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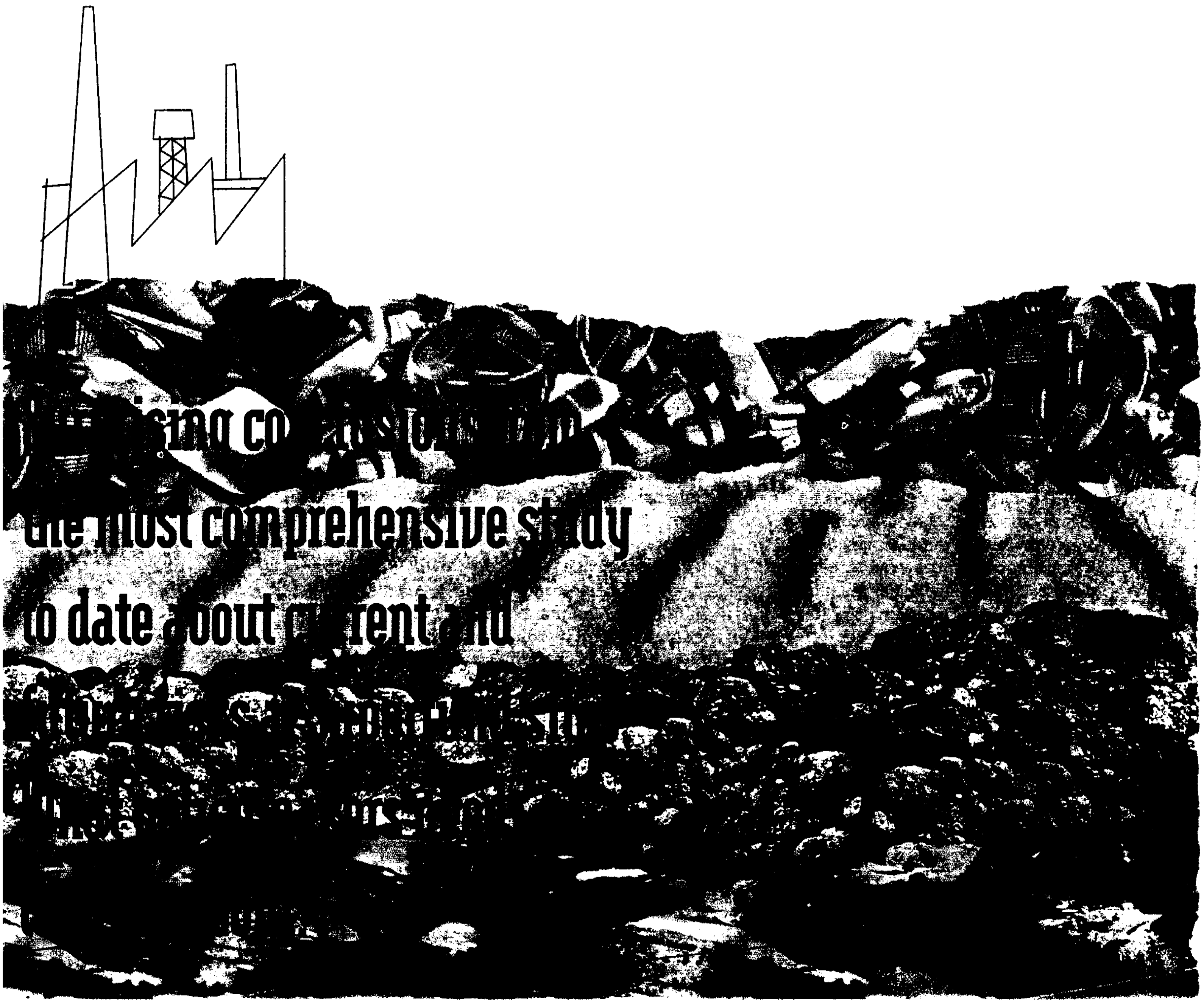

REAL RISKS

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ILLUSTRATION BY RICO LINS STUDIO

In the highly charged atmosphere of controversy over the potential health hazards posed by leaking chemicals at industrial sites such as Love Canal, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. The act created the Superfund program and directed the Environmental Protection Agency (EPA) to identify hazardous waste sites that substantially endangered human health and the environment and to supervise their cleanup. The EPA, with assistance from the states, has evaluated about 36,000 potential problem areas thus far. Of these, the agency has put over 1,200 sites on the National Priorities List (NPL), which qualifies a site for remediation expenditures from the Superfund program. An EPA assessment of the risks at each site is the first step in a process that eventually produces an evaluation of options for responding to the dangers that exist. The EPA then selects a cleanup option if one is necessary. The administrative record of all this activity at each site contains a substantial amount of quantitative information on the cancer and noncancer risks for different exposed populations. Researchers and policymakers have not systematically examined these data, however, in part because the considerable cost of collecting the information from regional EPA offices is significant.

