

Procedures for Dealing with Transboundary Risks in Siting Noxious Facilities¹

Howard Kunreuther²
November 2007
Working Paper # 2007-11-21

Paper Prepared for
International Conference on the Siting of Locally Unwanted Facilities:
Challenges and Issues
The Chinese University of Hong Kong
December 12-14, 2007

3730 Walnut Street, Jon M. Huntsman Hall, Suite 500
Philadelphia, PA 19104
USA
Phone: 215-898-4589
Fax: 215-573-2130
<http://opim.wharton.upenn.edu/risk/>

¹ This paper is based on studies undertaken with my colleagues involved in the dialog associated with siting a high level radioactive waste repository in Nevada as well as related papers on siting locally unwanted land use (LULU) facilities. The ideas also reflect many discussions on siting issues over the years with Doug Easterling, Jim Flynn, Robin Gregory, Hank Jenkins-Smith, Roger Kasperson, Joanne Linnerooth-Beyer, Hayden Lesbirel, Michael O'Hare, Daigee Shaw, Larry Susskind and Paul Slovic. Support from NSF Grant No. CMS-0527598 and the Wharton Risk Management and Decision Processes Center is gratefully acknowledged.

² Cecilia Yen Koo Professor of Decisions Sciences and Public Policy at the Wharton School, University of Pennsylvania and co-director of the Wharton Risk Management and Decision Processes Center.
E-mail address: Kunreuther@wharton.upenn.edu

CITATION AND REPRODUCTION

This document appears as a Working Paper of the Wharton Risk Management and Decision Processes Center, The Wharton School of the University of Pennsylvania. Comments are welcome and may be directed to the authors.

This paper may be cited as: Howard Kunreuther, “**Procedures for Dealing with Transboundary Risks in Siting Noxious Facilities**,” Risk Management and Decision Processes Center, Wharton School of the University of Pennsylvania, November 2007.

The views expressed in this paper are those of the author and publication does not imply their endorsement by the Wharton Risk Center and the University of Pennsylvania. This paper may be reproduced for personal and classroom use. Any other reproduction is not permitted without written permission of the author.

THE WHARTON RISK MANAGEMENT AND DECISION PROCESSES CENTER

Since its creation 25 years ago, the mission of the Wharton Risk Management and Decision Processes Center has been to carry out a program of basic and applied research to promote effective corporate and public policies for low-probability events with potentially catastrophic consequences. The Risk Center has focused on natural and technological hazards through the integration of risk assessment, risk perception and risk financing with risk management strategies. After 9/11, research activities extended also to national and international security issues (e.g., terrorism risk insurance markets, protection of critical infrastructure, global security).

Building on the disciplines of economics, decision sciences, finance, insurance, marketing and psychology, the Center's research program has been oriented around descriptive and prescriptive analyses. Descriptive research focuses on how individuals and organizations interact and make decisions regarding the management of risk under existing institutional arrangements. Prescriptive analyses propose ways that individuals and organizations, both private and governmental, can make better decisions regarding risk. The Center supports and undertakes field and experimental studies of risk and uncertainty to better understand the linkage between descriptive and prescriptive approaches under various regulatory and market conditions. Risk Center research investigates the effectiveness of strategies such as risk communication, information sharing, incentive systems, insurance and regulation.

The Center is also concerned with training decision makers and actively engaging multiple viewpoints, including the expertise of top-level representatives in the world from industry, government, international organizations, interest groups and academics through its research and policy publications and through sponsored seminars, roundtables and forums.

More information is available at <http://opim.wharton.upenn.edu/risk>

Procedures for Dealing with Transboundary Risks in Siting Noxious Facilities

ABSTRACT

The city of Hong Kong faces a number of siting problems that have health and environmental consequences which can affect a wider population than the area in which the facility is located. This paper focuses on ways to better manage the transboundary risks associated with facilities such as a waste incinerator, chemical waste treatment facilities and landfills. After describing the nature of the problem from the perspective of the different stakeholders or interested parties affected by the risk, the paper suggests a framework for evaluating alternative siting strategies. It then examines how a siting authority can deal with transboundary issues and the role that mitigation measures and compensation can play in gaining consensus as to whether the facility should be approved. The concluding portion of the paper elaborates on the elements of the Facility Siting Credo that may be helpful in finding a home for a facility with transboundary risks and raises a set of issues as to how this approach would be relevant for Hong Kong siting problems

1. Introduction

The city of Hong Kong faces a number of siting problems that have health and environmental consequences which can affect a wider population than the area in which the facility is located. In other words, these proposed facilities pose a set of transboundary risks due to the negative externalities that they would create with respect to the ecosystem and neighboring districts. Some proposed facilities that have aroused public concern because of their negative externalities on either ecological sensitive areas or nearby communities are³:

- Proposed Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities by China Light and Power Company Limited (CLP)
- Proposed Waste Incinerator by the Hong Kong SAR Government
- Upgrading of the Chemical Waste Treatment Centre by the Hong Kong SAR Government
- Proposed Landfill Expansions by the Hong Kong SAR Government
- Proposed Central Slaughterhouse by the Hong Kong SAR Government

This paper focuses on ways to better manage the transboundary risks associated with facilities such as those noted above. It proposes a strategy for facilitating the siting process by focusing on the concerns of the relevant stakeholders and the nature of the risk. Section 2 describes the nature of the problem from the perspective of the different stakeholders or interested parties affected by the risk. Section 3 suggests a framework for evaluating alternative siting strategies using where to locate an incinerator as an illustrative example. The paper then examines how a siting authority can deal with transboundary issues and the role that mitigation measures and compensation can play in gaining consensus by the public and other key stakeholders as to whether the facility should be approved (Section 4). The concluding section elaborates on the elements of the Facility Siting Credo that may be helpful in finding a home for a facility with transboundary risks and raises a set of issues as to how this approach would be relevant for Hong Kong siting problems noted above.

