MANAGING UNCERTAINTY:
LESSONS FROM THE U.S. SUPERFUND PROGRAM

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I. THE RISK MANAGEMENT FRAMEWORK

Life is not a zero risk proposition, particularly life in modern industrialized societies. The risks come from many sources. The bacon you may have enjoyed at breakfast, the cigarette you maybe smoking now, and the beer you may be contemplating this evening all pose threats to your health because of the chemicals they contain.[i] Although advances in sanitation and medical science have virtually eradicated the infectious diseases which were the predominant cause of premature death in earlier cultures, our increased chemical and technological sophistication has created a new grim reaper. The likelihood of incurring cancer during your lifetime is high. One in four Americans are projected to have cancer of some sort during a seventy year lifetime expectancy.[ii] One out of five of those who contract the disease will die as a result of it.[iii] Numerous epidemiological and laboratory studies have demonstrated a link between certain toxic substances, cancer, and other health-threatening diseases. Studies also confirm that between sixty to ninety percent of all cancers can be traced to environmental origins.[iv] The term "environmental" includes not only contamination in the air, water, and soil but also lifestyle choices, including decisions relating to the foods we eat and the activities we undertake.

The fact that cancer as well as many other diseases may have an environmental origin is significant because it indicates that by changing our behavior to limit exposure we can theoretically prevent these illnesses from occurring. For example, interaction between humans and chemicals can be limited in several ways: by never allowing the chemical into the environment, by carefully controlling its use in the environment, or by removing it from the environment. On its face, this sounds like an easy task. Decision makers should exercise their authority to ban future production of dangerous chemicals, provide directions for safe applications of others, and move quickly to purge our environment of those that have already been released. The public expects nothing less from its decision makers. Unfortunately, the task is far from easy, involving complex factual situations, uncertain science, and value judgments.

Chemicals or toxic substances are the foundation of an industrial society. The problems we are experiencing today would not have occurred if the world had remained a rural, farming society. These problems are a result of progress in this century in the development of science and technology. Chemical substances protect our crops from infestation. They are the raw materials from which countless finished products emerge. Until recently, these toxic compounds fell neatly within "the Toilet Principle": out of sight, out of mind. The compounds were the by-product of the post World War II boom in the use of synthetic organic compounds: a silent revolution in the type and volume of chemicals manufactured.[v] Back then, our motto was the popular advertising slogan, "Better living through chemistry".[vi] Unlike chemicals produced earlier, these synthetic compounds are not readily biodegradable. Persisting indefinitely, impacting our ecosystems, and entering our foodchains, their deadly potential caught us entirely unaware.

Adding to the problem (since the end of World War II) the number of chemicals has multiplied twenty-five times.[vii] Of the more than five million chemicals identified today, approximately sixty thousand of them are in daily commercial use. Of these, only 102 are

specifically regulated in the United States.[viii] The remainder are manufactured and used without constraint. Once these chemicals have been used, their residue is considered waste since it has no further economic value. Cheap disposal of these wastes is in the best economic interests of the waste generator, but not the environment. The United States Environmental Protection Agency (U.S. EPA) is the chief Federal administrative agency charged with protection of human health and the environment. U.S. EPA estimates that prior to the enactment of national legislation in 1976 dealing with the safe generation, transportation and disposal of hazardous waste, 90% of all hazardous wastes were improperly disposed of in unsecured pits, ponds, and lagoons. Accordingly, the United States faces a forty year legacy of hazardous waste mismanagement.

The true breadth of the problem was not immediately evident. Starting with the discovery of isolated sites such as the Love Canal in Niagara, New York in 1976 followed by the Valley of the Drums in Kentucky, the number of hazardous waste sites identified has escalated dramatically. Time and again, the U.S. EPA has increased its calculations. We currently believe that there are between 25,000 to 30,000 hazardous waste sites in the United States. That estimate has been challenged, however, in a recent report of the U.S. Government Accounting Office which contends that the actual number is closer to 240,000 sites. Regardless, the problem is substantial.

Each of these sites could pose a serious risk to human health and the environment through exposure routes including inhalation, dermal absorption, and ingestion. The American public has vigorously voiced its objections to being exposed to such risks. In response to the public's outcry over this avalanche of sites and its panic over their possible impact, the United States Congress established a two-pronged legislative approach to toxic wastes in the United States.

