Development, H. Smith and D. Grierson, Eds. (Blackwell, Oxford, 1981).
36. H. J. Klee, personal communication.
37. _____ and V. Iyer, personal communication.
38. H. J. Klee, M. P. Gordon, E. W. Nester, *J. Bacteriol*, in press.
39. B. P. Koekman, P. J. J. Hooykaas, R. A. Schilperoort, *Plasmid* **4**, 184 (1980).
40. A. G. Matthysse, P. M. Wyman, K. V. Holmes, *Infection and Immunity* **22**, 516 (1978); J. A. Lippincott and B. B. Lippincott, in *Bacterial Adherence in Receptors and Recognition, Series B*, E. H. Beachey, Ed. (Chapman and Hall, London, 1980), vol. 6, pp. 439–451; A. G. Matthysse, K. V. Holmes, R. H. G. Gurlitz, *J. Bacteriol.* **145**, 583 (1981).
41. D. J. Merlo, R. C. Nutter, A. L. Montoya, D. J. Garfinkel, M. H. Drummond, M.-D. Chilton, M. P. Gordon, E. W. Nester, *Mol. Gen. Genet.* **177**, 637 (1980).
42. M. De Beuckeleer, M. Lemmers, G. De Vos, L. Willmitzer, M. Van Montagu, J. Schell, *ibid.* **183**, 283 (1981).
43. M. F. Thomashow, R. Nutter, A. L. Montoya, M. P. Gordon, E. W. Nester, *Cell* **19**, 729 (1980).
44. W. Kwok, unpublished results.
45. R. Deuring, *et al.*, *Nature (London)* **293**, 81 (1981).
46. R. B. Simpson *et al.*, *Cell*, in press.
47. M. Lemmers *et al.*, *J. Mol. Biol.* **144**, 353 (1980).
48. P. Zambryski, A. Depicker, K. Kruger, H. Goodman, personal communication.
49. N. Yadav, W. Barnes, M.-D. Chilton, personal communication.
50. S. Gelvin *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **79**, 76 (1982).
51. L. Willmitzer *et al.*, *Mol. Gen. Genet.* **182**, 255 (1981).
52. L. Willmitzer, G. Simons, J. Schell, *EMBO J.* **1**, 139 (1982).
53. J. Schröder, G. Schröder, H. Huisman, R. A. Schilperoort, J. Schell, *FEBS Lett.* **129**, 166 (1981).
54. N. Murai and J. D. Kemp, *Proc. Natl. Acad. Sci. U.S.A.* **79**, 86 (1982).
55. J. C. McPherson, E. W. Nester, M. P. Gordon, *ibid.* **77**, 2666 (1980).
56. F. Skoog and C. O. Miller, *Symp. Soc. Exp. Biol.* **11**, 118 (1957).
57. C. O. Miller, *Proc. Natl. Acad. Sci. U.S.A.* **71**, 334 (1974).
58. A. C. Braun, *ibid.* **44**, 344 (1958).
59. D. E. Akiyoshi, E. McDonald, R. O. Morris, W. Kwok, E. W. Nester, M. P. Gordon, in preparation.
60. L. Otten *et al.*, *Mol. Gen. Genet.* **183**, 209 (1981).
61. J. Leemans *et al.*, *EMBO J.* **1**, 147 (1982).
62. F. M. Yang and R. B. Simpson, *Proc. Natl. Acad. Sci. U.S.A.* **78**, 4151 (1981).
63. G. J. Wullems, L. Molendijk, G. Ooms, R. A. Schilperoort, *Cell* **24**, 719 (1981).
64. P. Constantino, P. J. J. Hooykaas, H. Den Dulk-Ras, R. A. Schilperoort, *Gene* **11**, 79 (1980).
65. D. A. Tepfer and J. Tempé, *C. R. Acad. Sci. Paris* **295**, 153 (1981).
66. For review, see E. C. Cocking, M. R. Davey, D. Pental, J. B. Power, *Nature (London)* **293**, 265 (1981).
67. J. P. Hernalsteens *et al.*, *ibid.* **287**, 654 (1980).
68. S. Hasezawa, T. Nagata, K. Syono, *Mol. Gen. Genet.* **182**, 206 (1981).
69. L. Marton, G. J. Wullems, L. Molendijk, R. Schilperoort, *Nature (London)* **277**, 129 (1979).
70. F. A. Krens, L. Molendijk, G. J. Wullems, R. A. Schilperoort, *ibid.* **296**, 72 (1982).
71. S. Dellaporta, thesis, Worcester Polytechnical Institute (1981).
72. J. Draper, M. R. Davey, F. P. Freeman, E. C. Cocking, B. J. Cox, *Plant Cell Physiol.* **23**, 255 (1982).
73. D. Ursic, J. D. Kemp, J. P. Helgeson, *Biochem. Biophys. Res. Commun.* **101**, 1031 (1981).
74. C. Lichtenstein, personal communication.
75. A. Jimenez and J. Davies, *Nature (London)* **287**, 869 (1980).
76. R. A. Jorgensen, S. J. Rothstein, W. S. Reznikoff, *Mol. Gen. Genet.* **177**, 65 (1979).
77. Supported by the National Cancer Institute grant CA13015, the American Cancer Society (IN-26V), and Standard Oil Company (Indiana); aided by grant PF-1913 from the American Cancer Society. We thank Dr. V. N. Iyer, Dr. E. W. Nester, Dr. D. J. Garfinkel, Dr. R. B. Simpson, and A. L. Montoya for critical reading of this manuscript.

