Evaluation of the State Water-Resources Research Institutes

by Madge O. Ertel

U.S. GEOLOGICAL SURVEY Open-File Report 88—85
1988

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

For additional information
write to:

Chief, Office of External Research
U.S. Geological Survey
Water Resources Division
424 National Center
Reston, Virginia 22092

Copies of this report can be
purchased from:

U.S. Geological Survey
Books and Open-File Reports
Section
Box 25425, Federal Center
Denver, Colorado 80225

CONTENTS

EVALUATION OF THE STATE WATER-RESOURCES RESEARCH INSTITUTES

by Madge O. Ertel

ABSTRACT

Water-resources research institutes, as authorized by the Water Resources Research Act of 1984 (Public Law 98-242), are located in each State and in the District of Columbia, Guam, Puerto Rico, and the Virgin Islands. Originally established by congressional action in 1964, and administered by the Geological Survey since 1983, these institutes are jointly supported by the States and the Federal Government for the purpose of mobilizing academic research expertise in addressing high-priority water-related problems of their respective States and regions.

Public Law 98-242 mandated an onsite evaluation of each of these institutes to determine whether ". . . the quality and relevance of its water-resources research and its effectiveness as an institution for planning, conducting, and arranging for research warrant its continued support in the national interest." The results of these evaluations, which were conducted between September 1985 and June 1987, are summarized in this report.

A formal process for evaluation of the institutes was developed from the requirements of Public Law 98-242 and the implementing rule for administration of the institute program by the Geological Survey (30 CFR 401), and from recommendations of a special committee of water-institute directors. The process was tailored to ensure a consistent review of how each institute was meeting its basic responsibilities, as defined in the authorizing legislation, while giving due recognition to the initiative and institutional support that make possible an augmented program (that is, the institute's effectiveness as a research institution). The process included provision for the imposition of a 1-year probationary period to allow corrective actions if an institute was determined by the evaluation team to be deficient in one or more of the elements specified in the evaluation procedures.

The evaluation teams found that all 54 institutes are meeting the basic objectives of the authorizing legislation in that they (1) use the grant funds to support research that addresses water problems of State and regional concern; (2) provide opportunities for training of water scientists through student involvement on research projects; and (3) promote the application of research results through preparation of technical reports and contributions to the technical literature. The differences among institutes relate primarily to degrees of effectiveness, and most often are determined by the financial, political, and geographical contexts in which the institutes function and by the quality of their leadership.

Based on the evaluation teams' findings, 48 institutes were determined to be fully eligible for continued support in the national interest under the provisions of Public Law 98-242. Deficiencies identified in the programs of

six institutes resulted in those institutes being placed on probation for 1 year to allow time for corrective actions to be taken. The four institutes whose probationary year has expired have submitted documentation of satisfactory remedial actions and have been restored to full eligibility. Those institutes perceived by the evaluation teams to be most effective as institutions for planning, conducting, and arranging for research share several general characteristics, the most substantive of which are:

1. Each receives from the State an appropriation of funds that can be used for direct support of research projects beyond those made possible by the Federal grant funds.

2. Each generates other extramural funding for water-related research.

3. Each has a director whose major responsibility is the administration of the institute, or who has significant professional assistance to that end.

4. Each exists as a separate administrative entity within its university.

5. Each receives from its host institution full salary support for the director and associated staff.

6. Each has an advisory structure that is actively involved in the definition of research priorities, the promotion of an interdisciplinary orientation, and quality control of the research program.

7. Each has a system of peer review that promotes the highest standards of quality in both project selection and the publication of research results.

8. Each has an active information-transfer program conducted by a staff with professional communications abilities and strong ties to its State's Cooperative Extension Service.

Overall, the single most common problem facing the institutes appears to be the lack of financial resources needed to mount major research efforts that can make significant impacts in addressing the Nation's water problems. Increased State funding probably is the key element in enabling institutes to better mobilize academic expertise to address identified water-research needs in their States. However, the availability of Federal funds to provide continuity and opportunities to initiate new lines of research is equally important to overall program success.

The most general conclusion that can be drawn from the evaluations is that the institutes as a whole are using their Federal funds in a cost-effective manner by marshaling the resources of the academic community to address important problems identified in cooperation with water interests in the States. Thus, they are serving the national interest as envisioned by the authorizing legislation.

INTRODUCTION

As authorized by the Water Resources Research Act of 1984 (Public Law 98-242), 54 water-resources research institutes are located at major universities in each State, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands. They exist to mobilize academic research expertise in addressing high-priority water-related problems that are identified through close consultation with leading water interests within their jurisdictions. They are jointly supported by the States and by the Federal Government through grants from the Department of the Interior, as administered by the Geological Survey. They were originally established by congressional action in 1964 and since that time have been conducting research of importance to their States and regions, providing the results of the research to the user community, and training new professionals for the water field.

The purpose of this report is to summarize the evaluations of the programs of the individual institutes. The onsite evaluations were conducted between September 1985 and June 1987, in response to a specific requirement of section 104 of Public Law 98-242 in reauthorizing the institute program. That legislation mandated an onsite evaluation of each institute to determine whether ". . . the quality and relevance of its water-resources research and its effectiveness as an institution for planning, conducting, and arranging for research warrant its continued support in the national interest." This provision was a response by its authors to longstanding objections to guaranteed funding of an institute in every State, regardless of the comparative quality and effectiveness of the various programs, in that it provided for cessation of funding to any institute that did not qualify for approval as a result of the evaluation process. In implementing the legislative requirement, the Geological Survey, which had assumed responsibility for the program only in late 1983, also gained indepth knowledge for the benefit of its management capabilities. The institutes received the benefits of an external examination of their programs by teams of objective, qualified reviewers.

Each evaluation resulted in a written report substantiating a recommendation on the issue of continuing eligibility for funding and offering suggestions for improvements where they were warranted. Individual reports were transmitted to each institute's host academic institution and were labeled as "administratively confidential," that is, any further release of their contents was the prerogative of the institutions. This report does not violate that confidentiality by citing identifiable circumstances, but it describes in general those characteristics that typify institutes of different levels of effectiveness. It also describes the process that was used to reach the determination of eligibility required by the law and the program improvement desired by the Geological Survey and the institutes.

ACKNOWLEDGMENTS

The evaluations described in this report could not have been successfully conducted without the substantial contributions of time and effort made by the many people who served on the review teams. The Geological Survey extends to them its sincere appreciation. Much appreciated, too, are the courtesy and cooperation of the institutes and the universities.

