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The Role of Compensation in Siting Hazardous Facilities

*Howard Kunreuther
Doug Easterling*

Abstract

Empirical evidence indicates that compensation can prove effective in gaining public acceptance for siting facilities on the benign end of the spectrum (e.g., landfills, prisons), but is subject to serious limitations when it comes to facilities that the public regards as particularly risky or of questionable legitimacy such as nuclear waste repositories. These facilities require creative mitigation measures such as independent inspections of the facility and local shutdown power. Even then they may be viewed as too risky to be acceptable with or without compensation. This article proposes a two-stage siting process which recognizes the importance of regulations and safety standards (Stage 1) while employing a voluntary process with compensation to address concerns with equity and efficiency (Stage 2).

INTRODUCTION

Attempts to site facilities that use, store, or emit hazardous substances have generated intense public controversy in recent years. Cries of NIMBY (Not in My Backyard) and NIMTOF (Not in My Term of Office) frequently greet waste disposal facilities and other Locally Unwanted Land Uses (LULUs) [Popper, 1983; Susskind and Cruikshank, 1987]. Although many parties will benefit from the construction of such a facility (e.g., manufacturers benefit from a hazardous waste incinerator, nuclear utilities benefit from radioactive waste repositories, entire communities benefit from solid waste landfills), the community designated to host the facility often views the *local* benefits to be small relative to the burdens.

The geographic inequity between the host community and intended beneficiaries of a waste disposal facility is obviously a source of tremendous concern for the host community; local residents typically perceive the facility to be an unjust imposition upon their welfare. In addition, the inequity also poses problems for the facility's proponents. Namely, the designated host community tends to express intense opposition to the facility, oftentimes succeeding

in delaying or even preventing it from being developed [Morrell and Magorian, 1982; O'Hare, Bacow, and Sanderson, 1983].

Perceptions of inequity have been especially pronounced in attempts to dispose of the high-level nuclear wastes (HLNW) accumulating at nuclear power plants. These wastes are in the form of "spent" fuel rods which will emit dangerous levels of radioactivity for thousands of years. The current proposal in the United States is to encase the spent fuel in corrosion-resistant canisters and bury these canisters deep underground in a geological repository at Yucca Mountain, Nevada. Elected state officials have repeatedly argued that the facility may impose severe impacts to the health of state residents, to the physical environment, and to the local economy [Miller, 1994].

At least theoretically, *compensation* provides a solution to siting dilemmas. Compensation involves the making of "payments" to those persons who are negatively affected by the facility. As will be discussed in this article, these payments can take a number of forms, either as a monetary payment or as a more indirect form of benefit. Compensation should be set at a level that at least offsets the burdens experienced by the host community. The developer can fund these payments by collecting fees from the beneficiaries of the facility.

At a practical level, compensation programs have been widespread and in some cases have led to successful siting agreements. They are also popular among states that are trying to site hazardous and solid waste facilities and form the basis for much of the activity taking place in the interstate compacts for trying to find homes for low-level radioactive waste (LLRW) facilities.¹ The question that has been raised by a number of studies is, Under what conditions will compensation be helpful in facilitating the siting process, and when is it likely to impede efforts to find homes for these LULUs?

This article investigates the potential of compensation to solve the siting problem. First, the theory of compensation is presented, using a normative model of choice. Next, the effectiveness of compensation in practice is discussed, pointing out both successes and failures. Then, a number of survey studies are reviewed to develop an understanding of how the public responds to monetary payments when they are applied to different types of facilities. We then present the advantages of nonmonetary compensation to individuals (e.g., in-kind awards to local governments) to transfer some of the facility's benefits to the affected residents. Finally, a number of other policy tools are identified that might be employed in cases where compensation is unable to increase public acceptance. Special attention is devoted to mitigation measures and a voluntary process of site selection.

The principal message of this article is that compensation is a potentially valuable tool in gaining local acceptance of a noxious facility, but that this tool has serious limitations in the case of "extreme" facilities such as a geologic repository for nuclear waste. Indeed, offering compensation may even intensify local opposition in this case; residents may view the offer as a *bribe* rather than as a form of benefit-sharing. In such cases, the developer would be advised to focus on mitigating the facility's impacts before introducing compensation into the picture.

¹ For a comprehensive discussion of the attempts and challenges in using compensation to site hazardous waste and LLRW facilities see Been [1994].

NORMATIVE THEORY OF COMPENSATION

The compensation strategy for resolving a siting dilemma begins with an acknowledgment that the proposed facility might impose certain negative impacts on the host community. Depending on the nature of the facility being sited, there are a wide range of potential impacts including: increased air or water pollution, releases of hazardous or radioactive substances, noxious odors, increased mortality and morbidity, loss of wildlife habitat, excess anxiety, increased traffic, drops in local property values, losses to the local visitor economy, and stigmatization [e.g., Slovic et al., 1991]. Gregory, Kunreuther, Easterling, and Richards [1991] classify these impacts into four broad categories: economic losses, impacts to human health, decrements to quality of life, and degradation of the physical environment.