First, to assure that additional sites would not be created, Congress enacted the Resource Conservation and Recovery Act, commonly known by its acronym "RCRA".[ix] The Act provides for cradle to grave management of hazardous waste through comprehensive regulations including licensing and tracking systems. RCRA guarantees that the 60,000 active U.S. generators of hazardous waste and the 3,000 facilities currently treating, storing or disposing of this waste do so in an environmentally sound manner. Failure to do so results in stiff civil and criminal penalties. The vigorous administrative and judicial enforcement of RCRA has dramatically reduced the creation of new problem waste sites.

To address those sites already in existence, the U.S. Congress enacted a unique piece of environmental legislation. The *Comprehensive Environmental Response Compensation and Liability Act* is commonly known either by its acronym, "CERCLA", or by the term, "Superfund" in reference to its unprecedented funding mechanism—an 8.5 billion dollar trust fund financed by a tax on the petro-chemical industry.[x] The sole purpose of Superfund is to clean up abandoned hazardous waste sites. Regulation of ongoing waste activities, manufacture of toxic substances, and registration of pesticides is left to other statutes.[xi]

In the eight years since Superfund's passage, the U.S. Government has learned a great deal about hazardous waste cleanups. It has also learned our limitations regarding the three primary

components of toxic waste management: risk assessment, risk communication and risk management. Implementation of Superfund has identified some crucial issues not only for risk managers but also for society at large. It has taught us that managing risk often means managing uncertainty. As members of the Canadian judiciary, you will ultimately be faced with many of these issues. You will be thrust into the role of risk managers, not of your own volition, but by necessity. Unfortunately, the questions you will be asked to rule on do not come down to a matter of clearcut scientific or technical expertise. They require sensitive value judgments encompassing political, economic, social, technological and ecological factors. Moreover, these judgments cannot be delayed. Responsible government action to address the threats posed by hazardous substances already released into the environment requires decisive action in situations which are complex and filled with uncertainty.

II. THE SUPERFUND PROGRAM

As a risk manager in the United States' program, I would like to share with you some of the key issues we have grappled with relating to risk assessment, risk communication and risk management. Our experience with these activities is bounded by the statutory parameters of the Superfund law which was first passed in 1980 and subsequently amended in 1986. Detailed requirements for implementation are contained in its regulatory companion, the National Contingency Plan.[xii] This novel legislation requires the U.S. EPA to identify hazardous waste sites, rank them in order of priority, address those sites posing an imminent and substantial endangerment to human health immediately, and study carefully those sites posing a longer-term threat so that an appropriate remedy can be selected and implemented.

In recognition of the magnitude of the problem, Congress included unusual and very broad liability provisions in the statute. All costs of cleaning up a hazardous waste site will be borne by those parties who generated hazardous substances found at the site, those transporters who selected the site for disposal, and current as well as past owners and operators of the site. The liability is strict, joint and several. Consequently, the Federal government does not need to prove that a party was negligent in its management of the hazardous substance. In fact, in many instances, the liable parties fully complied with all applicable Federal and State laws at the time of disposal. For example, in the 1970s the Federal and State governments referred many companies seeking the names of reputable disposal facilities to the Enviro-Chem recycling and disposal facility located south of Chicago. This once fully licensed, state-of-the art facility is currently a Superfund site which will cost its customers and owner over three million dollars in cleanup costs.

As to the scope of liability, Congress recognized the inherent difficulties in segregating and assessing the damages caused by chemicals commingled in a so-called "toxic soup". Therefore, the legislation provides that each and every responsible party can be held liable individually for the entire cost of site cleanup. The only exception occurs if the party can clearly show that the harm caused by the materials it disposed at the site is divisible. As a result, if you sent only *one* drum to a site containing fifty or sixty thousand drums, the Government can nevertheless hold you liable for the entire cost of site cleanup unless your one drum can be identified and removed intact.