THE EVALUATION PROCESS

Public Law 98-242 provided specific direction on the purpose of the evaluation requirement, the composition of the teams, the factors they should consider, and the timing of the process. Nevertheless, many conceptual and procedural matters had to be resolved before the process could begin. The National Association of Water Institute Directors took the first step in this direction by forming a Special Committee on Criteria for Institute Evaluation. Their report provided valuable input to the Geological Survey staff charged with the responsibility of preparing an operational plan. The implementing rule for administration of section 104 of the authorizing legislation (30 CFR 401), which became effective on July 1, 1985, added more administrative provisions, most importantly the one allowing for a 1-year period for corrective actions prior to elimination from the program of an institute found deficient in meeting the objectives of the legislation. This provision became commonly known as the "probation" option.

Based on the legislation, the rule, and the Special Committee report, the Geological Survey staff prepared an operational plan for the evaluation process that was distributed to all the institutes. It made clear that the overall goal was to provide constructive criticism and not to systematically eliminate institutes that did not meet some predetermined and uniform standard of performance. While stating clearly that the possibility of elimination had to be faced realistically if the process was to be credible, the plan recognized the diversities in the political and institutional contexts in which the institutes function. Because it was such an important guiding principle, this section of the plan is quoted here:

> For example, as a result of differing resources and management approaches, some institutes focus almost completely upon the activities made possible by Public Law 98-242 and its predecessors. Others combine those activities with resources from a broader range of funding sources. The evaluation approach must be consistent in reviewing the basic duties of each institute while giving due recognition to the initiative and institutional support which lead to augmented programs. These dual perspectives can be addressed by separating the two determinations required by the act. The first, that of the "quality and relevance of its water research," will be based solely upon a review of the research record that has originated from the funding made available through the Department of the Interior. The second determination, that of the institute's "effectiveness as an institution for planning, conducting, or arranging research," provides the opportunity for acknowledging the conduct of activities supported by other funding sources . . .. In general, the evaluation process must be consistent in scope, yet flexible enough to recognize the values of diversity.

The plan also discussed the guidelines to be used in making the above determinations, in examining the information-transfer and student-training records of the institutes, and in applying four other criteria contained in the act. They were: (1) "accreditation in sufficient disciplines to successfully mount a multidisciplinary research program;" (2) "sufficient resources, including laboratory, library, computer and support facilities;" (3) "a sufficiently close administrative relation and physical proximity to the university and to all the parts of it needed to provide an effective working relationship with researchers in a wide range of disciplines;" and (4) "institutional commitment to the support and continuation of an effective water-research program." The guidelines made clear that the first two criteria applied to the host institution, not just the institute, and that the actual involvement of a range of disciplines, not just their availability, should be considered.

The plan specified that the evaluation should focus on those activities that have taken place within the preceding 4 years, described the general schedule that would have to be followed to complete the process within the 2 years required by the act, and outlined the procedures that would be used to select the team members. More information on these and other activities of the process is found in Appendix A, Procedures for Conducting the Evaluations.

The criteria and guidelines from the plan were refined by staff into 10 evaluation "elements," each described by "indicators." These "Indicators of Institute Effectiveness," found in Appendix B, became the basic working guide for institutes in preparing for the reviews and for evaluators in conducting them and drafting their reports.

At 48 institutes, the determination made was of continuing eligibility. Six institutes were seen by the teams to be deficient on one or more elements of the evaluation to such an extent that they received determinations of limited eligibility. The four institutes whose year of "probation" has expired at the time of this report have all submitted documentation of satisfactory remedial actions having been taken and have been restored to full eligibility.

In summary, the evaluation process was considered by all involved to have been conducted in full compliance with the legal requirements, in a fair and professional manner, and in a way that met the goals of objectivity and constructiveness.

SUMMARY FINDINGS

The evaluation teams found that all institutes are meeting the objectives of the authorizing legislation in that they (1) use the grant funds to support research projects that address water problems of State and regional concern; (2) provide opportunities for training of water scientists through student involvement on the projects; and (3) promote the application of the research results through preparation of technical reports and contributions to the technical literature. The differences among the institutes are ones of degrees of effectiveness, most often determined by the financial, political, and geographical contexts in which they operate and by the quality of their leadership.

This summary of those degrees of effectiveness is based on compilation of data from evaluation ranking sheets completed by each evaluator. The individual perceptions of overall effectiveness were used to develop a numerical score for each institute, not for the purpose of rank ordering, but to provide a tool for comparative analysis. More information on the methodology of the scoring process can be found in Appendix C.

The normal distribution of the scores made it possible to divide institutes into groups reflecting different ranges of perceived effectiveness. All final evaluation reports were reviewed to identify those characteristics most commonly shared by institutes in each group. This summary only identifies those characteristics; a more complete discussion of their nature and recurrence among the institutes as a whole follows in the next section.

Highest group:

On the ranking sheet, the highest level of perceived effectiveness was described as "Superior quality; an example for others." Four institutes are in this category. Although widely distributed geographically, they share certain other characteristics:

1. Each receives from the State, through its university's budget, an appropriation of funds that can be used for direct support of research projects in addition to those made possible by the the Geological Survey grant.

2. Each can and does generate other extramural funding for water-related research.

3. Each has a director whose major responsibility is the administration of the organization responsible for the work done with these funds, or has significant professional assistance to that end.

4. Each exists as a separate administrative entity within its university, with the director reporting to a level above that of a college dean.

5. Each receives from its host institution full salary support for the director and associated staff.

6. Each has an advisory structure that is actively involved in the definition of research priorities, the promotion of an interdisciplinary orientation, and quality control of the research program.

7. Each has in place a system of peer review that promotes the highest standards of quality in both the project selection process and the published products of the research.

8. Each makes a meaningful effort to involve other qualified academic institutions in its State in the Geological Survey grant program.

9. Each has an active information-transfer program conducted by a staff with professional communications abilities and strong ties to its State's Cooperative Extension Service.

10. Each is located at a university that has strong graduate education programs in water-related disciplines.

11. Each has a clear record of supporting research in a broad range of water-related disciplines.

12. None of the universities at which these institutes are located charge indirect costs against the Geological Survey grant funds.