This gap in our knowledge is particularly striking given current policy deliberations. Superfund is scheduled for its second reauthorization this year, and the administration has forwarded its proposal to rewrite the law to Congress for consideration. The debate over reauthorization thus far has focused largely on who should pay for cleanups and how. But a far more fundamental issue—the character of the risks addressed by the legislation—is being ignored. This is vitally important because it will drive the total cleanup cost and determine the degree to which Superfund addresses the environmental risks. No sensible decision can be made about the future of Superfund unless we understand fully the program's fundamental mission, the reduction of risks from hazardous wastes. To date there has been little basis for making informed judgments about the risks other than anecdotal evidence.

This analysis represents the first systematic effort to document the character of the risks addressed by Superfund. Which population groups are most affected? How do the risks arise? Should we expand the range of remedial options at these sites?

The analysis here is the first systematic effort to document the character of the risks addressed by Superfund. Which population groups are most affected? How do the risks arise? What is the magnitude of the problem? Most important from a policy standpoint, should we expand the range of remedial options at these sites beyond the current policy of permanently and significantly reducing the volume, toxicity, and mobility of hazardous substances at each NPL site?

The conclusions are surprising in many respects. Whereas risks to current residents have been the key to generating political support for Superfund, our research shows that the overwhelming preponderance of risks is to future populations for land uses that represent changes from the way the land is currently being used. Many of these future uses are speculative potential uses, not likely activities. This finding suggests that much of the benefit of Superfund can be achieved through measures such as prohibiting new residential developments on Superfund sites. EPA can then take more extensive cleanup actions on those few sites that pose truly substantial risks to current populations. Beyond this, our research shows that some of the chemicals at the sites pose far greater dangers to human health than has been generally appreciated.

How Risks Are Measured

Risk assessments at each site are typically performed by contractors using methods devised by the EPA. The work is then reviewed by the agency's personnel. This process begins with an analysis of "baseline risks," that is, those that might exist if no remedial actions or other controls were adopted at a site, given current use patterns. In the first action of the baseline risk assessment, samples are taken to determine the concentration of potentially harmful chemicals at the site. Next, exposure assessments are made

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that analyze the contaminant data from the site, identify exposed populations, determine the ways in which people are or can be exposed to the hazardous material (these are called *pathways*), and estimate the exposure concentrations and intakes for each pathway. Finally, the information on exposure and toxicity is combined to estimate the cancer risks and noncancer hazards caused by the chemicals and exposure paths at the site. If the estimates of cancer and noncancer risks exceed EPA's target range, remedial action is generally undertaken. Although EPA assesses both cancer and noncancer risks, it is the cancer risks that play the central role in EPA's risk analyses. We focus on them here.

Consider a community whose groundwater is contaminated with benzene. To estimate the chance that a resident will develop cancer from drinking contaminated water, risk assessors have to weigh the concentration of the benzene and the extent of exposure to it. The extent of exposure depends on the ingestion rate, frequency, and duration at which one is exposed to it; on body weight; and on the time over which the exposure was averaged. EPA guidelines direct risk assessors to assume conservative values for these factors. The concentration of benzene and the extent of exposure are used to calculate the "chronic daily intake" of benzene—the estimated daily intake of benzene averaged over 70 years. The chronic daily intake is then multiplied by a conservative estimate of the probability that a unit of benzene will produce cancer over a lifetime to yield an estimate of cancer risk. For EPA's purposes, no dose of a cancer-causing chemical is thought to be risk free. After the risk assessment is completed, the EPA analyzes options for responding to the dangers that exist. These options are designed to meet certain remedial objectives, most important, keeping below a set level the maximum concentration of a chemical that may remain at a site after the cleanup effort.

