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Siting Noxious Facilities: A Test of the Facility Siting Credo

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Over the past decade it has become increasingly difficult to site noxious facilities, despite the fact that there is a growing need to do so. To address this problem, a set of guidelines for a fairer, wiser, and more workable siting process — the Facility Siting Credo — was developed during a National Facility Siting Workshop in 1990. This paper presents an empirical test of these guidelines. A questionnaire based on the Credo was completed by stakeholders in 29 waste facility siting cases, both successful and unsuccessful, across the United States and Canada. Using an independent determination of outcome (success), a preliminary ranking of the importance of various Credo principles was obtained. The data reveal that establishing trust between the developer and host community is an important factor in facilitating the siting process. The siting process is most likely to be successful when the community perceives the facility design to be appropriate and to satisfy its needs. Public participation also is seen to be an important process variable, particularly if it encourages a view that the facility best meets community needs. Moreover, a siting process where communities volunteer to host facilities is an approach that holds promise for meeting many of these key success criteria.

KEY WORDS: Siting; trust; public participation; fair procedures.

1. NATURE OF FACILITY SITING PROBLEM

Twenty-five years ago much less controversy would have been generated in siting a landfill, a chemical plant, or even a nuclear power plant. By 1980 the picture had changed dramatically. A national opinion poll taken that year found that over 95% of respondents would actively protest against siting a hazardous material facility near their home.(1) Today opposition to noxious facilities is likely to be even greater. A recent national survey revealed that 62% of respondents oppose placing a new landfill in their community.(2)[4]

The Environmental Protection Agency (EPA) estimated that between 50 and 125 new hazardous waste facilities (treatment, disposal, and incineration) would be needed during the 1980s.(5) However, a recent national survey showed that only six out of 81 applications between 1980 and 1987 resulted in operating facilities.(6) Of these six, one facility is an incinerator, one is a landfill that was recently closed, and the rest are treatment centers.(7)

The same problems currently exist for solid waste, where new disposal capacity will be needed, even with the most aggressive recycling goals. One only has to

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[4] This survey and another survey reported by Flynn(3) indicate that most residents are very concerned with having such facilities near their homes. See Kasperson, *et al.*(4) for a summary of the findings from these studies.

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turn to New York City which produces over 27,000 tons of municipal solid waste (MSW) per day and has only one dedicated landfill that handles 17,000 tons per day and is expected to reach capacity before the end of the century. According to one industry official, the time required to receive a permit for a solid waste landfill has increased threefold over the past 5 years, due, in large part, to increasing public awareness and environmental concern.[8]

A principal reason for the difficulty in siting these facilities is that procedures for making choices have commonly been viewed as unfair. In addition, the potential benefits are estimated to be low in relation to the costs and risks perceived by the public residing in or near the proposed site. During the past decade the public has gained substantial power in its ability to stop facilities that it does not want. Acronyms such as NIMBY (Not in My Backyard) and LULU (Locally Unwanted Land Use) are part of common parlance, and more recent additions include NIMTOF (Not In My Term of Office), BIYBYTIM (Better In Your Backyard Than In Mine), and even BANANA (Build Absolutely Nothing At All Near Anybody).

This paper sheds additional light on process and outcome considerations that are likely to be important in siting successes. A questionnaire was designed to determine the importance of different features of a Facility Siting Credo that emerged from a National Workshop on Facility Siting in 1990. Using data from interested parties involved in siting decisions, we examine the importance of different elements of the Facility Siting Credo against actual experience from 29 cases nationwide. The data suggest that it is important to design processes that involve the public, engender trust, and convince those directly affected by the site that the proposed facility is the best solution to the problem.

The next section highlights the importance of process and outcome considerations in siting noxious facilities, and presents three key features of the facility siting problem which influenced the development of the Facility Siting Credo. Section 3 illustrates each element of the Credo with specific examples. The nature of the survey of key stakeholders, including the sampling plan, definition of a siting outcome measure, and brief case studies of successful and unsuccessful siting experiences are presented in Section 4. Section 5 identifies factors associated with successful outcomes through statistical analysis of the questionnaire data. The concluding section suggests how process and outcome considerations can improve the chances of a successful siting experience.

2. PROCESS AND OUTCOME CONSIDERATIONS

The concepts of procedural and substantive rationality developed by Simon [9] for structuring choice under uncertainty are useful for formulating prescriptive guidelines for siting a noxious facility. *Procedural rationality* refers to the decision processes utilized by the different interested parties concerned with a particular problem, given inherent human limitations in collecting and processing information. *Substantive rationality* refers to the way an outcome is chosen from a set of alternatives. It focuses on the types of benefit–cost criteria that are utilized and how specific policy tools can facilitate the final outcome.

A large body of literature has emerged that recognizes the importance of both of these types of rationality in formulating siting strategies. Process considerations have been emphasized by a number of social scientists given the failure of the traditional Decide Announce Defend (DAD) approach to siting which was common through the 1970s.[10–14][5] This research points out that the DAD process has not worked in practice because it alienates many of the interested parties, including those who have veto power over the siting decision. There is general agreement across all these studies that one needs to involve the interested parties in siting discussions even if this requires more time and effort than the DAD approach.

Outcome-based approaches to siting have also been developed which involve the use of multi-attribute utility models to choose between alternative sites[15] and examine how compensation can play a role in encouraging communities or regions to accept a facility.[10,16] Today compensation or benefit-sharing is considered a legitimate policy tool for siting facilities. There is general agreement, however, that it should be introduced as a part of the process only after the affected public is convinced that appropriate mitigation and control measures will be in place so that the risk associated with the facility is considered to be acceptable.[17–19]

Although recent siting studies and analyses approach the problem from many different perspectives, there are several features that emerge from a review of the literature which played a key role in the development of the Facility Siting Credo.

[5] Under a DAD approach, the developer or contractor makes a unilateral series of choices on the type of facility and where to build it. These decisions are then publicly announced and are generally defended amidst conflict and opposition.[10]

2.1. Disagreement About Values and Goals

Stakeholders often disagree about the desirability of a proposed facility because they have different values. In a study of technological conflicts and disputes about risky technologies, von Winterfeldt and Edwards[20] point out that the debate between the relevant parties revolves primarily around value and moral issues where legitimate differences may exist. Should society develop technologies that we cannot fully control? The general public considers these issues to be of great concern but they have typically not been considered critical by the developer.