In offering compensation, one assumes that the objections (and opposition) of local residents will be overcome if those residents receive benefits that are sufficient to offset the expected negative impacts. This outcome is predicted by expected/utility theory that most economists employ to characterize choice behavior. According to this model (which is normative in character), an individual who expects to be affected by a proposed facility will compute his or her expected utility with and without the facility, and then express a preference depending on which of these two values is greater. If a person perceives that the net impact of the facility will be negative, then the model suggests compensation as a way of offsetting this opposition.²

To illustrate the role that compensation can play in the decision we will consider the simple case developed in Kunreuther and Easterling [1990] where the utility associated with having the facility in one's community is given by the following two-period additive utility function:

$$U(y, F) = U_1(y_1, F_1) + U_2(y_2, F_2) \tag{1}$$

In this equation, y_t denotes the individual's income in period t (either 1 or 2) and F_t denotes the consequences of the facility during period t . The vectors y and F are defined as simply $y = (y_1, y_2)$ and $F = (F_1, F_2)$. For each period t , U_t represents a von Neumann–Morgenstern utility function. The choice facing the individual is between (1) maintaining the status quo (where $F_1 = 0$ and $F_2 = 0$), and (2) having the facility (which provides a benefits package B during period 1 and imposes the risk (p, L) during period 2) where p is the probability of an accident with negative consequences L . The expected utility model allows one to specify the level of benefits B^* where an individual is indifferent between these two options. In particular, B^* is defined as the level of benefits where the utility associated with the facility is equal to the utility of the status quo:

$$U_1(y_1, 0) + U_2(y_2, 0) = U_1(y_1, B^*) + (1 - p)U_2(y_2, 0) + pU_2(y_2, L) \tag{2}$$

By rearranging terms, one obtains the following equation:

$$U_1(y_1, B^*) - U_1(y_1, 0) = p[U_2(y_2, 0) - U_2(y_2, L)] \tag{3}$$

² More sophisticated models of choice will account for strategizing on the part of the decision-maker (i.e., continuing to oppose the facility under the expectation that the developer will offer higher levels of compensation).

Equation (3) allows one to define B^* as the level of benefits that produces an improvement in an individual's utility during period 1 that just offsets his or her expected loss in utility from the facility during period 2.

COMPENSATION IN PRACTICE

There are a number of instances in which compensation has had its intended effect in overcoming local opposition to proposed facilities [Kunreuther, Fitzgerald, and Aarts, 1993; Rabe, 1994]. For example, the developer of a solid waste landfill in Charles City, Virginia was able to build local support by offering residents a package of benefits: A tipping fee provides the city with annual revenues of approximately \$1 million, which has been used to lower property taxes and to rebuild the city's ailing school system. In addition, the operator collects the county's garbage free of charge [Simon, 1990].

In other situations, residents view the facility as sufficiently hazardous that their opposition is not allayed by offers of monetary payments. For example, in 1990 three county commissioners in sparsely populated Grant County, North Dakota applied for a *nonbinding grant* to study the possibility of hosting a monitored retrievable storage (MRS) facility, which would temporarily store high-level radioactive waste. Even though the county was not expressing any commitment to the facility by accepting the grant, the three commissioners who initiated the process were all voted out of office in a recall election by an angry electorate [Kunreuther, Linnerooth, and Fitzgerald, 1996].

Even if residents in the host community agree to accept compensation in return for hosting a facility, their action may provoke very strong negative reactions by others who view such an arrangement as morally wrong. Elster [1992] suggests that people may view health and safety as inherent rights that should never be traded off for material goods. Gerrard [1994] makes a similar point in his comprehensive book on siting by indicating that the public will accept compensation in return for hosting a facility only if it feels that such a transaction is legitimate in the marketplace. Providing money for a decrease in one's health or environmental impairment is generally viewed as an inappropriate trade.

An illustration of this point is provided by a case in Taiwan where villagers forced all of the 23 petrochemical firms in the Lin-Yua Industrial Park in Kaohsiung County to close in 1988 after an overflow of wastewater from a treatment plant polluted nearby streams and adversely affected fishing in the area. In order to reduce the harm to the economy, the minister of economic affairs responded quickly by offering substantial amounts of monetary compensation to each of the residents of nearby villages, who accepted the funds in return for reopening the 23 facilities.³ This action produced an outcry throughout the country as to whether this type of monetary compensation was appropriate and morally acceptable. This concern led the new prime minister and the Environmental Protection Administration to announce in

³ In the three most affected villages, each of the 10,000 residents received NT\$80,000. A total of NT\$670 million was distributed to residents of 16 other villages in the area. NT\$10,000 is worth approximately US\$400.

1989 that this kind of individual compensation would not be accepted in the future⁴ [Shaw personal communication, May 1995, 1996].

External objections to compensation also stem from the potential for strategizing. This occurred in the city of Bergkamen where concerned citizens were persuaded by the prospective operator to accept a power plant in exchange for money. The German press objected, claiming that this exchange creates incentives for groups to protest a facility under the expectation that they will eventually be bought off by the developer [Kunreuther and Linne-rooth, 1983]. Since that time direct monetary compensation has *not* been utilized in Germany in connection with the siting of facilities.

These failures of compensation have been interpreted by researchers and practitioners as evidence that expected utility models provide inaccurate or incomplete descriptions of public responses to facilities. Frey, Oberholzer-Gee, and Eichenberger [in press] suggest that compensation will not be an effective mechanism for siting a facility if moral considerations dominate the scene. They hypothesize that compensation often reduces support for a facility because individuals consider financial incentives to be bribes. When viewed in this way, compensation can deprive individuals of the utility they gain from fulfilling their civic duty by agreeing to host a facility which enhances social welfare.

STUDIES OF INDIVIDUAL RESPONSES TO COMPENSATION

The varying effectiveness of compensation in siting facilities suggests that this policy tool deserves more careful scrutiny. A number of attitude surveys have investigated the impact that compensation has on a person's willingness to accept the development of a facility at a local site. These studies show a high degree of variability in the ability of compensation to change public opinion: Significant impacts occur when compensation is associated with a "common" facility such as a municipal waste landfill, but little impact is observed for facilities that dispose of radioactive waste.