Management of High-Level Waste Repository Siting

Douglas Hill, Barbara L. Pierce, William C. Metz
Michael D. Rowe, Edwin T. Haefele
F. Carlene Bryant, Edwin J. Tuthill

Disposal of high-level radioactive waste is an unsolved problem of our society. Simply stated, large quantities of highly toxic liquid and solid wastes must be isolated from the environment for tens or hundreds of thousands of years. Many people may be put at risk by proximity to this waste as may their children and grandchildren. Although deep-mined geologic disposal appears to be a satisfactory means of isolating the wastes, the problem requires more than a technical solution. Our democratic principles mandate that we define a framework in which society can ratify the technical approach by approving the selection of a repository site. We suggest that the use of existing democratic processes, rather than creation of novel arrangements, is the best way to achieve social approval. The unique function of the Nuclear Regulatory Commission (NRC) seems to have been inadequately considered in the proposals made so far.

Government Roles

Federal role. The basic legal framework for high-level waste repository siting is provided by the Constitution and seven federal statutes (*1*, *2*). Although interpretations and definitions are continually evolving in the courts, the Constitution and the statutes are generally interpreted to give the federal government the right to (i) control the nuclear field; (ii) supersede state and local laws, take land, and site a repository in the name of national interests; (iii) create the authority for a repository; (iv) establish a policy of environmental protection; and (v) provide decision-making guidelines. These statutes divide the responsibility for high-level waste disposal among several federal agencies. The Department of Energy (DOE) has been designated the lead agency (*3*), the NRC has regulatory authority over DOE commercial high-level waste disposal activities (*4*), the Environmental Protection Agency (EPA) establishes radiation standards (*5*), and the Department of Transportation (DOT) is responsible for rules on the routing of radioactive materials (*6*). Lack of sufficient interagency coordination has been a key historical weakness in the national waste management program.

In his nuclear policy statement, President Reagan charged that nuclear power development has been hampered by the failure of government "in meeting its responsibility to work with industry to develop an acceptable system for commercial waste disposal." He lifted the ban that had been imposed on commercial reprocessing of high-level wastes and instructed the Secretary of Energy, "working closely with industry and state governments, to proceed swiftly toward deployment of a means of storing and disposing of commercial high-level radioactive waste" (*7*). However, no new initiatives for facilitating the process appear to be in the offing.

The legislative history of the statutes regulating nuclear power suggests that Congress intended the federal government to have absolute control over the management of radioactive wastes. Indeed, three recent court cases have seemingly affirmed federal preemption of nuclear regulation on the basis of the commerce (*8*) and supremacy (*9*) clauses

D. Hill, B. L. Pierce, W. C. Metz, and M. D. Rowe are policy analysts at the National Center for Analysis of Energy Systems, Brookhaven National Laboratory, Upton, New York 11973. E. T. Haefele is professor of political science and public policy, University of Pennsylvania, Philadelphia 19104. F. C. Bryant and E. J. Tuthill are consultants to Brookhaven National Laboratory.

0036-8075/82/1126-0859$01.00/0

Summary. The selection of sites to store high-level radioactive waste will require more than technical decisions; an acceptable site must gain widespread public support. Ad hoc approaches have recently served as a stimulus to overcome institutional inertia in radioactive waste management, as exemplified by the Interagency Review Group and the State Planning Council for Radioactive Waste Management, but ad hoc approaches have not characteristically succeeded in resolving intense conflicts. Acceptable sites can best be established through traditional processes of legal and scientific advocacy, and their ultimate legitimacy will depend on the proper use of established democratic processes.

of the Constitution (*10*). A minority view holds that, because of unclear federal laws, regulatory gaps, and an apparent absence of federal leadership and Congressional "intent," state and local governments retain some rights in management of radioactive wastes, most importantly for the protection of public health and safety under the Tenth Amendment of the Constitution.

State role. States can be expected to be reluctant partners in siting a high-level waste repository, as Kansas, Michigan, and New Mexico have already proved to be. Approximately 156 state and local restrictions on nuclear waste disposal have been passed in the form of laws, initiatives, and resolutions (*11*). Of the seven states that have not yet enacted laws, six have legislation pending. In Congress, the issue has raised questions of states' rights and veto powers. Although the federal government can almost certainly preempt state authority, it is politically inexpedient to do so.

In the Carter Administration, the State Planning Council on Radioactive Waste Management was created by executive order in an effort to draw the states into an unaccustomed participation in federal decision-making. Before it was allowed to expire in August 1981, the council urged that six factors be recognized as the principal bases for state and tribal objections to a site for a high-level waste repository (*12*).

1) Unacceptable danger to public health and safety based on violation of criteria, rules, or standards established by NRC, EPA, or DOT, or in their absence, on interim criteria established by DOE.

2) Substantive violation of written agreements or Indian treaties.

3) Disagreement with DOE about sound scientific or technical practices prior to selection of a site for licensing.