³ For more details on these proposed facilities and the key problems that each of them face see Lai et al. (2007) "Siting Problems in Hong Kong" (Chap. 5) in Lai, P.W., L.Y. Woo, K.C. Lam, W.Y. Lee and T. Fung, *Siting and Community Response to Locally Unwanted Land Uses: A Literature Review*. Centre for Environmental Policy and Resource Management, Department of Geography and Resource Management, The Chinese University of Hong Kong.

2. Nature of the Problem

The nature of the transboundary risk problem from the perspective of the affected districts can be stated by using the following simple illustrative example. District Y is planning to site a facility that not only affects its own residents but also those of District Z. There may be benefits to both Y and Z from having the facility, but it is likely that Y gains considerably more than Z does either through tax revenues and/or employment opportunities for its residents. There are three interrelated questions that need to be addressed from the perspective of both districts:

(1) What actions should District Y take with respect to mitigating its risks, recognizing that the negative impacts (e.g., pollution) may extend beyond its own boundaries?

(2) Is there a role that a siting authority can play in managing these transboundary risks?

(3) What role can compensation or benefit-sharing by District Y play in satisfying the concerns of District Z?

There are a number of different parties who are affected by the facility that need to be considered in the siting process:

The developer who is interested in constructing the facility: In many countries the developer is synonymous with a government organization. For example, in Hungary and Slovakia the water management authority is responsible for developing hydroelectric power plants for managing their country's energy needs. Government agencies in Lithuania and Sweden are responsible for providing nuclear power as a source of energy.

The affected public who both benefit from the facility and are affected by the risk. Residents in districts near the facility may be more adversely impacted by it than those some distance away. In Hong Kong, the local community has been concerned with the negative impact of a proposed central slaughterhouse on the risks of bird flu and the decline in property values

Public interest groups who have their own agenda regarding future development projects: For example, "green" groups in Hong Kong have been concerned with the impact of a proposed LNG receiving terminal on the local ecology and the impact of a proposed waste incinerator on the environment.

Two questions that arise when dealing with transboundary risks and stakeholder groups are:

(1) What role should the public and different environmental groups have in making decisions regarding the siting and operation of certain facilities?

(2) How does one create trust in the process of siting facilities and managing them when there is great uncertainty associated with risks?

3. A Framework for Analyzing the Transboundary Problem

Consider the challenges facing a private firm or developer who is trying to find a home for a solid or hazardous waste facility. As a concrete example, suppose that the facility of interest is an incinerator. District Y has expressed an interest in hosting the incinerator right near its political boundary in a part of town that has relatively few homes and businesses. Residents in District Z are also subject to health and environmental risks from the facility.

A voluntary siting process has been proposed whereby all the residents in Y over 18 can vote on a referendum as to whether an incinerator should be located in their backyard. Suppose that if a certain percentage (e.g., two-thirds) of Y's residents support the facility, then it will be deemed approved and construction will begin. Those residing in Z have no official vote on whether the incinerator should be located in Y, but they can publicly protest the facility in order to encourage residents in Y to vote against it.

Each resident j in District Y will determine whether to vote in favor of a particular facility by considering the benefits to him or her (B_j) and the perceived risks associated with the facility. The benefits can be direct compensation to an individual, such as a reduction in property taxes, or it can take the form of community-wide or regional improvements such as additional health-related services, higher salaries to attract more and better teachers for the schools and/or new recreational facilities. A benefits package may also contain contingent arrangements such as guarantees against property value declines due to the facility if a family tries to sell its home, and reimbursement for any health and/or environmental impacts from the facility.

The risks associated with the incinerator for each individual j in District Y are characterized by a perceived probability (p_j) that some type of damage (D_j) will occur to him or her. These risks can be mitigated (but not necessarily eliminated) through enforcement of safety standards and regulations. If the benefits package is attractive enough and/or the perceived risks associated with the facility are sufficiently small to resident i in District Y, then he or she will vote "Yes" to constructing the incinerator.

The developer has no economic incentive to provide residents in District Z with any benefit package or to reduce the risks facing this group. From the developer's perspective, the only votes that count are the ones from District Y. Thus it is conceivable that the majority of the residents in District Z may face certain risks from the new facility for which they will not be sufficiently compensated by the developer, so that they would disapprove of the facility even though it was approved by those living in Y.

The above example illustrates the divergence between private and social costs due to transboundary risks. The private costs to the developer only revolve around residents in Y, while the social costs include the impact on individuals in both Y and Z. Unless some steps are taken to protect District Z against possible economic, health and safety losses, the above voluntary siting process can prove costly when the benefits and costs of residents in both districts are taken into account.

Transboundary risks are a form of externalities which are normally associated with public goods or bads. Thus, a hazardous waste facility poses risks of different degrees to all individuals within a certain radius of the site, and there is little that a person can do to alleviate this risk once a facility is built, short of moving out of the area. Individuals can engage in collective action to lobby against having a facility in the first place, but this involves costs to them which they may not be prepared to incur. Hamilton (1993) has shown that private firms will want to locate facilities in communities or regions which generate the least political opposition and provides empirical evidence that the host communities will not necessarily be the ones which generate the lowest externalities.

