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RISK REGULATION IN PERSPECTIVE:
RESERVE MINING REVISITED

By
DANIEL A. FARBER*

Reserve Mining v. EPA was the first major judicial decision to confront the difficult issues posed by environmental carcinogens. The court was faced with highly uncertain evidence of harm, combined with a cleanup cost estimated at $240 million. The U.S. Court of Appeals for the Eighth Circuit's resolution of these issues has provided a model for later decisions about toxics regulation. Professor Farber carefully reviews the history of the Reserve Mining litigation, and then attempts to reassess the wisdom of the court's decision. He concludes that the court's decision is defensible both from the perspective of cost-benefit analysis and from that of feasibility analysis. This conclusion suggests that the conflict between these two approaches may be less than generally believed.

I. INTRODUCTION

In the past decade, regulation of hazardous substances has been the hottest area in environmental law. The expansion in this field has a very concrete meaning to me as a casebook author. In the first edition of our environmental law casebook, Roger Findley and I included a short chapter on toxic substances, which at the time was an innovation. The second edition contained a much longer chapter. In the third edition, the material was too long for a single chapter, and we split it into two chapters. At this rate, perhaps the fourth edition will be entitled "Cases and Materials on Risk Regulation and Other Environmental Issues."

An event just after the presentation of this Essay in lecture

* Henry J. Fletcher Professor of Law, University of Minnesota. This Essay is based on a lecture delivered at Northwestern School of Law of Lewis & Clark College on November 6, 1990. I also benefitted from comments at a presentation of the paper at the Woodrow Wilson School of Princeton University. Carolyn Brue-Legried, Gary Kaufman, and Doug Winthrop contributed valuable research assistance.
form gave added emphasis to the importance of toxics regulation. On November 15, 1990, President Bush signed into law the Clean Air Act Amendments of 1990. Section 112 of the Act was extensively amended to create a stringent new regulatory scheme for toxic air pollutants. According to one economist, the cost of the new scheme when fully implemented may be six to ten billion dollars annually. Yet this is only one of a panoply of federal statutes dealing with toxic chemicals.

Apart from its practical importance, risk regulation raises fascinating intellectual problems. Often, regulatory decisions must be made although the best available scientific information is simply inadequate. Even when we can at least roughly estimate the level of risk, a more basic question remains: How much should society spend to reduce the existing level of risk? In other words, how do we decide the trade-off between human lives and economics?

Reserve Mining Company v. EPA was the first major judicial confrontation with these issues. It remains a leading case on the subject of risk regulation. Its dramatic facts make it an ideal

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3. 514 F.2d 492 (8th Cir. 1975) (en banc).
4. See United States v. Vertac Chem. Corp., 489 F. Supp. 870, 880 (E.D. Ark. 1980) (stating that Reserve Mining "is one of the most significant decisions in the field of environmental law"). Reserve Mining's risk analysis has been cited in approximately 25 cases. These cases involve a variety of pollution control schemes including: the 1972 amendments to the Federal Water Pollution Control Act; the Clean Air Act; the Comprehensive Environmental Response, Compensation, and Liability Act; National Environmental Policy Act requirements; and state pollution control and nuisance laws.

Perhaps the most important lesson courts have derived from Reserve Mining is that the fact finder has broad discretion in handling an uncertain but substantial risk. In Environmental Defense Fund v. EPA, 598 F.2d 62, 89 (D.C. Cir. 1978), the court upheld EPA's prohibition on the discharge of PCBs based on evidence that was "at least suggestive of carcinogenicity." The court stated that "[w]here the harm envisaged is cancer, courts have recognized the need for action based on lower standards of proof than otherwise applicable." Id. at 88 (citations omitted). Similarly, in Ethyl Corp. v. EPA, 541 F.2d 1, 17 (D.C. Cir. 1976), the court concluded that the "will endanger the public health or welfare" standard set forth in Clean Air Act § 211(c)(1)(A) was precautionary in nature and thus no proof of actual harm was necessary to support regulation of lead in gasoline. But see National Lime Ass'n v. EPA, 627 F.2d 416, 453 (D.C. Cir. 1980) (stating that fact
vehicle for thinking about environmental risks and how they should be controlled.

Section I of this Essay lays the groundwork by recounting the Reserve Mining litigation. The story of Reserve Mining is a fascinating piece of history, worth telling in its own right. Section II then considers whether the court made the correct decision. Was it right to force Reserve Mining Company (Reserve) to spend over $200 million to eliminate asbestos from Duluth's drinking water, given what is known about the possible risk? Without purporting to be definitive, I will discuss this question from two perspectives: the feasibility approach that is embodied in many of our environmental statutes, and its major competitor, cost-benefit analysis. These two approaches are usually thought to be radically different. In the Reserve Mining context, however, it turns out that

finder's determinations must be made in accordance with the preponderance of the evidence).

A related lesson derived from Reserve Mining is that, when regulating uncertain harm, probability is only one factor. In United States v. Northeastern Pharmaceutical and Chem. Co., 579 F. Supp. 823, 846 n.28 (W.D. Mo. 1984), the court cited Reserve Mining in support of the proposition that imminent hazard includes potential as well as actual harm. Similarly, the court in Sierra Club v. Sigler, 695 F.2d 957, 970 (5th Cir. 1983), reasoned that, when assessing uncertainty, the "magnitude of risk of harm must be considered." See also Ayers v. Jackson, 106 N.J. 557, 525 A.2d 287 (1987) (stating that the likelihood of harm is just one factor in determining proper intervention).

In contrast, Reserve Mining has at times been used to restrict environmental regulation. In Spannaus v. Maple Hill Estates, 317 N.W.2d 53, 55 (Minn. 1982), the Minnesota Supreme Court overturned an injunction restricting effluent discharges on the grounds that the balance between unpredictable health consequences and clearly predictable economic consequences did not justify such a drastic limitation. See also Harrison v. Indiana Auto Shredders Co., 528 F.2d 1107, 1125 (7th Cir. 1976) (stating that "in the absence of an imminent hazard to health or welfare—none of which was established or found present here, the appellant cannot be prevented from continuing to engage in the operation of its shredding").

5. See infra notes 95-118 and accompanying text.

6. See infra notes 119-143 and accompanying text.

7. For a recent discussion of this traditional conflict, see Heimann ed., Project: The Impact of Cost-Benefit Analysis on Federal Administrative Law, 42 ADMIN. L. REV. 545, 630-36 (1990). According to this article:

The use of cost-benefit analysis in environmental law is confusing and controversial. Like its opponents in health and safety regulation, opponents of cost-benefit analysis in environmental regulation argue that the purpose behind environmental statutes is to eliminate environmental harm, a purpose they allege is undermined by the use of cost-benefit analysis. Others argue
both of them lead to the same result. That conclusion itself raises important questions about whether the two approaches are really as incompatible as many people believe.

II. THE RESERVE MINING STORY

Reserve was a joint venture between Armco and Republic Steel,8 established to mine taconite. Taconite, a low-grade iron ore found on the north shore of Lake Superior, requires extensive processing before it can be used. Basically, the process involves smashing the taconite into small pieces, separating out those with the most iron, then breaking up those pieces, once again separating out the chunks with the most iron. The taconite goes through five rounds of purification. At the end, the process produces small green pellets with a high iron content. It also produces immense amounts of tailings, which are leftover pieces of rock. The company disposed of the tailings by letting them flow through troughs into Lake Superior.9

Reserve was ultimately discharging sixty-seven thousand tons of tailings per day into the lake.10 According to Reserve's own estimates, it had deposited tailings over more than a thousand square miles of Lake Superior.11 The manufacturing process used over two million tons of water per day, which was recycled back into the Lake.12

Given our general feelings these days toward polluters, it is important to keep in mind the other side of the story. When Reserve began operations, it was welcomed with open arms by local communities, state politicians, and the media. Other, richer ore deposits in the region had already been exhausted, and the area's economy was severely depressed, with chronic high unemployment. Reserve was seen as an economic savior for a region that

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that cost-benefit analysis is an inherently ineffective tool for weighing environmental values. 

Id. at 630 (citations omitted).

9. Id. at 20-31. Notably, other taconite processors disposed of their tailings on land. Id. at 64.
10. Id. at 36.
11. Id. at 38.
12. Id. at 31.
badly needed help.\textsuperscript{18}

Although the officers of Armco and Republic were no doubt pleased to be involved in such good works, their companies also found the venture profitable. From 1956 to 1973, Reserve returned \$240 million in profits after taxes. In 1973 it returned a profit of about twenty million dollars. The joint venture was highly leveraged, at least by the standards of the time, so this translated into over a fifty percent return on equity, though only a ten percent return on assets.\textsuperscript{14} This was well above Armco and Republic's required rate of return for investment projects.\textsuperscript{16} In short, the two companies, in their own view, had done well by doing good.