Each of the interested parties is likely to have its own goals and concerns with the proposed facility. Residents in the proximity of a proposed landfill or waste incinerator may be concerned about the impact of the facility on their future property values. The potential users of the facility may focus on the economic benefits of disposing of their future waste. Government regulatory agencies may focus on whether the facility meets safety standards and the developer wants to run a cost-effective operation that meets the letter of the law and makes profits.

Because of the wide range of potential impacts as well as the large uncertainty in predicting actual outcomes, each interested party collects its own data and uses its own experts to buttress its position and satisfy its objectives. With respect to the risks associated with the facility, there are likely to be significant discrepancies in the figures but often there are limited data to evaluate the accuracy of the estimates.

Such disagreements cause lines to be drawn that impede progress toward an acceptable solution. For example, efforts to site a highway in Atlanta were delayed for 24 years due to unresolved differences between the values and goals of different stakeholders and no acceptable procedure for bringing the parties together.[21]

2.2. Maintain the Status Quo

There is a tendency to cling to the status quo even if there may be attractive alternatives.[22] In the case of the proposed siting of a new facility, there will normally be strong objections by one or more groups unless all are convinced that there is a demonstrated need for the facility.

One reason that the status quo serves as a "reference point" for future actions is that the disutility induced by additional risks or losses is much larger than the utility induced by a comparable gain. This concept of loss aversion has been well documented in controlled experiments by Tversky and Kahneman.[23] In the context of siting decisions, Zeiss[24] provides evidence from five cases in Canada that residents are much more likely to be concerned with the potential negative impacts from a waste facility than they are to be attracted by the benefits of the same magnitude. This underscores the importance of undertaking preventive and mitigation measures for reducing the risks from any proposed facility before offering the community a benefits package to induce it to serve as a host site.

2.3. Lack of Trust

In recent years there has been a steady decline in the trust that the American public has placed in its scientists and institutions. Kasperson *et al.*[4] suggest that the NIMBY problem is due to a lack of confidence by the general public in scientists' ability to diagnose the relevant risks accurately. In fact, there is a growing concern by laypersons that the risks associated with new technologies may not be well understood so that there is little reason to trust the experts.[25] The different agendas of each of the interested parties in siting conflicts provides an additional reason why distrust exists.[26]

The lack of trust is exacerbated by the discovery of health hazards from facilities that are declared relatively safe. For example, recent reports on the increased risks to individuals who resided near the nuclear testing facilities in Nevada and the public health hazards from the Hanford nuclear facility in Washington state have exacerbated the problem. With respect to the siting of the high level nuclear waste repository in Nevada, there has been a loss of confidence by the public in the Department of Energy because of the absence of a trustworthy siting process.[27,28] One way to build trust between the public and technical experts is to relieve as many concerns as possible that the risk bearers and community have with respect to the safety of the facility.

3. THE FACILITY SITING CREDO

The three features discussed above pose challenges to developing effective siting procedures and are part of the reason it has been so difficult to make strides in solving this problem in theory or practice. The Facility Siting Credo is comprised of a set of guidelines designed to address these features and move toward a more work-

3.1.5. Consider a Competitive Siting Process

Assuming that several volunteer sites are found, facility sponsors should consider a competitive process of site selection. Potential host communities should propose benefit or incentive packages for later negotiation with sponsors. The advantage of having more than one site compete for the facility is that no particular community feels it has been singled out to house a facility. A lottery-auction mechanism which addresses equity as well as efficiency considerations associated with such a process has been proposed by Kunreuther and Portney.[31]

Example: Although Alberta, Canada did *not* actually have communities compete against each other for hosting a hazardous waste facility, the process was an open one. At an early stage, six communities expressed interest in hosting a facility, but eventually there were only two candidates. Swan Hills was chosen to site the facility because they did not have fierce opposition from the surrounding rural population. The other community, Ryley, placed a newspaper advertisement expressing the sentiment that they should have won.[32]

3.1.6. Set Realistic Timetables

It is helpful to set and enforce realistic siting deadlines. A good siting process allows all parties adequate time to consider the full range of options and weigh technical evidence as it is gathered. It may be necessary to "go slowly in order to go fast."

Example: In Camden County, New Jersey, a deadline of 8 weeks was issued by a judge to resolve the siting of a regional sewage facility through mediation. Realizing that this was not enough time to gain agreement from all parties, a realistic extension was granted and 39 communities came to an agreement with which they were satisfied.

3.1.7. Keep Multiple Options Open at All Times

It is never a good idea to have just one possible site for a facility, even at the final stage of the process. Negotiations regarding possible incentive packages are more likely to be reasonable if a host community does not feel "held hostage" by being the only place to be considered to house the facility.

Example: In the process of siting a toxic waste landfill in Blainville, Quebec (Canada), the developer requested simultaneous permits in two localities, which prevented the citizens from feeling "singled out." This approach facilitated acceptance of the proposal.[33]

3.2. Desired Outcomes

3.2.1. Achieve Agreement That the Status Quo Is Unacceptable

A siting process must begin with agreement that a facility is needed. The relevant parties need to understand the consequences of doing nothing — not just now, but in the future as well. Those who advocate building new facilities should be precise about the nature and scope of the problem that will result if the facility is NOT built.

Example: Through extensive public education and outreach efforts, residents of Indianapolis, Indiana came to understand that not having a facility to handle solid waste (in other words, maintaining the status quo) would "violate the community's responsibility to guarantee a healthy environment for its citizens".[34]

3.2.2. Choose the Solution That Best Addresses the Problem

A comprehensive list of alternative siting approaches and their long- and short-term implications — including the option of taking no action — should be made public in non-technical language. Communities or states are more likely to volunteer to be a host if they perceive their area to be the most appropriate choice based on technical and risk considerations. The choice of technology should be based on input from community residents who may well know more about the problem "on the ground" than many of the experts.

Example: In Minneapolis, Minnesota, incineration was proposed as the best means of addressing the long-term solid waste needs for the county. The plan was communicated widely to the public, discussed in public forums, and approved by a county board over a 4-year period. As a result of these actions, 93% of those polled in a survey supported the government's plan for an incinerator.[35]

3.2.3. Guarantee That Stringent Safety Standards Will Be Met

No community should be asked to compromise its basic health or safety by building a facility. The pro-

posed facility must meet all health, safety, and environmental standards. Interested parties should have an opportunity to propose additional standards that can be met through mitigation, such as changes in facility design, substitute technologies, operation modifications, and training of operators. Monitoring and control procedures for mitigating future risks and maintaining standards should involve the host community.