Importance of International Siting Authority

The presence of externalities suggests a clear role for a siting authority or government agency to play an active role in the siting process. More specifically, such a group would need to impose strict mitigation measures and standards that reduce the risks to both the host community and its affected neighbors before any developer or firm engages in the search for a site. It would also specify who is liable in case an accident occurs and what the appropriate compensation would have to be.

Role of Well Specified Standards. To adequately reflect the concerns of all the affected residents, the siting authority would need jurisdiction over a region that encompasses both the host district as well as those areas subject to the transboundary risks from a facility. Furthermore, it would need to be empowered by a governmental body that was concerned with the welfare of a wide area rather than the narrower interests of citizens from one jurisdiction.

There is an additional reason for imposing strict safety standards by a public authority or governmental authority before the search for a site begins. The standards are likely to reduce conflicts that are otherwise likely to emerge between the developer who relies on scientific experts for characterizing risks and the residents in the community who have their own perceptions of the risks. While the experts normally measure risks in quantitative terms (e.g. the probability and the anticipated consequences of an accident), the public takes other factors such as dread, unfamiliarity with the technology and catastrophic potential into account when evaluating their concerns. (Slovic 1997). Residents in Z who oppose the facility can feed into these fears of those residing in Y, encouraging them to vote against the proposal.

Evidence on how the public's perceptions of risk differ from the scientists' views is illustrated by two empirical studies. One study showed that the amount that a layperson was willing to pay for risk reductions is influenced by his or her degree of dread and the severity of risks, such as hazardous waste and sulfur air pollution, where there is considerable scientific uncertainty in the degree of risk exposure and their potential effects. Scientists do not consider factors such as dread or lack of familiarity to be relevant in characterizing the degree of risk from a particular activity (McDaniels, Kamlet and Fischer 1992). Another

study of laypersons and toxicologists revealed large differences between these two groups in their assessment of chemical risks. (Kraus, Malmfors and Slovic 1992).

Role of Monitoring and Control Procedures. In addition to imposing standards and regulations at the time the facility is sited to deal with risk perceptions of both the experts and the public, the public authority needs to undertake monitoring and control procedures at regular intervals to assess the performance of the facility once it is in place. One proposal that may convince the affected public that they will be protected against risks to themselves and future generations is to form a committee of local residents that is granted special oversight powers, including the power to suspend operations at the facility if the prescribed standards are not adhered to.

Use of Compensation or Benefit Sharing

In order for residents to support a facility, the benefits associated with having it must be greater than the benefits of maintaining the status quo. One way to satisfy this condition is to provide communities who site the facility, as well as those who are nearby, with compensation. However, compensation will be viewed as a bribe unless the affected groups feel that the facility satisfies rigorous safety standards that will be well enforced. Six types of compensation have been identified by Gregory et al. (1991) for facilitating siting decisions.

Direct Monetary Payments. This is the most common form of compensation and can take the form of guaranteed annual payments or tipping fees on the waste that is stored. In Charles City, Virginia, the developer of a landfill collected a tipping fee which it paid to the city, amounting to about \$1 million in revenues annually. This has lowered property taxes and allowed for the rebuilding of the city's ailing school system. (O'Hare, Bacow and Sanderson, 1983).

In-kind awards. These take the form of grants to communities or regions for improving health care facilities, housing, education or other services that enhance the citizens' well-being and reduces risks that they face. In Swan Hills, Alberta, subsidized housing was provided for 35 housing units in conjunction with the siting of a hazardous waste facility (Rabe 1991). In Charles City, the operator collects the county's garbage free of charge. This was also the case in Grandview, Idaho where Wes-Con provided free garbage pickup to residents as part of a package associated with siting a waste-disposal facility [O'Hare, Bacow, and Sanderson (1983)].

Contingency funds. These are used to cover losses from an accident or other adverse effects of the facility. For example, trust funds could be established to cover the damages and health-related costs to victims of an accident.

Property value guarantees. These protect residents of the host community and surrounding areas against any decline in the resale value of their home due to the location of the facility. This type of compensation was offered by Champion International Corp. as part of a program for siting an industrial landfill. The company monitored the changes in the sale prices of homes in the county over a ten year period and paid residents if there were any adverse changes in the property value due to the presence of a landfill. (Ewing 1990).

Benefit assurances guarantees direct or indirect employment for community members, either during construction of the facility or during its operation phase. These type of benefits have positive externalities that will make the facility more attractive to neighboring communities as well as the host site. The hazardous waste treatment center in Swan Hills, Alberta, promised 55 new jobs and convinced town leaders that other new developments, such as a new hospital, would now be feasible.

Economic goodwill. This refers to contributions to local organizations and expenditures for projects that are important to the community and the surrounding area. The private corporation responsible for the Swan Hills hazardous waste facility planted 400 trees for town beautification, provided \$65,000 to support local activities including golf course development and made charitable contributions such as sponsoring a hockey school and donating a bear rug to the town council chambers. (Rabe 1991).

Empirical Evidence on Compensation⁴

A number of surveys have been completed on attitude of residents toward a public authority who would impose well-specified standards that are monitored and the role that compensation can play in facilitating the siting process. This section briefly summarizes some of the key findings for different types of facilities.