4) Failure to resolve inconsistencies with state or tribal regulations or laws applied equally to all applications, unless preempted by federal law.

5) Adverse environmental and socioeconomic impacts that have not been resolved to the satisfaction of a state or tribe.

6) Failure of the federal government to determine that Price-Anderson Act coverage applies federal liability to transportation, disposal, or other repository-related activities.

States may also use the judicial system to define their roles. In May 1981, New Mexico filed a lawsuit against DOE to stop work on the Waste Isolation Pilot Project, a repository designed to hold military wastes (*13*). According to the state attorney general, this suit was decisive in getting DOE to recognize formally the state's rights.

Local role. The severity of the impacts of a repository site on the local community will depend on such factors as housing availability, site accessibility, local government leadership, and federal mitigation measures. Local government response to a prospective repository site may be shaped by expectations of economic benefit, concern over an influx of new residents, opposition to land withdrawals, and fears regarding environmental, health, and cultural impacts. The local government of an area hosting a repository may have little legal power to alter or halt the project, but if community needs and interests are ignored, and if compensation and mitigation measures are not planned, needless confrontations and project delays may result. Housing, schools, highway, and other "infrastructure" problems can often be solved by planning, but there will be other unmitigated social and psychological impacts.

Local ability to impede repository siting is derived from state police powers. States can also provide financial and technical assistance, change local funding and debt limits, and provide for the establishment of local public development agencies and special districts. Local governments, with the willingness of area residents, can themselves redefine area political boundaries such as school districts, fire districts, and community boundaries. Cooperation and communication between state and local governments is essential to reducing potential impacts and obstacles.

Role of Indian tribes. Indian tribal lands are situated close to many of DOE's possible repository site areas. Indian tribes are quasi-sovereign, independent governments that control their tribal property and other resource ownership rights under the protection both of their trustee, the U.S. government, and the Constitution. Whenever there is a possibility of tribal property and usage rights being affected, tribal governments could be encouraged to participate in repository decision-making, in consultation with the Secretary of the Interior. Federal dealings with tribal governments are distinct from those with states, localities, and the general public. Tribes have the right to initiate litigation or to petition Congress to resolve objections to repository siting decisions (*14*).

The Yakima Nation claims the right to use the Hanford Reservation, federal land in the state of Washington, for fishing, hunting, gathering food, and other purposes. In June 1979, the Yakima Tribal Council passed a resolution prohibiting nuclear wastes from their reservation and expressing concern about the use of ceded areas for nuclear waste storage. In its role of trustee, Congress must resolve the issue, but judicial proceedings may be needed to settle the conflict between Indian usage rights and Hanford's "prior land use" commitment to nuclear activities (*15*).

Mechanisms to Facilitate Site Selection

In March 1978, President Carter directed that the Interagency Review Group on Nuclear Waste Management (IRG) be formed to delineate strategies and policy options for waste management. In February 1980, the State Planning Council was formed after the Carter Administration outlined a comprehensive waste management plan based on IRG recommendations. Work on this National Plan for Radioactive Waste Management has been facilitating development of interagency and intergovernmental agreements as well as providing an element of continuity and integration that might otherwise be lacking. The success of these ad hoc arrangements perhaps inevitably led to the proposal that they be perpetuated as a "high-level and aggressive interagency management committee" (*12*, p. 107). Other proposals for ad hoc arrangements include recommendations for a new agency to manage

radioactive waste (*15*), a "siting jury" to settle conflicts (*16*), an investigatory agency and separate decision board (*17*), and "scientific mediation" to resolve conflicts (*18*).

The study of conflict resolution, however, suggests that intense issues such as nuclear waste disposal are not likely to be settled by novel approaches that lack the legitimacy conferred by traditional use. The conditions under which mediation and other modes of dispute processing are likely to be successful in environmental disputes have been identified by Gladwin (*19*): only when power relations are symmetric, norms are flimsy or unavailable, no precedents are to be established, time pressures are of moderate intensity, goals and interests are positively correlated, and continuing relations are important. These conditions are not likely to apply in disputes over repository siting for radioactive wastes. Instead, we are likely to witness disputes that only high levels of third-party intervention, such as legislation or adjudication, will be able to resolve. Novel approaches may be of use in deciding strictly procedural questions (for example, who is to participate, methods of compensation, and so on) but are likely to be of limited use in dealing with most substantive disputes. An institutional process is needed that will be stable over a period of decades as sites are identified, characterized, selected, and used (*16*). That process must depend on state and federal legislatures—the most enduring of Anglo-Saxon institutions—continuing to accept responsibility for resolving the political implications of the siting decision, and executive agencies must provide legislatures with the best technical judgments available, from analyses that have not been debased by political judgment.

There are a number of ways in which to facilitate siting: passage of new federal legislation, coordination of federal agency activities, clarification of the role of the states, encouragement of local government and Indian tribe involvement, and appropriate public participation.