The reasoning behind the course of action that EPA takes at each site is contained in a Record of Decision (ROD). Between 1991 and 1992, EPA regional offices issued 276 of these for NPL sites. In our research, we analyzed the way health risks arise at 77 of those sites, which mirror the distribution of the total NPL sites across the country. While we accepted the risk assessment methodology that the EPA used for its determinations, we considered it essential to go beyond the ROD to collect additional data. For example, we looked at risks that were smaller than those the EPA normally uses as a trigger for action at a site.

The Ways People Are Exposed

We examined a number of variables, beginning with the **time frame** for the exposure, in order to derive quantitative estimates of cancer risks. The EPA defines *current risks* as those that exist today given the way the land is being used. *Future risks*, on the other hand, are generally associated with changes in land use activities on the site. Our designation of a pathway as a current risk or a future risk is determined by whether the risk assessment defined the pathway as current or future. In its guidance documents, EPA characterizes future uses as potential rather than expected uses of the land. EPA gives the following illustrations of possible future risks: "If groundwater is not currently used in the area of the site as a source of drinking water but is of potable quality, future use of groundwater as drinking water would be possible." Another example involves a determination of whether land use on a site could change in the future. "If a site is currently classified as industrial, determine if it could possibly be used for residential or recreational purposes in the future." Land that is not in residential use today, for instance, may be put to such use in the future. Determining the relative magnitude of current versus future risks is important in finding how estimates of human health risks at Superfund sites are affected by assumptions about future land use.

We also looked at **exposed populations,** including *residents* of the area, *workers, recreational users,* and finally *trespassers.* Designating whom the risks involve is necessary in order to analyze the efficacy of different policy options for reducing human health risks. The data were also examined by **age group** (*adults* and *children* under 18 years). The **population location** refers to the place where the population is exposed to the contaminant. Is it *on the site* or *off the site?* The **exposure medium** is the medium by which the individual is exposed to the contaminant. This includes *ground* and *surface water, air, soil,* and *biota* (plants and animals that are exposed and later become part of the food chain for individuals). The **location of the medium**—whether *on* or *off the site*—is also important. The **exposure route** tells us how a person comes into contact with the chemical. Does he *ingest* it, *inhale* it, or come into contact with it in some other way? Analyzing the location of exposed populations and the contaminants themselves is a necessary part of evaluating the likely impact of remedial action at Superfund sites. All of these variables combined yield thousands of risk pathways, or ways in which a cancer risk could arise. In our investigation we tallied over 1,430 total risk pathways. Of these, 1,015 were pathways by which a cancer risk could arise.

We also analyzed the contributions of specific chemicals to the risks posed. Since uncertainty exists over the toxicity of particular chemicals, consideration of

TABLE 1

DISTRIBUTION OF PATHWAYS BY RISK ASSESSMENT CATEGORIES

Risk Assesment Category	Percent of Total Pathways (N=1,430)	Percent of Cancer Pathways (N=1,015)
Scenario *(whether the land use envisioned in the risk assessment corresponds to current or projected future use)*		
current*	27.8	30.5
future	72.2	69.5
Exposed Population		
residential	73.2	71.2
worker	17.4	17.8
recreational	3.6	3.8
trespasser	5.8	7.2
Age Group		
adult (ages 18 and up)	62.7	65.3
child (ages under 18)	37.3	34.7
Location of Population *(where the particular population is exposed to the contaminant; for residents, location of population refers to where they live)*		
on the site	69.2	70.2
off the site	23.3	23.3
not indicated	7.6	6.5
Location of Medium *(whether the contaminant for which the pathway is estimated is on the site or off the site)*		
on the site	79.6	80.3
off the site	13.7	14.3
not indicated	6.7	5.4
Principal Exposure Media *(the medium by which the individual is exposed to the contaminant)*		
air (from soil)	9.0	9.0
air (from water)	9.0	10.4
soil	33.6	38.2
groundwater	37.2	30.8
sediment	5.2	5.7
biota	3.6	2.9
Principal Exposure Routes *(how a person comes into contact with the chemical)*		
ingestion	58.4	53.7
dermal contact	22.6	25.7
inhalation (vapor phase chemicals)	13.0	14.6
inhalation (dust)	5.7	5.8

Note: *=Not all "current" risk pathways actually represent a risk today. Some assessments are based on scenarios where the land use in an area does not change but other things may change, such as the size of a groundwater contamination plume, so that wells not currently contaminated are assumed to become contaminated.
Source: Author tabulations.

the relative frequency of these chemicals at sites and their estimated contribution to pathway risks may help determine where additional resources should be devoted to defining the risks of these chemicals or developing remedies to deal with their particular types of contaminants.