Two surveys of particular relevance to this paper are by Bacot, Bowen, and Fitzgerald (BBF) (1994) and by Jenkins-Smith and Kunreuther, (JK) (2001) each of which 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 BBF sample and to 25 percent of the JK sample when compensation was *not* included. However, in both cases, the rate of acceptance approximately doubled with the introduction of compensation. In the JK survey, the form of the benefits was left vague ("economic benefits provided to residents within 50 miles of the facility"), whereas BBF 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).

⁴ For more details on the empirical findings discussed in this section see Kunreuther and Easterling (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 high-level nuclear waste 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 sub-sample of 150.

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 supposed 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 1. Effect of Compensation Measures in Increasing Acceptance of Facilities

	<u>Municipal Waste Landfill</u>		<u>Haz Waste Incin²</u>	<u>Prison²</u>
	<u>Study 1¹</u>	<u>Study 2²</u>		
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%			

¹ 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.

² Jenkins-Smith and Kunreuther (2001). Total sample of 1200 U.S. residents. Each condition has n = 150.

The JK survey also investigated the impact of compensation on acceptance in the case where the facility being sited was a hazardous-waste incinerator and a medium-security prison. These two facilities differed markedly in the absolute level of acceptability (15 percent versus 29 percent in the no-compensation case); however, the introduction of benefits produced similar levels of increased acceptance (17 percentage points for the incinerator, 22 percentage points for the prison) as shown in the last two columns of Table 1. From these data, one might conclude that economic benefits have a substantial impact on public sentiment toward noxious facilities, although they fail to convince everyone that the facility should be built.

Radioactive waste repositories. The positive impact of compensation on public acceptance is **not** replicated when the facility to be sited is a radioactive waste repository. This conclusion is supported by the five separate studies reported in Table 2: Carnes et al. (1983); Kunreuther, et al. (1990); Dunlap and Baxter (1988); Herzik (1993); and Jenkins-Smith and Kunreuther (2001).⁷ The different samples varied somewhat in their baseline willingness to accept a "local" high level nuclear waste repository (HLNW) with the greatest level of acceptance (60 percent) occurring among Dunlap and Baxter's (1988) sample of residents living near Hanford, Washington. However, 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 JK surveys. However, in the other three surveys (each of which offered 20 years of generous tax rebates), there was no evidence of increased acceptance.

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 et al. (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 (1992) 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).

Table 2. Limited Effectiveness of Compensation: the Case of Nuclear Waste Repositories

	<u>Study 1</u>	<u>Study 2</u>	<u>Study 3</u>	<u>Study 4</u>	<u>Study 5</u>	<u>Study 6</u>
Acceptance without incentives	22%	10%	27%	24%	60%	51%
Acceptance with economic benefits						25%
"substantial payments"	26%					
"economic benefits"		14%				
\$1,000/yr for 20 yrs			26%	23%		
\$3,000/yr for 20 yrs			30%			
\$5,000/yr for 20 yrs			30%			
\$100- \$900/yr for 20 yrs					51%	

¹ Carnes et al. (1983). 1980 survey of 420 Wisconsin residents.

² Jenkins-Smith and Kunreuther. (2001). Total sample of 1200 U.S. residents. Each condition has n = 150.

³ Kunreuther et al. (1990). 1987 survey of 1001 Nevada residents (n = 498 answered compensation questions).

⁴ Herzik (1993). 1993 survey of 1212 Nevada residents.

⁵ Dunlap and Baxter (1988). 1987 survey of 658 persons living near Hanford, Washington.

⁶ Frey et. al. (1996) 1993 survey of 305 persons living in Wolfenschiessen, Switzerland

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.⁸ This difference was not statistically significant, $\chi^2(3)$. In addition, there was no significant difference in acceptance across the three dollar amounts: \$1,000 per year (26 percent), \$3,000 per year (30 percent), and \$5,000 per year (30 percent).⁹

The contrast between radioactive waste repositories and other noxious facilities in the effectiveness of compensation is remarkable. *Threat to future generations* is a strong determinant of voting behavior in the case of HLNW repositories (Kunreuther et al., 1990). If a person believes that a repository will pose serious risks to future generations, rebates are unlikely to win his or her acceptance of a repository. This resistance to rebates 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. This figure shows that 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.

⁸ The referendum question was worded, "If a vote were held today on building a permanent repository, where would you vote to locate the repository?" Respondents were presented with four choices: Yucca Mountain, Hanford, Deaf Smith, and "none of the above." The following question was used to assess a respondent's willingness to accept a repository with compensation:

Suppose after thorough study, the Federal government decided to put a high-level nuclear waste repository at Yucca Mountain in Nevada. This repository would be built according to Federal safety standards. Suppose also that you could receive a [either \$1,000/\$3,000/\$5,000] rebate or credit on your Federal income taxes each year for 20 years. Would you vote to locate the repository at Yucca Mountain?

⁹ The effect of dollar amount was nonsignificant regardless of whether the dependent variable was vote or change in vote. In the latter case, respondents were classified into one of three categories: (1) rebate had no effect on voting response; (2) rebate made repository more acceptable; or (3) rebate made repository less acceptable. The effect of rebate level was then assessed by testing whether the distribution of this change variable differed across the three dollar amounts. This yielded a $\chi^2(4)$ of 4.16 ($p > .3$).

Very similar responses to compensation were obtained in a 1987 national survey conducted by the same authors (Kunreuther et al., 1990). Here, respondents were asked whether they would accept a repository 50 or 100 miles away in return for rebates of between \$1,000 and \$5,000 (distance and dollar amount were varied experimentally). Overall, 28.7 percent of the sample responded positively to the compensation offer, compared to 28.9 percent of the Nevada sample.