Federal Legislation

Congress will have to finally select or ratify sites for a repository, but before legislation is enacted the process of selecting sites is subject to challenge on the basis of numerous laws and regulations. A number of current federal and state statutes, for example, disqualify or preclude certain areas from consideration as repository sites (*20*). Other statutes, which do not entirely eliminate or disqualify a site as a potential repository, do provide limited protection to certain areas and resources (*21*). Although Congress can almost certainly override state preferences, the current political reality is that it will probably serve only as a court of last resort for specific decisions. On the other hand, early federal legislation to reinforce the procedural aspects of site selection could limit and focus subsequent litigation. Congress could, for example, clarify the roles of the NRC and other agencies in the siting decision process, ratify criteria for siting, and make provision for compensation of people adversely affected by the choice of a disposal site, a concern that usually receives only lip service. Congress could also set criteria for evaluating specified environmental effects, risks, and impacts as well as clarify uncertainties about repository management, financing, staffing, and surveillance. Legislation could provide for adequate funding for repository surveillance, could decide the public or private character of the repository management organization, and could provide for its accountability, adaptability, stability, and economic efficiency (*22, 23*).

Mitigation and compensation issues are under review at Oak Ridge National Laboratory, Battelle's Human Affairs Research Center, and the Science and Education Administration of the Department of Agriculture (*22, 24, 25*), but legislation could ensure implementation of appropriate measures. The Senate subcommittee on rural development (of the Committee on Agriculture, Nutrition, and Forestry) has already held one hearing on the socioeconomic effects of a repository and possible means of compensating local communities (*26*). There are numerous legislative precedents for providing assistance to mitigate adverse local effects, notably five acts (*27*) that have provisions for aiding state and local governments affected by rapid energy development on federal land. Aside from these, more than 100 federal aid programs may be applicable to areas affected by energy projects (*28*).

None of the acts or programs is expressly designed to aid an area with a repository. In two cases, however, Congress has approved legislation to aid specific communities. One was in connection with the construction of an additional powerhouse at North Bonneville, Washington, where the Army Corps of Engineers was permitted to compensate area communities for "whatever is necessary and appropriate" (*25*). A second involved a Navy expenditure of $400 million to aid Kitsap County, Washington, communities affected by rapid population growth associated with the construction of the Trident submarine base (*29*). Before approving a repository, Congress could develop a plan of assistance stressing seed money, funds for "grantsmen," direct monetary assistance, and other efforts to reduce negative impacts of a national repository on small rural communities. State and local laws on debt limits could be reviewed to ensure that communities adjacent to a repository can accept federal loans and grants. If a firm congressional pledge is made to mitigate adverse effects before actual site selection, local resistance to a repository might be reduced.

To dispel fears that individuals near repositories might be put involuntarily at risk with no possibility of compensation, an insurance and a tort liability system could be established. The Price-Anderson Act is not applicable in cases of injury or risk due to radioactive releases at final waste repositories, and it is questionable whether individuals could sue for compensation under the Federal Tort Act. Congress could decide what constitutes an injury, who can be declared at fault, and whether a no-fault system should be instituted (*22*, p. 37; *30*).

The timing of these congressional initiatives could be crucial. A major complaint against the Trans-Alaska Pipeline Authorization Act was that Congress waited too long to wrest an issue of such national and international significance from the courts. Since that authorization act "overruled all that the courts had taken a necessarily long time to decide, much time and expense could have been saved had Congress acted earlier" (*31*).

Perhaps most importantly, legislation could clarify federal agency responsibilities, such as NRC's adjudicatory role in the site-selection process. Because statutory responsibility for waste management is divided, often somewhat uncertainly, among many agencies, the role of the NRC is often blurred with that of DOE, and the possibility of using NRC's regulatory function to focus the process of site selection seems to go unrecognized. In early work, the staff of the State Planning Council, for example, proposed that the "NRC consults with DOE on preparation of regulatory guides" (*32*), hardly suggesting an arm's length regulator-applicant relationship. The State Planning Council also suggested that NRC "consider whether its public meeting on the site characterization

plan could be combined with DOE's in some manner" (*33*). Legislation pending in Congress has the guidelines for repository sites issued not by the NRC but by the Secretary of Energy. House bill H.R. 3809, has DOE issuing guidelines "in consultation with" the NRC among other agencies (*34*); in Senate bill S.1662, the role of the NRC has been upgraded to "concurrence" (*35*). With this official view of the relation between the two agencies, small wonder that the public may perceive NRC not so much as DOE's regulator as its accomplice.

Moreover, under the Senate bill, the NRC would receive construction applications from DOE only after Congress and the President had approved a site, and although the bill specifies that a resolution by Congress "shall in no way be considered as binding" on the NRC, it would take a courageous commission at that point to serve as anything but a rubber stamp.

Legislation may well be enacted by this Congress. We suggest that such legislation permit the NRC, as the responsible regulatory agency, to perform its role in the time-honored traditions of legal and scientific advocacy. The NRC is mandated to review DOE's site selection methodology and criteria and to approve the final site. In this process, NRC will be guided by the National Environmental Policy Act (NEPA) and the Administrative Procedure Act, especially by requirements for a "hard look" and a "whole record" (*36*). In fact, NEPA extends NRC's purview beyond radiological safety considerations to include both direct and indirect impacts of a proposed facility (*37*). Congressional approval of the criteria used by the NRC and the sites selected might eliminate some legal challenges.