Finally, realizing the difficulty in establishing cause and effect relationships between hazardous substances and human health and environmental damage, Congress provided that the U.S. Government need not demonstrate harm resulting from the hazardous waste sites in order to recover cleanup costs. The Government must only show that there is "a release or threat of release" of a hazardous substance, contaminant or pollutant. Consequently, if U.S. EPA can demonstrate that trichlorethylene, a solvent commonly used in the dry-cleaning industry, has been released into the environment by a party, that entity is responsible for cleanup costs regardless of whether anyone has been harmed. This eliminates problems of proving harm when many cancers have a twenty year latency period and environmental impacts are not immediately evident as toxic substances slowly bio-accumulate in the fatty tissues of animals. Liability for personal injury related to a hazardous waste site is outside the scope of Superfund, left to individual state laws.

Under the Superfund legislation, U.S. EPA can clean up a site in one of two ways: It can either remediate a site and judicially seek to recover costs from the responsible parties or it can administratively or judicially compel the responsible parties to undertake the cleanups themselves. To recover costs, the courts will review EPA actions based on an administrative record applying an "arbitrary and capricious" standard of review. While the legal framework within which cleanup decisions are made is very strong, implementation of the law is nevertheless complex involving the synthesis of risk assessment, risk communication and risk management.

III. RISK ASSESSMENT

The difficulties begin at the outset of hazardous waste cleanups. In order to understand the magnitude and extent of the problems posed by a hazardous waste site, extensive field investigations are necessary. These investigations involve the drilling of wells to identify the characteristics of groundwater flow and the spread of contamination; the sampling of soil, air, and water to identify the types and quantities of contamination; and the search for potential ways in which humans and the environment could be exposed to the contamination. These remedial investigations are costly, currently requiring expenditures of over a million dollars. They are also time-consuming, taking anywhere from eighteen months to four years to complete. These remedial investigations fall under the rubric of "risk assessment". Risk assessment has been defined by the National Academy of Sciences as

> *. . . the scientific activity of evaluating the toxic properties of a chemical and the conditions of human exposure to it in order both to ascertain the likelihood that exposed humans will be adversely affected, and to characterize the nature of the effects they may experience.*[xiii]

Unfortunately, there are numerous challenges in assessing problems at a hazardous waste site with any degree of certainty. The sources of uncertainty are many. They include our lack of ability even to identify problems because of the absence of analytical capabilities in laboratories. Many hazardous substances are present below the detection limits of state- of-the-art laboratory equipment and techniques. Additionally, uncertainty occurs because much of the contamination from hazardous waste sites occurs beneath the ground. Navigating the subsurface with accuracy is no less perilous than flying an airplane blind. There is even uncertainty as to the transport mechanisms responsible for spreading the contamination problem. Even after extensive studies, we are often uncertain how contamination moves from the soil to the groundwater to the air. Pollutant fate and transport frequently remain question marks.

Actual interpretation of the data from field investigations also has many sources of uncertainty. Scientific disputes arise over the impact of sampling techniques such as the use of filters. At the Wauconda Landfill site in northern Illinois, responsible parties vigorously contended that U.S. EPA's failure to use a filter inappropriately elevated contaminant concentration levels

while U.S. EPA countered that the absence of a filter more accurately reflected potential ingestion risks. Members of the scientific community support both viewpoints and would willingly testify as expert witnesses in any court proceeding.

This is a small issue compared with our lack of knowledge regarding the cumulative impacts of randomly commingled chemicals. The current absence of precise information on the potential effects of any single chemical on humans and the environment frame the magnitude of the problem in dealing with many chemicals. Will the chemicals react synergistically, exacerbating the negative impacts of any one chemical or will they react additively? Given our current state of knowledge, we may not know the answer to those questions.

Some of the most serious scientific controversies relate to the issue of how much of a given chemical is necessary to cause a negative response. The fact that a chemical causes a tumor in laboratory mice exposed to high doses does not automatically mean that it will have the same impact on human beings exposed to much lower doses over longer time frames. Typifying this is the much-ridiculed attempt to ban saccharin based on feeding laboratory mice such high doses that a human would have to consume preposterous amounts to approximate the impact. Further, extrapolations of the chemical impact on humans can vary dramatically depending on the type of mathematical dose-response model used. One example using five different scientifically accepted models to review the same laboratory data found that the risk from the chemical ranged from one excess cancer in 17,000 to one in 5.2 billion depending on the model.[xiv] Such a wide variation gives a risk manager small comfort in the accuracy of his data base.