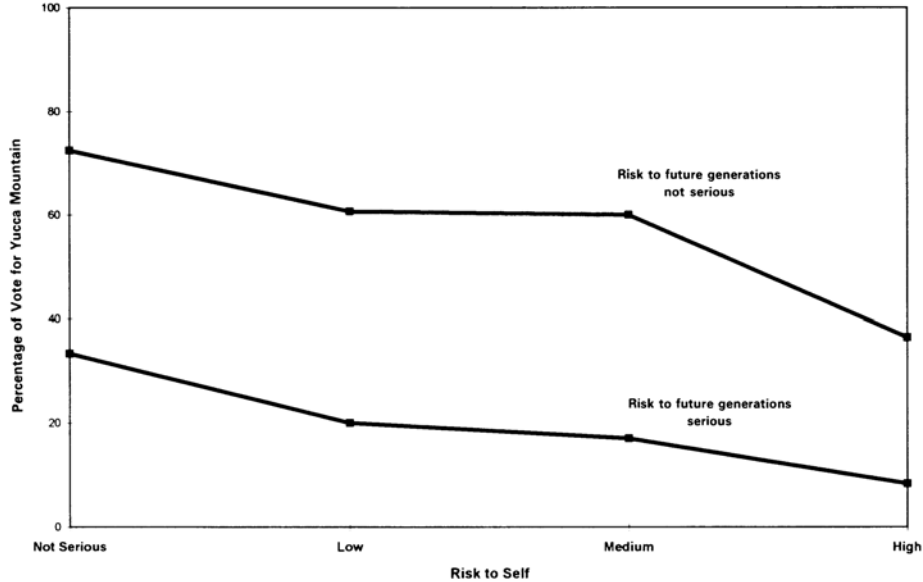


Figure 1. Approval of Yucca Mountain by perceived risk to self and risk to future generations.

The data in Figure 1 cast doubt on one of the assumptions that underlie most compensation strategies: compensation will succeed in gaining a person's acceptance of a facility if that person believes he or she will be better off with the facility than without it. 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 not told anything regarding the fate of the plant, the average asking price was \$8. However, among subjects who were told that the plant 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.

Individuals who consider the proposed HLNW repository to be illegitimate will similarly be inclined to reject offers 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). Monetary payments are inherently unable to offset these objections. For example, a rebate package paid out over 20 years rewards the current generation for accepting the repository, but imposes uncompensated costs on future generations.

*Empirical Evidence on Well-enforced Standards*¹⁰

By requiring stringent standards which address public concerns with the risk, there is a greater likelihood that a positive vote will be forthcoming if a siting referendum was instituted. In the JK survey, individuals were asked about their attitudes toward alternative risk reduction measures as a condition for siting four different types of facilities: a prison; a landfill; an incinerator; or a high level radioactive waste repository. After the respondents stated their degree of acceptability of one of the four facilities, they were given a series of questions to determine whether one or more of the following measures would cause them to change their stated opinion:

- An independent agency approved by the local government will perform regular inspections to insure that the facility is meeting all federal and state regulations (INSPECT);
- The facility will not be built until local elected officials have approved the design (APPROVE);
- Local elected officials will have the authority to close down the facility if they detect any problems (SHUTDOWN); and
- Economic benefits were provided to residents living within 50 miles of the facility (BENEFITS).

The sample was randomly divided into two equal-sized groups. **GROUP 1** respondents were given the measures, in an additive fashion, in the following order; INSPECT, APPROVE, SHUTDOWN and BENEFITS. **GROUP 2** respondents began with BENEFITS, followed by INSPECT, APPROVE and SHUTDOWN in that order. The reason for the different orderings is to test whether the sequence of measures affects their acceptance of the facility.

Tables 3a and 3b present the percentage of respondents who would support the facility for **GROUP 1** and **GROUP 2** under five different scenarios. The scenarios consist of the different combinations of mitigation and compensation packages that were given to the survey respondents. The tables also show whether the change in the percentage of respondents who accept the facility after each of the sequential steps in the mitigation scenarios was statistically significant.

¹⁰ This subsection is based on material in Jenkins-Smith and Kunreuther (2001). More details can be found in the paper.

Table 3a: Percentage Completely or Mostly Accepting Facilities Based on Combinations of Safety and Economic Benefits Measures (Group 1 Respondents: Benefits Offered Last)

Sequence of Measures	Prison	Landfill	Incinerator	Repository
No Measures	30.5%	18.1%	14.5%	12.4%
INSPECT	54.9%***	53.7%***	42.1%***	31%***
APPROVE	51.8%	46.3%	36.8%	26.2%*
SHUTDOWN	59.8%	65.8%***	55.4%***	42.8%***
BENEFITS	62.8%	56.4%	42.8%***	31.7%

Statistical significance of change from cell above: *** = <0.01; ** = <0.01; * = <0.05

Table 3b: Percentage Completely or Mostly Accepting Facilities Based on Combinations of Safety and Economic Benefits Measures (Group 2 Respondents: Benefits Offered First)

Sequence of Measures	Prison	Landfill	Incinerator	Repository
No Measures	39%	25.2%	14.5%	10.2%
BENEFITS	52.1%***	49.0%***	30.3%***	13.4%
INSPECT	65.1%**	67.7%***	47.4%***	30.0%***
APPROVE	56.8%**	57.4%**	39.5%*	25.5%*
SHUTDOWN	56.2%	75.5%***	52.0%***	42.0%***