Moderately Noxious Facilities

Surveys by Bacot, Bowen, and Fitzgerald [1994] and by Jenkins-Smith, Kunreuther, Barke, and Easterling [1993] asked respondents to consider compensation in the context of a landfill for municipal waste.⁵ Respondents were first asked to indicate whether they would "accept" the construction of a landfill at a nearby site with no mention of benefits.⁶ As shown in Table 1, a local landfill was acceptable to 30 percent of the Bacot, Bowen, and Fitzgerald [1994] sample and to 25 percent of the Jenkins-Smith et al. [1993] sample when benefits were not included. In both cases, however, the rate of accep-

⁴ This announcement was formalized in the Pollution Conflicts Resolution Act which was passed in 1992.

⁵ Bacot, Bowen, and Fitzgerald [1994] surveyed 844 Tennessee residents in 1989. Jenkins-Smith et al. [1993] surveyed 1200 U.S. households in 1993. This sample was split into eight experimental conditions, defined by the type of facility being considered (municipal waste landfill, hazardous waste incinerator, medium-security prison, or HLNW repository) and by the order in which the respondent was presented with various compensation and mitigation measures. The effect of economic benefits for any given facility is assessed with a subsample of 150.

Table 1. Effect of compensation measures in increasing acceptance of facilities.

	Landfill for municipal waste			
	Study 1 ^a	Study 2 ^b	Hazardous waste incinerator ^b	Prison ^b
Acceptance without incentives	30	25	15	29
Acceptance with economic benefits		50	32	51
Rebates on property tax	63			
State money for schools	62			
State money for roads	56			

Numbers in percent.

^a Bacot, Bowen, and Fitzgerald [1994]. Sample of 844 Tennessee residents. The 30 percent figure for acceptance without incentives was derived from the reported result that 70 percent opposed the landfill; 30 percent is an upper bound on the actual figure. The authors do report the proportion in favor under the incentives conditions.

^b Jenkins-Smith et al. [1993]. Total sample of 1200 U.S. residents. Each condition has $n = 150$.

tance approximately doubled with the introduction of compensation. In the Jenkins-Smith et al. [1993] survey, the form of the benefits was left vague (“economic benefits provided to residents within 50 miles of the facility”), whereas Bacot, Bowen, and Fitzgerald [1994] provided respondents with specific forms of compensation—rebates on property taxes, state money for schools, and state money for road improvements. Tax rebates produced the greatest level of acceptance (63 percent).

The Jenkins-Smith et al. [1993] survey also investigated the impact of compensation on acceptance in the case where the facility being sited was a hazardous waste incinerator or a medium-security prison. Although these two facilities differed markedly in the absolute level of acceptability (15 percent versus 29 percent in the no-compensation case), the introduction of benefits produced similar levels of increased acceptance (17 percentage points for the incinerator, 22 percentage points for the prison). From these data, one might conclude that economic benefits have a substantial impact on public sentiment toward noxious facilities, although they fail to convince many people that the facility should be built.

Radioactive Waste Repositories

The positive impact of compensation on public acceptance is *not* replicated when the proposed facility is a radioactive waste repository. This conclusion

⁶ In the Bacot, Bowen, and Fitzgerald [1994] survey, respondents were told that the landfill was proposed for a site five miles from their home. Acceptance was gauged by a voting question. Jenkins-Smith et al. [1993] experimentally manipulated the distance to the landfill (either 1 or 10 miles away). Respondents indicated how acceptable such a facility would be. We have coded a respondent as “accepting” the facility if he or she gave a response of either “acceptable” or “completely acceptable.”

Table 2. Limited effect of compensation in the case of nuclear waste repositories.

	Study 1 ^a	Study 2 ^b	Study 3 ^c	Study 4 ^d	Study 5 ^e	Study 6 ^f
Acceptance without incentives	22	10	27	24	60	51
Acceptance with economic benefits						
"Substantial payments"	26					
"Economic benefits"		14				
\$1000/yr for 20 yrs			26	23		
\$3000/yr for 20 yrs			30			
\$5000/yr for 20 yrs			30			
\$100–\$900/yr for 20 yrs					51	
\$1900–\$5800/yr for life of facility						25

Numbers in percent.

^a Carnes et al. [1983]. 1980 survey of 420 Wisconsin residents.

^b Jenkins-Smith et al. [1993]. Total sample of 1200 U.S. residents. Each condition has n = 150.

^c Kunreuther et al. [1990]. 1987 survey of 1001 Nevada residents (n = 498 answered compensation questions).

^d Herzik [1993]. 1993 survey of 1212 Nevada residents.

^e Dunlap and Baxter [1988]. 1987 survey of 658 persons living near Hanford, Washington.

^f Frey, Oberholzer-Gee, and Eichenberger [in press]. 1993 survey of 305 persons living in Wolfenschiessen, Switzerland.

is supported by the six separate studies reported in Table 2.⁷ The different samples varied somewhat in their baseline willingness to accept a "local" HLNW repository, with the greatest level of acceptance (60 percent) occurring among Dunlap and Baxter's [1988] sample of residents living near Hanford, Washington. One reason for the more positive acceptance of a repository by Hanford residents than those residing in other areas is that the city has had a long history with nuclear technology and hence may be more accepting of the waste. This finding is consistent with Gerrard's [1994] conclusion that acceptance of a facility is often affected by local culture.⁸

⁷ Carnes et al. [1983] surveyed 420 Wisconsin residents in 1980 on whether they "favored" the siting of a "nuclear waste repository in their community." Kunreuther, Easterling, Desvougues, and Slovic [1990] conducted a survey of 1001 Nevada residents in March 1987. Approximately half of these persons (n = 498) were asked about their willingness to vote for a HLNW repository at Yucca Mountain, with and without rebates; the other half was asked about their willingness to pay to have the repository located somewhere else (see Kunreuther and Easterling [1990] for results). Herzik [1993] used a similar rebate question in a 1993 survey of 1212 Nevada residents. Dunlap and Baxter [1988] also used this sort of question in a survey of 658 residents of Franklin and Benton Counties in Washington State. Respondents indicated their willingness to vote for a HLNW repository at Hanford (which was then still in contention). Jenkins-Smith et al. [1993] asked 150 U.S. residents "how acceptable" a HLNW repository would be if it were located either 10 miles or 50 miles from their home (distance was varied experimentally). In the Frey, Oberholzer-Gee, and Eichenberger [in press] survey of Wolfenschiessen, residents were offered annual amounts of either \$1920 (N = 117), \$3850 (N = 102), or \$5770 (N = 86) per person for the total life of the facility and asked whether they would be willing to accept the repository.