Coordination Among Federal Agencies

The current structure of the high-level radioactive waste management program puts the NRC in the position of regulating another federal agency—a role that can be exploited to the advantage of the siting process. The NRC has defined the procedures that DOE must follow to obtain a license for a geologic repository (*38*), and they require DOE to characterize several sites before selecting one. In addition, DOE must submit to the NRC a site characterization report describing the selection process and the geological characterization planned to determine suitability of the site. When a repository site has been selected from those characterized, DOE must submit an environmental report with its application for construction authorization.

One area of overlap of statutory authority between the two agencies is in the implementation of the NEPA. Both the construction and the licensing of a high-level waste repository would normally be considered major federal actions requiring preparation of an environmental impact statement. DOE has developed an implementation plan, outlining when its various environmental documents are to be prepared (Fig. 1). This plan includes preparation of an environmental impact statement at the time of site selection. Yet the NRC is planning to prepare an environmental impact statement when it grants construction authorization. Pending legislation such as S.1662 would clarify the NEPA responsibilities of the two agencies.

Duplication of responsibilities for environmental impact statements is only a symptom of the confusion in the roles of DOE and the NRC. In our view, the role of the NRC as objective judge in the site selection process should be protected with the aim of developing a full record by the repository construction licensing stage, for judicial or congressional review, if appropriate. Although the NRC must participate in the process of identifying, screening, and selecting sites, it

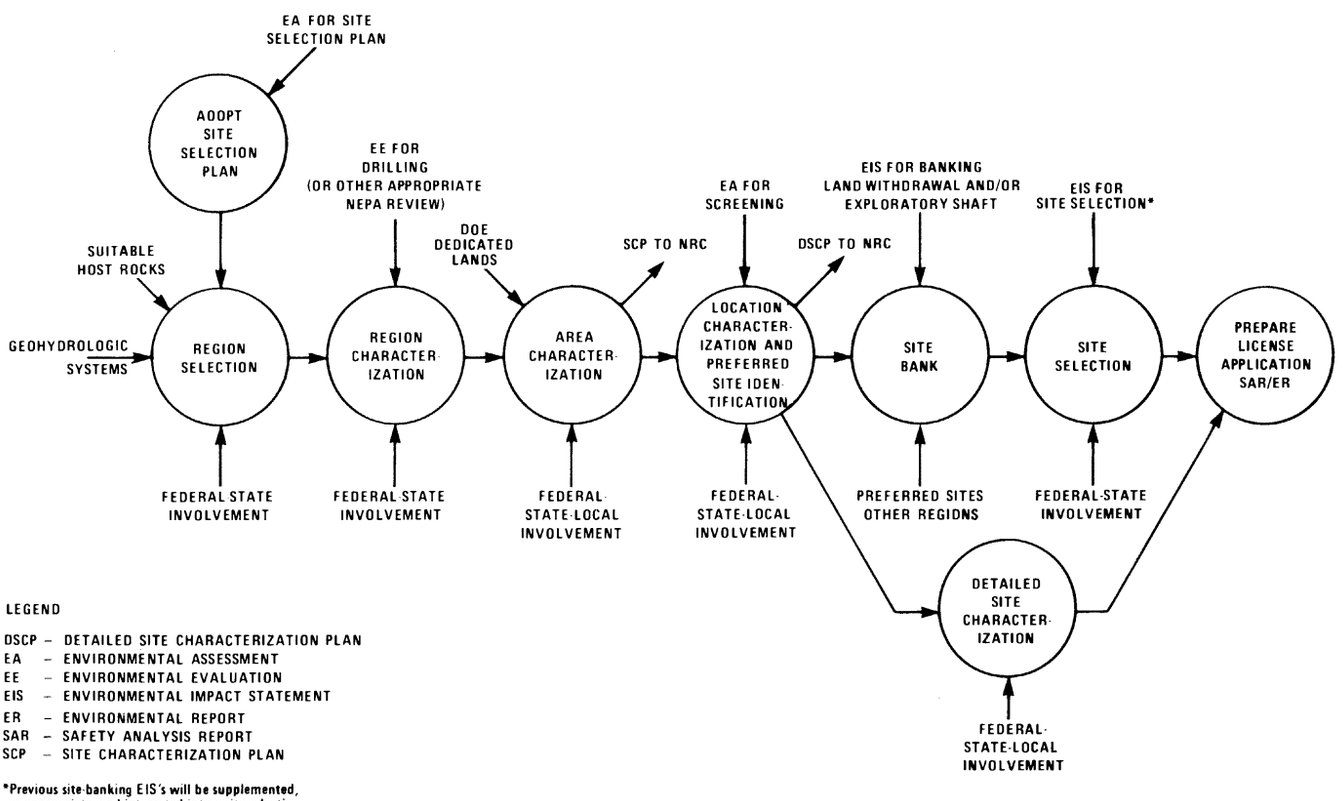

Fig. 1. Site characterization and selection process. [Source: Department of Energy]

must also disentangle itself from any appearance of partisanship. Before licensing, NRC's involvement should be similar to a judge's preliminary rulings, which focus the proceedings but do not bind him or her to a particular outcome.