Statistical significance of change from cell above: *** = <0.001; ** = <0.01; * = <0.05

Focusing on the specific measures, INSPECT and SHUTDOWN have strong positive effects on acceptance of the facility for both **GROUPS 1** and **2**. In other words, whether BENEFITS are offered first or last has no impact in the effects of these two measures. Tables 3a and 3b also reveal that the approval of design by local officials consistently has a *negative* impact on the percentage of respondents who support the siting of these four types of facilities.¹¹ This finding suggest that, from the perspective of the public, the oversight of independent inspectors and the power to shut down facilities should be left in the hands of local officials. On the other hand the technical issue of the approval of the facility design should not be delegated to government officials.¹²

¹¹ For **GROUP 1** the APPROVE measure is only statistically significant for the repository. However, for **GROUP 2** it is statistically significant (in reducing approval) for all four facilities.

¹² More research is needed to determine who it is that people would trust to judge technical issues with respect to facility design. For work on this question, see Jenkins-Smith and Silva (1998).

Two explanations for this differentiation of public views of the roles of local officials have been offered. One, consistent with the findings of Jenkins-Smith and Stewart (1998), suggests that while local officials are trusted to express the residents' interests, they are not seen as sufficiently competent to directly oversee a complex hazardous materials management program. O'Connor et al (1994) offer an alternative explanation; local officials may be seen as too susceptible to the influence of the facility operator, and therefore cannot be trusted with decisions about facility design. Either way, program designs that seek public acceptance for hazardous facilities must account for the differentiation in public expectations of different kinds of public officials.

Turning to the BENEFIT measure, it makes a big difference whether it is offered first or last. For the landfill, incinerator and repository, the final percentage of supporters is at least 10 percent higher when economic benefits are offered first (Table 3b) rather than last (Table 3a). Apparently, when the facility is perceived to be risky, providing economic benefits *after* safety measures have been instituted has a negative influence on the percentage of individuals supporting the facility. This finding implies that when economic benefits are offered first, they are more likely to be perceived by the respondents as compensation for the increased risk from hosting a facility. When these benefits are offered *after* safety measures have been addressed, they are perceived by some as a bribe for taking the facility.

This finding is a puzzling one, and requires further research. Indeed, it seems counter-intuitive in the light of Kasperson's (1999) argument that compensation is only ethically justifiable after safety measures have been addressed. Our findings suggest to us that, in the relatively untrusting times in which we live, the introduction of benefits after the safety issue has been addressed leads many of those affected to suspect that the facility is even more dangerous than they were initially led to believe. After all, if the facility is safe, why should those living nearby need to be plied with goodies? Hence, support for the facility is eroded by providing some forms of benefits as an apparent afterthought.

4. A Siting Procedure for Dealing with Transboundary Risks

At a National Workshop on Facility Siting in 1990, a group of practitioners and researchers developed a set of guidelines for siting noxious and/or hazardous facilities. These guidelines, which were formalized in a Facility Siting Credo, focused on developing a workable and fair procedure for locating a facility as well as an outcome which satisfied distributional (equity) and benefit-cost (efficiency) considerations.

A study of 29 siting cases, both successful and unsuccessful, across the United States and Canada, confirmed the importance of two features of the process in finding a community that agrees to host a facility: having a broad-based public participation process, and the perception by host community residents that the facility was the best solution to their waste problem. (Kunreuther, Fitzgerald and Aarts, 1993). Both of these elements should be considered in designing a siting process.

The Facility Siting Credo also emphasized the desirability of a voluntary siting process but did not explicitly take into account the presence of transboundary risks. This section proposes a two stage siting process which explicitly addresses the issues of transboundary risks while addressing the concerns of equity and efficiency through compensation. The implicit assumption is made that a new facility is viewed as socially desirable. However, if a volunteer site cannot be found then the status quo will be maintained rather than forcing a community or region to site a facility. The key questions are what type of facility to construct and where it should be located.

Stage 1: Screen Appropriate Sites and Specify Standards

In this first stage of the process, the 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. The PSA can be based at the local, regional or national level depending on the nature of the transboundary risks and the candidate areas for the facility. The PSA could consist of representatives from more than one country if the facility poses transnational risks.

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 destination, 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 for the facility.

One issue that should be addressed in screening acceptable sites is whether to exclude certain communities or regions on equity or fairness grounds. There are two extreme views normally taken with respect to this question. If a voluntary siting process is to be utilized, then one can argue that any community can decide for itself whether or not it wants the facility. On the other hand, suppose that most taxpayers feel that low income areas which already have noxious facilities should be excluded from consideration. Then a siting map should be drawn which excludes these places from being considered, even though they may be technically suitable areas.

Stage 2: Engage in a voluntary siting process

The proposed procedure for finding a site is a voluntary one based on a procedure that was successfully used in Alberta. Fourteen 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 situations, planning grants were given to communities that expressed an interest in hosting the facility without implying 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.

Depending on the type of facility that is being considered, different types of compensation arrangements might be proposed. 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 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 1992, the town of Eagle (with 1300 residents) overwhelmingly voted in favor of hosting such a facility in return for a benefits package that included tipping fees, local jobs, and free trash disposal worth between \$1 million and \$2 million (Angell, 1993).