The 1960s saw a great upsurge in environmentalism. By the end of that decade, massive dumping like Reserve's was no longer easily tolerated. A 1968 U.S. Department of the Interior report concluded that Reserve was a serious source of pollution.\textsuperscript{19} In response, Secretary of the Interior Udall began the cumbersome process of federal regulation under the pre-1972 federal water pollution statute.\textsuperscript{17} After a series of "enforcement conferences"
failed to produce any resolution, the chair of the conference recommended that EPA file suit because of Reserve's uncooperative attitude. EPA went to court, and in the end Reserve paid dearly for its intransigence.

A. The Trial

The case was assigned to Judge Miles Lord. When I moved to Minnesota, Judge Lord was still on the bench, and I soon learned his reputation with local lawyers. Perhaps the best way of capturing Judge Lord's local reputation is to say that by comparison William O. Douglas was considered a hair-splitting legalist. In the

(FWPCA) could be sought under two different proceedings. The original enforcement mechanism was a conference procedure established under the 1948 law. Act of June 30, 1948, ch. 757, § 2(d), 62 Stat. 1155, 1156 (codified at 33 U.S.C. § 466a(d) (1952)). The procedure could be initiated either by the federal government, or at the request of the governor of the state in which pollution of interstate or navigable waterways was endangering human health or welfare. Id. The first step was to call a conference of the water pollution control agencies of all the states affected by the pollution. The federal administrator would then direct the appropriate state agency to act in accordance with the conference discussions. If appropriate action was not taken within six months, the polluter could be called before a hearing board appointed by the federal administrator. Following the hearing, the polluter was given another six months, or a reasonable time, whichever came last, to take steps toward abatement of the pollution. Finally, if the pollution continued, the administrator could ask the Attorney General to bring a suit for abatement. Id. See also 1 F. Grad, Treatise on Environmental Law 3-78 (1990).

The 1965 amendments created a second mechanism designed to provide federal enforcement of state water pollution control standards. Water Quality Act of 1965, Pub. L. No. 82-234, § 5, 79 Stat. 903, 909 (codified at 33 U.S.C. § 1160(c)(5) (1970)). Under this plan, abatement actions could be brought following a 180-day notice period. If, however, the pollution did not create interstate "endangerment," an action could only be brought with the written consent of the governor of the state where the discharge was occurring. Id.

Besides greatly expanding the federal administrator's regulatory powers, the 1972 amendments streamlined enforcement mechanisms. Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, 86 Stat. 816 (codified at 42 U.S.C. §§ 1251-1376 (1976)). Under the 1972 amendments, the administrator may, upon thirty days notice and failure of the state to enforce the statute, issue an order requiring appropriate pollution abatement steps. To enforce this order the administrator may bring a civil suit. Id. § 2, 86 Stat. at 859 (codified at 33 U.S.C. § 1319 (1976)). The 1972 amendments also created criminal penalties and added a citizen suit provision. Id. § 2, 86 Stat. at 880, 888 (codified at 33 U.S.C. §§ 1319(c), 1365 (1976)).

18. F. Schumberg, supra note 13, at 144-46.
view of many lawyers, Judge Lord was on the bench to do justice; he did not allow anything to stand in the way—whether it was Congress, appellate courts, or the evidence in a case. This righteous attitude—which produced the nickname, "Miles the Lord"—led him into continual conflicts with the U.S. Court of Appeals for the Eighth Circuit, in Reserve Mining as well as later cases. Nevertheless, until he lost his temper late in the proceedings, Judge Lord's writings in Reserve Mining gave every impression of being thorough and well considered.

Judge Lord's conduct of Reserve Mining became something of a model of what has been called "public law litigation." He opened the suit to numerous intervenors in order to obtain greater input. He also brought in a number of experts who were responsible to him rather than to the parties. As we will see, these experts had an important impact on the ultimate resolution of the case.

Until just before the trial, the dispute had centered on ecological damage to Lake Superior. The focus of the case then changed radically, almost by accident. The rather peculiar events are recounted in a book about the case:

[In May 1973, Glass, the EPA scientist with the Duluth National Water Quality Laboratory, had a dream—a bad dream. He awoke with a fear of drinking water from Lake Superior. The next day, Glass explained his vision to Dr. Phillip Cook, a colleague at the NWQL. Cook, prompted by this vision and the alarm sounded by Mrs. Lehto [a Duluth resident who had heard about asbestos at a hearing], initiated a search for asbestos in Duluth's water supply. He found it.]

EPA immediately went to Judge Lord with this new evidence; the asbestos data was made public, causing a panic in Duluth; and the focus of the case irrevocably shifted from ecology to public health.

21. See infra text accompanying notes 52-60.
22. F. Schaumberg, supra note 13, at 149.
23. Id. at 150.
The trial took 139 days. The evidence included testimony from over a hundred witnesses, over fifteen hundred exhibits, and eighteen thousand pages of transcript.  

Reserve initially claimed that the tailings did not contain asbestos, that they settled to the bottom of the lake without causing any pollution, and that any asbestos found in the lake must come from natural sources. Judge Lord had to hear extensive testimony about matters such as the chemistry of asbestos, the behavior of the Lake Superior thermocline, and erosion patterns on the north shore. For example, asbestos is not the name of a particular compound but of a family of minerals; there was debate about whether the minerals contained in the taconite belonged in the same family as the minerals causing cancer among insulation workers.

We often talk loosely about environmental regulation being on the “frontiers of science,” but this was especially true in Reserve Mining. The technology of the time was barely up to the task of identifying, let alone accurately counting, small asbestos fibers. For that reason, the judge faced great difficulty in simply ascertaining the asbestos level in Duluth drinking water. Today, we are often unsure whether a substance is a carcinogen, and the dose-response curve remains somewhat mysterious. For Judge Lord, however, even knowing the dose was a problem: fiber counts by different labs varied by a factor of ten. He concluded that the fiber count in Duluth drinking water varied from twelve million fibers per liter up to perhaps one hundred million.

By the time of the Reserve Mining trial, it was clear that inhaled asbestos is an extremely serious carcinogen. One issue in the case involved the effect of airborne asbestos on Reserve’s workers and their families. There seems to be little doubt that

24. Id. at 158.
25. Id. at 31-33.
26. Id. at 47-48.
27. F. Schaumberg, supra note 13, at 47.
28. Id. at 48.
29. In examining the effect of airborne asbestos, the court relied primarily upon studies of workers who manufactured and installed asbestos insulation. Reserve Mining Co. v. EPA, 514 F.2d 492, 507-08 (8th Cir. 1975) (en banc). The studies showed that individuals working with asbestos contracted cancer at a rate of three to four times higher than would otherwise be expected. Id. at 508. Additional studies demonstrated the carcinogenic effect of lower level asbestos expo-
this health hazard required stringent pollution control. For present purposes, however, the relevant portion of the case relates to the water pollution issue. Here, even after asbestos counts in Duluth water were established and traced to Reserve's discharge, a major problem remained: nobody knew whether drinking asbestos was dangerous, and there was actually evidence it was perfectly safe. The evidence on this central issue is discussed below in connection with the Eighth Circuit's opinion.\textsuperscript{30}

Judge Lord viewed asbestos as a major public health threat to Duluth's drinking water. The crux of his opinion is contained in the following passage:

Defendants are exposing thousands to significant quantities of a known human carcinogen. If there is such a thing as a safe level of exposure to this human carcinogen, it must be very low and there is no credible evidence before this Court to indicate what that level is. Nonetheless the Court is asked to permit the present discharge until such a time as it can be established that it has actually resulted in death to a statistically significant number of people. The sanctity of human life is of too great value to this Court to permit such a thing.\textsuperscript{31}

Judge Lord was hardly alone in taking this approach to environmental risks. The Occupational Safety and Health Administration's (OSHA) cancer policy embodied a similar approach, and four Justices on the Supreme Court would later emphatically endorse this approach in \textit{The Benzene Case}.\textsuperscript{32}

\textsuperscript{30} See id. at 508 n.26. Reserve sought to refute the plaintiff's evidence on two grounds: first, that the fibers discharged into the air by Reserve were materially different than those examined in the plaintiff's studies, and second, that the level of exposure was significantly lower. The court rejected Reserve's first contention on the grounds that the fibers discharged at Silver Bay were substantially identical to the fibers shown to have a carcinogenic effect. \textit{Id.} at 510. The court had a more difficult time disposing of Reserve's second argument. See \textit{id.} at 510-12. Both the exact level of discharge from Reserve's operations and the level at which asbestos posed a health risk were unclear. Nevertheless the court accepted the conclusion of the court-appointed expert that Reserve's discharge presented a threat to public health. \textit{Id.} at 513. In fashioning a remedy, however, the court did not believe a shutdown of Reserve's facilities was justified. Rather, the court required Reserve to use available technology to reduce airborne asbestos emissions "below a medically significant level." \textit{Id.} at 538.

\textsuperscript{31} See infra notes 48-66 and accompanying text.


\textsuperscript{32} Industrial Union Dep't, AFL-CIO v. American Petroleum Inst., 448 U.S.
This left Judge Lord only with the question of remedy. Until late in the proceedings, Judge Lord apparently hoped to find a solution that would not disrupt Reserve's operations.\textsuperscript{8} By the end of the trial, however, he had lost patience with Reserve. Reserve had filed misleading discovery responses and had also presented inaccurate if not dishonest testimony about the feasibility of land disposal.\textsuperscript{3} Given the company's intransigence, Judge Lord saw no alternative but an immediate shutdown order, which he issued on April 20, 1974. If Reserve had taken a more cooperative attitude, Lord probably would have given it time to put land disposal into effect.\textsuperscript{6} But he was apparently too outraged by Reserve's litigation tactics to allow any delay.