In remediating hazardous waste sites, another critical element of the risk assessment is exposure. The mere fact that a chemical is toxic does not mean it poses a risk. Risk is formed by the combination of toxicity and exposure to that chemical. One of the hardest things to convince the public living next to a hazardous waste site is that it may not pose a threat to them. If the waste facility was properly sited in terrain that minimizes migration or if technological safeguards were incorporated such as synthetic liners and leachate collection systems, the toxic chemicals may be effectively separated from the public. Unfortunately, faced with a legacy of improperly sited hazardous waste facilities, the likelihood is far greater that the public is or will be affected at some point. A risk manager is asked not only to define current exposure routes but also future ones. This entails being clairvoyant and reading a crystal ball or tarot cards to predict future land use patterns for the next five years into infinity.

All of these elements of uncertainty come together as the overall characterization of risk is assembled for a hazardous waste site. As the above discussion highlights, in order to conclude a risk assessment many assumptions must be made resulting in layer upon layer of uncertainty. It is on this scientific house of cards that we must make significant risk management decisions. Before we do that, however, we have an obligation to report our findings to the public.

IV. RISK COMMUNICATION

The public expects and deserves a role in this process. "A basic tenet of risk communication in a democracy is that people and communities have a right to participate in decisions that affect their lives, their property, and the things they value".[xv] When you add the public's perceptions and expectations into the process, the difficulties we have in objectively assessing sites are further compounded. Although the public defines risk in a much less rational manner than scientists and government bureaucrats, its definition is a potent force of uncertainty in the overall risk management equation.

Some themes emerging in the public's perception of risk include:

1. Threats from toxic substances are particularly odious to the public because they are risks that are not within their control. In the public's mind, these risks generally have been inflicted by a faceless "big business" that benefits at the expense of innocent citizens. There is little recognition of the nexus between our standard of living and these "crimes against nature." There is even less recognition by the public that the plastic hamburger carton they discard, the car they drive, and the pesticide they apply to their prize tomato plants were not only manufactured with chemicals which generate waste but also may generate waste themselves.

   Numerous studies have demonstrated that when a risk is not voluntarily assumed, unlike the risks people accept by smoking cigarettes, drinking beer or sky-diving, then the risks are far more unacceptable to the public. My experience with the Agency validates these studies. Although the normal public reaction to a company that has contaminated their drinking water and despoiled their land is outrage, in towns where most of the citizens work for the company, the reaction is generally much different. In these instances, the community is more supportive and trusting since they are familiar with the facility and its workings, they know and interact with the facility's managers, and they reap an economic benefit from its operation.

2. Unlike the familiar risks posed by alcohol, cigarettes and automobiles, the public believes that there is something inherently evil about toxic chemicals. "The very word 'chemical' has acquired sinister implications with 'dread-inducing' capabilities directly opposed to the ideals of rational decisionmaking with the active participation of an informed public."[xvi] Accordingly, the public sees the risks from hazardous waste as a life and death issue rather than a nuisance factor. The issue is framed in emotionally charged terms: "You're murdering my children;" or "We'll all die of leukemia." And, the expectation is that something should be done about it. With these perceptions, the public demands that the government provide it with zero risk. In the United States, the Constitutional guarantee of "life, liberty, and the pursuit of happiness" has come unrealistically to mean a life totally free from the threat of hazardous substances for many individuals.

3. Consequently, the American public ranks the threat of chemical waste disposal our country's number one environmental risk. A recent U.S. EPA study performed a comparative assessment of environmental problems by individually polling Agency experts and the public.[xvii] Interestingly, the study revealed a wide disparity in the public's assessments of environmental problems and those of the experts. Whereas the experts considered pesticides, indoor air pollution, consumer product exposure and global warming the highest risk environmental problems today, the public ranked these problems medium or low in its estimation of risk. In the public's opinion, the primary environmental threats today are posed by chemical waste disposal and chemical plant accidents.