Example: In Leominster, Massachusetts, a polystyrene recycling facility was sited successfully after the manufacturer negotiated with the community. Together with the community, the firm decided to eliminate many features of the original facility plan in order to meet stringent safety standards acceptable to the host community.[36]

3.2.4. Fully Address All Negative Aspects of the Facility

Various forms of compensation or benefit-sharing agreements — specified by the stakeholders involved — can be negotiated to mitigate potential negative economic impacts of the facility. These arrangements include property value guarantees, creation of equivalent habitats when loss is unavoidable, and the guarantee of continued service (such as water supplies) if contamination occurs. A negotiated schedule of contingent compensation payments for any harmful effects should be described in a written siting agreement.

Example: Before siting a paper sludge landfill in Hamilton, Ohio, Champion International implemented a program to protect owners of property within two miles of the facility from any loss in resale value. Each property was appraised by two independent appraisers, one chosen by the owner and the other by Champion.[37]

3.2.5. Make the Host Community Better Off

A package of benefits should be proposed by the applicant so that the host community feels that it is better off with the facility than without it. These benefits could be in the form of grants to make long-sought-after neighborhood improvements, property tax reductions, and/or promises not to site other LULUs in the same area.

Example: In Charles City, Virginia, the developer of a landfill — Chambers Development, Inc. — collects a tipping fee which it pays 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. In addition, the operator collects the county's garbage free of charge and pays for environmental monitoring at the landfill.[30]

3.2.6. Use Contingent Agreements

Concerns about the management of facilities can be resolved by using contingent agreements that spell out in writing what will be done in case of accidents, interruptions of service, changes in standards, or the emergence of new scientific information about risks or impacts. Such agreements should specify the conditions under which the facility must be shut down temporarily or permanently. They should also describe the triggers for action, responsibilities for taking action, and provide means of guaranteeing that contingent promises will be met at no cost to those likely to be adversely affected.

Example: In Idaho, Wes-Con, Inc. was able to convert abandoned Titan missile silos into small waste-disposal facilities with no local opposition because the state was given the power to shut down the operation should the risks of operating these facilities prove too high.[10]

3.2.7. Work for Geographic Fairness

Geographic fairness ought to be a siting goal unto itself for purposes of equity. It is inappropriate to locate too many noxious facilities in a single locale even if a community is willing to accept them. The principle of geographic fairness argues for siting several smaller facilities to distribute impacts more evenly rather than building a single large facility.

Example: New York City recently approved new "Fair Share Criteria" for the location of city facilities that emphasize geographic distribution of sites.[38] These criteria enlist community support from the beginning and require the sponsoring agency to address geographic fairness considerations. These criteria are now being used in the siting of homeless shelters and sewage sludge facilities.[39]

4. A SURVEY OF KEY INTERESTED PARTIES INVOLVED IN SITING CASES

This section describes the nature of the sampling plan, definition of key variables, and specific case studies based on the survey data. The next section presents a statistical analysis of the factors influencing outcomes of siting efforts. To our knowledge, this is the first attempt to survey interested parties systematically, who

were involved in a large number of siting efforts in order to characterize success or failure by using a formal set of principles.[6]

A questionnaire addressed the different elements of the Credo so their relative importance could be determined in the context of different siting cases. In addition, the survey gathered information on the current status of the facility. With this information, we were able to construct an independent measure of what constitutes a siting success.

4.1. Sampling Plan

To evaluate the Credo, a questionnaire was mailed to 281 individuals identified by experts across the country as having been actively involved in the siting of landfills, incinerators, or processing facilities for hazardous or solid waste.[7] To maintain anonymity and increase the likelihood of a response, individuals were not required to identify themselves or the specific siting case in which they were involved. Those who were interested in receiving the survey results independently returned a postcard with their name and address. One follow-up postcard was mailed and up to two phone calls were placed to all individuals who did not return a postcard requesting the survey results.

Completed surveys were received from 150 respondents — a 53% response rate. We obtained sufficient information from 104 of these respondents to identify the siting case with which they were associated.[8] Since the siting cases with which the remaining 46 individuals were associated could not be determined, they are not included in the analysis below. Cross-tabulations by respondent characteristics indicated that there is *no* systematic exclusion of any particular group or affiliation from the analysis. For example, the 104 individuals included in the analysis are no more or less likely to be developers, government officials, or members of environmental groups than the 46 individuals excluded from the analysis. If respondent characteristics are any guide, there appears to be *no* measurable selection bias introduced by using only the 104 identified respondents in the analysis.

Table I provides a summary of the 29 siting cases with which the 104 individuals were associated. Of the 29 cases in the study, 10 facilities are operating, seven were canceled or are on hold, three have received a permit for construction, and nine are still in the process of being sited.

4.2. A Siting Outcome Measure

In analyzing data from the survey, it is necessary to define the outcome of a siting process for each case. The simplest way is to consider the process a "success" if the facility is sited; otherwise, it is considered a "failure." But this dichotomy does not enable one to differentiate between facilities that are still in the process of being sited. Furthermore, this measure does not differentiate between two sited facilities — one that is supported strongly by the public, and another that is permitted and operating but where a substantial portion of the host and surrounding communities are opposed to it.

The measure of success utilized in this paper (OUTCOME) takes into account the degree of controversy surrounding the facility. We interpret the extent of controversy in a siting process as a signal of the degree of community contentment. Specifically, the outcome measure for each siting case in our sample ranges from 0 (outright failure) to 1 (operating facility with minimal or no controversy). In the 9 cases that were still in the process of being sited, respondents were asked to assess the chances that the facility would eventually be approved (on a scale from 0–100%). OUTCOME is computed for each respondent as a function of current project status, the respondent's assessment of the chances that a site will be selected (for early siting efforts), and the respondent's assessment of the degree of controversy over the facility.

Each respondent was asked to assess the level of controversy surrounding the case in question on a scale of 1 (no controversy) to 7 (intense controversy). The simple penalty function we have chosen to operationalize

[6] There have been a number of surveys over the years on factors which are important in the siting process (e.g., Refs. 6,14,24). However, none of these studies asked respondents to characterize the nature of the siting process using a set of factors such as those posed in the Credo.