We need to be concerned about the manner in which the risks arise at Superfund sites. But an examination of the risk pathways is also instructive from a policy standpoint. EPA can clean up a Superfund site in a number of different ways. If the main risk is from groundwater contamination, households can switch to alternative water supplies. In other instances, land use can be restricted or sites can be capped or fenced in to reduce the way in which a health risk arises. These measures may not eliminate the presence of a chemical, but they can eliminate the risk pathways that make it dangerous to health.

Who Is Affected, How, and Where?

Table 1 provides a comprehensive overview of the distribution of risk pathways by seven major categories. The statistics provide the pertinent breakdowns within the risk assessment categories for all 1,430 pathways in our sample. The first category in the table, which presents perhaps the most salient result of the study, shows the number of risks arising from current uses of the land and from future uses. The striking result is that the great majority of the risk pathways pertain to future risk exposures—which may be avoidable—and not to current ones. Seventy percent of the cancer pathways, and 72 percent of the total ways in which risks arise, pertain to future uses.

Of the exposed populations, residents are the category affected by the largest number of risk pathways. Approximately three-fourths of all pathways pertain to residential populations with the next most important group being workers, for whom only 17 percent of the pathways are pertinent. Recreational users and trespassers account for a small fraction of all the risk pathways.

Most of the risk pathways (over 60 percent) affect adults, and just over one-third pertain to children under age 18. But whereas 37 percent of the risks are to children, this group comprises only 26 percent of the U.S. population overall. Thus we see that the pathways affecting children occur almost 1.5 times more than if they matched the representation of children in the population.

The locations where the risks arise are also of substantial interest, particularly for evaluating the efficacy of options that limit future uses of land at or near a site. Both the location of the populations and the location of the medium through which the risk arises are heavily concentrated toward on-site risks. Sixty-nine percent of the total pathways represent risks to on-site populations, and 80 percent of the media associated with the pathways are on-site media. The most prominent media are soil and groundwater, each of which accounts for over one-third of all pathways. Air (from the soil), air (from the water), and sediment each account for 5 to 10 percent of total pathway risks.

The final component of Table 1 lists the exposure routes through which the risks arise. The dominant exposure route is ingestion, such as drinking contaminated groundwater or ingesting dirt, and this category gives rise to 58 percent of all pathways. Skin contact accounts for 23 percent of all the different exposure routes, and inhalation and dust are next in importance.

When we combine the variables and look at the distribution of the exposed population and the locations of the exposed population by current or future land use, overall results show that nearly 6 in 10 of the pathways affect residents based on future risk scenarios. These data do not appear in the table. Risks to current residents and future populations in current residential areas account for only 14 percent of all risk pathways. There is also a substantial difference in the character of the risks according to the population location and time frame of the analysis. On-site risks under current time frames account for 15 percent of the pathways, a figure only somewhat greater than the current off-site risks of 11 percent. For future-based scenarios, however, on-site risks escalate to 54 percent of the pathways, over four times as many as the 12 percent that are due to future off-site risks.

EPA can clean up a Superfund site in a number of different ways. Land use can be restricted or sites can be capped or fenced in to reduce the way in which a health risk arises. These measures may not eliminate the presence of a chemical, but they can eliminate the risk pathways that make it dangerous to health.

A finding with significant policy implications can be gleaned by crossing the attributes discussed above. The dominant future risks, risks to future exposed populations, are to on-site residents. Of the total pathways analyzed, on-site future residents account for eight times as many pathways as current on-site residents.

When looking at exposed populations such as residents and workers and factoring in exposure media and exposure routes, our analysis shows that the chief risks come to residents and workers from ingestion of groundwater and soil. Resident ingestion of groundwater accounts for a quarter of all pathways. And although Superfund anecdotes frequently highlight the importance of problems for children who eat dirt, ingestion of soil plays a much greater proportional role in the risk pathways for workers than it does for residents, either adults or children. Skin contact with soil and ingestion of groundwater also account for a substantial share of the risks to workers. The risk pathways for recreational users and trespassers account for only a very small percentage of all pathways in the sample.

