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THE WASTE-MANAGEMENT EDUCATION & RESEARCH CONSORTIUM

ANNUAL PROGRESS REPORT, 1992-1993

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FINAL REPORT FOR 1992-1993

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INTRODUCTION

Efficient and safe management of nuclear, hazardous and solid waste is an increasingly critical national issue. Further, it is a broad multi-disciplinary issue that cannot be addressed by any one entity or organization, but requires a collaborative effort between multiple organizations with diverse expertise and experience.

In February, 1990, The Secretary of Energy, James Watkins, approved a grant for a waste-management education and research consortium program proposed by New Mexico State University (NMSU) to the U.S. Department of Energy (DOE). This program known by the acronym, "WERC" includes as its founding members NMSU, the University of New Mexico (UNM), the New Mexico Institute of Mining and Technology (NMIMT), the Los Alamos National Laboratory, and the Sandia National Laboratories. The Navajo Community College joined the program later in 1991.

The program has the mission of expanding the nation's capability to address the issues related to management of all types of waste. The program is unique and innovative in many aspects. It provides an integrated approach to this national need, and includes:

1) Education in waste management at the educational institutions resulting in graduate, undergraduate, and associate degrees with concentration in environmental management. (The terms waste management and environmental management are used in a broad sense throughout this paper and includes all aspects of environmental management and environmental restoration.)
2) Professional development via teleconference for industry and government.
3) Technology development programs at the leading edge, providing hands-on training at the leading edge to students and information feeding into the education programs.
4) Education by technology development at the campuses, as well as from four field sites.
5) Ties with other multidisciplinary university facilities.
6) Ties with two National Laboratories (Los Alamos & Sandia) located in New Mexico and with the Oak Ridge Associated Universities and others.
7) Technology transfer and education via an existing fiber optic network, a satellite link, and an existing state-wide extension program.
8) Outreach programs of special interest to pre-college students, communities and business and government leaders throughout the United States.

Educational Courses

In the first three years, WERC successfully implemented the following educational programs:

1) An undergraduate option or concentration in Environmental Management at the three consortium universities with a major in any field that is accredited and provides the necessary prerequisites. This program is available to over 30,000 students, in schools with minority enrollment of about 35%.

2) Master of Science degree options in any field that provides the necessary pre-requisites.

3) A Master of Science in Environmental Engineering started with students enrolled, but with state approvals still in the process.

4) A two-year Engineering Technology Associate degree program in Hazardous & Radioactive materials handling at Carlsbad, New Mexico and a two-year program for Native American students at the Navajo Community College. NCC has about 600 students with a 95% minority enrollment.

5) A professional development intensive state-of-the-art series presented through interactive satellite video to laboratories, industry, and federal agencies throughout the country with a current enrollment of over 1000 professionals.

6) A capstone design course on environmental process design with competition between universities at an international level.

7) Pre-college education programs interesting thousands of students in science and engineering.

8) An International Environmental Fellows Program to provide graduate level education to emerging leaders from government and industry.

9) A two-year Solid-Waste Management degree program for Native American students.

The Consortium's first major task in education was to set up the curriculum and establish undergraduate degrees at the Consortium universities in the fields accredited by ABET. This resulted in options leading to a minor in Environmental Management in Fall 1990.

The core programs necessary to satisfy ABET requirements in each of the disciplines are specified in the catalogs of the respective universities. These core requirements are supplemented by 18-30 hours of courses relevant to waste management, covering not just technology, but also other aspects such as legal, public policy, economics and risk evaluation. These courses were reevaluated in 1992-93, and modified as necessary.

The graduate program was also established by Fall 1990. This program requires the students to take core courses in their chosen discipline, but with approximately one half of their credits in the waste management concentration, including a research thesis or research project in waste management. Graduates of these programs are ready to take leadership roles in industry and government.

The Associate Degree program was started in Fall 1991 in radioactive and hazardous materials technology closely patterned after the accredited engineering technology programs offered on the main campus of NMSU at Las Cruces. An important feature of the new curriculum is the high degree of transferability into existing, accredited four-year engineering technology programs. The engineering technology approach to program design and operation carries implications with respect to faculty credentials as well as course content, level and rigor. The technology program uses the WIPP facility in conjunction with the New Mexico State University Carlsbad Campus as the training facilities. This program was reevaluated in 1992-93 and a 40 hour OSHA course was added to assist the graduating students. Graduates of this program are prepared for entry-level employment as technicians in industries, laboratories and government agencies concerned with the generation, mining, disposal, transportation, storage or regulation of hazardous wastes and materials.

In Fall 1991, a two-year program in environmental science was also started at the Shiprock campus of the Navajo Community College, together with a laboratory for hands-on training. Expansion of this program to solid waste management was implemented in 1992-93; this is expected to have 100 students by the third year.

