and members of Congress, argued that the proposed rule was based on unreliable science and ignored the intent of Congress. The Environmental Defense Fund said the proposed rule represented "a giant step backwards in the current level of groundwater protection provided in EPA regulations."<sup>17</sup> Based on criticisms received from these latter groups, EPA switched its initial risk-based approach to a technology-based one that would require waste to be treated with best demonstrated available technology (BDAT) before it could be disposed on the land. BDAT applies to both RCRA and CERCLA cleanups. In the proposed corrective action rule, there are four general performance standards that corrective action must meet. One of these is compliance with the RCRA standards for managing wastes, e.g., BDAT. BDAT is also often a CERCLA requirement because Superfund cleanups are required to meet ARARs, which include LDRs. Mandating the use of BDAT, as opposed to using risk-based criteria to set treatment levels can lead to inefficient operations and increased costs. RCRA provides for the use of alternative technologies that are equivalent to BDAT, but the process for proving such equivalency is costly and complex. Some industry representatives have argued that BDAT has forced U.S. industry to use technologies that existed in the early 1980s, has discouraged normal engineering development, and that technology-based rules may be contributing to the decline of the U.S. leadership role in the development of environmental control technologies.<sup>18</sup>



**Cleanup Costs.** Superfund authorizations have grown tenfold since the law was enacted in 1980. The original program was funded at \$1.6 billion dollars, and this amount was expected to pay for the cleanup of a few hundred sites. To address the growing number of Superfund sites, Congress added additional funds in 1986 (\$8.5 billion) and 1991 (\$5.1 billion), and is likely to authorize additional funds during the 104th Congress. Even more money will be needed to pay for future Superfund cleanups. Various entities, including EPA, GAO, and the CBO have estimated the total costs to clean up hazardous waste sites. An often-cited study, and one which estimates costs for both RCRA and CERCLA, is the 1991 University of Tennessee report, *Hazardous Waste Remediation: The Task Ahead*.<sup>19</sup> This report provides a best guess estimate for cleaning up nonfederal Superfund sites, assuming a continuation of current policies, of about \$150 billion. Not included in this estimate are central administrative costs or transaction costs. Transaction costs are expenditures incurred in assigning liability among parties involved at a site. RAND has estimated that transaction costs average roughly 20 to 30 percent of investigation and remediation costs.<sup>20</sup> These high costs can be attributed, in part, to the growing universe of sites needing cleanup. But several industry groups maintain that dollars are being spent beyond what is actually necessary to protect human health and the environment.<sup>21</sup> The University of Tennessee Report points out that the best-guess estimate for nonfederal Superfund of about \$150 billion could be reduced by roughly 40 percent through the use of technologies that emphasized containment and isolation of wastes rather than permanent treatment -- without significantly affecting the ultimate impacts on human health and the environment.<sup>22</sup> But the 1986 amendments to CERCLA require EPA to favor permanence and treatment over containment, and as noted above, cleanups must also comply with ARARs, even if those ARARs do not always significantly reduce risks to human health and the environment. The NCP requires that costs be considered, but only as one of 9 evaluation factors. Incorporating a risk basis into the remedy selection process could help reduce the costs without compromising the goal of protecting human health and the environment.

As expensive as the Superfund program is, many argue that the RCRA corrective action program will be even more costly.<sup>23</sup> The University of Tennessee report provides a best-guess estimate of about \$230 billion to cleanup nonfederal RCRA corrective action sites. In March 1993, EPA issued a draft regulatory impact analysis, which projected that roughly 2,600 facilities (approximately double the number of sites listed on the National Priorities List under CERCLA) will require corrective action remediation, and that the total costs of the program will exceed the total benefits by about \$16 billion.<sup>24</sup> As with the Superfund program, cost is considered, but in this case, as only the last of 5 factors to be considered for remedies that already meet four general performance standards (protecting human health and the environment, attaining final media cleanup standards, controlling the source of the contamination, and complying with the standards for managing wastes). There is no legislative or regulatory requirement that the incremental health and environmental benefits associated with a particular remedy be commensurate with the costs of that remedy. EPA recognizes that many of the corrective action requirements could lead to high costs. Implementing risk-based cleanup criteria is one approach for beginning to mitigate these costs.