[7] This nonrandom sample was generated with the following two-step procedure: First, master lists were generated from national organizations and agencies (e.g., EPA Solid Waste Division), conference lists, and recognized siting experts; in most cases, a contact was identified for each particular case. Second, the key contact was telephoned and after some simple screening questions about obtaining access to stakeholders and nature of the outcome, a request was made for the names and addresses of as many stakeholders as possible: project developers, regulators, government officials, mediators, concerned citizens, and members of environmental groups.

[8] Seventy-three respondents identified the siting case by either naming a principal agency or project developer that was unique to a particular siting case or by writing extensive notes. Thirty-one of the remaining questionnaires were matched to particular cases that had the same facility type, the identical organization that proposed the facility, date the facility was first proposed, and current status.

Table I. Siting Cases and Respondents/Case in the Sample

Siting case	*Facility*	*Status*	*Valid responses*
Auburn, AL	Solid waste landfill	Operating	1
Swan Hills, Alberta	Integrated hazardous waste facility	Operating	2
Maricopa County, AZ	Northwest Regional Solid Waste Landfill	Operating	2
Maricopa County, AZ	Southwest Regional Solid Waste Landfill	Pre-site	3
Mobile, AZ (Ensco)	Hazardous waste incinerator/landfill	Permit issued	7
Los Angeles Basin, CA (CTTS)	Hazardous waste incinerator	Permit issued	4
Newberry Springs, CA (HVR)	Hazardous waste residuals landfill	Tentative site selected	5
San Bernardino County, CA (BKK)	Hazardous waste residuals landfill	Tentative site selected	3
California State	Low Level RadWaste facility	Tentative site selected	1
Jasper, FL	Medical waste incinerator	Tentative site selected	2
Indianapolis, IN	Waste to energy facility	Operating	2
Ashland, KS	Medical waste incinerator	Canceled	2
Greenup County, KY (Addington Resources)	Solid waste landfill	Built, but not operating	1
Louisville, KY (Cecos)	Hazardous waste incinerator	Canceled	1
Louisa County, KY (Pyrochem)	Hazardous waste incinerator	Canceled	1
Braintree, MA (Clean Harbors)	Hazardous waste incinerator	Canceled	12
Detroit, MI (CEI)	Hazardous waste incinerator	Operating	6
Minneapolis, MN	Solid waste incinerator	Operating	4
Kearney, NE	Solid waste landfill expansion	Operating	2
Lincoln, NE	Solid waste landfill	Operating	5
New York City	Resource Recovery facility	Site approved	1
New York State	Low Level RadWaste facility	Pre-site	3
Gainesville, TX	Regional solid waste landfill	Pre-site	2
Sherman, TX	Highway 69 Landfill	Canceled	6
Lind, WA (Ecos)	Hazardous waste incinerator	Tentative site selected	16
East Troy, WI	Solid waste landfill	Operating	2
East Troy, WI	Solid waste landfill expansion	Tentative site selected	2
Neenah, WI	Solid waste landfill	Operating	4
Guernsey, WY	State solid waste landfill	Canceled	2

controversy is shown in Fig. 1. Low levels of controversy receive no penalty ($\beta = 0$). Higher levels of controversy are penalized linearly with the most significant penalty of $\beta = 0.5$ for a very controversial case.

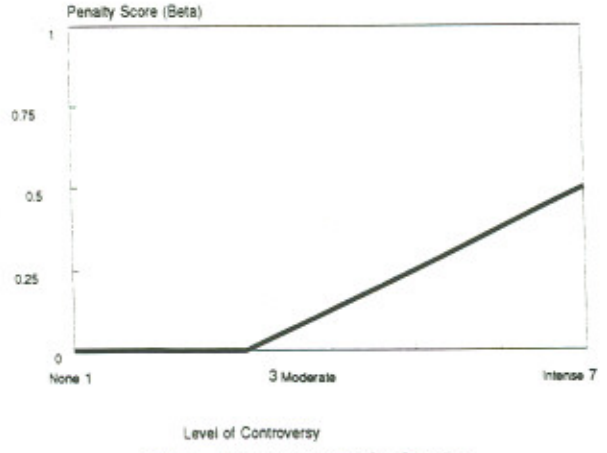

Fig. 1. Controversy penalty function.

Siting proposals that have been canceled or are indefinitely on hold are assigned an OUTCOME score of zero.[9] Those that have been sited, built, and are operating or have been granted a permit to begin construction are assigned an OUTCOME score of $1 \times (1 - \beta)$. In siting cases still early in the process of site selection (where no permit has been issued), OUTCOME is determined by multiplying the chances of success (as estimated by each respondent) by $(1 - \beta)$.[10] The value of OUTCOME used for each siting case is the *mean* of

[9] It is, of course, possible that a canceled facility could be seen as a success because it was an inappropriate proposal from the outset.

[10] Due to collinearity between independent variables (see Table II), the statistical results presented in Section 5 are sensitive to the curvature and severity of the controversy penalty function. However, the set of process characteristics that explain a significant amount of variation in outcomes does not change over a wide range of controversy penalty functions.

OUTCOME for all valid respondents associated with the case.

4.3. Key Variables Operationalizing the Credo Principles

Section 2 of the questionnaire contained 25 questions about the siting process — each of which corresponds roughly to one or more of the Credo principles. For example, two Credo principles classified as procedural steps, "Institute a Broad Based Participatory Process" and "Seek Consensus" are operationalized by a number of questions including: "Were *facility supporters* effective in making public participation part of the siting process?" (PUBPART), "Did most of the *host community* feel that the facility design was appropriate?"(DESIGN), and "Did the *facility developer* maintain a visible presence in the host community?" (PRESENCE).

Following Easterling,[40] we chose to operationalize another Goal, "Work to Develop Trust," by creating a new variable, MINTRUST, whose value is the minimum level of trust achieved between the project developer and the host or neighboring communities.[11] As a final example, a Credo principle, "Choose the Solution that Best Addresses the Problem," is measured directly by responses to the question "Did the *host community* feel that the facility was the best solution to their waste problem?" (BESTFAC).

Responses to all of the variables associated with Credo principles are coded on a scale of 1–7 (in general, 1 = strongly disagree and 7 = strongly agree). The actual wording and coding of each question is presented in the Appendix. As with the OUTCOME measure defined above, the values of the variables used in the analysis represent the average response from all individuals associated with each of the 29 cases.