607, 688 (1980) (Marshall, J., dissenting) (The Benzene Case). In The Benzene Case, the Court invalidated OSHA benzene regulations on the grounds that OSHA had not established that such regulations were "reasonably necessary . . . to provide safe and healthful employment" as required by the Occupational Safety and Health Act. \textit{Id.} at 642, 662. For a more detailed discussion of the Court's holding, see \textit{infra} notes 102-106 and accompanying text.

Justice Marshall's dissent emphasized the importance of deferring to agency discretion where the risk is uncertain. Marshall specifically rejected the Court's contention that the Secretary was required to show that it was more likely than not that the risk posed by benzene was significant. \textit{Id.} at 708 (Marshall, J., dissenting). Rather, Marshall concluded that:

In recent years there has been increasing recognition that the products of technological development may have harmful effects whose incidence and severity cannot be predicted with certainty. The responsibility to regulate such products has fallen to administrative agencies. Their task is not an enviable one. Frequently no clear causal link can be established between the regulated substance and the harm to be averted. Risks of harm are often uncertain, but inaction has considerable costs of its own. The agency must decide whether to take regulatory action against possibly substantial risks or to wait until more definitive information becomes available—a judgment which by its very nature cannot be based solely on determinations of fact.

\textit{Id.} at 722-23 (Marshall, J., dissenting).

34. \textit{Id.} at 64-68.
35. \textit{Id.} at 83-84.
B. The Appeal

Lord's shutdown order was almost immediately stayed by the Eighth Circuit. The judges were all out of town for a judicial conference, so the stay arguments were held in a motel room, apparently in rather casual dress.\(^{38}\)

The key to the stay order was the issue of risk. The court of appeals concluded that the evidence "does not support a finding of substantial danger,"\(^{37}\) and that the discharges represented at most a "possible medical danger."\(^{38}\) Relying on the fact that the actual level of risk was simply unknown, the appellate court said that Lord's "determination to resolve all doubts in favor of health safety represents a legislative policy judgment, not a judicial one."\(^{39}\) Although it expected Reserve to prevail on the health hazard issue, the appellate court did believe that Reserve's pollution of Lake Superior would eventually have to be abated.\(^{40}\)

The government immediately asked the Supreme Court to vacate the Eighth Circuit order.\(^{41}\) Only Justice Douglas voted in favor of the request.\(^{42}\) Proceedings immediately began before Judge Lord to identify a feasible method of land disposal.\(^{43}\) Reserve initially planned to dispose of the tailings near the Lake, but this plan was rejected, primarily because of the possibility that the dam would fail and spill tons of tailings into the lake.\(^{44}\) In the meantime, the appeal was briefed, and oral argument took place before the Eighth Circuit, en banc, on December 9, 1974.\(^{45}\) That court's opinion was issued on March 14, 1975. By then, the trial court was immersed in disputes about a new Reserve plan to dispose of the tailings at a site known as Milepost 7.\(^{46}\)

36. F. Schaumberg, supra note 13, at 194.
37. Reserve Mining Co. v. United States, 498 F.2d 1073, 1077 (8th Cir. 1974).
38. Id. at 1083.
40. Reserve Mining Co. v. United States, 498 F.2d at 1084.
41. Reserve Mining Co. v. EPA, 514 F.2d 492, 504 (8th Cir. 1975) (en banc).
43. Reserve Mining Co. v. EPA, 514 F.2d at 504.
45. Reserve Mining Co. v. EPA, 514 F.2d at 492.
46. Reserve Mining Co. v. EPA, 514 F.2d 492, 506 (8th Cir. 1975) (en banc).
The Eighth Circuit's decision focuses on the possible existence of a serious health hazard. As mentioned earlier, everyone knew that inhaling asbestos was terribly unhealthy.\textsuperscript{47} The question was whether drinking asbestos was also hazardous—and indeed, whether ingested asbestos even enters the body at all. Ingesting asbestos presumably doesn't provide any health benefits—so far as I know, no one has ever recommended asbestos as a source of dietary fiber—but there was very real doubt about whether it was harmful.

The Eighth Circuit carefully summarized the evidence bearing on this issue. This evidence fell into three major groups: (1) animal studies; (2) studies of Duluth residents; and (3) inferences from studies of asbestos workers.\textsuperscript{48}

The animal studies were designed to determine whether asbestos fibers can penetrate the intestinal tract and enter the body. The results of the studies were conflicting as to whether asbestos can enter the body in this way. In none of the studies was there evidence that asbestos caused gastrointestinal cancer in lab animals that drank asbestos.\textsuperscript{49}

The crucial study of Duluth residents was initiated by Judge Lord. The purpose of the study was to determine whether the tissues of long-time residents contained asbestos fibers. Tissue samples from Duluth cadavers were compared with samples from Houston, which does not have asbestos in its drinking water. The plaintiffs predicted that the study would yield solid information about the risk to Duluth residents. When the study was completed, however, the asbestos fibers failed to appear. The court of appeals found this result highly significant and was not impressed by post hoc efforts to explain away the negative findings.\textsuperscript{50} As the court also noted, epidemiological studies had failed to produce ev-
idence of an elevated gastrointestinal cancer rate in Duluth.\textsuperscript{51}

Up to this point, the court had found virtually no evidence of harm. The really troubling point, however, was that asbestos workers do have an increased rate of gastrointestinal cancer. A reasonable explanation is that they cough up asbestos fibers and then swallow them, resulting in gastrointestinal cancer. Dr. Selikoff, the leading expert on asbestos-related disease, considered this a likely mechanism.\textsuperscript{52} Assuming that to be correct, another expert testified that the total exposure of Duluth residents was comparable to that of asbestos workers.\textsuperscript{53}

In evaluating this evidence, the Eighth Circuit was obviously impressed by the testimony of another expert, who was quoted at length twice in the text of the opinion.\textsuperscript{54} The witness, Dr. Arnold Brown, chaired the pathology department at the Mayo Clinic, and had served the district judge as both a technical advisor and impartial witness.\textsuperscript{55} Speaking as a scientist, Dr. Brown said that the evidence "is not complete in terms of allowing me to draw a conclusion one way or another concerning the problem of a public health hazard in the water in Lake Superior."\textsuperscript{56} Speaking as a physician, however, he had more definite views:

As a medical person, sir, I think that I have to err, if I do, on the side of what is best for the greatest number. And having concluded or having come to the conclusions that I have given you, the carcinogenicity of asbestos, I can come to no conclusion, sir, other than that the fibers should not be present in the drinking water of the people of the North Shore.\textsuperscript{57}

The appellate court's own conclusions were quite similar. According to the court, "it cannot be said that the probability of harm is more likely than not . . . . On this record it cannot be forecast that the rates of cancer will increase."\textsuperscript{58} The most that

\textsuperscript{51.} Reserve Mining Co. v. EPA, 514 F.2d 492, 518 n.50 (8th Cir. 1975) (en banc).
\textsuperscript{52.} Id. at 516.
\textsuperscript{53.} Id. at 517.
\textsuperscript{54.} Id. at 513-14 (Dr. Brown's testimony concerning air pollution); id. at 518-19 (Dr. Brown's testimony on the water pollution issue).
\textsuperscript{55.} Id. at 506 n.18.
\textsuperscript{56.} Reserve Mining Co. v. EPA, 514 F.2d 492, 518 (8th Cir. 1975) (en banc).
\textsuperscript{57.} Id. at 519.
\textsuperscript{58.} Id. at 520.
could be said was that asbestos contamination in Lake Superior "gives rise to a reasonable medical concern for the public health." The existence of this concern was enough, however, to justify what the court called "abatement of the health hazard on reasonable terms.

The remaining issue was the remedy. Given the weak evidence of any danger to the public, the court believed that an immediate shutdown was untenable. The firm produced over ten percent of the nation's iron. A shutdown would harm not only shareholders but also employees. Reserve had over three thousand employees, each of whom directly or indirectly supported between four and six other people. Moreover, the employee's labor union argued that the health effects of a plant closure on workers might be more severe than those caused by the asbestos. Furthermore, at oral argument, Reserve offered to spend $243 million to halt its air and water pollution. Based on all these factors, the court concluded that Judge Lord had abused his discretion by ordering an immediate shutdown, and that the company should be given a reasonable time to switch to land disposal.