The related but distinct roles of the governmental agencies involved in repository siting can be understood by analogy to a basic regulatory mechanism: the feedback loop. In a feedback loop the desired output of the process (EPA standards) is one input to a comparator (NRC). Information on the actual output of the process under control (DOE's siting process) feeds back to the comparator through a sensor (suggested here as the states). The comparator observes the error between the actual and desired outputs and signals the need for a correction. Whether or not a feedback loop provides stability depends on the strength and timing of the signals. A clearer concept of the relations among the governmental bodies may help get the signals straight.

State Participation

The NRC might benefit by designing the role of states as that of sensors of the siting process. The NRC could, for instance, encourage DOE to hold joint public hearings with states to develop technical and institutional data. DOE could be required to submit independent site characterizations but the NRC should encourage state comments, both supporting and opposing, at the stage of site characterization. The NRC could monitor the public hearings and allow states to appeal DOE decisions to the commission with the assistance of federal money. Contrary to its present plans, however, the NRC should not provide staff assistance to the states since this puts it in the position of reviewing information that its own staff helped develop.

Although interactions between DOE and the states are to be encouraged, DOE should make decisions not on the basis of political considerations but on the basis of technical and environmental criteria, and a promising site should not be overlooked because of state or local resistance. Public participation, particularly if it occurs in meetings jointly sponsored by DOE and the states, could provide the basis for state political input in subsequent national NRC hearings before site characterization. Thus, the avenue for political inputs is through state legislatures and state legislation, while the avenue for technical and environmental inputs is the hearing process conducted by the states, DOE, and the NRC. With this process, we can hope to minimize what has been called "the worst of both worlds—technical analysis debased by political judgments, and political deals in which only a small number and perhaps the wrong people may play" (*39*).

At the construction licensing stage, state disapproval of a site could take the form of a resolution by the state legislature addressed to the NRC. In this way, the trade-off in interests that is the heart of the political process is made in an appropriate forum, the state legislature. When the NRC has rendered its decision on a construction license application, the full record is ready for judicial appeal or congressional review. This process allows for continuing negotiation and replaces the one-time, and ultimately futile, decision of a state veto.

Public Participation

Bills pending in Congress specify public participation and require DOE to hold public meetings in the vicinity of candidate sites. H.R. 3809 would fund public participation in NRC rule-making proceedings. Public participation is already required under the Atomic Energy Act, the Department of Energy Organization Act, and the NEPA implementation guidelines of the Council on Environment Quality, but the nature and form of this participation is largely undefined.

At the least, public participation can provide an avenue for ventilating feelings as well as remind participating bureaucrats that they are trafficking in real lives. Moreover, if the siting decision process is to remedy the inadequacy of analytical decision methods in dealing with the issue of intergenerational equity and such intangibles as aesthetics and wilderness values, it is essential that members of the public be given a genuine opportunity to develop and defend different points of view. There is no societal consensus on these "higher" values; the decision process itself may assist in formulating and articulating them (*40*).

The question is how participation by the public can best be designed to contribute to a satisfactory social decision. The NRC and DOE plans and responsibilities for public participation currently overlap. In the process of selecting a site for characterization, DOE will undoubtedly hold public meetings in the vicinity. After NRC receives a site characterization report, it also plans to hold public meetings. The result is likely to be further confusion about the responsibilities of the agencies. We propose that DOE and the affected state hold local public meetings, and that the NRC reserve its hearings to the national level, where it can adjudicate. Of course the public's ultimate avenue for influence is through its vote and those of its representatives. Thus we urge that public views be presented through state legislatures in the form of state resolutions at national NRC hearings.

Conclusion

Our survey of the social choice problems associated with the siting of repositories for high-level radioactive wastes suggests that solutions must come from the use of the appropriate mechanisms for decision-making at various points in the process. The first of these is the technical choice mechanism associated with scientific and engineering testing which should be unencumbered by political considerations. This realm is preeminently the province of executive branches of government and depends on (i) a coherent sorting-out of agency responsibilities, (ii) a rational process of sifting alternatives, and (iii) a timely indication by Congress as to which of the existing constraints imposed by previous statutes the Congress wishes this rational process to be bound by.

The second mechanism is the adjudicating process associated with the legal remedies available to persons and groups who may feel aggrieved by the results of the technical choice process. The success of the adjudicatory process depends on (i) clear expression of intent by the Congress relative to the criteria that the technical choice process should use, (ii) the development of the "whole record" by the technical choice process, and (iii) further development by the courts of any limits on federal power when opposed by state police powers and the Tenth Amendment.

The third mechanism is the social choice mechanism—that is, legislative statutes, particularly by the Congress. Many of the difficulties of legislation enacted in the 1960's and 1970's result from statutes that fail to establish clear intent and consistent criteria for executive agencies, leading both to bureaucratic policy-making and interminable legal challenges to those policies. If progress on repository siting for high-level radioactive wastes is to be made in this century, then Congress will have to face

up to the words of Justice Robert H. Jackson (*41*), "that the Executive be under the law, and that the law be made in parliamentary deliberations."