Second-highest group:

The 13 institutes in this group received scores indicating a perception of "Consistently high quality; above usual expectations." They exhibit most of the characteristics of the highest group, with the notable exception that only six of them receive State funds for direct support of research beyond that supported by the Geological Survey grant. Only one of their host institutions does not waive indirect costs, and in three, the director's position must be partially supported by the grant. Several, while actively promoting information transfer, do not have the working relationships with the Cooperative Extension Service that typify the highest ranked institutes. Significant generation of other extramural funds is not as frequent, in some cases because of institutional constraints.

Middle group:

Nineteen institutes are in this largest group, receiving a ranking that indicated a perception of "Adequate consistent quality." The most common ways in which they differed from the two higher groups were in (1) less available administrative time for the director; (2) no State funding for direct support except on a project-by-project basis; (3) less administrative stature within the university structure; (4) more likelihood that the university was charging indirect costs against the grant; (5) less generation of extramural funds; and (6) less university support for staff positions.

Lower groups:

Twelve institutes were characterized by the evaluators as exhibiting "Sporadic quality; some weak, some strong." The areas that were most commonly addressed with suggestions and recommendations for improvement included:

1. The lack of a meaningful involvement, in an advisory role, of water-related interests from throughout the State in identifying those problems that should receive priority attention in the research program.

2. Inadequate procedures for peer review of proposals and products.

3. Lack of, or perfunctory participation by, an academic advisory board in setting policy, ensuring quality control, and encouraging the involvement of faculty from all water-related disciplines and all qualified institutions in the State.

4. Minimal efforts toward promoting the application of research results through active information programs, most often because of a lack of financial resources to do so.

5. Directors whose other academic responsibilities were so heavy as to prohibit institute activities beyond minimal administration.

6. Institutional policies that prevented the institute from seeking extramural support for water-related research beyond that supported by the Geological Survey grant.

7. Administrative relationships that prevented the institute from being recognized as a significant focal point for water-related research.

8. Lack of institutional commitment to the institute program in the form of administrative salaries, operational funds, or adequate facilities.

The six institutes that were placed on "probation" either demonstrated the kinds of problems identified above to such a degree that their effectiveness was severely limited, or had such unique problems as the lack of adequate documentation for the team, a lack of stable leadership or administrative oversight, and a severe shortage of qualified personnel to conduct research of professional quality.

The single most common problem facing the institutes as a whole is the lack of financial resources necessary to mount major research efforts that can make a significant impact in addressing the Nation's water problems. The best contribution that most of them can and do make is in fostering the importance of water research, attracting scientific talent to the field, and then supplying the "seed-money" projects where results can lead to major research efforts. The most successful institutes are those that, whatever their funding base, are seen as a focal point for water research, and so are recognized in their States as having a value far beyond that of administering their annual grant.

DISCUSSION OF INSTITUTE CHARACTERISTICS

The evaluators recognized that the matters of "research relevance," "research quality," and "effectiveness" are not ones that can be objectively defined or measured. To make these essentially subjective judgments as required by law, the evaluators necessarily had to examine the operating policies and procedures of the institutes as a measure of the overall product. As pointed out in the previous section, those institutes perceived to be most effective shared certain characteristics, and those 12 items provide a framework for discussing the kinds of attributes and problems most often observed by the evaluation teams.

1. State Funds. Although many institutes conduct research for State agencies on a project-by-project basis and many receive substantial operational support through their universities, only 10 of them receive State funds that can be used for discretionary support of research projects in addition to those

supported by Geological Survey funds. Whether combined with the Federal funds into a single competitive pool or awarded through a separate process, these unrestricted State dollars obviously give these institutes the greatest ability to contribute to the solution of their States' water-related problems. Even at those institutes that are limited to supporting research with Federal dollars combined with the required State match [1/], the evaluators generally found that the work being done was directly relevant to State needs. Their ability to make a major impact, however, is severely limited by the amount of funds available in comparison to the needs identified through their consultation processes with State interests. Expansion of their resource base with State funds is probably the key element in enabling institutes to better mobilize academic expertise in addressing the breadth of problems that exist. At the same time, availability of the Federal funds was seen to be critically important. Even at institutes with substantial State funds, it was pointed out to the evaluation teams that the significance of the Federal funds far outweighs their monetary value. Federal funding provides continuity, the opportunity to initiate new lines of research, and the rationale for existence that makes further growth possible.

2. Extramural Funds. At least 30 of the institutes have demonstrated a clear capacity for generating research support from such sources as the National Science Foundation, the U.S. Environmental Protection Agency, the U.S. Corps of Engineers, and private industry, and then maintaining budgetary and technical oversight for such projects even though the actual work may be conducted in other segments of the university. The ability to secure and manage such grants is largely dependent on two factors: first, the host institution's administrative policies; and second, the director's ability and motivation to pursue such funding sources. Several other institutes have external grants tied to the director's own research expertise alone, but such instances do not demonstrate the kind of coordinating activity that is one of the most valuable contributions that an institute can make in bringing the varied resources of an institution to bear on complex problems.

Although it is significant that extramural grants are so often brought to the universities by the institutes, it is equally important that such grants, wherever in the institution they may be housed, are often the result of efforts originated with institute support. Evaluation teams were given many illustrations of the productivity of the "seed-money" approach to the use of the Federal funds. Given that individual institute projects seldom exceed approximately $20,000 per year, their greatest value is often in providing the resources necessary to begin work on a promising research topic, the results of which can be used to demonstrate its validity to a sponsor with the larger funding needed to carry it forward. Unfortunately, those institutes that cannot retain administrative responsibility for such grants also

---

1/ The law requires in fiscal years (FY) 1985-1986, no less than one non-Federal dollar for each Federal dollar received; in FY 1987-1988, one and one-half non-Federal dollars for each Federal dollar; and in FY 1989, two non-Federal dollars for each Federal dollar.

tend to lose the institutional recognition for their originating role. The most successful institutes are those that, whether or not they manage external grants, perform a facilitating role in helping researchers build on their institute-sponsored activities and are viewed as the focal point for water-related research in the State and the university.

3. Director's Position. Two-thirds of the institute directors have an adequate assignment of time to that responsibility, depending not just on the individual's actual time allocation but on the availability of supporting staff. In the others, the evaluation teams usually recommended a greater allocation of a director's time to provide for program development and to carry out the coordination role called for by Public Law 98-242. A common and productive arrangement was seen to be one of a half-time assignment to institute management, with the rest of the time allocated to teaching, research, or administration in areas closely related to the institute's functions.