### **Options for Increased Use of Risk**

Concerns associated with the current RCRA and CERCLA cleanup programs include high costs, long lead times, need for more efficient cleanup technologies, cumbersome compliance requirements, and stringent requirements for managing low-risk wastes. An increased consideration of risk in the regulatory and legislative requirements governing these programs could help mitigate these concerns, while still meeting the goals of protecting human health and the environment.

**Regulatory and Policy Options.** Many of the options for increasing the use of risk in cleanup actions may be accomplished through changes to the regulations. Some of these are described below.

**Redefine Remediation Wastes.** Remediation wastes are currently defined under 40 CFR §260.10 as "all solid and hazardous wastes, and all media (including groundwater, surface water, soils and sediments) and debris that contain listed hazardous wastes, or which themselves exhibit a hazardous waste characteristic, that are managed at a facility for the purpose of implementing corrective action requirements under 40 CFR §264.101 or RCRA §3008(h). For a given facility, remediation wastes may originate only from within the facility boundary, but may include waste managed in implementing RCRA §3004(v) or RCRA §3008(h) for releases beyond the facility boundary." Unless managed in a CAMU or temporary unit, EPA's application of the "mixture," "derived-from," and "contained-in" rules causes many low-risk remediation wastes to be managed in full compliance with the stringent requirements of Subtitle C. EPA is currently considering approaches for modifying the definition so that these low-risk wastes can be managed in a way that more consistently reflects the risks they pose. EPA's yet-to-be proposed rules could apply to RCRA corrective action and CERCLA sites, as well as emergency spill, voluntary cleanup, and leaking underground storage tank sites. The types of waste could include contaminated soils, debris, groundwater, surface water, sludges, and sediments. EPA plans to establish a "bright line" which would divide remediation wastes into two categories. Those with hazardous constituent concentrations greater than certain to-be-determined thresholds would fall above the bright line and would be managed according to full Subtitle C requirements. Those below the line would be subject to site-specific management standards determined by state regulatory agencies. In establishing the bright line, EPA is considering a number of risk- and nonrisk-based approaches. One approach would use risk assessment to set constituent-specific or chemical group concentration levels, which would apply nationally -- possibly with some modification based on site-specific considerations. Another approach would require the use of specific treatment technologies for wastes that fall above the bright line. One problem with using risk-based approaches relates to the data needed to establish the concentration levels. Indeed, EPA's May 1992 proposal, which would have eliminated the concept of listed wastes and substituted a program that identified all hazardous wastes based on characteristics, required data to set risk-based concentration levels that were not currently available. Critics claimed at that time that when data are not available, assumptions are set conservatively, with the result that even more wastes would be managed as hazardous.<sup>25</sup> Nonetheless, a phased implementation of such an approach, as data are collected, could provide for a smooth transition from the current system of waste listing to a more realistic characteristic-based system. By using a risk-based approach, EPA could achieve human health and environmental protection goals without producing undesirable side effects (e.g., impeding the use of optimal cleanup remedies) often associated with technology-based approaches.

**Encourage Use of Risk-Based Standards.** In RCRA, the preamble to the proposed corrective action rule (67 pages) contains risk-based language and philosophy, which in many cases is not transferred to the actual rules (11 pages). For example, the preamble states that where there is little likelihood of exposure due to remoteness of a site, alternative points of compliance may be considered.<sup>26</sup> EPA authority to designate such risk-based alternative points of compliance should be stated explicitly in the language of the rule itself. Formalizing the risk basis in the actual rules will allow both the regulated community and the regulators to base actions on the same information. For LDRs, the debate over technology- versus risk-based standards has been underway since EPA proposed the first LDRs in 1986. EPA maintains that its ultimate policy preference is to establish risk-based levels that minimize threats to human health and the environment, but has experienced formidable and

controversial difficulties in establishing such standards.<sup>27</sup> As recently as September 1994, EPA proposed universal treatment standards to replace existing constituent-specific/waste-specific standards for many hazardous wastes, but even these proposed standards are not risk-based. EPA says that before increased use of risk-based standards can occur, a variety of technical issues, such as assessing exposure pathways other than migration to groundwater, accounting for environmental risks, and developing adequate toxicological information for the short term must be resolved.