In none of the surveys did the introduction of benefits produce a major increase in acceptance. The largest increase (4 percentage points) occurred in the Carnes et al. [1983] and Jenkins-Smith et al. [1993] surveys. Two of the six surveys found equivalent levels of acceptance with and without compensation. In Kunreuther et al. [1990], 27 percent of the sample voted to put a repository at Yucca Mountain in a question that did not mention compensation, compared to 29 percent when rebates were offered. In addition, there was no significant difference in acceptance across the three dollar amounts: \$1000 per year (26 percent), \$3000 per year (30 percent), and \$5000 per year (30 percent). Herzik [1993] also found virtually no difference in voting between a no-compensation condition (24 percent in favor) and when rebates of \$1000 per year were offered (23 percent in favor).

In contrast, two studies found that offering payments led respondents to be *less* accepting of a radioactive waste repository. In the Dunlap and Baxter [1988] survey, 60 percent of the sample voted in favor of a HLNW repository at Hanford without benefits, while only 51 percent voted in favor when tax rebates were offered. In the Frey, Oberholzer-Gee, and Eichenberger [in press] survey of attitudes toward a low- and mid-level waste repository, acceptance was cut in half—from 51 percent to 25 percent. Moreover, the size of the compensation did not significantly influence the acceptance rate. Overwhelmingly, those who refused compensation reported that they could not be bribed.⁹

Explaining the Difference

The contrast between the effectiveness of compensation for radioactive waste repositories and other noxious facilities is remarkable. We feel that the principal explanation for the inability of compensation to overcome the objections of HLNW opponents is that many residents feel that the facility will create severe health and environmental risks. For example, of those persons in the 1987 Nevada survey who voted against having a repository at Yucca Mountain, 82 percent thought that it was either “very likely” or “somewhat likely” that wastes would leak from the repository into the groundwater. With this level of perceived threat, even large rebates will prove to be inadequate for these individuals. They are likely to believe that no amount of money will offset these large increases in the perceived risk of death to themselves and their loved ones.

In addition, if the facility is viewed as a *threat to future generations*, as in the case of HLNW repositories, rebates are unlikely to win acceptance. This

⁸ The Dunlap and Baxter [1988] survey sampled residents in the vicinity of the Hanford nuclear weapons facility. This population, due to its historical relationship with nuclear technology, has a more benign view of the risks associated with a HLNW repository [Easterling and Kunreuther, 1995].

⁹ The Frey, Oberholzer-Gee, and Eichenberger [in press] survey was conducted during the time that Switzerland was searching for a community to host a low- and mid-level radioactive nuclear waste repository. In June 1993, after an intensive search of more than 15 years and expenditures totaling \$390 million, the small village of Wolfenschiessen with 2000 inhabitants located in central Switzerland was selected to house the repository. The survey of Wolfenschiessen residents was conducted before this announcement was made, when there were still four communities being considered as possible sites.

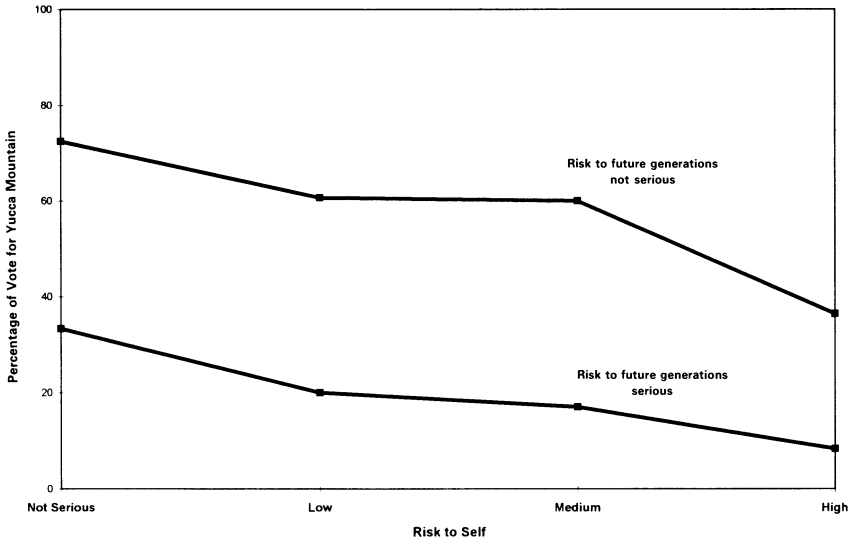


Figure 1. Approval of Yucca Mountain by perceived risk to self and risk to future generations.

resistance is illustrated in Figure 1, which shows the proportion of respondents in the 1987 Nevada survey who favor a repository at Yucca Mountain (with rebates) as a function of perceived risk to self and risk to future generations. The majority of respondents reject rebates if *either* the perceived risk to self is high or the risk to future generations is deemed serious. Among respondents with both beliefs, only 8 percent vote in favor of the repository when rebates are offered. These results indicate that individual behavior is influenced by a rich set of values that go beyond narrowly defined self-interest [Becker, 1993].