More important to the effective functioning of an institute director's position than time allocation are the abilities and qualifications of the incumbent. Experience in the conduct of water-related research and administrative ability are critical. The ability, however, to interact effectively within both the academic environment and the spectrum of water-related interests outside that environment also is essential if a director is to meet the responsibilities of an institute program. In those few instances where the evaluation teams had reason to question the appropriateness of a director's qualifications for the position, it was because the university in making the appointment had not adequately recognized the nature of the responsibilities and opportunities of the position. Appointment of a director and an associate director whose individual backgrounds and skills were complementary was often seen as particularly desirable.

4. Administrative Status. The placement of an institute within the university's organizational structure is a significant, but not necessarily determining, factor in its ability to function on a campus-wide, statewide basis. Those institutes that are in the best position to function in this manner have an independent status that provides easy access to the highest level of the university's administration. Thirty-three of the fifty-four institutes do have such administrative status and, in most cases, it is a positive attribute. A "free-standing" institute, however, may lack the visibility and support services that can only be secured through the pooling of its resources with a college or "umbrella" organization. In seven States, this kind of arrangement was seen to be working satisfactorily. In most of the others, however, the evaluators had reason to express some concern that the institute's placement within another organization constrained its ability to involve a full range of academic disciplines. On the other hand, there was concern in six cases where independent status was observed to have resulted in a lack of interest or oversight on the part of the senior administrative level to which they report. Whatever the administrative structure, the key necessity is a director's freedom, ability, and motivation to interact with a broad range of interests, both within and outside the university.

5. Position Support. Thirty-nine of the universities at which the institutes are located provide all of the salary of at least the director, and several of the larger institutes also have funded positions for other professional staff. Those institutes where a portion of professional salaries must come from the section 104 grant are at a distinct disadvantage. This situation reduces the proportion of the grant that can be allocated to direct project support, and it means that these salaries cannot be used as part of the non-Federal contribution of funds required by Public Law 98-242. Unless other significant sources of funds are available, these institutes are facing increasing difficulty in providing these matching funds. Those university administrators who expect an institute to be essentially "self supporting" are ones that tend to view the institute's responsibilities in a very narrow programmatic sense. Evaluators often stressed to administrators both the "land-grant mission" concept of the the program and the potential for growth that would be possible with additional institutional resources.

6. Advisory Structure. At fully half of the institutes, the evaluators saw reason to make suggestions for improvement in the composition and roles of advisory boards, whether ones made up primarily of representatives of water-related agencies and interests external to the university or of university faculty and administrators.

The evaluation teams invariably saw the active involvement of an external advisory body in helping the institute define its research priorities as extremely important. Where ones did not exist, the evaluation teams recommended their creation, and where existing groups were narrowly constituted or only nominally active, their broadening or reactivation was urged. Some institute directors expressed the view that the instability of the Federal funds over the last few years, and their low level relative to the problems an advisory group would identify, did not merit the effort needed to activate such a group. The evaluation teams, however, consistently pointed out the advantages to be gained in terms of constituency building, information transfer, and potential extramural funding, in addition to contributions to problem definition and priority setting.

The evaluation teams, too, often called for the creation or expansion of academic advisory groups that would build working linkages between the institute and all other water-related disciplines and activities. Members of such groups are most likely to participate in the proposal review process, but the teams saw their role as most valuable when it also was addressed to more general policy matters.

7. Peer-Review Process. As a means of judging the elusive element of research quality, the evaluation teams considered the matter of peer review from two perspectives. First, they looked at the record of peer-reviewed publications stemming from institute-sponsored projects. This record is generally satisfactory, especially at that majority of academic institutions where professional publication is stressed by their promotion and tenure policies. Secondly, they looked at the institute's procedures for peer review of proposals submitted for funding and of institute-published reports on completed research. Fifteen institutes were given suggestions for improving these procedures, most commonly in regard to broadening the number and range

of expertise of proposal reviewers. Institutes at several smaller institutions, particularly, were encouraged to go beyond their own campuses to get reviewers who possess the expertise to judge the scientific merit of proposals. Non-academic advisory boards were seen as being most valuable for judging the relevance of proposed work, but not necessarily its scientific merit.

8. Statewide Involvement. Except in those few States where the institute is located at the only existing research institution, almost all conduct a satisfactory statewide solicitation of proposals. Only seven institutes were urged to improve their performance in this area. Particularly admirable strategies for promoting meaningful statewide involvement were representation from other institutions on institute advisory bodies and actual visits by institute directors to other campuses to explain and promote the program. The routine distribution of program announcements was not seen as important as the active seeking out of relevant expertise, wherever it exists.

The statewide perspective and visibility of an institute was also most apparent when its director served as a member of State task forces or boards or on advisory bodies to other research organizations.

9. Information Transfer. Slightly more than two-thirds of the institutes have information-transfer programs that go beyond the basic distribution of research reports and the sponsorship of an occasional conference or workshop.

Fifteen of these have on their staffs either persons with professional communications training or specialists from the Cooperative Extension Service. All of these positions are largely supported by resources available in addition to the Geological Survey grant funds. At those institutes without such resources, active information-transfer programs are possible only when a director has the time and capability to promote the application of research results through a variety of means. At those institutes with minimal programs, evaluation teams recommended increased efforts to promote the visibility of their activities and products. The most frequent recommendation for improvement within recognized financial constraints was for more collaboration with other existing information networks, most notably the Cooperative Extension Service and university publications or public relations offices. One aspect of information transfer that received commendation where it occurred was the existence of a well-organized, accessible library containing the water-related "gray literature" that is unlikely to be available elsewhere.

10. Graduate Programs. All but one of the institutes are located at institutions with graduate-degree programs or have access to such programs at neighboring institutions. Therefore, graduate students are employed as research assistants on almost every project, with their work usually leading to a thesis or dissertation in a water-related discipline. This means that, in any academic year, approximately 250 graduate students are involved in institute-supported research.

Because of the usually limited funding and short duration of most institute projects, and because some universities offer doctoral degrees in only a limited number of fields, the majority of these students are in master's degree programs and pursue water-related careers in public agencies and private industry. Institutes at major universities with doctoral programs in a broad range of water-related disciplines, and particularly those with a nationally or internationally recognized reputation in water research, naturally support more of the doctoral degree candidates who are more likely to go into academic careers where they continue to pursue their research interests. The evaluation teams often recommended that institutes increase the funding duration of their projects to provide the continuity needed for completion of graduate-level research.