Judge Lord had made no secret of his displeasure with the stay order. The appellate court rebuked him in the closing por-
tion of its opinion for taking actions “which appear to be in conflict with the express language” of the stay. After the court of appeals’s opinion on the merits, Judge Lord became even more outspoken. At one point, he hauled a number of company officers and state officials into court to hear a lecture—perhaps sermon would be a better word—about the danger of asbestos pollution. The court of appeals then removed him from the case for bias, violation of the company’s due process rights, and disregard of the Eighth Circuit’s mandate. Lord’s unconcealed disdain for the appellate court received the following response:

Disregard of this court’s mandate by a lawyer would be contemptuous; it can hardly be excused when the reckless action emanates from a judicial officer. It is one thing for a district judge to disagree on a legal basis with a judgment of this court. It is quite another to openly challenge the court’s ruling and attempt to discredit the integrity of the judgment in the eyes of the public.

Lord was replaced by Judge Devitt, a considerably less colorful but “sounder” jurist.

The court of appeals may have thought that it had set the stage for a prompt resolution of the case. In reality, the court of appeals’s decision was followed by protracted litigation in the state courts over the location of the land disposal site. In the spring of 1977, the Minnesota Supreme Court issued an opinion approving the Milepost 7 plan. Further litigation followed about the conditions of the permit, which resulted in another Minnesota

the discharge, and the discharge has continued to date. . . . [D]efendants have had their day in court in the form of this nine-month trial. Based on the substantial evidence adduced at this trial, this Court found not only was defendants’ discharge in violation of several state and federal laws and regulations, but also constituted a threat to the health of thousands. Due process requires that defendants be permitted the right to appeal this Court’s decision. Due process does not require that defendants be permitted to violate the laws aimed at protecting the public and to continue exposing thousands of people to substantial quantities of a known human carcinogen during the several years remaining in which the appellate process continues.

Id. at 90-91 (footnote omitted).
68. Reserve Mining Co. v. EPA, 514 F.2d 492, 541 (8th Cir. 1975) (en banc).
69. Reserve Mining Co. v. Lord, 529 F.2d 181, 187 (8th Cir. 1976).
70. Id. at 188-89.
71. Id. at 188.
72. Reserve Mining Co. v. Herbst, 256 N.W.2d 808 (Minn. 1977).
Supreme Court decision a year later. Reserve then announced that it was proceeding with its conversion to land disposal. The conversion was completed in 1980.

Ironically, the issue of waste disposal soon became rather academic for Reserve. In June 1982, the company temporarily shut down, blaming deterioration in the steel industry. It reopened six months later, but then closed for another six months. The company never did regain its financial footing. In 1986, LTV, which had replaced Republic as a co-owner of Reserve, filed for bankruptcy under Chapter 11 and withdrew from the partnership. Shortly thereafter, Armco announced it was closing Reserve's operations. By August 1988, the Armco subsidiary running Reserve had also filed under Chapter 11. At last report, Reserve had been sold for fifty-two million dollars to a firm called Cyprus Minerals Co., which had resumed operations on a greatly reduced scale.

Is this later history relevant to assessing the Reserve Mining decision? The financial history naturally raises the question of whether land disposal bankrupted the company. Apparently, however, the blame was placed on declines in the U.S. steel industry generally, rather than any special problems at Reserve. Because Reserve's operations were so sharply curtailed in the 1980s, any risk to Duluth was obviously much smaller than anticipated. It seems unfair, however, to criticize 1975 judicial rulings for apparently unforeseeable economic developments. The courts in 1975 were faced with an economically healthy defendant; they had no reason to know that the U.S. manufacturing economy, including the steel industry, faced precipitous decline.

73. Reserve Mining Co. v. Minnesota Pollution Control Agency, 267 N.W.2d 720 (Minn. 1979).
74. Reserve to Continue Mining, FACTS ON FILE WORLD NEWS DIG., July 21, 1978, at 553 E2 [hereinafter Reserve to Continue].
76. ReserveClosure, MINING J., June 18, 1982, at 457.
77. Reserve Mining to Close, MINING J., Apr. 1, 1983, at 211.
79. Id.
82. See sources cited supra notes 76-80.
Ultimately, the courts in Reserve Mining were faced with a difficult task in weighing an uncertain risk to public health against an approximately $200 million expenditure. The question posed by the case is how to go about making such trade-offs between safety and cost. Reserve Mining provides an excellent context in which to discuss why these choices are so hard, what methods have been proposed for making them, and how we might go about resolving cases like Reserve Mining in a sensible way.

III. How to Analyze Environmental Risks

Like Judge Lord, some readers may find Reserve Mining an easy case on the ground that health considerations should always outweigh mere cost, so that Reserve should have been closed immediately to eliminate the risk. But Reserve Mining is actually a good illustration of why both cost and risk have to be considered. A shutdown would not merely have taken money out of the pockets of some wealthy shareholders. It would also have imposed enormous costs on the company's employees, their communities, and the economy of the whole region. There is some possibility—in the view of the Eighth Circuit, more than a fifty percent chance—that switching to land disposal would not in fact save a single human life. And if we were looking for ways to save lives, perhaps we could find better ways to use $200 million. So the

83. According to a news report, the air-cleansing equipment needed to protect Silver Bay from airborne asbestos would cost approximately $40 million. McWethy, Classic Confrontation: When Government and Industry Tangle Over the Environment, U.S. NEWS & WORLD REP., Jan. 10, 1977, at 64. This leaves approximately $200 million of the company's estimated $240 million expenditure to be spent on abating water pollution by switching to land disposal. Whether $200 million is an accurate estimate, however, is unclear. By 1977, Reserve was estimating that the cleanup job would cost more than $300 million. Id. at 63; Wehrwein, Court Backs Minn. Firm on Dumping Site, Wash. Post, Apr. 9, 1977, at A4, col. 6. Within a year, Reserve had increased the estimate to $370 million. Reserve to Continue, supra note 74, at 553 E2. Of course, this increase may be due to inflation. Moreover, a portion of the expenditures could be characterized as modernization that would reap economic benefits for Reserve. In 1977, Reserve estimated that $36 million of the estimated $300 million total cost would be used for modernization of its processing system. Reserve's critics disputed this claim, asserting that at least $100 million would go toward modernization. McWethy, supra, at 63. See also United States v. Reserve Mining Co., 380 F. Supp. 11, 60-61 (D. Minn. 1974) (Judge Lord's finding that pollution abatement would reap economic gains for Reserve).
mere abstract possibility that spending two hundred million dollars might conceivably save one life is not enough. We need to take both the cost and the benefits of regulation into account in some way. This, of course, is easier said than done.

A. The Perplexities of Risk Regulation

One reason that risk regulation is so hard is that our responses to both costs and benefits are fairly complex. When assessing the benefit of regulations, the most important factor is the effect on the mortality rate—or, more brutally, the body count.\textsuperscript{84} As the courts in Reserve Mining were all too aware, this risk information is often difficult to obtain, given the limits of scientific knowledge about toxic chemicals. The special problems of identifying carcinogens are notorious, as are the difficulties of determining the effects of low doses over extended periods.\textsuperscript{85}

The risk analysis is even more complex because most people consider other factors in evaluating the seriousness of risks.\textsuperscript{86} The cause of death is important; a slow death from cancer is worse than a sudden heart attack or accidental death. Age is another factor; accelerating the death of an elderly person is not quite as horrible as causing the death of a child. Clusters of deaths are also taken more seriously. It is bad to kill three people in the general population, worse to kill three in the same community, worst to kill three in the same family.\textsuperscript{87}

People find two other factors important to assessing risk. One is the unfamiliarity of the risk. Familiar risks are given less weight than those involving mysterious technology or esoteric scientific knowledge. This is understandable and to some extent reasonable.\textsuperscript{88} But the fear of novel technological risks can become


\textsuperscript{86} Much of my discussion is purely impressionistic, but it does find some support in empirical studies of risk perception. See Slovic, Perception of Risk, 236 Sci. 280 (1987). See also, Gillette & Krier, supra note 84, at 1073-75.

\textsuperscript{87} Ruckelshaus, supra note 85, at 10,192.

\textsuperscript{88} It is important that people be able to understand the major events in their lives, particularly something as important as their own impending death or
almost hysterical, leading to burdensome regulations on extraordinarily small risks.

The other major factor is voluntariness. Like unfamiliarity, this too has some reasonable basis. Regulation of voluntary risks raises problems of paternalism. Nevertheless, perceptions of voluntariness seem to play an exaggerated role in risk assessment.

The most dramatic example is cigarette smoking, which poses the most serious public health threat of any known toxic substance. Cigarettes kill approximately 350,000 people per year. They are known to be addictive and most smokers start before they are sixteen, so even the voluntariness argument is somewhat dubious. Nevertheless, because smoking at least appears voluntary, most people think government intervention is much less warranted than for hazardous waste sites or drinking water contamination. The result is that we spend vast sums of money dealing with relatively minute health hazards, but very little on controlling cigarettes. Yet, cutting smoking in half would save more lives than every environmental statute ever passed. Voluntariness is important, but sometimes it can become something of a fetish.

Obviously, deciding how seriously to take various risks is neither straightforward nor uncontroversial. Evaluating the costs the death of someone they love. It is easier to understand and accept the familiar than the exotic.

89. Smoking also involves two of the other factors used to assess risk: it is a familiar risk and it kills mostly the old.


91. This is always the answer I get when I ask my environmental law students why it is worth spending hundreds of millions of dollars to clean up toxic waste sites based on speculative health risks while the government does virtually nothing about cigarettes.