Danger Levels of Pathways

Examining the distribution of the pathways can be instructive in assessing the mechanisms by which risks arise, but the level of risk associated with each pathway is also of substantial consequence. Some pathways involve intense exposure to very hazardous chemicals, whereas others involve more minimal exposure levels. Over half of the cancer pathways in the sample pertain to risk levels below 1 in 10,000, the EPA's ceiling for acceptable cancer risks. It is quite striking, however, that many of the pathways involve considerable risks, with 18 of them posing cancer risks in excess of 1 in 10.

TABLE 2

RISK-WEIGHTED SHARES OF CANCER PATHWAY RISKS

Risk Assessment Category	Percent of Total Cancer Pathway Risk	Percent of Future Cancer Pathway Risk	Percent of Current Cancer Pathway Risk
Scenario			
current	8.8		100.0
future	91.2	100.0	
Age Group			
adult	74.9	74.5	78.5
child	25.1	25.5	21.5
Exposed Population			
residential	87.3	89.4	65.6
worker	11.0	9.4	27.7
recreational user	1.4	1.2	3.6
trespasser	0.2	0.0	3.1
Location of Population			
on the site	77.5	81.0	40.9
off the site	19.9	17.4	45.4
not indicated	2.7	1.6	13.7
Principal Exposure Media			
air (from soil)	4.5	4.2	7.3
air (from water)	2.1	2.0	3.1
soil	32.9	34.2	19.4
groundwater	47.7	49.1	32.8
sediment	0.5	0.5	1.0
biota	10.0	7.5	36.5
Principal Exposure Routes			
ingestion	65.4	64.6	74.1
dermal exposure	28.0	29.2	15.6
inhalation (vapor phase)	6.2	5.9	9.4
inhalation (dust)	0.3	0.3	0.9

Source: Author tabulations.

Health-risk levels of this kind are not unprecedented. Cigarettes, for example, pose a lifetime cancer risk of about 1 in 3. But these high-risk pathways are very risky compared to the targets of most government policies. The cancer risk threshold for most federal risk policies is either 1 in 100,000 or 1 in 1,000,000; and even job fatality risks for blue collar workers are only as high as 1 in 10,000. In contrast, many of the risk pathways in our study are associated with far greater risk levels.

Such large risks arise in part because of particular risks associated with some extremely hazardous sites. The Westinghouse site in Sunnyvale, California, is probably the most noteworthy as it accounts for 4 of the 10 most risky cancer pathways. High concentrations of PCBs and several exposed population groups there create both high risks and many pathways. But as in the case of overall distribution of risk pathways, it is the future scenarios that pose the greatest dangers. The risk pathways responsible for the high risk of the Westinghouse site are those to adults on site (dermal exposure to soil), workers on site (dermal exposure to soil), children on site (soil ingestion), and on-site resident children (dermal exposure to soil), all according to future risk scenarios as opposed to current risk pathways. The prominence of future risk pathways extends beyond this particular site. All of the 14 most risky pathways are associated with future rather than current risk scenarios.

The data in Table 1 provide information about the percentage of pathways in each of the various risk assessment categories. When we take this analysis a step further by looking at the risk levels associated with each pathway, we find that the frequency and severity of the risks of the future pathways are much greater than those of the current ones. The mean risk levels per future risk pathway exceed the risk levels per current use pathway by a factor of 4.5, the median risk levels by a factor of 2. Once again residential populations and workers face a greater risk than trespassers or recreational users. Perhaps surprisingly, the data show that the level of risk faced by adults is far greater than that faced by children. On-site populations and media incur the greatest risks. Thus, preventing future development of the site or use of the site for other purposes would eliminate the most severe risks that arise. The most prevalent pathways, those linked to soil and groundwater, pose mean cancer risks on the order of 1 in 1,000 and 1 in 100. These estimated risks are several orders of magnitude larger than those driving many other federal risk reduction efforts.

Additional cross-tabulations of population, population locations, and time scenarios reinforce the point that future risks are significantly greater than current risks, whatever the combination. Because of the conservative assumptions embodied in each stage of EPA risk assessment and compounded through the stages of the procedure, the calculated risks greatly overstate the actual mean risks posed by Superfund sites. But to the extent that these conservative biases are consistent across different pathways, comparisons of relative risks of different pathways will be meaningful.