11. Multidisciplinary Research. The evaluation teams recommended to only six institutes that they should make an improved effort to support research in a greater variety of water-related disciplines, usually in the social sciences. Even at those institutes without significant extramural funds, and thus where work in only a few disciplines can be supported at one time, the record still shows a multidisciplinary approach to water research. The teams found that this multidisciplinary approach was most evident when the institute's advisory structure included representation of a broad range of interests and disciplines. They also viewed very favorably those cases where related projects were supported in different disciplines, with benefits to the participants and to the overall outcome of their work.

12. Waiver of Indirect Costs. Universities incur costs in maintaining their overall research capability, such as the provision of libraries, laboratory space, and administrative services. Any specific research activity's share of these indirect costs, or "overhead," either is paid for out of grant funds or waived by the university as a contribution to a jointly supported activity.

Because Public Law 98-242, unlike its predecessor legislation, does not prohibit the payment of indirect costs from grants to the institutes, 15 universities as a matter of policy have required this payment. The other 39 have continued to waive the charge. Where it is not waived, the proportion of the grant that can be used to support specific projects is reduced and the institutes cannot claim that amount as part of the required non-Federal matching funds. While at least part of these overhead funds are often returned to the institute for operational support, this policy does cause difficulty in maintaining a viable program. The problem is most acute for the five institutes who must charge both indirect costs and the director's salary against the grant.

CONCLUSIONS

The evaluation process accomplished its objective of giving every institute the benefit of an objective, constructive examination of its program by a team of qualified reviewers. All the institutes, even those that were viewed in the most favorable terms, benefited from the opportunity to have their accomplishments brought into focus for the attention of their university and State water communities by the visits of the evaluation teams. The six

institutes failing to receive approval for full continuing eligibility were given the motivation and specific requirements for significant improvement. At those institutes that received full approval along with suggestions and recommendations from the teams, improvements are dependent upon the extent to which those comments are acted upon. Informal communications already have revealed many instances of such actions. The institutes are being requested, in their fiscal year 1988 grant applications, to report on changes and improvements that have been made as a result of their evaluations. Documentation of overall program enhancement will be possible with their cooperation in responding to this request.

A common theme revealed by the evaluations was the critical importance to program effectiveness of a director's experience, availability, motivation, and ability to interact productively with water-related interests throughout the State. At the same time, it was clear that not all university administrators have had the opportunity to be fully informed on the nature of the responsibilities inherent in the institute director's position. To assist such administrators and to offer to all the institutes the benefit of the knowledge that has been gained through the evaluation process, the Geological Survey is establishing a program management advisory service. This service will be available primarily for those institutes whose evaluations revealed problems that could be alleviated by application of experience elsewhere, for institutes requesting advice because of new problems or changing circumstances, and for institutes with new directors.

The most general conclusion that can be drawn from the evaluations is that the institutes as a whole are using their Federal funds in a cost-effective manner by marshaling the resources of the academic community to address important problems identified in cooperation with water interests in the States. Thus, they are serving the national interest as envisioned by the authorizing legislation.

APPENDIX A

PROCEDURES FOR CONDUCTING THE EVALUATIONS

A. Team selection:

Public Law 98-242 requires that each evaluation team be made up of five specific types of persons. They were selected as follows:

1. Employee of the Department of the Interior. This member served as the team leader and was chosen from the District Chiefs of the Water Resources Division of the Geological Survey, as nominated by the Regional Hydrologists. Seven District Chiefs were included on this roster and led teams in regions other than those of their current District assignment.

2. Director of another water-research institute. This member was chosen on the basis of experience, availability, and location, so that there were no directly reciprocal or intra-regional evaluations. Eleven directors made up this roster, with two others serving as general advisers.

3. University faculty member or administrator. Persons with experience relevant to the conduct or administration of water-resources research were nominated by institute directors. Selections were made on the basis of availability and location. This team member was always chosen from a State other than that of the institute being evaluated, but within the same geographical area. Sixteen persons filled this role.

4. State or local water-resources employee from the State of the institute being evaluated. Nominations were provided by the Water Resources Division's District Chief in each State.

5. Private citizens. Each institute director was asked to submit the names of three individuals who were familiar with water problems and issues of the State; the final selection rested with the Geological Survey.

This mix of types of team members proved extremely workable by combining outside expertise and objectivity with the knowledge of State issues and circumtances needed to conduct the review within a limited time period. Each team was accompanied by the same staff member from the Geological Survey, who always served as executive secretary, and as team leader on eight occasions when District Chiefs were not available.

The evaluation schedule was established so that two neighboring institutes could be visited in 1 week, with the three team members from out of State participating in both visits. All travel expenses, but not honoraria, were paid by the Geological Survey. A full complement of five team members was present for the evaluation of each institute, and all evaluations were completed as scheduled.

B. Pre-site visit activities:

Team members from the first two categories met in an orientation session with Geological Survey staff in July 1985, after the general process had been established. A consensus was reached on the operational procedures to be followed. Each team held a brief orientation meeting before the evaluation began to discuss objectives and procedures and to address questions. A staff-prepared document, the "Guide for Evaluators," was sent to each team member in advance and proved to be adequate as an introduction to the process and a definition of responsibilities.

As required by 30 CFS 401, formal notice of the impending visit of an evaluation team was provided by the Geological Survey to each institute at least 60 days in advance. Each institute, however, was given the entire schedule before the process began, and staff contact was made before the formal notification to discuss general arrangements and to identify the private citizen members. The "60-day letter" listed the evaluation elements, gave guidance on the briefing materials, and set a deadline of 2 weeks in advance for their receipt by the team members. The goal of constructive criticism was emphasized.

This letter of notification satisfied legal requirements, but another letter was sent from the Director of the Geological Survey to the president or chancellor of the responsible institution to outline the purpose of the visit and identify the team members. This step proved to be helpful to the institute directors in arranging meetings between the teams and the university administrators.

The institutes were required to address the 10 evaluation elements in the briefing materials, with direction as to specificity of subjects of importance from the "Indicators of Institute Effectiveness." Despite these uniform instructions, however, the quality, completeness, and usefulness of the advance briefing materials varied considerably among institutes. When, as in most cases, they were conscientiously prepared, the teams had most of the basic information they needed and could use the site visit most productively. When the materials were inadequately prepared, the team members were forced to spend most of their time ascertaining basic facts. The quality and timeliness of the briefing materials also were important in that they gave an initial impression of an institute's efficiency, its staff capabilities, and the seriousness with which it approached the evaluation.