For Superfund cleanups, a key concern is the lack of specified cleanup standards and the resulting requirements for meeting ARARs. Eliminating ARARs (or at least the relevant and appropriate portion of ARARs) and replacing them with a set of national cleanup goals based on risk reduction could provide for cleanup levels that protect human health and the environment while being cost-effective. Replacing state and federal ARARs with risk-based goals would help reduce cleanup costs, introduce more consistency, and help mitigate overly protective remedies where risks do not always warrant the costs. Technology-based approaches to establishing cleanup standards may also speed decision making and increase consistency, but if EPA develops excessively protective and expensive standards, PRPs may become less willing to cooperate in the cleanup process.<sup>28</sup> Technology-based approaches also preclude consideration of site-specific conditions such as geology and hydrology, which affect contaminant dispersion and resultant risk. A standardized, risk-based assessment process would provide a basis for site-specific remediation plans that reflect local factors such as exposure pathways.

Several options exist for giving more weight to risk reduction in the remedy selection process. EPA has developed an approach for prioritizing risk reduction at all Superfund sites. The Superfund Accelerated Cleanup Model (SACM) is designed to expedite initial assessment and subsequent cleanup of Superfund sites.<sup>29</sup> Under the model, distinctions between removal and remedial actions are eliminated. A regional decision team undertakes short-term activities to eliminate much of the risk from Superfund sites. It also determines if and when long-term remediation is appropriate. Initial reports on the success of pilot SACM projects indicate that the cleanup process can be cut at some sites from 5-12 years to 2 years.<sup>30</sup> Arthur D. Little, Inc. has recommended a similar two-phased approach that would first identify primary site issues, define cleanup objectives, and formulate a preliminary remedial strategy.<sup>31</sup> The second phase would formally determine the need for cleanup versus site control and cleanup deferral. Where cleanup was found to be necessary, project managers would conduct detailed remedial studies and select remedies to meet objectives. Such a process is not inconsistent with the NCP, but goes beyond EPA's current process by incorporating risk more explicitly. Such a process may require Congress to confirm that cleanup deferral is consistent with the overall goal of protecting human health and the environment.

Consider Land Use. How land will be used after cleanup is an appropriate consideration for establishing risk-based cleanup levels for contaminated media. Realistic land use assumptions are critical inputs to risk assessments. Unrealistic assumptions can significantly increase cleanup costs without providing commensurate benefits. EPA has often assumed that the future land use at Superfund sites will be residential, even when existing and prior uses were not residential.<sup>32</sup> EPA could require site managers to consult with the public and local planning authorities when determining future land use scenarios. It could also invoke a policy that future land use assumptions be based on current land use unless information is provided verifying that the current use is likely to change.

Consider Management of Waste. The threat to human health and the environment should not be based on the assumption that if a waste is not managed according to Subtitle C, it will not be managed at all. For wastes where RCRA Subtitle D requirements will be applied, concentration limits could be raised without increasing risks to public health and the environment. Developing risk-based standards for evaluating whether wastes should continue to be managed according to Subtitle C could improve the system so that wastes addressed by other regulatory requirements are not over-regulated.

Set Priorities Based on Risk. Environmental needs often exceed scarce human and economic resources. When not all environmental needs can be met, resources should be directed toward the more serious environmental problems. The CERCLA and RCRA cleanup programs can be enhanced by requiring that actions are taken first at those sites and at those portions within sites where risks to human health and the environment are greatest.