A key aspect of this procedure is that no community is forced to accept a facility against its wishes. 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 underlying the facility before they will be willing to enter into negotiations with the developer. 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. In such a case, it may be necessary for the developer to revisit the choice of technology, examining whether other facilities might be more acceptable to the potential host communities. 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. Opening up this decision process provides the only chance of the selected facility being regarded as legitimate by persons living in a candidate state (Easterling and Kunreuther, 1995).

5. General Conclusions and Recommendations

In this concluding section we will suggest a set of issues that need to be addressed regarding the involvement of the interaction between policy makers, risk management institutions and the public in dealing with transboundary risk problems facing the public and private sectors. It should have relevance to the siting problems facing Hong Kong today that are outlined in the introductory section of the paper.

Higher Quality Public Involvement

Research clearly shows that public involvement is a necessary part of risk management. Research is less clear on the specifics of what that involvement should look like. Though some researchers recommend *greater* public involvement in risk management decisions, we are less certain that more is necessarily better. It is perhaps more appropriate to conclude that public involvement of high quality is more important than, for example, involving more members of the public, or involving the public more deeply in issues that they are poorly prepared to grasp. There is a risk in taking the tack of "involving" the public by allowing them to express their anger and rage, but doing very little to accommodate their views or change how things are done. This form of involvement is perhaps better characterized as indulging the public, which sometimes happens under the guise of "involving the public."

High quality public involvement has not yet been well defined. We suggest that risk management institutions develop guidelines for high quality public involvement. These guidelines should be based on definitions of what is wanted by the public and from the public, and how their viewpoints will be incorporated into risk management decisions. Are there technical decisions where public values would be relevant? Can the public be helpful in defining approaches for relating to their own constituency? Is there training and education that the public needs in order to be an active, valued, and respected participant in risk management?

Earlier Involvement of the Public

Very often, the difficulties in dealing with the public are brought about because those impacted by a project are among the last to know of its existence. Project development is a complex and inexact process. For project developers, the road that leads from an idea to a construction permit or operating license is a long and uncertain one. Only a very small number of the projects that are considered actually make it to the point of filing an application with a regulatory or licensing agency.

Usually by the time an application is filed, many decisions have been made that are very difficult to reverse, making it difficult, if not impossible, for a proponent to incorporate the public's input. Project proponents need better advice on how to involve the public earlier in the development cycle. And, risk management institutions need better guidance on how they can give that advice in a responsible way that is sensitive both to the needs of the public and to the constraints and problems faced by the proponents.

Greater Reliance on "Volunteer Communities"

For the public to be a willing partner in technology, it needs to know what is in it for them. For a project to be of true benefit to a country or a region within the country, it must fit within their own framework of goals and objectives, and not just those of project developers. Project proponents should be encouraged to strive for a partnership with host countries and their neighbors. The first step in establishing that partnership is recognizing the critical importance of voluntariness in decisions about technology. The "normal" project development process can seem to community members as imposing the results of decisions made by others upon them, particularly when public involvement does not occur until far downstream from project planning. By working toward voluntary participation in project development, proponents may actually reduce the risks that a project will run into trouble that can result in costly delays or even more costly abandonment.

Role of Public Interest Groups

One of the issues that deserves further discussion is the role that environmental groups and organizations can play if a voluntary siting process is utilized. Suppose that one of these public interest groups feels that it would be inappropriate for community Y to host a proposed incinerator because they feel that the technology is unsafe. It is fair game for information on the public interest group's views of the risk to be presented to the affected residents, who may then revise their feelings about the facility and/or demand additional safety and mitigation measures before agreeing to vote in favor of hosting it in their backyard.

Organizations like Greenpeace have strongly opposed the construction of incinerators in communities because they feel they produce environmental hazards. They have developed a set of guidelines for preventing these facilities from being built (Greenpeace 1991), but there is limited empirical evidence as to what impact these efforts have had on community attitudes toward these facilities.

Increase Public Trust

We are currently at an important junction in the evolution of socially accountable risk management. All the research to date on the failures of risk management point strongly to the erosion of trust both in government and in many of our social institutions as an important causal factor in the conflicts that exist between the community of risk experts and the public.

At this juncture, we need to move forward in one of two directions. One path that has been advocated by a number of researchers is to work toward increasing public trust in risk management. While it is much too soon to express either optimism or pessimism about the likely success of this strategy, it is a significantly challenging problem that at the moment appears to have no easy answers.

A second path leads in the direction of developing risk management processes that don't rely on trust, or rely on it only minimally. Though it is seldom acknowledged explicitly, many of the steps currently being taken by government and industry to involve the public through community advisory panels and the like are, in effect, establishing layers of oversight such that the checks-and-balances principles inherent in democratic governments are instituted within technological risk management. This may be a fruitful avenue to pursue, and research along these lines is currently needed.