The institutes were directed to obtain approval of the executive secretary for their proposed site visit agendas to ensure that all pertinent areas were covered.

C. The site visit:

On the first evening of the evaluation visit, the team members were often guests at a reception or dinner attended by persons who would meet with them the following day. These social occasions were not only enjoyable expressions of the universities' professional courtesy to the visitors, but were helpful in providing an opportunity for "one-on-one" conversations and in paving the way for the more formal interviews.

At a minimum, the institutes were asked to plan an agenda that included:

Opening meeting with the director/staff.
Meeting with university administrators.
Meeting with campus advisory group.
Session focusing on information-transfer activities.
Meeting with research faculty.

The most common additions to these agenda items were meetings with graduate students, meetings with off-campus advisory groups when logistics permitted, and tours of special research facilities. Only in those rare cases where adequate advance preparations had not been made were the team members unable to obtain to their satisfaction the information they needed to make their report. On the whole, cooperation from all involved was excellent and spoke well of the institutes' stature in the university community. When faculty from other institutions and public agency or other representatives of water-related interests traveled long distances to meet with the team, a particularly favorable impression of the institute's statewide image was gained.

At the end of a long and intense day of meetings, the team would meet alone to discuss its findings and agree on the points to be covered in its final report. The discussions were candid and thorough, with the objective of reaching a group consensus before individuals drafted their assigned sections of the report. The most important function of the team leaders was to chair these discussions and to ensure that all relevant points were covered and all views considered. The writing process often went on well into the night, especially for the two academic team members who were responsible for reporting on elements that dealt with the more generic issues of research quality, coordination, training, interdisciplinary relationships, institutional resources and commitment, and administrative relationships. The in-State evaluators, because of their familiarity with each State's problems and needs, were asked to draft the sections on research relevance and information transfer. Again, it is critical to understanding the evaluation process to recognize that although different individuals drafted certain sections of the reports, their total substance resulted from consolidated group effort. Serious differences were rare, and were resolved before discussions with institute personnel and university administrators.

Two exit interviews were conducted on the morning of the final day, one with the institute director (and associated staff, if appropriate), and another with senior administrator(s) to whom the director was responsible. The purpose of the separate interviews was to allow for appropriate differences in emphasis, but a standing rule of the process was that both interviews would include the same information. Each interview was opened with a statement by the leader of the team's recommendation as to future eligibility.

The team members made oral presentations on those elements for which they had individual lead responsibility. Almost invariably, the interviews concluded with expressions of appreciation for the hospitality of the institution and the work of the team. When the site visit began on a Monday and concluded on a Wednesday, the out-of-State members moved on to the next evaluation. Only in the cases of Guam, Hawaii, and Alaska was it necessary to allow more than a half-day of traveltime.

D. Post-site visit activities:

Within 10 days after each site visit, the team leader submitted the draft report to Geological Survey Headquarters as evidence that the evaluation had been properly conducted. At the same time, the draft was sent to the team members for their comment and to the institute director for verification of its factual content. It was made clear, however, to both writers and recipients, that the final report should not include any substantive information that had not been presented at the exit interviews. The team leaders, after incorporating any suitable comments, corrections, or revisions, transmitted a final version to the Geological Survey Headquarters where it was reviewed and revised for editorial consistency and clarity. The final report was transmitted by the Director of the Geological Survey to the chief administrative officer of the academic institution, with copies to the institute director, the senior administrators with whom the team had interacted, and the team members. The letters transmitting the reports stated the Geological Survey's determination as to the future eligibility of the institute, based on analysis of the teams' reports and their recommendations on this matter. The letters also pointed out those program attributes particulary worthy of commendation and areas where improvements were possible. The approach in these letters was one of positive support where warranted and of constructive criticism where needed.

In the six cases where the determination was one of limited eligibility, the letters specified the actions needed in the next year if unlimited eligibility was to be regained.

APPENDIX B

INDICATORS OF INSTITUTE EFFECTIVENESS

1. Research Relevance

   a. Broad range of State interests actively involved in advisory capacity.
   b. In-State evaluators provide examples of usefulness of research.
   c. Briefing materials demonstrate clear linkage of research program and identifiable problems.
   d. Direct State funds available for research support.
   e. Examples of problem solution provided in briefing materials.

2. Research Quality

   a. Most projects result in peer-reviewed, professional publications.
   b. Researchers held in high professional regard by colleagues.
   c. Most research personally directed by experienced faculty.
   d. Deans/Department heads have positive view of research products.
   e. Quality-control procedures are evident in project selection process.

3. Research Coordination

   a. Interaction with other research programs on campus/in State.
   b. Proposals actively solicited from other institutions in State.
   c. Generation of funded projects from sources other than the Geological Survey.
   d. Participation in regional research initiatives.

4. Information Transfer

   a. Products promote the application of research results.
   b. Public awareness of institute activities.
   c. Staff with professional communications qualifications.
   d. Cooperation with other university/State communications networks.
   e. Maintenance of reference collection for researcher/public use.

5. Training

   a. Graduate students supported by most projects, leading to advanced degrees.
   b. Former students employed in water-related professional positions.

6. Accreditation

   a. Briefing materials document institutional accreditation in major water-related fields.

7. Physical Resources

   a. Briefing materials document presence and use of needed laboratories, libraries, computer facilities, and so on.

8. Interdisciplinary Relationships

   a. Principal water-related disciplines represented on advisory body.
   b. Projects funded to a variety of disciplines.
   c. Interdisciplinary projects encouraged.

9. Administrative Relationships

   a. Access/influence of Director with pertinent segments of institution.
   b. Director has adequate assignment to research administration.
   c. Director's other responsibilities closely related to institute functions.
   d. Management procedures promote adequate accountability.

10. Institutional Commitment

   a. Hard-money positions for institute Director/staff.
   b. Line-item budget for institute support.
   c. Waiver of indirect cost recovery.
   d. University administrators knowledgeable and interested concerning program.
   e. Institute interests are well represented by institution in budget processes.

APPENDIX C

METHODOLOGY FOR INSTITUTE CATEGORIZATION

At the end of each evaluation visit, following oral presentation of the draft report, each team member was asked to complete an evaluation ranking sheet. The sheets contained abbreviated versions of the 35 Indicators of Institute Effectiveness grouped under the heading of the 10 evaluation elements. Each team member individually scored all of the Indicators on a scale of 1 to 5, indicating their personal perceptions of that institute's level of performance. The team members were told that these rankings would be used only for compiling summary data.