4.4. Brief Case Histories

To indicate some of the variation across siting cases in the sample, brief histories for four cases are presented below. For each case we also present a profile of the mean responses to key variables.

4.4.1. Successful Siting Processes

MARICOPA COUNTY, AZ. Facility: Regional Solid Waste Landfill — Operating. Initiated By: Public Process. Timeframe: February 1984–December 1988. Key Illustrative Variables: Trust, Public Participation.

In 1984, a privately owned, 100-acre solid waste landfill operation located within the city limits of El Mirage, a small municipality in the northwest quadrant of Maricopa County, was facing closure. While citizens accepted the need for a regional landfill, concern over where it would be located was high. During its initial efforts, every site under consideration by Maricopa County met substantial public opposition. Key participants supported the concept of public involvement as a positive and constructive process. A citizen advisory committee was formed with broad representation from local municipalities, area residents, the farming community, and other interested parties. Over the course of a 2-year period, public officials reached consensus with the citizens on many controversial issues. The 5-year process with extensive public outreach and participation resulted in the successful siting of the Northwest Regional Landfill designed for a 50 year life.[29]

MINNEAPOLIS, MN. Facility: Solid Waste Incinerator — Operating. Initiator: Public. Timeframe: 1980–1989. Key Illustrative Variables: Best Solution, Public Participation.

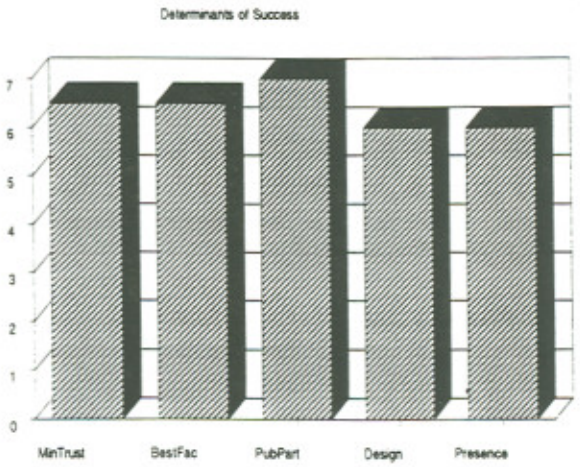

Fig. 2. Maricopa, Arizona.

[11] MINTRUST is the minimum value of the following two questions, "Did the *host community* seem to trust the facility supporters during the siting process?" and "Did the *surrounding neighborhood* seem to trust the facility supporters during the siting process?" The rationale for using MINTRUST as an explanatory variable to explain siting outcomes is that as the level of trust between the project developer and the least satisfied stakeholder group decreases, the more likely this group is to affect outcomes by attempting to block the project.

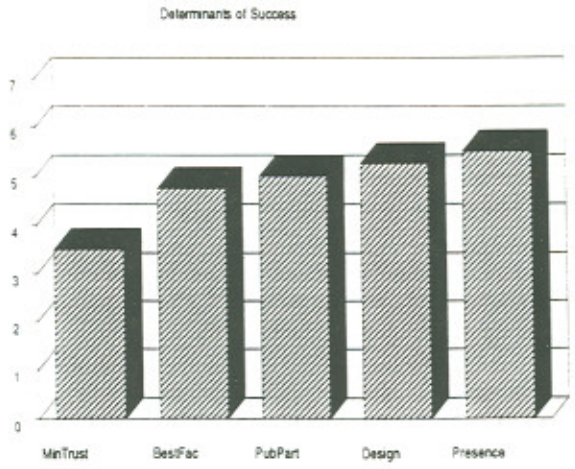

Fig. 3. Minneapolis, Minnesota.

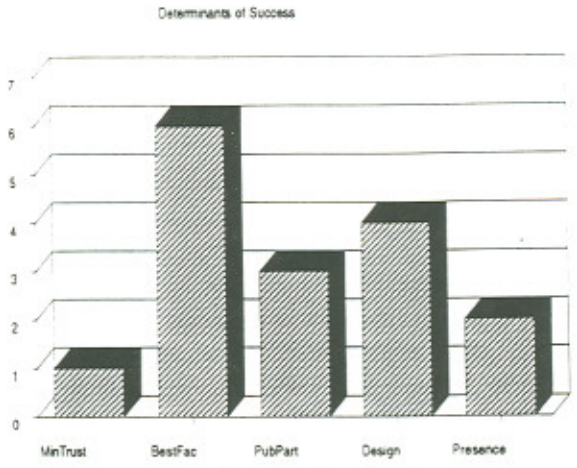

Fig. 4. Brooklyn Navy Yard.

In 1980, the Minnesota legislature passed a Waste Management Act. In April 1981, after a series of studies on Mass Burn vs. Refuse Derived Fuel alternatives, a county consultant recommended a waste-to-energy plant to be built in Hennepin County.

The public was kept informed through excellent communication by the Hennepin County Department of Environment and Energy (through newsletters and announcements, etc.). A survey conducted in 1985 by a university research center showed wide support for the facility. Persons were asked if they supported county government plans to burn garbage, and 93% responded that they did. These results were made public.

There were open public meetings and the site was approved in mid-1985, completed in 1988, and started operating in October, 1989.[35]

4.4.2. Unsuccessful Siting Processes

BROOKLYN, NY (Navy Yard). Solid Waste Incinerator — Site Approved. Initiator: Public and Private. Timeframe: 1977–1992. Key Illustrative Variables: Lack of Trust, Lack of Public Participation.

Despite the fact that the New York City Council finally approved a solid waste incinerator at the Brooklyn Navy Yard in August 1992, we feel the siting process left much to be desired and hence have classified it as unsuccessful.

New York City began the search for a solid waste facility in 1977, and after evaluating 14 possible locations concluded that the Brooklyn Navy Yard offered the best potential. In October 1980, the city agreed that an incinerator could be constructed at the Brooklyn Navy Yard but permit applications were only issued in 1985.

There was limited public participation in the siting process and substantial opposition from residents near the proposed facility, 15,000 of whom marched over the Brooklyn Bridge to protest the incinerator. In 1986 the New York Public Interest Research Group (NYPIRG) released a report entitled "The Burning Question," a 200-page critique of the Brooklyn Navy yard incinerator.