The experts agreed with the public that these risks are high in specific locations but ranked them as low for the population at large. Although hazardous waste does pose a very serious risk in certain locations, relatively few people live close enough to be directly impacted. Even the public recognizes this fact. Of the 76% polled who rated chemical waste disposal the number one threat, only 36% were aware of toxic waste problems in their own communities and only 16% considered toxic wastes to be close enough to their homes to be a personal health threat.[xviii] By contrast, the U.S. EPA estimates that 5,000 to 20,000 individuals will die of lung cancer each year caused by exposure to unsafe levels of naturally-occurring radon. Despite the fact that 30% of the homes in northern New Jersey have unsafe levels of radon, only 5% of the homeowners have taken any action to monitor or reduce this serious health threat.[xix] Clearly, the very real threat of radon does not compare with the public's perception of the risk from hazardous waste. What is not so clear is the role of a responsible government official in situations where his or her technical judgment is at odds with the public's concerns. Resolution of this sensitive issue falls on lawmakers, bureaucrats and the judiciary.

While there are strong trends nationally, as U.S. EPA works from site to site, there is also a large amount of community variability. Certain communities want zero risk and are willing to fight year after year in every possible public, political and legal forum to obtain it. One bulletin distributed by a community activist group in Uniontown, Ohio puts it this way:

> *Many people are aware that 'Concerned Citizens' have continually battled on a daily basis, some for nearly (5) years, to get thorough testing of (the Industrial Excess Landfill site). We are tired of USEPA's pathetic excuses about their own countless delays, deadlines, contradictions, staffing problems, cost effectiveness (skimping), their complaining about other Superfund sites they must contend with. That's their problem and that's their job! Nor can we help it that the companies used our town as their chemical toilet. In analyzing the USEPA's behavior over the years, we've often wondered if their long term strategy was to drag this thing out doing minimal testing in hopes of wearing citizens down. Did they figure at the end of this process we'd be so desperate that we'd cry 'uncle' and take any cleanup they tossed our way? Well, they're wrong!! We've fought too long to accept a cleanup that leaves our families' health in jeopardy.*

In contrast to these strong sentiments, other communities consider factors besides zero risk paramount. In these communities, priorities such as economic need drive the communities' assessment of appropriate cleanup technologies. An inexpensive minimal response to a hazardous waste site may be appropriate if a more sophisticated and costly response would lead to plant closure or employee lay-offs. Still other communities are totally indifferent to the entire issue. We have held public meetings to explain a risk assessment study or risk management decision to the affected communities which were attended only by U.S. EPA and state staff. Obviously, a community's response to a hazardous waste site cannot be predicted, running the gamut from intense interest to apathy.

While a community's interest and response may be unpredictable, the Superfund statute establishes consistent procedures to assure the citizenry due process. Superfund mandates public participation in the risk assessment and risk management process through provision of an administrative record, opportunity to participate in a public meeting, and the right to provide public comments on the risk assessment and proposed remedy for the site. Additionally, the statute includes an innovative provision allowing citizen's groups to obtain Federal grants of up to $50,000 to hire outside experts to review and explain U.S. EPA's technical studies and proposals. Significantly, this unique provision is a direct response to public protests that the technical aspects of the process were too complex for average citizens to understand and, more importantly, that the public did not trust Government risk managers to fairly collect and interpret data for remedy selection. In deference to the public, U.S. EPA considers "community acceptance" one of the nine criteria it must review prior to selecting a remedy for a Superfund site. Unlike the majority of other criteria which relate to technical and legal requirements, "community acceptance" expressly acknowledges the value judgments inherent in Superfund cleanups.

V. RISK MANAGEMENT

These two areas of uncertainty, risk assessment and risk communication, play into what is already an extremely complex decision for the risk manager. Risk management is the "process of weighing policy alternatives and selecting the most appropriate regulatory action, integrating the results of risk assessment with engineering data and with social, economic, and political concerns to reach a decision." There are as many ways to construct risk management processes as there are individuals to devise them.

In the Superfund program, the statute sets up parameters within which decision makers are to select appropriate cleanup remedies for hazardous waste sites. Even with these parameters, the task is not an easy one. Reflecting societal tensions, the statute establishes several aggressive and sometimes competing goals. One of the focal points of the 1986 amendments to the original statute was Congressional guidance on the type of remedy the Agency must select. In response to public concerns that the Agency was merely moving hazardous waste from one location to another, the statute has a strong thrust in favor of using treatment technologies, like incineration, which destroy or significantly reduce the inherent hazards posed by the waste. One emphasis is on the achievement of permanent solutions that will eliminate the threat once and for all. However, while promoting the maximum use of treatment and permanent remedies, the statute simultaneously requires that the remedy at a Superfund site be cost-effective. We must assure that the government is getting a reasonable value in terms of cleanup relative to the costs of remediation. This is an important consideration when the average cost of remediating a Superfund site has soared to twenty million dollars. One recent cleanup proposal for a large, politically controversial site in California, the Stringfellow tar pits, could cost 227 million dollars alone. Reconciliation of the competing interests of high cost treatment versus cost effectiveness is accomplished through a process which attempts to determine what is most appropriate on a site by site basis. There are very few cookie cutters in the Superfund program.