References and Notes

1. Atomic Energy Act of 1946, 60 Stat. 755 (amended 1954); Atomic Energy Act of 1954, Public Law 83-703, 68 Stat. 919 (1954) (amended later); Amendments to the Atomic Energy Act, Act of September 23, 1959, Public Law 86-373, 73 Stat. 688; Energy Reorganization Act of 1974, Public Law 93-438, 88 Stat. 1233 (1974) (amended later); 1978 Appropriations Act Rider, Public Law 95-691, 92 Stat. 2953 (1978); National Environmental Policy Act of 1969 as amended, Public Law 91-190, 83 Stat. 852 [codified at 42 U.S. Code sects. 4321–4361 (1970)]; Administrative Procedure Act, 5 U.S. Code sects. 500–576 (1980).
2. For a more complete account of the legal foundations of repository siting see, National Center for Analysis of Energy Systems, *Institutional Barriers and Mechanisms to Facilitate High-Level Waste Repository Site Selection* (BNL 31113, Brookhaven National Laboratory, Upton, N.Y., February 1981).
3. 42 U.S. Code sect. 7133 (a) (8) (1977).
4. 42 U.S. Code sects. 5841 (f), 5842 (1974).
5. Reorganization Plan 3 of 1970, 35 Fed. Reg. 15623, 84 Stat. 2086 (1970); Marine Protection, Research, and Sanctuaries Act of 1972, 33 U.S. Code sects. 1411–1421 (1976); Clean Air Act Amendments of 1977, 42 U.S. Code A sects. 7401–7626 (Supp. 1977).
6. Hazardous Materials Transportation Act, 49 U.S. Code sects. 1801–1812 (1976). See *City of New York* v. *Department of Transportation*—F. Supp.—(SDNY) 1982, Order 81 Div. 1778 (ADS) (in litigation).
7. Reagan Nuclear Policy Statement, *Nucl. News* **24**, 31 (1981).
8. U.S. Constitution Art. I, sect. 8, cl. 3.
9. U.S. Constitution Art. VI, sect. 2.
10. *Northern State Power Company* v. *Minnesota*, 447 F.2d 1143 (8th Cir. 1971), aff'd mem., 405 U.S. 1035 (1972), *Pacific Legal Foundation* v. *State Energy Resources and Development Commission*, 472 F. Supp. 191 (S.D. Cal. 1979), and *Washington State Building Council* v. *Spellman*, 518 F. Supp. 928 (E. D. Wash. 1981).
11. S. Haber, "Year-end nuclear legislative report," prepared for Atomic Industrial Forum, Inc., Washington, D.C. (1980, 1981, and 1982).
12. State Planning Council on Radioactive Waste Management, "Recommendations on national radioactive waste management policies" report to the President (1981), pp. 13–14.
13. *New Mexico* v. *Department of Energy*, No. CIV 81 0207C (D.N.M., complaint filed 14 May 1981).
14. Council of Energy Resource Tribes, "Impact of nuclear waste legislation on Indian tribes," (Washington, D.C., no date), pp. 13–14.
15. R. D. Lipschitz, *Radioactive Waste: Politics, Technology, and Risk; A Report of the Union of Concerned Scientists* (Ballinger, Cambridge, Mass., 1980).
16. K. N. Lee, *Science* **208**, 679 (1980).
17. S. Ramo, *ibid.* **213**, 837 (1981).
18. N. E. Abrams and R. S. Berry, *Bull. At. Sci.* **33**, 50 (April 1977).
19. T. N. Gladwin, Memorandum to Douglas Hill, 10 February 1981. For a contrary view, see Conservation Foundation, "Managing the nation's high-level radioactive waste: Key issues and recommendations" (Washington, D.C., 1981), pp. 30–35.
20. Endangered Species Act, 16 U.S. Code sects. 1531–1543; Protection of Wetlands, Exec. Order 11990, 42 Fed. Reg. 26961 (1977); Coastal Zone Management Act, 16 U.S. Code sects. 1451–1464; Wilderness Act, 16 U.S. Code sects. 1131–1136; Wild and Scenic Rivers Act, 16 U.S. Code sects. 1271–1278; various state laws pertaining to mineral rights.
21. National Historic Preservation Act, 16 U.S. Code sects. 470; Protection and Enhancement of the Cultural Environment, Exec. Order 11593, 36 Fed. Reg. 8921 (1971); Safe Drinking Water Act, 42 U.S. Code sects. 300f–300j-9; at the state and local level, various statutes pertaining to land use, pollution control, and energy facility siting.
22. J. A. Hébert *et al.*, "Nontechnical issues in waste management" (PNL-2400, Battelle Human Affairs Research Center, Seattle, Wash., 1977).
23. R. F. Smith, "Institutional problems in nuclear waste management," report to the California Energy Resources Conservation and Development Commission (Sacramento, 1977), pp. 17–20.
24. E. Peelle, D. Bjornstad, K. Johnson, R. Stevenson, in *Proceedings of the National Waste Terminal Storage Program Information Meeting* (Office of Nuclear Waste Isolation, Columbus, Ohio, 1980), pp. 60–61.
25. R. J. Cole, K. V. Friedman, F. A. Morris, S. Smolhin, "Compensation for the adverse effects of nuclear waste facilities," (Battelle Human Affairs Research Center, Seattle, Wash., 1978).
26. Senate subcommittee on rural development of the Senate Committee on Agriculture, Nutrition, and Forestry, oversight hearings on "The socioeconomic effects of a nuclear waste storage site on nearby rural areas and small communities," 25 August 1980.