We have discussed above the frequency with which different pathways occur and the risk levels associated with different pathways. Table 2 combines this information to show us what portion of total cancer risks are accounted for by different pathways. Rather than simply determine the fraction of pathways represented by each type of exposure—for instance, risk to future generations—each pathway is weighted by the total magnitude of the risk estimated for it, and then summed for all pathways. The statistics in Table 2 thus provide information on the percentage of the total

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pathway risk accounted for by each pathway type after the risk weighting. This generates a hybrid of the two influences—frequency of pathway and magnitude of risk. For example, in the case of future risk scenarios, we found that future risk pathways were not only more prevalent than pathways based on current risk scenarios, but that these pathways also posed a greater risk level per pathway. After compounding these influences, we see clearly in Table 2 that 91 percent of all cancer pathway risks are attributable to future risk scenarios. This share of future risks is much greater than the unweighted share of future pathways, which Table 1 showed to be only 72 percent.

The other statistics in Table 2 are presented for total cancer pathway risks, future cancer pathway risks, and current cancer pathway risks. Adults, not children, face by far the larger share of risks. The exposed populations most affected by risk pathways are easily distinguished by this method. Residential populations account for 66 percent of the current cancer pathway risks; this figure escalates to 89 percent for future risk pathways. Exposed workers account for 28 percent of current pathway risks, but the figure drops to only 9 percent for future risk pathways.

The location of the populations affected by these risks also changes dramatically as the time frame for the risk scenario varies. The contribution of on-site population risks rises from 41 to 81 percent when one moves to the future risk scenarios, while the contribution of off-site risk drops substantially. These results suggest that future risk scenarios put a much greater weight on risks posed to on-site residential areas. EPA analysts have hypothesized that residential development of Superfund sites will be much more prevalent in the future than today even though comparatively inexpensive land-use restrictions could eliminate the source of risks. Further, groundwater risks account for almost half of the future cancer-risk pathways, though they are only about one-third of the pathways for current cancer risk.

Perhaps the clearest way to see the extent of the future risk orientation is to assess the number of sites most apt to hold potential future risks. For 53 percent of the sites analyzed, future risks comprised 99.5 percent or more of the risk-weighted pathways for that site. Thus, for more than half of the Superfund sites, risks to current populations are not matters of concern. Indeed, for only 10 percent of the sites do the risks to current populations constitute over half of the risk-weighted pathways for the site. The popular image of risks being borne by current residents located near Superfund sites is seriously misleading as risks to current populations are consequential for only a small segment of the sites.

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The Problem of Emphasizing Maximum Risk

Although the overall risk-weighted pathways provide the most comprehensive assessment of risk level from the standpoint of policy analysis, the maximum risk at particular sites may be what drives the policy choice. While a comprehensive risk analysis is preferable, maximum risks are often the most salient argument in the policy debate and are frequently given considerable emphasis in Superfund documents. Future risks account for 79 percent of cancer pathways that are the maximum risk pathways for the site, which is greater than the percentage they account for when only pathway frequency is considered (72 percent) and less than the percentage when pathway risks are weighted (91 percent).

The implication of examining only the maximum risk pathways is that their distribution does not always parallel the distribution of all pathways. In terms of total pathways, for example, soil-related risks account for 34 percent, and groundwater accounts for 37 percent. The risk-weighted pathway shares are only slightly different, as soil has a 33 percent risk-weighted share and groundwater has a 48 percent risk-weighted share. If, however, one examines the maximum site pathway, the share of the soil pathway drops to 20 percent, and the groundwater share rises to 65 percent, far in excess of the overall risk-weighted share of cancer risk pathways. The public debate may have placed inordinate attention on the role of groundwater hazards since these risks are frequently the maximum site pathways. But a more comprehensive analysis that takes into account the frequency of pathways as well as their severity suggests that the role of groundwater contamination is much less than indicated by the maximum risk pathways.

Chemicals Associated with Risk Pathways

It is useful to consider the overall risk levels and distribution of risk pathways by chemical. Frequently government agencies target specific chemicals for special policy emphasis. Here we look at which chemicals are most prominent in the analysis of the Superfund cancer risks.

When chemicals are ranked by the frequency with which they are mentioned in the pathway risk assessments, the most prominent chemical is arsenic, a frequent ingredient in pesticides. Chemicals such as beryllium, trichloroethylene, and benzene are next in importance, and highly regulated chemicals such as vinyl chloride and PCBS also place among the top carcinogens.