The over-arching requirement is the selection of remedies which are protective of human health and the environment. The statute provides choices, however, on the means of achieving that goal. Superfund requires risk managers to resolve its dynamic tensions on the merits of each case. While certain types of remedies tend to emerge quickly for certain types of sites (e.g., containment for large municipal landfills), in most cases it is difficult, if not impossible to predict the appropriate cleanup remedy in advance. As the attorney for one large company has said, "All participants in our nation's waste site cleanup program agree that remedial actions at sites must provide adequate protection of human health and the environment. Difficulties arise when we attempt to define what constitutes adequate protection." For example, the views of the public often directly contradict the statute's mandate that the Government select cost-effective remedies. The Citizens Clearinghouse for Hazardous Wastes is a non-profit organization dedicated to mobilizing and assisting communities to obtain "safe" cleanups. Its Executive Directorw, Lois Marie Gibbs, a former Love Canal housewife, has stated that citizens want government to "clean up the site until the area is the same as it was before the chemical wastes were deposited there." She justifies this strong stance noting that the community will foot the bill from any cleanup either through increased consumer prices or higher taxes. Unfortunately, one thing has become clear in the implementation of the program. The Government may not be able to satisfy the public's cry that we "put it back the way it was." Economic considerations aside, the earth's physical structure and the limits of technology will often preclude this option.

Each hazardous waste cleanup is bounded by unique factors including its environmental setting (e.g., a cliff or wetlands), the proximity of humans exposed, the attitudes of those individuals affected by it, the monetary resources of the State and Federal governments, and political dynamics. Having identified and explored these unique factors, the risk manager must make value judgments to balance the inevitable tradeoffs. Should similar sites be cleaned up differently because one is located in a populated area and the other is in a rural location? Should the entire budget be spent on several comprehensive cleanups or on addressing the worst problems at numerous sites? Should an extensive cleanup be undertaken because of public concerns when the experts tell you it isn't needed? All of these judgment calls and more must be made.

Throughout the entire hazardous waste risk management process, there is uncertainty. Despite this uncertainty, there is no choice but action for responsible officials because of the very real health and environmental threats posed by these sites. We cannot wait for science to catch up with technology. We must make decisions now. An important thing to remember is that "uncertainty does not imply chaos." In fact, "uncertainty does not mean that there is no direction or progress; rather it defines the limits of the path heading in a certain direction. When we make decisions, we try to learn as much as possible, but at some point, we must make the decision." My advice to you as a fellow risk manager is that you ask tough questions about what is known about the problem and the threat posed by it so that you can bracket the degree of uncertainty to determine its significance to the decision at hand. You must separate those issues which are fact and those which are judgment, even when the separation is unclear. Justice David Bazelon of the United States Court of Appeals for the District of Columbia believes that the court's role is to

> *. . . make sure that decision-makers articulate the basis for their decisions. In the scientists realm, courts can ask that data be described, hypotheses articulated, and above all, in those areas where we lack knowledge, the ignorance be confessed. In the political realm, courts can ask that decision-makers explain why they believe that a risk is too great to run, or why a particular tradeoff is acceptable.*

By doing this, Justice Bazelon believes that even in the face of great uncertainty, the courts will improve the quality of the decision-making process.