The data in Figure 1 cast doubt on one of the assumptions underlying most compensation strategies: A person's acceptance of a facility is determined by comparing his or her welfare of agreeing to host the facility with maintaining the status quo. [Rosenman, Fort, and Budd, 1988; Kunreuther and Easterling, 1990]. Rather compensation is likely to be rejected whenever a person believes that the proposed facility is somehow *illegitimate* (i.e., should not be built on ethical or moral grounds). This conclusion is supported by McClelland and Schulze [1991]. In their study, subjects were given a Norfolk pine at the outset of the task and were asked to indicate the price at which they would sell the pine back to the experimenter. In the condition where subjects were told nothing regarding the fate of the tree, the average asking price was \$8. However, among subjects who were told that the tree would be destroyed at the end of the experiment, the average asking price was \$18 and a number of subjects reported an asking price that they knew was higher than the experimenter would accept.¹⁰

¹⁰ It is also possible that the higher asking price may reflect existence and option values for the trees.

A comparable response was observed when the federal government offered the Western Shoshone Tribe compensation to resolve a land dispute [Fowler, Hamby, Rusco, and Rusco, 1990]. In 1979, a court awarded the tribe \$26 million as "just compensation" for the federal government's seizure of deeded land in southern Nevada (including the Nevada Test Site and the proposed Yucca Mountain repository site.)¹¹ The tribe, however, refused to accept the award on the grounds that they had an obligation to maintain their claim to the lands. Tribal members argued that the testing of nuclear weapons and the disposal of nuclear waste inflict irreparable harm upon their ancestral lands; from their vantage point, relinquishing the tribe's claims would constitute an abdication of their obligation to the land, the spirits that reside there, and future generations. As such, the tribe has continued to refuse the compensation award, even though it would provide major economic benefits to tribal members (the award was placed in escrow and is now valued at approximately \$60 million, or about a \$500,000 for each member).

Individuals who consider the proposed HLNW repository to be illegitimate will similarly be inclined to reject offers of any amount of compensation. The facility might be viewed as illegitimate because of a perceived inequity in the distribution of risks across generations or because of beliefs about the potential of the facility to contaminate the planet [Easterling and Kunreuther, 1995]. In addition, many people regard nuclear power to be an illegitimate technology and thus view a repository as a means of promoting that technology. Their considerable distrust of the nuclear industry will be extremely difficult to overcome with any type of incentives [Kemp, 1992]. In particular, monetary payments are inherently unable to offset the moral objections that many people bring to the whole area of nuclear technology.

NONMONETARY FORMS OF COMPENSATION

The evidence from the previous section suggests that simply providing monetary benefits to individuals will do little to enhance the attractiveness of facilities that are perceived to be risky, and may even make them less acceptable to the affected residents. One possible remedy is to use mechanisms other than money to transfer some of the facility's benefits to local residents. This section describes a number of forms of nonmonetary compensation and presents empirical evidence on their relative effectiveness in gaining public acceptance.

Types of Measures

Compensation packages can take a variety of forms in addition to direct payments to individuals (e.g., grants to local government, the allocation of a proportion of the facility's employment or procurement to local residents). Nonmonetary forms of compensation have been classified into five categories

¹¹ All of southern Nevada was originally inhabited by the Shoshone and Paiute Tribes. By signing the 1863 Treaty of Ruby Valley, the federal government agreed that these tribes would have jurisdiction over this land. However, the land was subsequently seized by the army, the air force, and the Atomic Energy Commission for their own uses (for forts, roads, communication lines, and military bases) during the 19th and 20th centuries.

by Gregory et al. [1991]: (1) in-kind awards; (2) contingency funds; (3) property value guarantees; (4) benefit assurances; and (5) economic goodwill incentives.

In-kind awards can be employed to directly offset the expected impacts of the facility. For example, if the facility is likely to impose new health risks on the local community (or if there is a general perception that new risks will be imposed), the developer can award benefits in the form of new or improved health care services (e.g., a new trauma unit or oncology unit at the local hospital, an expanded cadre of health care professionals within the community). With a *contingency fund*, the developer promises to cover any losses that might occur from a future accident or release of hazardous materials. This constitutes a form of insurance for the host community.

Property value guarantees protect against any decline that might occur in the monetary value of property near the facility. For example, Champion International Corporation recently established a program to protect the property values of residents within two miles of an industrial landfill they sited. The company monitors changes in the sale prices of property in the county over a 10-year period and pays residents who sell their homes for any decrease in property value that is attributed to the presence of the landfill [Ewing, 1990].

The final two forms of compensation, *benefit assurances* and *economic goodwill incentives*, are similar to one another in that they both raise the overall standard of living in the host community. The former involves a guarantee of direct or indirect employment for community members, either during construction of the facility or during its operation phase. Goodwill measures, or charitable contributions, include expenditures for projects that are important to local residents. These are made on an ongoing basis to maintain a positive corporate presence within the community.

Empirical Evidence

A set of attitude surveys indicates that these other forms of compensation may be more effective than monetary compensation in gaining public acceptance of a facility when its risk is perceived to be high. Table 3 presents relevant data from two surveys conducted in 1987, one of 1001 Nevada residents, the other of 1201 persons living in states other than Nevada [Kunreuther et al., 1990]. Respondents were asked to rate a number of compensation and mitigation measures in terms of their "importance in gaining public acceptance for a repository." Table 3 reports the proportion of each sample who rated each measure as "very important." Direct payments to individuals (i.e., via tax rebates) are regarded as the *least* important measure tested in each sample: 35 percent of Nevada respondents and 31 percent of the national sample rated this measure as very important. Protection of property values (a measure that responds directly to the actual impacts that occur) was regarded as much more important in gaining public acceptance (60 percent of the Nevada sample). Providing "large grants for community facilities" or "a high-tech project with new jobs" was also deemed more effective than direct payments by both samples.