The principal reason that the facility was finally approved despite strong opposition from the Brooklyn City Council members was that garbage was piling up so that the default option of not having a new facility was viewed by Mayor David Dinkins and a majority of the Council members as being untenable. The approval of the incinerator came primarily because it was accompanied by a program that calls for a vast increase in recycling by all city dwellers. The facility still requires approval by New York State regulatory authorities.[41]

BRAINTREE, MA. Hazardous Waste Incinerator— Canceled before construction, 1990. Initiator: Private through State Program. Timeframe: 1987–1990. Key Illustrative Variables: Lack of Trust, Lack of Best Solution, Lack of Public Participation.

In April 1987, Clean Harbors began its second attempt to site a hazardous waste treatment facility in Massachusetts by submitting a proposal for a $42 million incinerator with the capacity to process 45,000 tons of hazardous waste annually. The site was located in Brain-

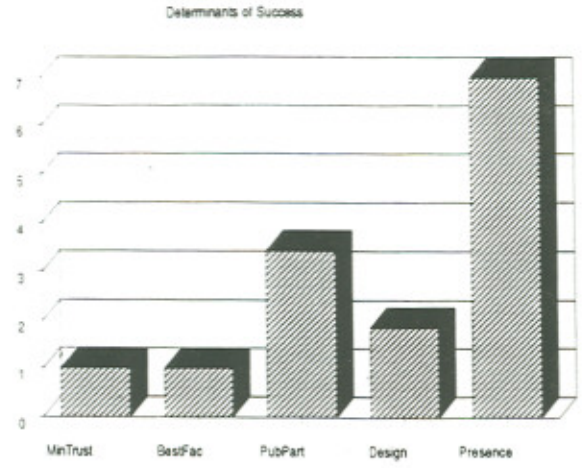

Fig. 5. Clean Harbors–Braintree, Massachusetts.

tree, a densely populated area with 200,000 people living within a 5-mile radius of the proposed site. Three months before Clean Harbors submitted its proposal, the state environmental department suspended Clean Harbor's license and imposed a fine of $112,000 for violations of conditions at another facility in Kingston, Massachusetts. This incident contributed to citizen opposition upon the submission of the Braintree proposal. Well-attended public demonstrations followed, and before the siting case was over separate Local Assessment Committees had formed in three surrounding communities: Braintree, Quincy, and Weymouth, spending well over $700,000 in their investigations. The Department of Environmental Protection (DEP) recommended against approval of the facility in the fall of 1990, noting that an insufficient buffer zone around the site and a potential for accidents along truck routes to the site created unacceptable health risks to the large surrounding population.[42]

4.4.3. Summary of Siting Cases

The level of trust was extraordinarily low in the two unsuccessful cases. There was little formal public participation in the Brooklyn Navy Yard process and the developer did not maintain a high profile; in Braintree, there was no agreement that the facility was the best solution to the problem of disposing of hazardous waste. The two successful cases had a high level of trust between the interested parties. In both Maricopa County and Minneapolis, the public was actively involved in the process which helped generate strong support for the proposed facility in each locality.

5. STATISTICAL ANALYSIS OF SURVEY DATA

This section presents a statistical analysis of the survey data in two stages. The first stage examines which elements of the Credo are significantly correlated with OUTCOME. To the extent that these variables are associated with Credo principles, these results provide empirical grounding to the Credo guidelines for building effective siting strategies. Moreover, this approach gives a preliminary ranking of Credo principles in terms of association with successful siting outcomes. In the second stage, a simple multivariate model is built to test the independent effects of the most significant explanatory variables in explaining OUTCOME.

5.1. Factors Influencing Siting Outcomes

Table II depicts the most significant correlations between OUTCOME and variables that operationalize Credo elements for the 29 cases in our sample. With the exception of PRESENCE, only variables that are highly correlated with OUTCOME are included in this table.[12] A measure of trust (MINTRUST) and a measure of confidence in the lead facility supporter group (SUPPORTER) are significant. A number of process characteristics that measure the degree of consensus seeking and the importance of getting agreement with the community are significant: The level of public participation in the siting process (PUBPART); the perception that the facility design is appropriate (DESIGN); facility supporters gained general agreement with the host community for selecting a site (AGREESITE); and facility developers were open with information (OPENINFO). This reaffirms the importance of establishing trust between the different parties and the need to have the public involved in the siting process, factors that have not been considered as important to successful siting in many past efforts. Finally, two measures of broad community sentiment carry significant weight: the status quo is worse than having the facility (NEEDHOST) and the proposed facility provides the best solution to the community's waste problem (BESTFAC).

The high collinearity between characteristics of the siting process in Table II is worthy of note. PUBPART

[12] PRESENCE is also included since it is significant in the multivariate model.

Table II. Correlations Between OUTCOME and Key Variables[a]

	OUTCOME	*MINTRUST*	*BESTFAC*	*PUBPART*	*DESIGN*	*PRESENCE*
OUTCOME	1.0000					
MINTRUST	.5073 (.002)	1.0000				
BESTFAC	.6618 (.000)	.5201 (.002)	1.0000			
PUBPART	.6589 (.000)	.8438 (.000)	.6764 (.000)	1.0000		
DESIGN	.7331 (.000)	.7354 (.000)	.8126 (.000)	.8311 (.001)	1.0000	
PRESENCE	.3721 (.023)	.3497 (.031)	.1089 (.287)	.1887 (.163)	.2619 (.085)	1.0000
AGREESITE	.6869 (.000)	.7981 (.000)	.8444 (.000)	.8422 (.000)	.9394 (.000)	.2592 (.087)
SUPPORTER	.6261 (.000)	.7043 (.000)	.6539 (.000)	.8988 (.000)	.7399 (.000)	.1480 (.222)
NEEDHOST	.5986 (.000)	.5801 (.000)	.9069 (.000)	.7098 (.000)	.8157 (.000)	.0524 (.394)
OPENINFO	.5086 (.002)	.4813 (.004)	.4167 (.012)	.4748 (.005)	.5498 (.001)	.5887 (.000)

[a] *P*-values (reported in parentheses) are 1-tailed significance levels. All correlations are based on 29 cases. Only variables correlated with OUTCOME at $p \leq .002$ are included in this table (with the exception of PRESENCE).

and DESIGN are highly correlated with the level of trust built between the lead project supporter and the community (MINTRUST). In fact, DESIGN is highly correlated with *every* other process characteristic that is significantly correlated with OUTCOME. This collinearity plays an important role in determining the final form of the simple multivariate model below.