92. The recent scientific trend has been toward downplaying many toxics risks. See, e.g., Shabecoff, Estimate of Risk of Dioxin is Cut in Cancer Study, N.Y. Times, Dec. 9, 1987, at 1, col. 1.

93. Outlawing cigarettes would be impractical but an increased tax would be useful, as would greater investment in public education. See Passell, Who Should Pay Smoking's Cost, N.Y. Times, June 22, 1988, at 2, col. 1. As Lowenstein points out, a ban on cigarette advertising might well be warranted. See Lowenstein, supra note 90. A ban on vending machines would also reduce availability, particularly to children.
of regulation is also more than a matter of calculating expenses. The weight society should place on costs depends where they fall. It may well be reasonable to require a million people to each pay one a dollar apiece to save a life, but unreasonable to require ten people to sacrifice $100,000 each, or to impose the entire costs on a small town whose economic foundation is destroyed by a plant closure. It may also matter whether the beneficiaries of the regulation are poorer or wealthier than those incurring the costs. Moreover, decreased output may not be a serious concern for luxury goods, but may be much more important for necessities or new technologies that promise important social benefits. We also need to think about the effect of regulation on productivity and international competitiveness.

Given the difficulty of assigning values to the costs and benefits of health regulations, regulatory decisions clearly cannot be made by any mechanical formula or test. It is tempting to fall back on sheer intuition, but intuition is a treacherous guide. When the decision is being made by an administrator or a judge, we would like to have a little more guidance than simply the decision maker's gut reaction. Too many different kinds of people get jobs as administrators and judges for us to simply trust their intuitions.

Even when we are making the decisions ourselves, intuition may fail. In thinking about Reserve Mining, my own intuition has waffled. On some days, it seemed clear to me that even one extra case of cancer in Duluth would be one too many. On other days, the thought of spending $200 million dollars to combat a risk that may well be chimeric seemed bizarrely unrealistic. Intuition is not enough.

In place of intuition, two methods have been suggested for making risk decisions. One, cost-benefit analysis, is essentially a utilitarian effort at balancing. The other method calls for avoidance of risks whenever feasible. As Mark Sagoff has suggested, feasibility analysis appears to be based on the view that people have a right to be free from environmental risks.94 Cost-benefit

94. M. SAGOFF, THE ECONOMY OF THE EARTH: PHILOSOPHY, LAW, AND THE ENVIRONMENT 185, 197-98 (1988); see also Weyerhaeuser Co. v. Costle, 590 F.2d 1011, 1043 (D.C. Cir. 1978) (noting that the best practicable technology standard under the Clean Water Act embodies the view that the public has a right to a clean environment limited only by the extent to which cleanup is impractical or
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focuses on two main factors: the predicted body count and the total cost of control. In contrast, feasibility analysis stresses the nuances—factors such as voluntariness, strangeness of risk, and concentration of costs on particular firms—rather than overall cost and mortality reduction. The biggest difference, however, is that feasibility analysis incorporates a strong presumption in favor of control, while cost-benefit analysis eschews any such presumption in favor of impartial balancing.

The battle between these perspectives has killed many a tree. In some situations, particularly where risks are very small or extremely difficult to estimate, they may lead to different results. Nevertheless, the practical differences between these approaches may have been exaggerated. It may be time to call a truce, and admit that both approaches may be useful tools in risk regulation.

B. Feasibility Analysis

When first thinking about toxics problems, many people begin with the notion that carcinogens are bad things and should be eliminated from the environment at all costs. This turns out to be simply untenable. We are surrounded by natural carcinogens, including chemicals naturally found in a variety of foods. Even apart from natural causes, our ability to measure tiny traces of chemicals makes the idea of complete purity obsolete. And even where we could attain purity, the costs may be excessive: for example, we may eliminate preservatives causing a small risk of cancer, only to foster the growth of pathogens that will cause greater risks of cancer. As Professors Gillette and Krier say, "Risk inheres in our condition. Whether brought on by nature in such forms as earthquakes and disease, or by humans with mundane machines like the automobile and high technologies like nuclear energy, hazard is ubiquitous and inevitable."

95. See Ames, Magaw & Gold, Ranking Possible Carcinogenic Hazards, 236 Sci. 271, 273 (1987) (table ranking possible carcinogenic hazards); id. at 276-77 (discussing natural carcinogens).

96. See C. SUNSTEIN, AFTER THE RIGHTS REVOLUTION: RECONCEIVING THE REGULATORY STATE 88-89 (1990) (discussing the adverse effects of the Delaney Clause, which prohibits FDA from permitting any food additive found to be carcinogenic).

97. Id. at 89.

Some environmental statutes purport to require health at all cost. These statutes are invariably stymied in the implementation phase, because society simply is unwilling to close down entire industries.99

The fallback position is to require only as much regulation of health risks as is feasible. A typical provision is found in the recently enacted version of Clean Air Act section 112(d)(2), requiring use of the maximum achievable control technology to reduce the emission of hazardous air pollutants.100 In a variety of statutory formulations, efforts to achieve the maximum possible reduction in risk have become the dominant mode of regulation in contemporary environmental law.101 Often, industries are required to eliminate known carcinogens as much as possible. Reserve Mining illustrates one difficulty of such an approach: should we consider "asbestos" to be a known carcinogen because its inhalation causes cancer, or should we say that "ingested asbestos" is not a known carcinogen? Even for a known carcinogen, if current exposure levels present only a minute risk, should we still require the industry to spend huge amounts on pollution control?

In The Benzene Case, the Supreme Court clarified feasibility analysis by requiring a showing of a significant risk of harm at current levels of exposure before permitting an agency to establish risk reduction standards.102 Justice Stevens' plurality opinion in that case clearly allows the agency to make conservative policy judgments in estimating the current risk, even in the face of considerable scientific uncertainty. Although his opinion has been criticized for putting too heavy a burden on the agency,103 on closer inspection it does give the agency a great deal of leeway, so


101. See F. Cross, supra note 99, at 90-93. See also Schroeder, In the Regulation of Mannmade Carcinogens, If Feasibility Analysis is the Answer, What is the Question?, 88 Mich. L. Rev. 1483, 1486 (1990).


long as the agency is explicit about what it is doing.\textsuperscript{104}

On one reading, the Stevens opinion requires the agency to make a finding that a chemical "more likely than not" causes some increase in mortality.\textsuperscript{105} If taken literally, this could lead to absurd results. If there were a sixty percent chance that a substance is harmless, the agency could never act—not even if there were also a forty percent chance that the substance might kill a million people. Stevens is more plausibly read as saying that the agency must find a significant risk of harm, taking into account both the likelihood that there is any increase in mortality and the probable extent of the increase if there is one.

In a later opinion interpreting the same statute, the Court

\begin{quote}

104. Justice Stevens stressed the flexibility afforded regulatory agencies:

Contrary to the Government's contentions, imposing a burden on the Agency of demonstrating a significant risk of harm will not strip it of its ability to regulate carcinogens, nor will it require the Agency to wait for deaths to occur before taking any action. First, the requirement that a "significant" risk be identified is not a mathematical straitjacket. It is the Agency's responsibility to determine, in the first instance, what it considers to be a "significant" risk. Some risks are plainly acceptable and others are plainly unacceptable. If, for example, the odds are one in a billion that a person will die from cancer by taking a drink of chlorinated water, the risk clearly could not be considered significant. On the other hand, if the odds are one in a thousand that regular inhalation of gasoline vapors that are 2% benzene will be fatal, a reasonable person might well consider the risk significant and take appropriate steps to decrease or eliminate it. . . .

Second, OSHA is not required to support its finding that a significant risk exists with anything approaching scientific certainty. Although the Agency's findings must be supported by substantial evidence, [the Occupational Safety and Health Act] specifically allows the Secretary to regulate on the basis of the "best available evidence." As several Courts of Appeals have held, this provision requires a reviewing court to give OSHA some leeway where its findings must be made on the frontiers of scientific knowledge. Thus, so long as they are supported by a body of reputable scientific thought, the Agency is free to use conservative assumptions in interpreting the data with respect to carcinogens, risking error on the side of overprotection rather than underprotection.

Finally, the record in this case and OSHA's own rulings on other carcinogens indicate that there are a number of ways in which the Agency can make a rational judgment about the relative significance of the risks associated with exposure to a particular carcinogen.

448 U.S. at 655-57 (citations omitted). \textit{See also id. at 663} (Burger, C.J., concurring); \textit{id.} at 666-67 (Powell, J., concurring).

105. \textit{Id. at 653. See also Latin, supra note 103, at 344-49} (critiquing plurality's allocation of burden of proof).
\end{quote}
held that once a significant risk is found, the agency must assure workers’ safety to the extent feasible. Cost-benefit analysis is neither required nor even appropriate.\textsuperscript{106}

In applying this analysis to \textit{Reserve Mining}, the first step is to determine if there was a significant risk. Unfortunately, even today, we cannot be sure of the answer. There has been a great deal of research on the carcinogenic properties of ingested asbestos, but the results remain inconclusive. The increased rate of gastrointestinal cancer among asbestos workers is well established.\textsuperscript{107} The “coughing up and swallowing,” more politely known as pulmonary clearance, hypothesis remains well accepted.\textsuperscript{108} Also, the most carefully conducted epidemiological study, from the San Francisco Bay Area, did find a significant increase in cancer related to asbestos in the drinking water. Other studies, including a follow-up study of Duluth, point in the opposite direction.\textsuperscript{109}


\textsuperscript{108} Id. at 1193.