Similar findings were reported by Portney [1991] in a study of residents of six Massachusetts communities who were asked about their attitudes toward having a hazardous waste treatment plant built in their community. To

Table 3. Perceived importance of mitigation and compensation measures (1987 surveys).

Measure	Percentage (%) who rate the measure as very important in gaining support	
	Nevada sample	National sample
Strict safety standards set by federal government, plus an inspector on site	90.2	88.3
Local committee gives safety advice to management	69.8	67.8
Local committee has power to shut down repository	67.5	69.6
Property values are protected	60.1	NA ^a
Large grants for community facilities	47.9	42.4
High-tech project with new jobs near repository	42.3	38.5
Rebates to residents within 100 miles of repository	34.9	31.3

Source: Kunreuther et al. [1990].

^a The property value question was not asked in the national survey.

change their minds those who opposed the facility were offered a set of economic incentive proposals. These incentives included: direct monetary payments of \$50 per family, payment of all property taxes, compensation for decreased property value, improved fire protection, and five college scholarships. In five of the six communities the direct monetary payments had the smallest impact of all the measures.¹²

A 1993 national survey [Jenkins-Smith et al., 1993] also found that payments to individuals were viewed as less helpful than alternative forms of compensation. In this case, respondents indicated "how appropriate" each of seven compensation measures would be in the context of a HLNW repository being sited. As shown in Table 4, tax rebates were regarded as "completely" or "somewhat" appropriate by 44 percent of the sample, compared to 56 percent who believed that it was appropriate to reimburse the local community for the new public services required by the facility.

These findings were largely replicated in three surveys conducted in 1994 of 800 Nevada residents, 400 Phoenix residents, and 801 residents of southern California [Mertz, Flynn, and Slovic, 1994a, 1994b]. Respondents were asked to indicate the appropriateness of each of five compensation measures in the context of a "facility with some degree of risk or hazard involved."¹³ Table 5 shows the proportion of respondents who rated the measures to be either "appropriate" or "completely appropriate." As with the other surveys, com-

¹² In the remaining community, direct payments tied for the second least attractive option. Paying all property taxes, another monetary form of compensation, had the least impact in changing people's minds within this community.

¹³ The Phoenix and southern California surveys included only four of the five.

Table 4. Perceived appropriateness of various compensation measures in the siting of a HLNW repository (1993 U.S. survey).

Measure	Percentage (%) who rate measure as completely or somewhat acceptable
Reimburse the local community for any new public services required to build and operate the repository	56
Make up any losses in property value that might be caused by the repository	54
Pay medical costs for residents who suffer any negative health effects from the repository	53
Establish a trust fund that would compensate future generations for any harm they might suffer from the repository	52
Include with repository new special services, such as additional police and fire protection or health clinics	49
Provide tax rebates to all residents within 10 miles of the facility	44
Offer a large grant to local government that could be used for any improvement desired by the community	41
Provide free garbage pickup for all residents within 10 miles of the facility	36

Source: Jenkins-Smith et al. [1993]. Total sample of 1200 U.S. residents. Three hundred respondents provided responses to the appropriateness of compensation with respect to a HLNW repository.

compensation strategies that offset impacts once they occur (e.g., negative health effects, property value declines) were deemed more appropriate than tax rebates.¹⁴

Implications for Policy

The survey results suggest two recommendations with respect to making compensation more germane to the concerns of persons living near a proposed site for a radioactive waste repository. First, residents want assurances that they will receive payments for their losses if an accident were to occur.

¹⁴ It is also apparent from Table 5 that there are marked and consistent differences in response between the Nevada survey and the other two: Except for making up any losses in property value, the measures were each rated as more appropriate by the Nevada sample than by the California or Phoenix sample. It is possible that this reflects attitudinal differences between the three populations, but more likely it is due to differences in question wording across the questionnaires. Whereas the Nevada sample was asked to indicate if "the offer of this benefit is appropriate" (the same as in the Jenkins-Smith et al. [1993] survey), the Phoenix and California samples were asked if "this offer of benefits is appropriate for a community to consider in return for accepting an otherwise unacceptable facility."

Table 5. Perceived appropriateness of various compensation measures in the siting of a HLNW repository (1994 surveys).

Measure	Percentage (%) who rate measure as completely or somewhat acceptable		
	Nevada sample	Southern California sample	Phoenix sample
Pay compensation to any residents who suffer negative health effects from the repository	63	NA ^a	NA ^a
Establish a trust fund that would compensate future generations for any harm they might suffer from the repository	62	42	43
Offer large grant to local government that could be used for any improvement desired by the community	52	42	42
Provide tax rebates to all residents living near the repository	45	34	36
Make up any losses in property value that might be caused by the repository	42	46	61

Source: Mertz, Flynn, and Slovic [1994a, 1994b].

^a Compensation for negative health effects was not asked for in the Phoenix and Southern California surveys.

Contingency funds should be designed to cover negative economic impacts and accident and recovery costs from the facility. For example, if it could be shown that there was a 20 percent drop in convention business in Las Vegas, Nevada because of a concern with the risks from the HLNW repository, then a payment would be made to the affected organizations to cover the lost business resulting from this decrease. This sort of contingent compensation is not incorporated into existing HLNW policy and the Department of Energy (DOE) has shown no inclination toward such an agreement [Easterling and Kunreuther, 1995].

Second, compensation must address the issue of intergenerational equity. One possibility is to establish a trust fund that ensures that benefits will be disbursed to all those who suffer negative impacts from the facility [Carnes et al., 1983; Petterson, 1992]. On the other hand, it is unclear that residents would have faith that such a fund would be maintained over the years that persons will be placed at risk; there are always political incentives to utilize money in long-term trust funds for immediate needs and it is highly unclear what form the political structure will take over the lifetime of the repository [Erikson, 1994].¹⁵

¹⁵ With respect to the low- and mid-level radioactive nuclear waste repository in Switzerland, the developer has agreed to a contract with Wolfenschiessen, which requires the community to reinvest a fixed part of the compensation into a mixed portfolio consisting of bonds and stocks. Compensation will be paid out during the next 40 years. After this period, the annual interest generated by the community's investment fund will serve as the amount of compensation to the community each year into the future. Personal communication with Felix Oberholzer-Gee [July 1995].