The Superfund law provides no explicit direction for setting priorities. EPA has taken steps to use risk in setting priorities, but more needs to be done. In 1989, EPA established a "worst first" policy, and issued guidance delegating the priority-setting task to the Regions. However, GAO has found that the Regions have done little to implement this policy, and that they often base priorities more on such considerations as the level of effort required to evaluate sites than on the risks posed to human health and the environment.<sup>11</sup> Compounding this problem is that national comparisons are difficult, because Regional Administrators respond to sites in only in their own Regions. In 1990, EPA's Science Advisory Board recommended that EPA reflect risk-based priorities in its budget and strategic planning processes.<sup>14</sup> This recommendation can be extended to individual programs, and can be applied to within and among individual waste sites in the Superfund program. Using risk-based criteria to help set cleanup priorities and to solicit development in areas needing new technologies can help ensure that new technologies are used to solve problems that cause the greatest risks to human health and the environment.

The need to set priorities in allocating resources in the RCRA corrective action program is underscored by the fact that RCRA places many unnecessary burdens on the management of low-risk wastes. In many ways, EPA is already setting priorities for corrective action based on risk. It is incorporating the concept of relative risk analysis in its National Corrective Action Prioritization System (NCAPS) for corrective action sites. NCAPS is a computer-based system that uses factors such as pathways and exposure potential to produce a high, medium, or low ranking for each facility. These rankings are used with other factors to identify general priorities for initiating cleanup of RCRA facilities. The existing risk-based priority setting processes can be improved, however, by using better data collection and management procedures, increasing consideration of societal values; and incorporating additional risks such as noncancer health effects, ecological effects, multiple exposure pathways, and impacts of cumulative exposures. It is possible that full and successful implementation of risk-based priorities may require Congressional action.

**Legislative Options.** Many options for incorporating risk-based criteria into the Superfund and RCRA corrective action programs can be accomplished without legislative action. However, in some cases additional Congressional authority may be needed to facilitate such implementation. Specific actions include the following:

- Clarify the language of both RCRA and CERCLA to require action only in cases where releases pose an actual threat to human health and the environment.
- Modify CERCLA so that actual or planned future land and water uses at and around Superfund sites are considered when setting cleanup levels and selecting remedies for sites.

Besides clearly establishing a requirement for EPA to incorporate risk-based criteria, specific amendments to RCRA and CERCLA may help facilitate the use of risk in cleanup programs. One action would be for Congress to provide guidance on what constitutes an acceptable level of risk. Risk assessments can provide objective estimates of increased mortality or morbidity per unit of population, but risk managers need to evaluate those results. Congress should address the question of what mortality rates are acceptable. Another area for explicit action would be to amend both laws to provide for the use of site-specific, risk-based cleanup standards -- for determining the need for cleanup and for choosing the remedies to be implemented.

RCRA and CERCLA should also provide for setting cleanup priorities within and among sites based on risk. This would entail a consolidation of priorities across the EPA Regions and should provide consistent measures for considering social and economic costs and providing for public involvement. Ultimately an integration of Superfund and RCRA corrective action priorities could occur if the systems for prioritizing cleanups were the same.

Additional changes to RCRA for providing increased use of risk include the following:

- Exempt contaminated media from Subtitle C requirements such as the LDRs in cases where there is an EPA-approved plan for treating and disposing of contaminated media, and not require approval of a CAMU for the post-treatment management of the treated media.
- Provide for a flexible, contingent management system for hazardous wastes that would authorize state and federal authorities to oversee management of low-risk wastes in a system that was less demanding than Subtitle C, while still protecting human health and the environment.

Specific CERCLA amendments for enhancing the use of risk include the following:

- Encourage the use of realistic land-use assumptions in risk assessment and remedy selection. Such assumptions would consider current and prior uses of the land, land use in the surrounding area, and long-term land use controls.
- Continue the requirement for compliance with all applicable laws, but replace the reliance on relevant and appropriate requirements with a risk-based process for determining actions. This process would consider such factors as risks to the public and cleanup workers risks posed by moving contaminants from one medium to another, cost-effectiveness, resources, and overall environmental impact.
- Give a preference, when selecting remedies to institutional controls, containment, and other interim measures, in cases where these measures will adequately protect human health and the environment.