A major emphasis of the consortium is to interchange courses between the Universities and to transmit the courses throughout the U.S. and even internationally. An interactive satellite video system has been set up. The satellite system has been installed and is currently in use for course transmission between the three universities as well as to several other sites. Six to eight different courses have been transmitted in Spring 1991, Fall 1991, Spring 1992, Fall 1992 and Spring 1993. These courses have changed every semester and presented economic, legal, policy, management, and technical courses in the problems of radioactive, hazardous, and solid waste management and environmental restoration for U.S. research, industry and educational facilities.

As part of the program, student fellowships have been awarded to both undergraduate and graduate students. These fellowships are awarded on basis of academic merit and desire to pursue a career in the environmental field. In the third year approximately 80 fellowships were awarded to undergraduate students and an equal number of graduate students were awarded research assistantships. Industrial interest has resulted in increase of our fellowship funds, thus leveraging the DOE funds.

The degree programs started in Fall 1990 at all three universities. The enrollment has grown since the start of the program. The first year's enrollment was 198 and this increased to 471 in the second year and to 500+ in year three. The Consortium awarded about 40 degree minors and certificates. Our estimate is that we will be awarding 100-200 degrees with the environmental concentration (or minor) in the first 4 years of the program, leveling off at about

100 each year.

As part of the effort to introduce a design component and, at the same time, encourage inter-university exchange of information, we have developed and implemented an international university design competition. Universities throughout the United States, Canada and Mexico were invited to compete in the design of a plant for an environmental process and follow this up with a small scale demonstration at a central site. This provided a capstone design course to some universities and, at the same time, brought university students and faculty from diverse parts of America together to exchange information. In 1991, we had seven universities participating and 19 universities participated in 1992. The first two years have been fantastic successes in achieving the objectives of design education and information exchange based on feedback from the participants and the judges. In 1993 we expect the competition to grow to 30-40 teams.

Pre-college education projects (under WERC but funded separately) were also started, including:

1) A summer intensive training course in environmental design for high-school teachers and students,

2) a pilot program on a Los Alamos originated program for student participation called "Students Watching Over Our Planet Earth" (SWOOPE) and

3) a project for international water quality monitoring for high-school students called project Del Rio.

4) a summer internship program (Project SEED) in cooperation with the ACS.

5) a project to produce research results videos to interest pre-college students in environmental discoveries.

6) presentations to high-schools on WERC.

Education By Technology Development

A very important result of the WERC program is the production of students with advanced degrees in environmental management via hands-on independent technology development projects at the leading edge of technology. This form of education is the focus of our technology development projects.

The scope of the Center's research is broad-based and is designed to include all areas of radioactive, hazardous and solid waste management and environmental restoration. The third round of projects were selected from proposals submitted by faculty and employees of the consortium members with collaboration from the National Laboratories and industry.

The third round process started with solicitation of proposals. The evaluation of projects to fund was made by a panel of experts based on the following criteria: student education potential, technical merit, collaboration between universities and national laboratories, application to critical issues, industry involvement and investigator's credentials. The final selection was made by a committee of the Consortium Members using the evaluations of the experts as a guideline.

In the third round we received 71 proposals. Forty-three of these were selected for funding. These projects were scheduled to start in February 1992, but for many the start was delayed to April 1992 due to a delay in budget approval. These covered a range of waste management issues. Almost all of these projects have principal investigators from at least two universities and a national laboratory. A fourth round of 81 proposals were received in October 1992. Following an evaluation, as above, 35 were chosen for funding in 1993 and the projects are scheduled to start in February 1993, after approval of the fourth year's budget.

As a means of facilitating the use of the results for education in a timely manner, a special teleconference was conducted on the Clean Water Act that attracted a very wide professional audience. A major conference on research results was conducted at Los Alamos with over 150 participants.

It is too early to predict the impact of the technology development projects. However, several of the projects are already showing promise for meaningful applications, examples of these are shown in Table 2. It is our objective that in the next 2 years, commercial applications will result from this program activity. Equally important is the practical experience that about 150 faculty members and students are getting from the involvement in the research projects and the exchange of technology between the universities, the national laboratories and industry.

Educational and Testing Facilities

Four facilities have been set up to assist with the research and education.

1) The Soil-Water-Air Testing Facility (SWAT) at Las Cruces is functional and is currently providing analytical services in the areas of toxic and hazardous waste management to faculty and students from the universities and other organizations. The laboratory is equipped for physical, inorganic, organic and bacterial analysis of soil, water, air, and plants.

2) The Environmental Radioactive Measurement Laboratory (ERML) has the role of exploratory development and projects associated with transuranic waste isolation. Furthermore, it provides support for radioactive related technology development and for instrumenting experimental activities planned by other facilities.