The three highest correlation coefficients in Table II are between BESTFAC and NEEDHOST, PUBPART and SUPPORTER, and DESIGN and AGREESITE. There is a story that goes with each of these pairings.

- When the host community feels that the facility design is appropriate (DESIGN), an agreement on a site is usally forthcoming (AGREESITE).
- The perception in the host community that the facility is better than the status quo (NEEDHOST) tends to be formed in conjunction with the belief that the facility presents the best solution for the host community's waste problem (BESTFAC).
- Where the lead facility supporter is effective in making public participation part of the siting process (PUBPART), the host community appears to build a high degree of confidence in the supporter (SUPPORTER).

5.2. Multivariate Analysis of Survey Data

To gain more insight into the *independent effects* of different factors influencing siting outcomes, OUTCOME was regressed on the credo variables for 29 siting cases. Given the importance that MINTRUST appears to play in the siting process, we were interested in examining its relationship to OUTCOME when it was combined with other variables. A series of ordinary least squares (OLS) regressions were run to determine which variables measuring case characteristics were best able to predict the degree of success of the siting process.

Table III depicts the results of a three-stage scenario. In Stage 1, MINTRUST is treated as the only variable which explains OUTCOME. It is statistically significant (t-ratio = 3.06) and can explain 23% of the variance in siting outcomes (i.e., $R^2 = .23$). When other

Table III. OLS Regression of OUTCOME on Measures of Trust and Need[a]

	Stage 1	*Stage 2*	*Stage 3*
MINTRUST	.09 (3.06)		
DESIGN		.13 (5.60)	
BESTFAC			.06 (2.34)
PUBPART			.06 (1.89)
PRESENCE			.05 (2.03)
Constant	.23 (2.41)	−.06 (−.55)	−.28 (−1.75)
Adjusted R^2	.23	.52	.54

[a] Figures in parentheses are *t*-statistics.

variables are entered into the equation MINTRUST becomes insignificant.

The model in Stage 2 includes only DESIGN, the single most significant explanatory variable in the data set. DESIGN alone is highly significant and explains 52% of the variation in OUTCOME. This stage in the scenario suggests that when the facility supporter designs the facility in accord with community preferences, the chance of a successful outcome is greatly enhanced. When DESIGN is in the equation, no other process characteristics can be added to significantly explain more variation in OUTCOME.[13] This is due to the high collinearity between DESIGN and the other process variables noted above.

Stage 3 reveals the power of other process characteristics to explain siting outcomes, independent of DESIGN. The model in Stage 3 explains 54% of the variance in OUTCOME and is the multivariate model which best fits the data when DESIGN is not included. BESTFAC, PUBPART, and PRESENCE are all significant at the 5% level.[14] It is not very surprising that BESTFAC (the facility was seen as the best solution to the host community's waste problem) is in the model since it is a closely related concept to design.

[13] Stage 2 is the model selected by a stepwise regression as a best fit to the data. A more severe penalty on controversy (used to derive the OUTCOME measure) would serve to reduce the significance of DESIGN relative to the three variables entered in Stage 3. Using a penalty function that is more severe than that depicted in Fig. 1 (i.e., one that rises linearly from $\beta = 0$ at controversy = 2 to $\beta = 0.75$ at controversy = 7) results in a stepwise regression selecting the model of Stage 3 as a best fit to the data.

[14] Since we expect coefficients to be positive, a one-tailed test statistic is appropriate. The 5% significance level for a one-tailed *t*-test statistic with 25 degrees of freedom is 1.71.

5.3. Discussion of Results

A participatory process appears to be an important ingredient for siting success. If there is a feeling that the supporters were effective in encouraging public participation, then the community will be much more responsive to hosting the facility than if residents were not involved. Moreover, if the public can effectively participate in siting and design decisions, a visible presence in the community by the facility developer raises the chances of a successful outcome considerably. Although MINTRUST is not part of the Stage 3 model, active public involvement is likely to engender trust. Note that if a facility developer is visible in the community, but members of the community do not feel they have the opportunity to participate adequately in the design process, the siting efforts may backfire as did the Clean Harbors proposal at Braintree, MA summarized in Section 4.4.

One tentative conclusion that we can draw from Stage 3 is that public participation influences outcomes directly, without necessarily operating through an intervening construct such as trust between facility supporters and stakeholders. In other words, a siting process that encourages public participation and contributes to the formation of a view that the facility best meets community needs, explains siting outcomes, whether or not the interested parties trust the facility supporters.

6. CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The Facility Siting Credo is an attempt to codify some of the key ingredients required to successfully site facilities. It emphasizes the importance of both process and outcome characteristics in overcoming the natural resistance by individuals and communities to change the status quo. The survey of different interested parties in 29 communities is a first step in gaining insight as to what factors are viewed as significant in influencing the final outcome of the siting process.

The findings support the view of Easterling[40] that communities will be much more willing to host a facility if they agree that the facility design is appropriate and they believe that it is the best solution to the particular problem which they face. The data also suggest that the more involved the public is in the process, the more

likely that they will accept a facility if it meets other concerns. These data are based on a relatively small and nonrandom sample of cases, so they should be viewed as suggestive. It would be useful to expand the set of case studies to determine whether the findings can be generalized to other situations.

The survey responses do suggest that participatory siting procedures may stand a far better chance of success than the Decide Announce Defend (DAD) approach or legislated siting procedures. Legislated siting procedures generally involve formal negotiations between the various parties with a direct interest in a proposed facility. This procedure requires the proposed host community to prove that the facility should *not* be sited there.

A participatory procedure by definition satisfies the factors that appear to be most important in increasing the chance that a facility will be successfully sited. Any community will normally decide to host a facility if the residents perceive it to be the best solution to their problem. This implies that communities will not even consider entering into a siting process unless they are assured and believe that the facility design is appropriate (i.e., it will operate safely). For the community to agree to consider a site, community members would have to be actively involved in the process. It also means that the package of benefits that they would receive would outweigh the costs.