While epidemiological studies are important tools in risk assessment, one must nonetheless approach them with caution. The asbestos studies focus on the incidence of disease in a geographic area exposed to a substance as compared to the incidence of disease in an unexposed area. MacRae, \textit{supra}, at 7. Because of the long latency period for the development of cancer and the probability of population migration during that period, one runs the risk that the population being
Fortunately, I need not attempt my own assessment of the medical data. In 1983, the EPA conducted a careful survey of the asbestos research and issued its own assessment of risk.\textsuperscript{110} A recent article converts the EPA assessment into a formula for estimating mortality rates.\textsuperscript{111} The EPA estimate is based on lifetime exposure of one million people to 100 million fibers per liter of water. EPA estimates the increased risk of death at 1/300 per person, or a total of 3300 excess deaths. Duluth's population was about 100,000,\textsuperscript{112} and a reasonable estimate of fiber density was about thirty-three million fibers per liter.\textsuperscript{113} With these modifications, the formula predicts about one hundred excess deaths from gastrointestinal cancer in Duluth. Alternatively, this means about 1.5 excess deaths annually.\textsuperscript{114}

Was this a "significant risk?" Justice Stevens opined that a "one in a thousand" risk was significant.\textsuperscript{115} Duluth residents were subject to more than that risk on a normal lifetime basis. In any event, one or two excess deaths per year in Duluth seems to be a large enough figure to justify some type of government intervention.

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\textsuperscript{110} Assuming ingestion of two liters of water per day over a 70-year lifespan, EPA estimated increased cancer risks of $10^5$, $10^6$, and $10^7$ from exposure to 300,000 fibers/liter, 30,000 fibers/liter, and 3,000 fibers/liter, respectively. WATER QUALITY CRITERIA FOR ASBESTOS, supra note 50, at C-113. Some of these data were not available in 1975 when the court ruled, but I believe that rough estimates of about the same magnitude could have been made.

\textsuperscript{111} The formula is explained in Nicholson, Human Cancer Risk from Ingested Asbestos: A Problem of Uncertainty, 53 ENVTL. HEALTH PERSP. 111, 111-13 (1983).

\textsuperscript{112} Levy, supra note 109, at 364.

\textsuperscript{113} This is about the mid-point of the range found by Judge Lord in normal weather conditions, United States v. Reserve Mining Co., 380 F. Supp. 11, 48 (D. Minn. 1974), and is also reasonable in light of the more recent epidemiological study. Sigurdson, supra note 109, at 61.

\textsuperscript{114} The formula is explained in Nicholson, supra note 111, at 111-13.

Assuming that the risk is significant, the next question is whether land disposal was "feasible." As the Supreme Court interprets the term, this requires a determination of whether it is economically and technologically possible to accomplish land disposal.\footnote{116. See American Textile Mfrs. Inst. v. Donovan, 452 U.S. 490, 507 (1981) (The Cotton Dust Case).} The Eighth Circuit clearly believed land disposal would be feasible. In retrospect, they were obviously right, since the company managed to make the change; Reserve's subsequent financial collapse appears to be unrelated to the change to land disposal. Thus, the \textit{Reserve Mining} decision seems to be consistent with the Supreme Court's later interpretation of significant risk and feasibility.

On its surface, this kind of feasibility analysis looks very different from a cost-benefit analysis. However, the difference may not be as fundamental as it appears. In reality, a decision maker is very likely to consider costs when deciding whether a risk is significant. What is considered "feasible" to control a major risk might be considered infeasible when the risk is much smaller. In this sense, feasibility analysis is like "compelling interest" analysis in constitutional law.\footnote{117. See generally, J. NOWAK, R. ROTUNDA, J. YOUNG, CONSTITUTIONAL LAW 530-31 (3d ed. 1986).} It still allows some degree of balancing, but in a structure that gives a decided preference to one side of the balance. As Professor Schroeder has argued, this structure may best fit the public's preferences about risk control.\footnote{118. See Schroeder, \textit{supra} note 101, at 1503-04. Some of these issues are explored further in Farber, \textit{Playing the Baseline: Civil Rights, Environmental Law, and Statutory Interpretation} (Book Review), 91 COLUM. L. R. 676 (1991) (review of C. Sunstein, \textit{supra} note 96).}

The disadvantages of feasibility analysis are (1) that it may lead to pollution controls far out of proportion to any actual health risk, and (2) that its rhetoric may conceal the trade-offs that we are really making. Its major competitor, cost-benefit analysis, is an effort to make trade-offs explicitly and even-handedly.

\textbf{C. Cost-benefit Analysis}

In place of the intuitive balancing that sometimes takes place in the guise of the feasibility test, cost-benefit analysis purports to offer a precise, scientific way of comparing costs and benefits.
The key to this comparison is to place a dollar value on the benefits of regulation, that is, on the lives saved. Thus, in applying cost-benefit analysis to situations like Reserve Mining, economists must specify the value of a human life.

Many people find the idea of putting a monetary value on a life to be intrinsically offensive. Rather than speaking of the cash value of a life, we might better speak of the amount that we collectively and individually are willing to spend to save a life. We may want to pretend that this amount is infinite, but the hard reality is that there are limits to the resources we can or should devote to safety.

In assessing this value, economists usually look to the amount people are willing to sacrifice to reduce the amount of risk in their own lives. The best information comes from labor markets. People have to be paid extra to take dangerous jobs, and this provides a measure of how much they value their lives.

Although this information is useful, it would be a mistake to rely on it absolutely. There are strong reasons to question the risk preferences revealed by industry wage patterns. Studies by cognitive psychologists and others show that individuals are quite bad at estimating risk levels. Even where a risk is known, peo-

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120. Id.

121. See id. at 24-26 (analyzing the ethical difficulties in putting a monetary value on human life).

122. See id. at 1-4 (discussing different costs assumed by federal regulations designed to save lives).

123. One commentator has estimated that individuals are willing to place themselves in high risk situations for around $600,000. Viscusi, The Valuation of Risks to Life and Health: Guidelines for Policy Analysis, in BENEFITS ASSESSMENT: THE STATE OF THE ART 193, 201 (J. Bentkover, V. Covello & J. Mumpower eds. 1986); see C. Gillette & T. Hopkins, supra note 119, at 39-41 (discussing a range of estimates of the value of a human life).

124. C. Gillette & T. Hopkins, supra note 119, at 41-49. As Gillette and Hopkins point out, a number of biases created by the realities of labor markets prejudice the accuracy of this approach. These include the absence of meaningful employment options, the lack of information available to workers, and the presence of externalities whereby some of the costs associated with a given risk are not borne by the worker or the worker's immediate family. See also Gillette & Krier, supra note 84, at 1038-42.

125. Page, A Generic View of Toxic Chemicals and Similar Risks, 7 Ecology
ple do not process the information very well. They are irrational when considering combinations of risks, they ignore background information in assessing new data, and they are easily swayed by trivial changes in the presentation of information. Furthermore, the operation of labor markets is poorly understood by economists, which makes interpretation of the labor data difficult. Therefore, although labor information is commonly employed as a basis for assessing risk preferences, we must be cautious of its use.

Because the methodology economists use to determine risk preferences is quite unreliable, it is not surprising that their results are extremely variable. Estimates of the value of life range from fifteen thousand dollars to three million dollars per life. Substantially higher values can reasonably be justified for involuntary risks.

L.Q. 207, 225-28 (1978). While part of the problem may be attributed to limited knowledge, research indicates that people systematically assign insufficiently low probabilities to rare events. *Id.* at 226-27 (citing experiments by Alpert and Raiffa, and by Tversky and Kahneman). See also Alovic, Kunreuther & White, *Decision Processes, Rationality and Adjustment to Natural Hazards*, in *NATURAL HAZARDS: LOCAL, NATIONAL AND GLOBAL* 187 (G. White ed. 1974). In addition, people frequently assign too great a value to tests predicting low probability events, and tend to be influenced by worthless information. Tversky & Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 *Sci.* 1124, 1125 (1974); Page, *supra*, at 228 n.50 (discussing Bayes Theorem); C. Gillette & T. Hopkins, *supra* note 119, at 43, 45-47.