RECOMMENDATIONS

The empirical data suggest that compensation is a promising strategy for gaining public acceptance for facilities on the benign end of the spectrum (e.g., landfills, prisons), but it is subject to serious limitations when it comes to facilities that the public regards as particularly risky or of questionable legitimacy (e.g., radioactive waste repositories). For these facilities the more important remedial measures involve addressing the public's safety concerns (through mitigation). For all types of facilities we feel it is important to induce more legitimate decisionmaking through voluntary siting where the magnitude and type of compensation can be negotiated in advance. By taking these steps, one may be able to overcome the moral issues associated with accepting some funds in exchange for hosting a facility which is perceived to pose health and safety risks.

Mitigation of Risks

The contrast between the effectiveness of compensation in the case of landfills versus repositories suggests that people will trade off "small" increases in risk for economic benefits, but not huge increases. This sentiment was expressed by Senator Richard Bryan of Nevada:

[I]n order for any state to ever be able to accept a repository, a situation must be created whereby the leaders and citizens in that state are able to see and believe that the site selected was the product of an impeccable, scientifically objective screening process. No amount of compensation or federal "incentives" can ever substitute for safety and technical suitability in the site selection effort. [Bryan, 1987, p. 33]

If compensation is to be effective, it must be preceded by measures that lead the public to regard the facility as more benign. This implies that an essential step early in the siting process is the mitigation of facility risks.¹⁶ Should compensation be used without some effort to reduce these risks, opponents of the facility are likely to charge that the funds are a bribe to buy public support [Gibbs and Lippsett, 1993].

Data in Table 3, presented earlier, provide an indication of the relative importance of mitigation versus compensation. Among the 1987 Nevada and national samples, each of the three mitigation measures (strict safety standards set by the federal government plus an inspector on site, local committee gives safety advice to management, local committee has power to shut down repository) was deemed more important in gaining support for the facility than any of the compensation measures.

The Carnes et al. [1983] survey described earlier suggests that providing authority to local residents could have a decided effect on the acceptability of a radioactive waste repository. As shown in Table 6, by including measures such as independent monitoring, and local power to shut down the repository, the proportion favoring a local repository increased from 26 percent to 41 percent. In contrast, "substantial payments to the community" produced

¹⁶ This point has been argued by a number of authors, including Morell and Magorian [1982], O'Hare, Bacow, and Sanderson [1983], Carnes et al. [1983], and Peelle [1987].

Table 6. Effect of incentives on acceptance of nuclear waste repositories.

Incentives	Percentage (%) favoring repository
Study 1 [Carnes et al., 1983]	
No incentives	22
Substantial payments to community	26
plus access to information	31
plus independent monitoring	34
plus representation on a governing board	36
plus power to shut down	41
Study 2 [Jenkins-Smith et al., 1993], Condition I (benefits first)	
No incentives	10
Economic benefits to residents within 50 miles	14
plus independent agency could inspect	31
plus local officials approve design	25
plus local officials can shut down if they detect problems	42
Study 2 [Jenkins-Smith et al., 1993], Condition II (mitigation first)	
No incentives	13
Independent agency could inspect	32
plus local officials approve design	26
plus local officials can shut down if they detect problems	43
plus economic benefits to residents within 50 miles	32

only a 4-point increase (from 22 percent to 26 percent). Given the research design employed by Carnes et al. (i.e., a fixed order for adding in the different mitigation measures), it is difficult to determine which measure has the greatest impact on public acceptance, although access to information and shutdown power seems to be particularly promising. The shutdown provision has proven effective in practice: Wes-Con averted local opposition to its proposal to convert abandoned Titan missile silos into small waste disposal facilities by allowing the state to shut down the operations under certain risk scenarios [O'Hare, Bacow, and Sanderson, 1983].

Table 6 also shows a corresponding set of data from the Jenkins-Smith et al. [1993] survey. As with Carnes et al. [1983], mitigation measures do more for the acceptability of a repository than does compensation. Whereas economic benefits only increased the level of acceptance from 10 percent to 14 percent, providing for an independent agency to perform regular inspections of the facility increased acceptance to 31 percent. Moreover, adding the provision that local elected officials have the authority to shut down the facility increases acceptance to 42 percent. Curiously, allowing local elected officials to approve the facility design *decreased* the level of acceptance (from 31 percent to 25 percent), possibly because respondents did not believe that these officials would have the technical expertise to make a wise choice.

The bottom portion of Table 6 calls into question our recommendation to offer compensation after putting into place a set of mitigation measures. These data describe the responses of persons who were presented with the

mitigation measures prior to the compensation measure. As with the other segment of this sample, allowing independent inspections and giving local officials shutdown power strongly increased the level of acceptance (to 32 percent and 43 percent, respectively). However, if economic benefits were *then* added to the list, the proportion accepting the repository *decreased* to 32 percent. A similar pattern was observed for two of the other facilities included in this survey (landfill and hazardous waste incinerator), but not for a prison. Whereas the mitigation measures implied that the developer was conscientiously seeking to address the real concerns of local residents, an offer of economic benefits might have been regarded as an attempt to “buy off” the opponents. In addition, an offer of compensation may have been viewed as a signal by some individuals that the facility was more risky than had been perceived earlier.