The ranking sheets were scored as follows: the scores for the indicators of each element were totaled, for example, indicator rankings of 3, 3, 4, 4, and 5 under the element of "relevance" resulted in a raw score of 19. These raw scores were totaled for the 10 elements and the 5 evaluators' raw scores totaled. Because of a few missing cases, neither total raw scores nor averages could be used for comparative purposes. Instead, the raw scores were translated into a percentage of the total possible points available (875 when all five ranking sheets were completed.) Similar percentage results were computed for each indicator and for each evaluator, revealing a level of consistency among team members that validates use of the total scores as a measure of comparative analysis.

APPENDIX D

EVALUATION PARTICIPANTS

USGS Team Leaders

Jeffrey T. Armbruster, Chief, Georgia District
James F. Blakey, Regional Hydrologist, Central Region
Charles W. Boning, Chief, Texas District
Philip A. Emery, Chief, Alaska District
Madge O. Ertel, State Liaison Specialist, Reston, Virginia
Ivan C. James II, Chief, New England District
L. Grady Moore, Chief, North Dakota District
Garald G. Parker, Jr., Chief, Pacific Northwest District

Institute Directors: Team Members

Marvin T. Bond, Water Resources Research Institute, Mississippi State University
Gordon L. Byers, Water Resources Research Center, University of New Hampshire (now retired)
James P. Heaney, Water Resources Research Center, University of Florida
L. Douglas James, Center for Water Resources Research, Utah State University
Peter C. Klingeman, Water Resources Research Institute, Oregon State University
Archie J. McDonnell, Environmental Resources Research Institute, Pennsylvania State University
William L. Powers, Water Resources Center, University of Nebraska
J. Herbert Snyder, Water Resources Center, University of California-Davis (now retired)
Robert C. Stiefel, Water Resources Center, The Ohio State University
Robert D. Varrin, Water Resources Center, University of Delaware
William L. Walker, Water Resources Research Center, Virginia Polytechnic Institute and State University

Institute Directors: Advisers

Thomas G. Bahr, Water Resources Research Institute, New Mexico State University
James C. Warman, Water Resources Research Institute, Auburn University

Institute Directors: Reviewers of Draft Report

T. Al Austin, Water Resources Research Institute, Iowa State University
Gordon Chesters, Water Resources Center, The University of Wisconsin
James C. Warman, Water Resources Research Institute, Auburn University

University Faculty and Administrators: Team Members

David J. Allee, Department of Agricultural Economics, Cornell University
A. Bruce Bishop, Dean, College of Engineering, Utah State University
N. Bruce Hanes, Department of Civil Engineering, Tufts University
William E. Kelley, Chairman, Department of Civil Engineering, University of Nebraska
George J. Kriz, Associate Director, Agricultural Research Service, North Carolina State University
Joseph S. Larson, Director, The Environmental Institute, University of Massachusetts
Marion T. Loftin, Vice President for Graduate Studies and Research, Mississippi State University (now retired)
Roger A. Minear, Director, Institute for Environmental Studies, University of Illinois
Ronald M. North, Director, Institute of Natural Resources, University of Georgia
Stephen C. Smith, Associate Dean, School of Natural Resources, University of Wisconsin (now retired)
Robert M. Sweazy, Associate Vice President for Research, Texas Tech University
Paul D. Uttormark, Director, Sponsored Programs Division, University of Maine
Warren Viessman, Jr., Chairman, Department of Environmental Sciences, University of Florida
Joseph W. Westphal, Chairman, Department of Political Science, Oklahoma State University
Louis F. Weschler, School of Public Affairs, Arizona State University
Reginald H. F. Young, Associate Dean, College of Engineering, University of Hawaii

State Water Agency Representatives and Private Citizens: Team Members

Alabama:
James McIndoe, Alabama Department of Environmental Management
Dennis Smith, Stauffer Chemical Company, Bucks, Alabama

Alaska:
William Barnwell, Deputy Director, Alaska Department of Natural Resources
Cyril Wanamaker, Alaska Water Resources Board (public member), Juneau, Alaska

Arizona:
Philip Briggs, Deputy Director, Arizona Department of Water Resources
Marybeth Carlile, Southern Arizona Water Resources Association, Tucson, Arizona

Arkansas:
Earl Smith, Arkansas Soil and Water Commission
Charles Smith, Arkansas Federation of Water and Air Users, Inc., Little Rock, Arkansas

California:
Randall Brown, Chief, Bay Delta Studies, California Division of Water Resources
W. R. Z. Willey, Environmental Defense Fund, Berkeley, California

Colorado:
Harold Simpson, Deputy State Engineer, Colorado Division of Water Resources
Kenneth Wright, Wright Water Engineers, Inc., Denver, Colorado

Connecticut:
Hugo Thomas, State Geologist and Director, Natural Resources Center, Connecticut Department of Environmental Protection
Richard McHugh, New Haven Water Company, New Haven, Connecticut

Delaware:
Gerard Esposito, Deputy Director, Water Resources Division, Delaware Department of Natural Resources and Environmental Control
Norman Wilder, Delaware Academy of Science, Hockessin, Delaware

District of Columbia:
James Collier, Chief, Water Hygiene Branch, District of Columbia Department of Consumer and Regulatory Affairs
James Hannaham, Washington, D.C.

Florida:
Gary Kuhl, Executive Director, Southwest Florida Water Management District
Ignacio Garcia-Bengochea, CH2M Hill, Gainesville, Florida

Georgia:
David Word, Chief, Water Resources Management Branch, Georgia Department of Natural Resources
G. Robert Kerr, Georgia Conservancy, Atlanta, Georgia

Guam:
James Branch, Administrator, Guam Environmental Protection Agency
Mark Hurford, Tamuning, Guam

Hawaii:
Menabu Tagomori, Manager-Chief Engineer, Division of Water and Land Development, Department of Land and Natural Resources
Michael Chun, Park Engineering, Honolulu, Hawaii

Idaho:
Wayne Haas, Idaho Department of Water Resources
Dale McGreer, Potlatch Corporation, Lewiston, Idaho

Illinois:
Donald Vonnahme, Director, Division of Water Resources, Illinois Department of Transportation
Kenneth Kesler, Dewey, Illinois