128. See Mishan, *Consistency in the Valuation of Life: A Wild Goose Chase?*, in *ETHICS & ECONOMICS* 152, 160-61 (E. Paul, F. Miller & J. Paul, eds. 1985). The discrepancy in the cost effectiveness of safety regulations is even greater, ranging from $132 million per life saved for the 1979 regulation of diethyl stilbestrol in cattle feed to $200,000 per life saved for protection from airplane cabin fires. Zeckhauser & Viscusi, *Risk Within Reason*, 248 *Sci.* 559, 562 (1990). To a large degree such discrepancies can be attributed to different risk-cost assumptions made by the various federal regulatory agencies. For example, the Fed-
The value of life figure is an important source of "play in the joints" of cost-benefit analysis. Another important source is discounting. A dollar received a year from now is less valuable than a dollar received today, because the year's delay provides the opportunity to earn interest in the meantime. On similar grounds, many economists believe that a life saved a year from now should weigh somewhat less than a life saved today. In Reserve Mining, for example, future cancer deaths would be spread over a long period, and their weight would be diminished accordingly.

There is a fascinating philosophical debate about whether discounting future deaths is appropriate at all. However, putting aside that deeper question, economists disagree about what discount rate should be used to calculate the present value of future deaths. The issue is in part technical and in part a matter of policy, that is, the extent to which government should take a long view of the public welfare and weigh future consequences more highly than the private marketplace. The Office of Management and Budget (OMB) has used a ten percent discount rate for both the costs and benefits of regulation. The result is to weigh future deaths relatively lightly. The more appropriate discount...

eral Aviation Administration's (FAA) regulatory policy considers the cost effectiveness of a regulation on the basis of earnings lost through accidental deaths. By contrast, theoretically at least, EPA and the Food and Drug Administration often regulate without directly comparing costs and benefits. See C. Gillette & T. Hopkins supra note 119, at 56-57. From an economic perspective, discounting is justified as a means of accounting for the lost opportunity to immediately reinvest or consume the resources locked up into saving lives in the future. Id. at 57 (citing Baumol, On the Social Rate of Discount, 58 AM. ECON. REV. 788 (1968)).

For a discussion of the philosophical debate over the appropriateness of discounting future deaths, see id. at 58-53.

Another difficulty in discounting future harm is determining the appropriate discount period. The federal government discounts from the time of regulation to the end of the illness's latency period. Id. at 58. Essentially this reflects a judgment that no benefits arise from regulation until the illness that is prevented would have arisen. This assumption ignores the fact that elimination of risk is a benefit in itself, which is manifested as soon as regulations go into effect. Id. at 57-58.

The 10% figure reflects "an estimate of the average rate of return on private investment, before taxes and after inflation." Id. Despite OMB's discounting recommendation, individual agencies frequently decline to apply a discount rate, or apply lower rates for discounting future deaths. Id. at 64-65.

For example, at a discount rate of only five percent, one billion deaths in...
rate for future deaths is probably lower.\textsuperscript{134}

In performing a cost-benefit analysis in a situation like Reserve Mining, at least three discretionary judgments must be made. The first is appraising the risk.\textsuperscript{135} How cautious should we be in estimating risk levels? The best argument for caution is that mortality rates alone do not fully define risk. In Reserve Mining, other factors were important, the risk was novel, it involved cancer, and a whole community was at risk.\textsuperscript{136} Moreover, the mortality estimates themselves were highly uncertain.\textsuperscript{137} In short, it was a frightening situation, and merely estimating mortality does not capture the public's desire to avoid the risk. In such circumstances, it is appropriate for the public decision maker to recognize the public's increased risk aversion.\textsuperscript{138}

The second discretionary decision is the choice of a value for human life. Since this is an involuntary risk, the range of defensible choices runs from something under one million dollars up to about ten million dollars.\textsuperscript{139} In addition, we might want to increase this figure to compensate for industry's tendency to proffer inflated estimates of compliance costs.

The third discretionary decision is the choice of the discount rate, if any, for future deaths.\textsuperscript{140} Relatively small changes in inter-

the year 2500 have a current value less than a single death today. See D. Parfit, Reasons and Persons 357 (1986).

134. C. Gillette & T. Hopkins, supra note 119, at 67. But see R. Tresch, Public Finance: A Normative Theory (1981) (arguing that a discount rate as high as 25\% could be justified). For a discussion of the variables to be considered in choosing a discount rate, see C. Gillette & T. Hopkins, supra note 119, at 65-67. Among their recommendations, Gillette and Hopkins endorse the use of a variable discount rate based upon application of a general methodology to specific situations. Id. at 68-69.

135. Risk assessment is inevitably difficult and the results are subject to considerable uncertainty. See Dwyer, Limits of Environmental Risk Assessment, 116 J. Energy Eng'g 231 (1990).

136. See supra notes 84-93 and accompanying text.

137. Since the risk assessment is based on occupational exposures, it may underestimate the risk to special groups, including children. Water Quality Criteria for Asbestos, supra note 50, at C-99.

138. See supra note 131 (arguing that avoidance of risk is a benefit in itself apart from prevention of any physical harm).

139. See supra notes 88-92 and accompanying text.

140. Assuming about one hundred deaths, see supra text accompanying notes 112-114, land-based disposal is justified, without discounting, at any "value of life" over two million dollars. If we discount the value of the company's expendi-
Some rough cost-benefit calculations with the Reserve Mining set of facts, using the EPA's estimate of risk, indicate that the result can come out either way, depending on how the three discretionary decisions are made. Essentially, if a conservative choice is made for any two of the three, the cost-benefit analysis comes out in favor of land disposal. For example, land disposal is justified if we assume a five percent discount rate for future deaths, the EPA risk estimate, and a value of life of six million dollars. If we assume a lower discount rate or make a higher estimate of risk, we could reach the same result with a lower value of life figure. For instance, land disposal is also justified if the decision maker chooses the EPA risk estimate, a two million dollar value of life, and a one percent discount rate for future deaths. The medical data are also subject to interpretation, and choice of a risk figure depends partly on how concerned we are with the possibility of underestimating the risk. If our estimate exceeds the EPA's risk estimate, then the other two figures can be adjusted downward and the calculation will still support land disposal.

Therefore, at least with the Reserve Mining set of facts, it seems that the methodology of cost-benefit analysis does not determine the result. The result is determined by the discretionary policy decisions incorporated in the analysis. If we make highly risk-averse policy decisions, then regulation is justified; if we

tures because they took place over several years, we can get by with a lower value of life figure. See infra note 141. Considering that the risk imposed is involuntary, a two million dollar value of life figure seems quite reasonable. See supra text accompanying note 128.

141. I assume that the estimated $200 million would be spent over a period of four years with a 10% discount rate, corresponding both to OMB's standard discount rate and the firm's return on assets. See supra text accompanying notes 13-14 and 132. This comes to $162 million in present value. We are assuming 1.5 lives saved per year, at a value of six million dollars each, or nine million dollars per year. The discounted value of an infinite stream of one dollar per year is $20, because $20 produces one dollar of interest annually. See R. Brealey & S. Myers, Principles of Corporate Finance 30-33 (1981). This gives a total present value of $180 million, which exceeds the cost of regulation.

142. The present value of annual payments of one dollar per year is $100 at a one percent discount rate. See R. Brealy & S. Myers, supra note 141, at 30-33. So, we have a total value of lives saved of $300 million.
make more risk-accepting decisions, then regulation is not justified.

It seems that both the advocates and the opponents of cost-benefit analysis assume that cost-benefit methodology provides answers. Their debate is about whether these are the right answers. However, if *Reserve Mining* is at all typical, and I suspect that it is, their shared premise may be incorrect. In practice, perhaps cost-benefit analysis does not provide answers but merely a framework which can be used to make policy decisions about public risk aversion.

Either a feasibility analysis or a risk-averse cost-benefit analysis would support the decision the Eighth Circuit reached in *Reserve Mining*. Therefore, perhaps the differences between the two methods of analysis is not as important as the heated debate between their supporters would suggest. Although cost-benefit analysis provides a framework for calculating costs and benefits, in cases like *Reserve Mining* it turns out that it is the policy judgments that are determinative. Ultimately, the figures chosen, and thus the decision to regulate or not, depend on certain moral or philosophical beliefs, rather than economic calculations. Feasibility analysis, on the other hand, purports to make an uncompromised policy decision, but the terms "feasibility" and "significant risk" have enough play to allow informal consideration of the cost-benefit relationship. At least in cases like *Reserve Mining*, under either type of analysis, the same factors will probably determine the decision. The result of a risk-averse cost-benefit analysis may not differ very much from the result of a sensible feasibility analysis. Therefore, rather than continue the debate

143. *See supra* notes 119-140 and accompanying text.
144. For example, regulation may almost always be justified if we choose a high enough value of life figure. *See generally* notes 118-123 *supra* (discussing the wide disparity in value of life figures).
145. Justice Rehnquist has recognized the inherent ambiguity of these terms, stating that "Congress required the Secretary to engage in something called 'feasibility analysis.' But these words mean nothing at all. They are a 'legislative mirage' appearing to some. . . . but not to others, and assuming any form desired by the beholder." *American Textile Mfrs. Inst. v. Donovan*, 452 U.S. 490, 546 (1981) (Rehnquist, J., dissenting) (*The Cotton Dust Case*) (citations omitted). Rehnquist went on to conclude that the feasibility requirement could include a number of variables, such as "considerations of administrative or even political feasibility." *Id.*
146. It is likely that the regulations which OMB now rejects based upon a
about cost-benefit analysis versus feasibility, I suggest a synthesis: that we adopt feasibility analysis, but that we use a risk-adverse cost-benefit analysis as a benchmark for what is feasible. When even a conservative analysis—using a high value of life, conservative risk estimates, and a low discount rate for future deaths—shows that regulation is unwarranted, we ought to reconsider whether such a risk is significant and whether regulation should truly be considered feasible. Perhaps we should proceed with the regulation anyway, but we should do so only after very careful thought.  