Establish Legitimacy and Fairness

It is also important to take steps that convince local residents that the proposed facility is needed from a societal perspective and that the siting procedure is fair. Instilling these beliefs can have a positive impact on public acceptance of risky facilities [Easterling, 1992; Lober, 1993; Gerrard, 1994]. Below we outline a two-stage siting process that attempts to achieve these ends. The procedure recognizes the importance of regulations and standards as a part of the siting process (Stage 1) while also employing a voluntary process with negotiated compensation to address equity and efficiency concerns (Stage 2).

Stage 1: Screen Appropriate Sites and Specify Standards

In this first stage of the process, a Public Siting Authority (PSA) determines a set of sites that meet prespecified technical criteria. At the same time, the PSA specifies a set of safety standards that a proposed facility will have to meet. Swallow, Opaluch, and Weaver [1992] suggest a procedure for screening sites to see if they satisfy a set of technical constraints associated with health, safety, and environmental impacts. For example, landfill sites must meet certain hydrologic and geologic conditions so as to make it highly unlikely that pollutants will migrate off-site.

The screening and standard-setting process should take into account both the risks of the facility to the host community as well as the expected impact it will have on the surrounding areas. If there are transportation risks associated with shipping the material from different sources to their final resting place, then this factor should play a role in determining what sites are suitable candidates. If the facility has the possibility of causing air pollution to neighboring areas, then this risk needs to be considered when setting specific performance standards. Appropriate monitoring and control procedures need to be put in place that make the residents of the affected region feel that they have some control over the future of the facility.

Stage 2: Engage in a Voluntary Siting Process

We propose a voluntary siting process with a negotiated compensation package similar to one successfully used in Alberta. There, 14 communities were initially interested in hosting a proposed hazardous waste facility. Nine of

these were subsequently eliminated either on environmental grounds or because of strong public opposition. Of the remaining five, Swan Hills presented a proposal (including benefits) that best met the needs of the developer [McGlennon, 1983]. A similar procedure was used in Illinois in an attempt to find a home for a low-level radioactive waste repository [English, 1992] and by the Nuclear Waste Negotiator in an attempt to find a state or Indian tribe willing to host an MRS facility for the temporary storage of spent nuclear fuel [Office of Nuclear Waste Negotiator, 1993; Easterling and Kunreuther, 1995].

In each of these cases, planning grants were given to communities that expressed an interest in hosting the facility. These funds were used for feasibility studies and public information efforts. The acceptance of a grant did not imply a commitment to accept the facility. Rather, the funds were designed to initiate a process so that the community or region would have input into the process and could specify conditions, including compensation arrangements, that would make the site acceptable to it.

Wisconsin enacted a facility siting law in 1981 that has had unusual success in locating solid waste management facilities because it focuses to a large extent on host community impacts and concerns. As part of the siting process, communities have the opportunity to negotiate compensation agreements with the developers as a way of balancing regional benefits and local burdens generated by new or expanded disposal facilities [Nieves, Himmelberger, Ratick, and White, 1992].¹⁷ With respect to the siting of MRS facilities for storing high-level radioactive waste, Sigmon [1987] points to the importance of negotiating safety concerns and compensation agreements, with local interests as an essential ingredient. He uses the experience of trying to site an MRS facility in Oak Ridge, Tennessee as an example of the importance of such a process in gaining local acceptance of the facility.¹⁸

If a private developer is the applicant, the firm could offer a monetary payment that could be utilized by the community in any way it sees fit. Browning Ferris has operated in this manner in contacting communities in New York State that might be interested in hosting a landfill through its Community Partnership Program. In 1993, the town of Eagle (with 1300 residents) overwhelmingly voted in favor of hosting such a facility in return of a negotiated benefits package that included tipping fees, local jobs, and free trash disposal worth between \$1 million and \$2 million [Kunreuther, Linnerooth, and Fitzgerald, 1996, p. 152].¹⁹

A key aspect of a voluntary procedure is that no community is forced into accepting a facility against its wishes and that the state or larger political unit of analysis is willing to accept the facility if the community approves it. This means that it may take a great deal of time to site a particular facility; communities must gain some familiarity and comfort with the concept under-

¹⁷ Wisconsin does not provide money to local communities to do their own health and safety analyses, or to hire their own consultants. This may put towns at a disadvantage relative to the developers in gathering information about the risks and harms from these facilities [Been, 1994].

¹⁸ The MRS facility was strongly supported by Oak Ridge but opposed by the Tennessee state legislature on grounds that the facility was not needed, would unnecessarily raise electric rates in Tennessee, and would impose a negative image on the greater region [Sigmon, 1987, p. 174].

¹⁹ Eagle first held a referendum in 1992 in which the citizens turned down the facility. Only after a grassroots movement organized another referendum was the facility approved in 1993.

lying the facility before they are willing to enter into negotiations with the developer. The state or larger political unit must also buy into the concept of having the facility in its backyard; otherwise one may be faced with situations such as the one in Tennessee where the town of Oak Ridge supported an MRS facility but the state legislature vetoed the agreement with the developer [Sigmon, 1987]. In some cases (particularly with respect to radioactive waste disposal facilities), the developer might even conclude that the procedure will not succeed in finding a willing host community.

When the developer perceives such an impasse, it may be necessary to revisit the choice of technology, examining whether other facilities might be more acceptable to the potential host communities or other strategies for disposing of waste may be viewed as more desirable than the current policy. For the HLNW case, this revisiting of the waste-disposal technology should be performed by a group that includes not only scientists and utility executives, but also representatives of the general public. New proposals, such as interim storage of waste at the reactor or in centralized MRS facilities may be necessary if the current negative view of long-term storage continues. These alternatives have recently been proposed in several studies [Shrader-Frechette, 1993; Easterling and Kunreuther, 1995; Flynn et al., 1995]. In our view, opening up this decision process greatly increases the chance that the selected options will be regarded as legitimate by persons living in the region proposed for hosting these facilities.

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