When different cancer risks are weighted to account not only for the frequency of their occurrence but also for the risk associated with their pathway, arsenic falls behind aroclor 1260, which accounts for 31 percent of the total cancer risk of the sites we examined, as the leading carcinogen. Aroclor 1260 and other PCBS are chemicals used as transformer insulating fluids and in capacitors. These chemicals were banned by EPA in 1977 but are chemically stable and present in toxic waste sites. Because of its high risk level, the share of the risk-weighted pathways accounted for by this chemical is much more substantial than arsenic, even though the frequency with which arsenic pathways occur is four times greater than that of aroclor 1260.

Perhaps more so than their simple frequency, ranking carcinogens by risk strikes a resounding chord in terms of the target nature of the chemicals. Chemicals such as arsenic, dioxin, vinyl chloride, and PCBs, are well-known targets of government regulation. These chemicals couple relatively high frequency of appearances with high risks per pathway to play a substantial role in the risk assessments.

Beyond the potency of the chemicals themselves, the medium in which they are influential should be factored in. Consider the two most prominent Superfund media—soil exposure and groundwater. In the case of soil, aroclor 1260 is responsible for 91 percent of the cancer risk associated with that medium, and for groundwater, arsenic accounts for over one-third of the risk. Thus, which chemicals will be influential depends in large part upon which pathways are operative. These results are pertinent from the standpoint of judging different Superfund policy alternatives since the choice of which chemical risks will be mitigated will depend on which particular pathways are shut down by the policy option.

Conclusion

To form a reliable assessment of the merits of the Superfund program and possible alternative modes of government intervention, risk analysis needs to be refined in a variety of ways. Our study considered the frequency and level of different types of risk, but it did not address the magnitude of the populations affected or the cost of achieving risk reductions. Moreover, one should assess the effect of different policy alternatives on cost and risk. The current legislative focus of the Superfund program is risk oriented, as are most other governmental human health regulations. Given this emphasis, there must be tougher scrutiny and analysis of the real risks. This is where our research begins.

Most of the political pressures that gave us the Superfund program arose from the concern of existing populations for the risks that they believed these sites currently posed. Consideration of the risk assessments for Superfund sites indicates, however, that it is not the existing risks that are most significant. Rather, the dominant risks arise from future risk scenarios that involve alternative uses of the land. Indeed, these future risks account for 90 percent of all the risk-weighted pathways for the Superfund sites in our sample. Moreover, for one-third of the sites, 100 percent of the risk is to possible future populations. Chief among these hypothesized future risks is that there may be residents on the site in the future. The underlying assumption driving the EPA risk analyses is that there will be new residential development on existing Superfund sites that are, at present, nonresidential areas. But this assumption distorts policy choices since there is no certainty of such development. Moreover, one can eliminate these risks altogether by restricting future land use.

Many of the estimated hazards are quite substantial. Although the EPA risk threshold for considering a pathway risky is generally a lifetime cancer risk of 1 in 1 million, the calculated risk level associated with pathways is typically several orders of magnitude larger than this threshold.

Analysis of the structure of risks is of fundamental importance in choosing different possible modes of government intervention. If some mechanisms, such as use restrictions and containment options, could eliminate these future risks, then the great preponderance of the risks analyzed in human health assessments at Superfund sites would be eliminated. Indeed, examination of the risk pathways suggests that many of the risks likely to remain after implementing such containment and land-use restriction options, principally those to trespassers, are very low even without adopting policies such as fencing to reduce these risks.

Many of the estimated hazards are quite substantial. Although the EPA risk threshold for considering a pathway risky is generally a lifetime cancer risk of 1 in 1 million, the calculated risk level associated with pathways is typically several orders of magnitude larger than this threshold. Moreover, these risk levels pertain not only to the site generally, but also to a variety of pathway mechanisms and groups of exposed populations. These risk assessments suggest Superfund risks exceed estimated risks for other activities affected under federal cancer regulation efforts. Thus, even if one chooses to disregard some pathway mechanisms as being unlikely, the overall scale of the risks is sufficiently large that casual dismissals of Superfund risks based on anecdotal evidence are not warranted. To determine the actual extent of the risk's, it is, however, essential to estimate the mean risks posed by the sites rather than the estimated risks that EPA calculates.

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