Ideally, the potential benefits will be attractive enough so that several communities will each make offers to host the facility. This voluntary approach has been successfully employed to site hazardous waste facilities in the province of Alberta, Canada.[43] It is also being utilized by Browning Ferris Industries (BFI) to find volunteer communities for solid waste facilities in New York State. Although it is still early in the process, considerable success has been achieved by BFI by using a voluntary siting model.[15] In fact, as pointed out earlier, Eagle, New York voted by referendum in August 1992 to invite BFI into their community to select a site and to negotiate an agreement.[8]

A voluntary approach is also being utilized to locate a monitored retrievable storage facility for temporarily storing commercial spent fuel as high level radioactive waste under the assumption that a permanent repository may be built at Yucca Mountain, Nevada.[44] David Leroy, the U.S. Nuclear Waste Negotiator, states that the DOE has provided preliminary study grants of $100,000 and subsequent study funds of up to $3,000,000 to communities expressing a serious interest in exploring the possibility of hosting an MRS facility. The acceptance of a grant does not imply a commitment to accept an MRS facility. The prospective host can terminate the process at any time. As of April 1993, initial planning grants had been made to 20 communities or Indian tribes. Nine Indian tribes have expressed sufficient interest that they are now undertaking more detailed Phase II evaluations of the proposed MRS facility.

Ultimately, the success of a siting process depends on finding ways to deal with different values and goals of the key stakeholders, overcome a tendency to maintain the status quo as well as address the mistrust that pervades siting issues. These three key features of the siting process provide the greatest challenge in moving communities from a NIMBY stance to a YIMBY (Yes In My Backyard) position.

[15] For the 29 siting cases in the survey, only eight proponents solicited volunteers. This factor by itself was not significantly correlated with the OUTCOME measure.

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APPENDIX: SURVEY QUESTIONS AND CONSTRUCTED VARIABLES FOR ANALYSIS

Institute a Broad-Based Participatory Process
Seek Concensus

#	Name	Question
L2.1	PUBPART	Were *facility supporters* effective in making public participation part of the siting process? 1 Not at all effective 7 Extremely effective
L2.2	AGREESITE	Did *facility supporters* gain general agreement with host community for selecting a site? 1 No agreement 7 Complete agreement
L2.5	PRESENTDESIGN	Did the *facility developer* present a comprehensive facility design to the host community? 1 No design presented 7 Complete design presented
L2.6	DESIGN	Did most of the *host community* feel that the facility design was appropriate? 1 Widely considered inappropriate 7 Widely considered appropriate
L2.7	PRESENCE	Did the *facility developer* maintain a visible present in the host community? 1 Not at all visible 7 Highly visible
L2.8	OPENINFO	Were *facility developers* open with information? 1 Not at all open 7 Extremely open

Work to Develop Trust

L2.3		Did the *host community* seem to trust the facility supporters during the siting process? 1 No trust developed 7 Complete trust developed
L2.4		Did the *surrounding neighborhood* seem to trust the facility supporters during the siting process? 1 No trust developed 7 Complete trust developed

MINTRUST is the minimum level of trust in the project supporters by either the host community (L2.3) or the neighborhood (L2.4).

L2.15		Indicate the degree of confidence that you have had in the *most visible public* agency. 1 No confidence 7 Very high confidence
L2.16		Indicate the degree to which you think this agency was/is committed to protecting the public's health and safety in siting this facility. 1 No commitment 7 Very high commitment
L2.17		How competent do you think this agency was/is handling the technical issues of siting this facility? 1 Incompetent 7 Competent
L2.18		How competent do you think this agency was/is in ensuring that the facility will be operated safely? 1 Incompetent 7 Competent
L2.19		Indicate the degree of confidence that you have had/have in the *lead facility supporter group.* 1 No confidence 7 Very high confidence
L2.20		Indicate the degree of commitment that you think this group had in protecting the public's health and safety in siting this facility. 1 No commitment 7 Very high commitment
L2.21		How competent do you think this group was/is in handling the technical issues of this facility? 1 Incompetent 7 Highly competent
L2.22		How competent do you think this group was/is in ensuring that the facility will operate safely once built? 1 Incompetent 7 Highly competent

AGENCY and SUPPORTER are principal component combinations of questions measuring the degree of public confidence in the most visible public agency and the lead facility supporter group (L2.15, L2.16, L2.17, and L2.18 for public agency; L2.19, L2.20, L2.21, and L2.22 for lead supporter). Responses to each set of questions were highly collinear across the sample.

Achieve Agreement that the Status Quo Is Unacceptable and Make the Host Community Better Off

L2.9 Did the *host community* feel that the status quo (no facility) would be worse than having the facility?
1 Status quo much worse 7 Status quo much better

L2.10 Did the *surrounding neighborhoods* feel that the status quo (no facility) would be worse than having the facility?
1 Status quo much worse 7 Status quo much better

NEEDHOST and NEEDNEIGHBOR are recoded measures of need for the facility by the host community (L2.9) and by the neighborhood (L2.10). In the questionnaire, L2.9 and L2.10 were coded such that a *low* score indicated that the status quo was much worse than the facility (and so the facility was highly needed). NEEDHOST and NEEDNEIGHBOR have been recoded such that a low score indicates little need for the facility and a high score indicates high need.

Choose the Solution That Best Addresses the Problem

L2.11 BESTFAC Did the *host community* feel that the facility was the best solution to their waste problem?
1 Facility was not the best solution 7 Facility was the best solution

Seek Acceptable Sites Through a Volunteer Process

L2.12 VOLUNTEER Did the *facility supporters* solicit volunteer sites to host the facility?
0 No 1 Yes

Consider a Competitive Siting Process

L2.14 COMPETITIVE Did *Facility supporters* institute some form of competition among potential host communities to determine the host site?
0 No 1 Yes

Work for Geographic Fairness and Keep Multiple Options Open at All Times

L2.13 MULTIPLELOC Did *facility supporters* consider multiple locations in the process of site selection?
0 No 1 Yes

Set Realistic Timetables

L2.23 SCHEDULE Did facility supporters and the host community agree on firm deadlines for various steps in the siting process?
0 No 1 Yes

Use Contingent Agreements

L2.24 CONTRACT Was (will) some form of formal siting contract or agreement (be) signed between the developer and the local community?
0 No 1 Yes

Guarantee that Stringent Safety Standards Will Be Met and Fully Address All Negative Aspects of the Facility

L2.25 MONITOR Was (will) the host community (be) provided with an opportunity to monitor facility operations regularly?
0 No 1 Yes