REFERENCES

- Angell, P. (1993), Personal communication regarding Browning-Ferris Industries, Inc.'s program for siting landfills, April (Houston, TX: BFI).
- Bacot, H., T. Bowen, and M. Fitzgerald (1994), "Managing the Solid Waste Crisis: Exploring the Link Between Citizen Attitudes, Policy Incentives, and Siting Landfills," *Policy Studies Journal* 22(2): 229–244.
- Carnes, S.A., E.D. Copenhaver, J.H. Sorensen, E.J. Soderstrom, J.H. Reed, D.J. Bjornstad, and E. Peelle (1983), "Incentives and Nuclear Waste Siting: Prospects and Constraints," *Energy Systems and Policy* 7(4): 324–351.
- Dunlap, R.E. and R.K. Baxter (1988), "Public Reaction to Siting a High-level Nuclear Waste Repository at Hanford: A Survey of Local Area Residents," Report prepared by the Social and Economic Sciences Research Center, Washington State University, Pullman, WA for Impact Assessment, Inc.
- Easterling, D. and H. Kunreuther (1995), *The Dilemma of Siting a High-Level Nuclear Waste Repository* (Boston: Kluwer Academic Publishers).
- English, M. (1992), *Siting Low-Level Radioactive Waste Disposal Facilities: The Public Policy Dilemma* (New York: Quorum Books).
- Ewing, T.F. (1990), "Guarantees Near a Landfill," *New York Times*, July 8.
- Frey, B., F. Oberholzer-Gee and R. Eichenberger (1996), "The Old Lady Visits Your Backyard." A Tale of Morals and Markets, *Journal of Political Economy*, Vol. 104, No. 6
- Greenpeace (1991) "How to Stop the Incinerators: A Community Owner's Manual" *Greenpeace* Jan-Feb pp20-21.
- Gregory, R., H. Kunreuther, D. Easterling, and K. Richards (1991), "Incentives Policies to Site Hazardous Facilities," *Risk Analysis* 11, 667–675.
- Hamilton, J. (1993), "Politics and Social Costs: Estimating the Impact of Collective Action on Hazardous Waste Facilities." *RAND Journal of Economics* 24:101-125
- Herzik, E.. (1993), "Nevada Statewide Telephone Poll Survey Data," Report presented to Nevada State and Local Government Planning Group, University of Nevada, Reno, July 23.
- Jenkins-Smith, H. and H. Kunreuther, (2001), "Mitigation and Benefits Measures as Policy Tools for Siting Potentially Hazardous Facilities: Determinants of Effectiveness and Appropriateness" *Risk Analysis*, 21: 371-382
- Jenkins-Smith, H., H. Kunreuther, R. Barke, and D. Easterling (1993), "UNM Mitigation/Compensation Survey," Unpublished report, Institute for Public Policy, University of New Mexico, Albuquerque.
- Jenkins-Smith, H. and C. Silva. (1998), "The Role of Risk Perception and Technical Information in Scientific Debates Over Nuclear Waste Storage." *Reliability Engineering and System Safety*, 59, 107-122.

- Jenkins-Smith, H. and J. Stewart. (1998), "Who Will Protect My Back Yard: Dimensions of Federalism in Political Trust." Institute for Public Policy Working Paper Series, University of New Mexico, Albuquerque, New Mexico.
- Kasperson, R. (1999), "Process and Institutional Issues in Siting Facilities." Paper presented at International Workshop on Challenges and Issues in Facility Siting. Academia Sinica, Taipei, Taiwan, January 7-9.
- Kraus, N., T. Malmfors and P. Slovic, (1992) "Intuitive Toxicology: Expert and Lay Judgments of Chemical Risks," *Risk Analysis* 12:215-232.
- Kunreuther, H. and D. Easterling (1992), "Gaining Acceptance for Noxious Facilities with Economic Incentives," in D. Bromley and K. Segerson (eds.), *The Social Response to Environmental Risk* (Boston, MA: Kluwer Academic Publishers).
- Kunreuther, H., D. Easterling, W. Desvousges, and P. Slovic (1990), "Public Attitudes Toward Siting a High Level Nuclear Waste Repository in Nevada," *Risk Analysis* 10, 469-484.
- Kunreuther, H., K. Fitzgerald, and T.D. Aarts (1993), "Siting Noxious Facilities: A Test of the Facility Siting Credo," *Risk Analysis* 13, 301-318.
- Lai, P.W., L.Y. Woo, K.C. Lam, W.Y. Lee and T. Fung (2007), "Siting Problems in Hong Kong," in Lai, P.W., L.Y. Woo, K.C. Lam, W.Y. Lee and T. Fung (2007), *Siting and Community Response to Locally Unwanted Land Uses: A Literature Review*. Centre for Environmental Policy and Resource Management, Department of Geography and Resource Management, The Chinese University of Hong Kong.
- McClelland, G.H. and W.D. Schulze (1991), "The Disparity Between Willingness-to-pay and Willingness-to-accept as a Framing Effect," In D.R. Brown and J.E.K. Smith (eds.), *Frontiers in Mathematical Psychology* (New York: Springer-Verlag).
- McDaniels, T.L., Mark S. Kamlet, and Gregory W. Fischer. 1992. Risk perception and the value of safety. *Risk Analysis* 12 (4): 495-503.
- McGlennon, J. (1983), "The Alberta Experience ... Hazardous Wastes? Maybe in My Backyard," *The Environmental Forum* 2, 23-25.
- O'Connor, R., R. Bord, and K. Pflugh, (1994), "The Two Faces of Environmentalism: Environmental Protection and Development on Cape May." *Coastal Management*. 22: 183-194.
- Office of Nuclear Waste Negotiator (1993), 1992 Annual Report to Congress, Office of the United States Nuclear Waste Negotiator, Boise ID, January 1993.
- O'Hare, M., L. Bacow, and D. Sanderson (1983), *Facility Siting and Public Opposition* (New York: Van Nostrand Reinhold).
- Rabe, B. (1991). Beyond the NIMBY Syndrome in Hazardous Waste Facility Siting: The Alberta Breakthrough and the Prospects for Cooperation in Canada and the United States *Governance* 4:184-206
- Slovic, P. (1997), "Perception of Risk," *Science* 236:280-285.