27. Federal Coal Leasing Amendments Act of 1975, Public Law 94-377, 90 Stat. 1083 (1976); Federal Land Policy and Management Act of 1976, Public Law 94-579, 90 Stat. 2743 (1976); Surface Mining Control and Reclamation Act of 1977, Public Law 95-87, 91 Stat. 445 (1977); Power Plant and Industrial Fuel Use Act, Public Law 95-620, sect. 601, 92 Stat. 3289 (1978); Public Lands—Local Government Funds (Payment in Lieu of Taxes Act), Public Law 94-565, 90 Stat. 2262 (1976). The Payments in Lieu of Taxes Act is intended to compensate local governments for the losses in property tax revenue resulting from federal land tax immunity. The Atomic Energy Act of 1954 as amended allows the Atomic Energy Commission (now DOE) discretion in administering payments in lieu of property taxes. However, payments cannot be in excess of the taxes that would have been payable on the property in the condition in which it was acquired.
28. Senate subcommittee on energy, nuclear proliferation, and federal services of the Senate Committee on Governmental Affairs, hearings on the Energy Impact Assistance Act, S.1699, 96th Congress, 2nd sess., 1980, pp. 65–66.
29. R. D. Brenner, "The social, economic, and political impacts of national waste terminal storage repositories" (Center for International Studies, Princeton, N.J., 1979), p. 12.
30. J. G. Davis, in (*26*), p. 37.
31. Randall L. Tayler, *Environ. Aff.* **6**, 387 (1978).
32. State Planning Council on Radioactive Waste Management, *Docket Book, Fourth Meeting*, Arlington, Virginia (8 to 9 September 1980), tab B, road map B, p. 3.
33. ———, *Docket Book, Fifth Meeting*, Phoenix, Arizona (8 to 9 January 1981), p. 18g.
34. U.S., Congress, House, *A Bill to Provide Repositories for the Disposal of High-Level Radioactive Waste, Transuranic Waste, and Spent Nuclear Fuel, to Amend Provisions of the Atomic Energy Act of 1954 Relating to Low-Level Waste, to Modify the Price-Anderson Provisions of the Atomic Energy Act of 1954 and Certain Other Provisions pertaining to Facility Licensing and Safety, and for Other Purposes*, H.R. 3809, 97th Cong. 1st sess., 1981, p. 8.
35. U.S., Congress, Senate, *A Bill to Establish a Limited Program for Federal Storage of Spent Fuel from Civilian Nuclear Powerplants, to Set Forth a Federal Policy, Initiate a Program, and Establish a National Schedule for the Disposal of Nuclear Waste from Civilian Activities, and for Other Purposes*, S.1662, 97th Cong., 1st sess., 1981, p. 144.
36. W. Rodgers [*Georgetown Law J.* **67**, 706 (1979)], states that under the "hard look" doctrine, "assumptions must be spelled out, inconsistencies explained, methodologies disclosed, contradictory evidence rebutted, record references solidly grounded, guesswork eliminated, and conclusions supported in a 'manner capable of judicial understanding.'" M. Dougherty [*Law Forum* **1979**, 4 (1979)] states that the "whole record" which a court reviews is composed of everything the agency had before it when making its decisions.
37. The NRC has often required plans to mitigate adverse environmental effects as a condition to approve a license for power plants. Moreover, it has even rejected an application for construction of a power plant partly on aesthetic grounds [Office of Nuclear Reactor Regulation, *Environmental Impact Statement, Greene County Nuclear Power Plant* (Nuclear Regulatory Commission, Washington, D.C., 1979)]. Recently the U.S. Court of Appeals for the District of Columbia required the NRC to assess psychological stress of people living nearby Three Mile Island before starting up the undamaged nuclear reactor there [*New York Times*, 15 May 1982, p. 1].
38. Nuclear Regulatory Commission, 46 Fed. Reg. 13971 (1981).
39. E. T. Haefele, *Representative Government and Environmental Management* (Johns Hopkins Univ. Press, Baltimore, 1973), p. 19.
40. R. Dorfman, in *When Values Conflict*, L. H. Tribe, C. S. Schelling, J. Voss, Eds. (Ballinger, Cambridge, Mass., 1976).
41. *Youngstown Sheet and Tube* v. *Sawyer*, 343 U.S. 579 (1952).

42. We thank the following staff members at Brookhaven National Laboratory: P. M. Meier, V. L. Sailor, D. G. Schweitzer, J. J. Cadwell, J. P. Indusi, J. S. Munson, J. Nagy, and E. Seubert for helpful advice during the preparation of this article. Legal aspects of this article emerged from a conference of lawyers that included J. P. Bromberg, J. J. Cadwell, J. E. Haggard, T. P. Hunter, E. Jaksetic, H. E. Lippek, and K. Sheldon. We also thank D. F. Anderson and J. W. Rohrbaugh of the State University of New York at Albany and T. N. Gladwin of New York University, and K. Gramp, formerly of the Council of Energy Resource Tribes, for their contributions. We appreciate the comments on drafts of this article by two anonymous referees. We are indebted for guidance to P. F. Rathbun and F. A. Costanzi of the NRC staff. Supported by the Waste Standards Management Branch of the NRC.