I leave you with the thoughts of one U.S. EPA risk manager who said:

> *The people who call me often want yes or no answers: Will substance X give me cancer or won't it? The problem is only God can give you zero or 100 percent probability. We try to provide the public with something in between.*

ENDNOTES

i. D. Holzman, "Cancer Risks in the Refrigerator", June 30, 1987 *Insight* at 52-53.

ii. Office of Technology Assessment, *Assessment of Technologies for Determining Cancer Risks from the Environment*, (June 1981) Summary at 6.

iii. *Ibid.*

iv. *Ibid.*

v. Stern, "Analysis of the Decision-Making Process in Chemical Safety", *(1986) 51 The Science of the Total Environment* at 29.

vi. Dow Chemical Company Advertising Slogan.

vii. Rice, "Risk Management in Chemical Safety: Some General Observations Relating to the State of the Art" (1986) 51 *The Science of the Total Environment* at 6.

viii. Field & McCray, "Federal Risk Assessments for Potential Carcinogens: An Empirical Review" in *Risk Assessment in the Federal Government: Managing the Process, Working Papers* at 103-123 (National Academy Press, 1983) (prepared for the Committee on the Institutional Means for Assessment of Risks to Public Health, National Research Counsel).

ix. *Resource Conservation and Recovery Act* of 1976, as amended by the *Hazardous and Solid Waste Amendments of 1984*, 42 U.S.C. 6901 *et seq*. Implementing regulations are found at 40 C.F.R. Parts 260 through 265.

x. *Comprehensive Environmental Response, Compensation and Liability Act* of 1980 as amended by *Superfund Amendments and Reauthorization Act* of 1986, 42 U.S.C. 9601 *et seq*.

xi. Regulation of ongoing hazardous waste activities is a function of the *Resource Conservation and Recovery Act.* The manufacturing of chemicals is regulated by the *Toxic Substances Control Act* which requires manufacturers to provide U.S. EPA with 90 days notice before making a new chemical and authorizes U.S. EPA to regulate risks from a chemical at all stages of its life from production through disposal. The *Federal Insecticide, Rodenticide and Fungicide Act* regulates pesticides through provisions calling for registration, classification of pesticides for specific uses and accurate labeling and use information.

xii. 40 C.F.R., Part 300.

xiii. National Research Council, *Risk Assessment in the Federal Government: Managing the Process* (Washington, D.C.: National Academy Press, 1983).

xiv. U.S. EPA, Principles of Risk Assessment: A Nontechnical Review (Washington, D.C. Environ Corporation, 1986) at IV-7.

xv. U.S. EPA, *Pamphlet on "Seven Cardinal Rules of Risk Communication*" Vincent T. Covello and Frederick W. Allen) (Washington, D.C.: April 1988).

xvi. Rice, *supra* note 7 at 29.

xvii. U.S. EPA, Report on *"Unfinished Business: A Comparative Assessment of Environmental Problems*" (Washington, D.C.: February 1987).

xviii. F. W. Allen, "What the Public Believes; How the Experts See It" (1987) *EPA Journal* November at 10.

xix. U.S. EPA, *Brochure on "Explaining Environmental Risk"* (Washington, D.C.: November 1986).

- *Concerned Citizens of Lake Township Bulletin distributed July 19, 1988 at a U.S. EPA Public Meeting on the Industrial Excess Landfill Superfund Site in Uniontown, Ohio.*
- Sections 113 and 117 of CERCLA, as amended by SARA contain public participation provisions.
- Section 117(e) of CERCLA, as amended by SARA.
- U.S. EPA, Memorandum from J. Winston Porter, Assistant Administrator on "Interim Guidance on Superfund Selection of Remedy", December 24, 1986 and Memorandum from J. Winston Porter, Assistant Administrator on "Criteria for Selection of Remedy", July 1987. The nine remedy selection criteria include the remedy's compliance with all of the applicable or relevant and appropriate provisions of other environmental laws, its ability to reduce the mobility, toxicity or volume of the waste material, both its short and long term effectiveness, its cost and implementability and its acceptance by the local community and the state. The most important criterion, however, is the remedy's overall ability to protect human health and the environment.
- Section 121 of CERCLA, as amended by SARA, contains statutory provisions on remedy selection.
- *D. L. Bazelon, "Risk and Responsibility" (Article is based on presentation before the American Bar Association National Institute on Law, Science, and Technology in Health Risk Regulations in Washington, D.C.: April 1979).*
- *D. Wann, "On the Firing Line: The Challenge of Environmental Risk in Region 8" (1987) EPA Journal* (November) at 29, quoting U.S. EPA toxicologist Suzanne Wuerthele.