To combine cost-benefit and feasibility analysis may strike true believers on each side as heresy. Philosophical issues are at stake, however, only if either method is viewed as having some exclusive claim to being the only rational or moral approach to the problem. Even if that turns out to be so, and I am quite dubious that it will, the philosophical difference between the two is of little practical importance in cases like Reserve Mining. If Reserve Mining is at all typical of current issues of risk management, we might do well to leave the philosophical argument to our friends in the philosophy departments, and to focus our own energies on more practical concerns.

The primary attacks on both methods of analysis seem largely misplaced. Cost-benefit analysis is often attacked for reducing human life to a commodity. I agree that economists’ rhetoric can be dehumanizing. I also agree that private “willingness to pay” cannot be determinative of public policy. However, instead of talking about pricing lives, we could speak of the amount people are willing to sacrifice to avoid risks.

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147. Professor Dwyer makes a similar proposal that risk assessment should be used to exclude trivial risks from regulation. See Dwyer, supra note 135, at 243.

148. See C. Gillette & T. Hopkins, supra note 119, at 25. Compare M. Sagooff, supra note 94 (arguing that issues of human health and environmental quality are fundamental ethical considerations that cannot be reduced to economic variables) with Rose, Environmental Faust Succumbs to Temptations of Economic Mephistopheles, or, Value by Any Other Name is Preference (Book Review), 87 Mich. L. Rev. 1631 (1989) (arguing that ethical values are not so readily distinguishable from economic preferences, and that the use of market rhetoric forces individuals not inclined to consider environmental issues to consider them).

149. See supra notes 120-124 and accompanying text.

150. The advantage of this consideration in part is that it recognizes that...
marketplace behavior as important data, but also consider the preferences revealed by government regulations. Couched in those terms, cost-benefit analysis seems less offensive.

Feasibility analysis, on the other hand, is often attacked for requiring inefficient "command-and-control" regulations. But we could just as well conduct a feasibility analysis on an industry-wide or even an economy-wide level to determine the feasible level of safety. Then we could use marketable permits and other nonregulatory measures to implement that level of control.

As mentioned at the beginning of this Essay, Congress recently adopted an extensive new system of regulations for toxic air pollutants. In many ways, this statute represents a substantial improvement over previous legislative efforts. It does not merely use a vague word like "feasible" to define the first stage of standards. Instead, the amended section 112(d)(3) defines the first-stage standards on the basis of the pollution reduction achieved by the best twelve percent of existing plants. The second-stage standards do not merely contain some vague reference to "significant risk" instead, the new section 112(f)(2) seems to make a one-in-a-million risk the threshold. More importantly, the second phase of standards do not go into effect unless Congress fails to respond to an EPA report about their desirability. In contrast to earlier legislation, these changes indicate a drastic improvement in statutory clarity and indicate Congress's increased willingness to honestly address the policy choices. While both cost and significant risk are explicitly considered in the new section 112, it seems that little attention has been given to the relationship between them. In the past, EPA has proved adept at finding ways to introduce flexibility, when the Agency found it necessary. Perhaps the kind of risk-averse cost-benefit analysis advo-

avoidance of risk has its own distinct value. See supra note 131.

151. See C. Sunstein, supra note 96, at 87-88.
152. See M. Sagoff, supra note 94, at 215-17 (stating that economic tools such as marketable permits can be used to efficient realization of our ethical values).
154. Id. § 112(d)(3), 104 Stat. at 2540 (codified at 42 U.S.C.A. § 7412(d)(3)).
155. Id. § 112(f)(2), 104 Stat. at 2543-44 (codified at 42 U.S.C.A. § 7412(f)(2)).
156. Given the complexity of the new statute, I am reluctant to address spe-
cated here cannot be directly adopted as the legal standard under the current version of section 112, but it might guide EPA in thinking about implementation decisions. In any event, in most instances the maximum achievable control technology standards may well lead to the same results as a risk-averse cost-benefit analysis.

IV. AFTERWORD

Given a choice between land disposal and doing nothing, the Reserve Mining court was clearly correct to opt for land disposal. That decision is supported by either feasibility or cost-benefit analysis. I am tempted to leave the matter there, but there is some reason to believe that land disposal was not really necessary. By 1977, a water filtration system had been installed in Duluth which removed 99.9% of the asbestos fibers.157 This reduces the risk by a factor of one thousand, thereby decreasing the expected number of deaths to one every 600 years (1.5 deaths per year divided by a thousand). Whatever a "significant risk" may be, certainly that level of risk does not qualify.

Clearly, it was not worth spending $200 million dollars or more to eliminate such an insignificant risk.158 In a society that


158. For purposes of comparison, for example, this is hundreds of times less than the expected number of deaths from high school football, aircraft accidents, or drownings in Duluth. Mossman, Asbestos: Scientific Developments and Implications for Public Policy, 247 Sci. 294, 299 (1990).
complacently tolerates over a hundred deaths per year from
smoking in a city the size of Duluth, to have required Reserve
to spend a fortune to eliminate such a minuscule risk seems in-
consistent. In such a set of circumstances, a cost-benefit analysis
would justify land disposal only if we used virtually a zero dis-
count rate and valued each life saved at about $200 million dol-
ars. This is far out of line with the average cost per life saved
imposed by government regulations and vastly in excess of the
compensation that workers demand for assuming occupational
risks. It seems particularly bizarre to spend so much to remove
the last microscopic traces of asbestos from the drinking water,
when such common products as aspirin and rice may contain
much higher amounts of asbestos.

Perhaps, however, the prompt conversion to land disposal
can be justified by the possibility of ecological damage to the
Lake. That was the initial issue in the case, which was never
tried because of what appeared to be a more urgent concern
about public health. Ultimately, the sheer symbolic outrage of

159. This is also derived from Mossman, supra note 158, dividing by ten to
convert from rates per million to rate per hundred thousand (the size of Duluth). Id.
160. See C. Sunstein, supra note 96, at 239-40.
161. Even if the filters removed only 90% of the asbestos, the risk levels
would drop to the point where it would be hard to maintain that there was a
serious health concern. Professor Nicholson suggests that “standard flocculation
and sedimentation techniques can reduce asbestos concentration by about 90%”
at “relatively modest cost.” Nicholson, supra note 111, at 112. If risks can be re-
duced by that amount, some other factor in the cost-benefit analysis would have
to be increased by a factor of 10 to compensate. Similarly, whether the remaining
risk is significant seems at least debatable.
162. According to MacRae, “an ordinary diet including one beer per day,
some rice and three aspirin, “ contains asbestos fibers which are the consumption
equivalent of three liters of water having about 2500 million fibers per liter.
MacRae, supra note 109, at 7. That is about 25 times the peak level in Duluth
drinking water. See supra note 28 and accompanying text.
163. Judge Lord suggested early in the case that water filtration was inade-
quate because it might not work effectively (which apparently did not turn out to
be a problem) and because it did not address the air pollution problem. United
appear to have been other possible approaches to the air pollution problem, but in
any event, I have limited my consideration in this Essay to water pollution. Ironi-
cally, Judge Lord also objected to the use of filtration because it would take longer
to put into place. As it turned out, the filtration system was installed well before
land disposal was initiated. See supra note 75 and accompanying text.
dumping sixty-seven thousand tons of waste daily in a pristine lake may have been enough to justify a switch to land disposal.\textsuperscript{164} Therefore, in retrospect, if land disposal is to be justified, the justification should not rest too heavily on concern about drinking water, for that concern may have been fully addressed by water filtration.\textsuperscript{165}

However, since water filtration apparently was not proposed to the court of appeals, it would be unfair to blame the court for overlooking filtration as an alternative to land disposal. Given the options which the court of appeals did have available, it made the right choice—whether we employ cost-benefit or feasibility as the test.

Court decisions, the scholarly literature, and the latest legislation\textsuperscript{166} on the subject all make it clear that we have become far more sophisticated in our understanding of environmental risks than we were when \textit{Reserve Mining} was decided in 1975. At the time, courts and agencies were struggling to confront new problems of uncertain magnitude with a fragmentary data base. The Eighth Circuit did a creditable job in wrestling with those issues. Today, with the benefit of another fifteen years of thought, perhaps we can do a little better. In any event, if we are to progress, we might do well to spend less time on ideological debate about the relative merits of environmentalism and economics as views of the world. We could then spend more time confronting the hard problems presented by environmental risks in the real world.

\textsuperscript{164} The longer the delay in switching to land disposal, the lower the present value of the expense is to the company.
\textsuperscript{165} \textit{See supra} notes 153-163 and accompanying text.
\textsuperscript{166} \textit{See supra} note 156 and accompanying text.