Indiana:
William Andrews, Deputy Director, Bureau of Water and Mineral Resources, Indiana Department of Natural Resources
George Herr, Eli Lilly and Company, West Lafayette, Indiana

Iowa:
Bernard Hoyer, Associate State Geologist, Iowa State Geological Survey
Harold Jensen, Jensen, Cary and Shoff, Cedar Falls, Iowa

Kansas:
James Power, Division of Environment, Kansas Department of Health and Environment
Larry Panning, Ellinwood, Kansas

Kentucky:
Leon Smothers, Assistant Director, Kentucky Natural Resources Environmental Protection Cabinet
Raymond Barber, Lexington, Kentucky

Louisiana:
Coan Bueche, Chief, Federal Project Section, Louisiana Department of Transportation and Development
Dhamo Dhamotharan, Woodward-Clyde Consultants, Baton Rouge, Louisiana

Maine:
Matthew Scott, Director, Division of Environmental Evaluation and Lake Studies, Maine Department of Environmental Protection
Darryl Brown, Livermore Falls, Maine

Maryland:
Emery Cleaves, Deputy Director, Maryland Geological Survey
Arthur Theisen, Soil and Land Use Technology, Inc., Columbia, Maryland

Massachusetts:
Russell Isaacs, Division of Water Pollution Control, Massachusetts Department of Environmental Quality
John Fitch, Massachusetts Audubon Society, Lincoln, Massachusetts

Michigan:
R. Thomas Segall, Chief, Geological Survey, Michigan Department of Natural Resources
William Rustem, Public Sector Consultants, Inc., Lansing, Michigan

Minnesota:
Jack Ditmore, Deputy Director, Minnesota State Planning Agency
Marilynne Roberts, Hamline University Law School, St. Paul, Minnesota

Mississippi:
Charles Branch, Director, Bureau of Land and Water Resources
Larry Otis, Tupelo, Mississippi

Missouri:
Jerry Vineyard, Division of Geology and Land Survey
Bill Keener, Boone County Regional Sewer District, Columbia, Missouri

Montana:
Loren Bahls, Montana Department of Health and Environmental Sciences
Arlene Hill, Raynesford, Montana

Nebraska:
Verlon "Tony" Vrana, Chief, Planning Division, Nebraska Natural Resources Commission
Hal Schroeder, Olsson Associates, Lincoln, Nebraska

Nevada:
Peter Morros, Nevada State Engineer
Thomas R. C. Wilson III, Reno, Nevada

New Hampshire:
David Scott, Director, Office of State Planning
Richardson Blair, Holderness, New Hampshire

New Jersey:
William Whipple, Assistant Director, Division of Water Resources, New Jersey Department of Environmental Protection
Peggy McNeill, Princeton, New Jersey

New Mexico:
William Fleming, New Mexico State Engineer Office
Mary Thompson, Las Cruces, New Mexico

New York:
William Lee, Division of Water, New York Department of Environmental Conservation
Lydia Tortora, Mattituck, New York

North Carolina:
George Everett, Division of Environmental Management, North Carolina Department of Natural Resources and Community Development
Lucius Pullen, Texasgulf Chemicals Company, Raleigh, North Carolina

North Dakota:
Milton Lindvig, North Dakota State Water Commission
William Guy, Bismarck, North Dakota

Ohio:
John Estinik, Division of Water Quality Monitoring and Assessment, Ohio Environmental Protection Agency
Sherman Frost, Columbus, Ohio

Oklahoma:
James Barnett, Executive Director, Oklahoma Water Resources Board
Robert S. Kerr, Jr., Oklahoma City, Oklahoma

Oregon:
Darrell Learn, Chief of Policy and Planning, Oregon Water Resources Department
James Howland, CH2M Hill, Corvallis, Oregon

Pennsylvania:
John McSparran, Director, Bureau of Water Resources Management, Pennsylvania Department of Environmental Resources
Lysle Sherwin, Loyalhanna Watershed Association, Ligonier, Pennsylvania

Puerto Rico:
Felix Aponte, Director, Water Resources Division, Puerto Rico Department of Natural Resources
Ramon Amador, The Upjohn Manufacturing Company, Barceloneta, Puerto Rico

Rhode Island:
Daniel Varin, Chief, Rhode Island Statewide Planning Program
Milton Saloman, Bradford, Rhode Island

South Carolina:
Ann Nolte, Executive Assistant for Policy Development, South Carolina Water Resources Commission
B. C. Spigener, Soil and Material Engineers, Inc., Columbia, South Carolina

South Dakota:
Mark Steiken, Deputy Secretary, South Dakota Department of Water and Natural Resources
Donald Faulstich, Highmore, South Dakota

Tennessee:
Elmo Lunn, Administrator, Division of Water Management, Tennessee Department of Health and Environment
Tony Campbell, Tennessee Conservation League, Nashville, Tennessee

Texas:
Tommy Knowles, Director, Water Availability Data and Studies Section, Texas Water Development Board
Wayne Wyatt, High Plains Underground Water Conservation District #1, Lubbock, Texas

Utah:
Genevieve Atwood, Director and State Geologist, Utah Geological and Mineral Survey
Wayne Criddle, Salt Lake City, Utah

Vermont:
David Clough, Director, Water Quality Division, Vermont Department of Natural Resources
Monty Fisher, Vermont Natural Resources Council, Montpelier, Vermont

Virginia:
Bernard Caton, Director, Office of Policy Analysis, Virginia State Water Control Board
Joseph Cragwall, Jr., Virginia State Water Control Board (public member), Annandale, Virginia

Virgin Islands:
Brian Turnbull, Assistant Director, Virgin Islands Planning Office
Alton Adams, Adams and Associates, St. Thomas, Virgin Islands

Washington:
Robert Monn, Water Quality Management Division, Department of Ecology
Dennis Ashlock, Liberty Lake, Washington

West Virginia:
Robert Erwin, State Geologist, West Virginia Geological and Economic Survey
Perry Bryant, West Virginia Citizens Action Group, Charleston, West Virginia

Wisconsin:
Bruce Baker, Director, Bureau of Water Resources Management, Wisconsin Department of Natural Resources
James Wood, Wood, Brophy and Wood, Madison, Wisconsin

Wyoming:
Michael Carnevale, Water Quality Planning Supervisor, Wyoming Department of Water Quality
Myron Goodson, Sundance, Wyoming

☆ U.S. GOVERNMENT PRINTING OFFICE 1988 - 201-933 - 226/60076