## CONCLUSIONS

Both the CERCLA and RCRA cleanup programs suffer from lengthy investigation and remedy selection processes, high implementation costs, and the required use of treatments or technologies that in some cases may not be cost-effective. Underlying these problems are a variety of specific concerns, including the fact that many low-risk remediation wastes, contaminated media, and debris are subject to the strict Subtitle C requirements that were designed for highly toxic process wastes; that cleanup levels must consider, if not meet, requirements developed for wastes and processes often unrelated to cleanup; that when risk assessments are conducted, they often use conservative exposure assumptions, which when compounded lead to unrealistic results; and that there is no priority setting process to provide for efficient allocation of limited resources.

Many of these concerns could be mitigated, at least in part, by the increased consideration of risk in the laws and regulations that implement the cleanup programs. However, there is little indication that Congress intended risk to be explicitly considered when it drafted the legislation which now governs what materials must be managed as hazardous waste and how those wastes must be managed. EPA regulations, especially many of those proposed for RCRA corrective action, incorporate a risk basis, but much more can be done. By using risk in the remedy selection process and in prioritizing sites for cleanup, managers can help mitigate the problems associated with the fact that more and more sites are requiring cleanup, while both Federal and State funding of cleanup programs faces increased competition from other requirements.

In many ways, the timing for increasing the use of risk in cleanup actions is propitious. Superfund reauthorization, which may occur in the 104th Congress, is an excellent vehicle for encouraging a risk-based approach to environmental restoration activities. By providing for the use of site-specific risk assessments for determining the need for cleanup and the choice of remedies, requiring a risk-based system to establish cleanup priorities, encouraging the use of realistic land-use and water use assumptions in risk assessments, and reducing reliance on ARARs and permanent treatments while allowing for risk-based control measures, CERCLA could provide for significant risk reduction at more sites, and still maintain its goals of protecting human health and the environment.

That many low-risk wastes and other materials at cleanup sites must be treated in accordance with Subtitle C of RCRA can be remedied as part of EPA's rulemaking process for developing a hazardous waste identification rule. Using a risk-based approach to help determine what wastes need to be managed as hazardous and to help determine how those wastes should be managed is something EPA is considering as it develops its process waste and contaminated media definition rules, now scheduled for proposal in late 1995.

EPA has already taken a risk-based approach in its philosophy toward the corrective action program. The proposed corrective action rule has been used as guidance since 1990. During that time, weaknesses have surfaced, and as EPA repropose many facets of the July 1990 proposal, it can incorporate many of the risk-based approaches found in the preamble to the rule into the rule itself.

Although RCRA reauthorization is not a high priority for the 104th Congress, certain provisions could be considered for RCRA that would help facilitate the use of risk in the implementing regulations. These include provisions that require corrective action only when releases pose actual threats to human health or the environment, and that contaminated media would be exempt from

Subtitle C requirements when there are EPA-approved plans for treating and disposing of the contaminated media.

EPA regulations and guidance can go a long way toward increasing the risk basis in current programs, but in some cases, legislative changes may help facilitate these changes by clarifying that they are within the intent of Congress. Such changes also may be influenced by broader ongoing legislative activities, such as those requiring enhanced risk communication, comparative risk analysis, risk assessment for new regulations, incremental cost-benefit analysis, and sound science.

Although the timing and atmosphere may be better than ever for broadening the use of risk in cleanup programs, many obstacles remain. Although EPA headquarters may favor the increased use of risk, EPA Regions, States, and other stakeholders may oppose risk assessment for a variety of reasons. These include requirements for additional resources to conduct risk assessments, the possibility of national risk-based rankings that could push certain high-priority sites in a given state to a lower level in a broader scheme, and the concern of many environmentalists that risk assessment distorts outcomes and is viewed as a means to bypass important environmental regulations. While risk-based options could be addressed through changes in regulation or policy, it appears, that for the short term at least, the increased use of risk-based approaches will occur only after EPA has been able to address technical issues (e.g. methodologies for indirect risk assessments) and data needs associated with using a risk basis. At the same time, efforts to increase the use of risk, which are in large part seen as a way to help mitigate the problems that have surfaced with the implementation of cleanup programs in this county, should be pursued. Not only is there a need for a better means to protect human health and the environment in the United States, but other countries, which are still developing their programs may look to the United States for guidance. To the extent that these countries can emulate effective U.S. programs, global waste cleanup efforts will be improved.

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