3) The Oil-Water Experimental Facility at Hobbs (HOWE) provides for educational, and development programs related to environmental and waste disposal concerns of the petroleum industry in the United States. A field laboratory is also available for use. The field laboratory consists of a watered out petroleum reservoir. The producing formation is approximately 2,000 feet deep and 15 feet thick.

4) The Navajo Drylands Environmental Laboratory (NDEL) at NCC provides for environmental education and monitoring by the Native American students in the Shiprock area.

It is particularly important to note that each of the facilities has an educational component and a technology transfer component.

Technology Transfer

The technology transfer function of the Consortium is emphasized throughout the program. Specific activities for technology/knowledge transfer noted below are in various stages of implementation:

- An Executive Board, an Executive Committee and an Advisory Board composed of representatives from top management of government, industrial, academia and environmental organizations have been formed and functioning for the purpose of directing the program.

- Continual dialogue has been started with industry and government agencies via an Industrial Liaison Program, via briefings and via newsletters.

- The educational program is continually transferring knowledge from theory and research to the hundreds of students and industrial professionals.

- Technology development results are being transferred via seminars and via formal contacts with participants from industry and government. Results from each funded project are reported each quarter. The fiber optic communication network and the satellite link are used for wide communication of the results. A special teleconference on the Clean Water Act attracted a wide professional audience.

- An eleven part professional development teleconference series was completed on topics of interest to participants from government and industrial organizations. This series was transmitted via the satellite system throughout the U.S. Two new series, one on Risk Assessment and another on Radioactive Waste Management will be presented in 1993. A very successful "Ask-the-Experts" workshop was held to culminate the 1992 series and introduce the 1993 series.

- Over 80 technical papers have been presented and published on the various aspects of this program. This includes papers on progress in the education program, the laboratory operations, and the technology development results.

- A number of organizations have joined the Consortium's Industrial Affiliation Program and the program is being expanded to others.

Technology transfer is only meaningful if the information is utilized by the outside world. Therefore, the Consortium holds meetings and seminars where industrial and government

representatives discuss implementation of project results. These seminars, meetings, and workshops are held at various locations, including the three Consortium University campuses, the national laboratories and three field laboratory sites. A major conference on research results was held at Los Alamos in 1992 with over 150 attendees.

Outreach

Four significant outreach activities have started in 1992-93. These are:

1) An Environmental Fellows Program has been initiated to train emerging leaders from industry and government in environmental management. An international component of this program includes participants from Mexico and Europe. Currently twelve Fellows from Mexico have started.

2) A major new effort called the Carlsbad Environmental Monitoring & Research Center (CEMRC) has been started on environmental monitoring of the Carlsbad, New Mexico area. This community is located near the Waste Isolation Pilot Plant (WIPP) facility which is planned as a repository for transuranic (TRU) wastes. This program was started at the req' est of the Carlsbad community. An independent group has been formed to do complete monitoring of the area (flora, fauna, etc.). This group, which reports to the Director of WERC, will generate the data using state-of-the-art techniques and will also conduct research on monitoring techniques. This program is under the WERC management, but supported by other funds.

3) A solid waste management educational program has been started at NCC which will provide associate degree education to 100 Native American students annually. This will utilize the laboratory and environmental training program started in 1991 for Native American students at the Navajo Community College at Shiprock, NM. A laboratory has been set up for environmental monitoring around the Shiprock area. Students and faculty gain hands-on experience.

4) A first-response hazardous incident training program has been initiated for emergency response personnel. This program is fully supported by fees from the students. In addition, the education outreach has been extended with addition of the new MS in environmental engineering degree program and with the earth-view program for research results videos.

Other outreach activities started in previous years have progressed significantly in the past year. These include:

1) The Summer High School Design Institute

2) The International University Design Contest

3) The project SWOOPE for environmental data observation by K-12 students

4) The Associate Degree program for Native American students at NCC

5) The Teleconference series for professional development

Organization

The organization of the first three years is outlined in Figures 1 & 2. The DOE's cooperative agreement is with the Regents of New Mexico State University. The program is led by a Director who reports to the Dean of Engineering at NMSU. The Dean also serves as Chairman of an Executive Board that sets the strategic direction of the Consortium. The Executive Board is made up of top management representatives from DOE, EPA, the national laboratories, academia, government and industry, and provides oversight of Consortium plans and progress by reviewing overall program plans and strategies, key resource allocations and key hiring decisions, as well as evaluating progress against approved plans and budgets. The current members of the Executive Board are shown in Table 1. An Executive Committee, consisting of one voting member from each consortium entity, has been set up to discuss and resolve operational issues.

The operations are managed by the Director. An Advisory Board, made up of selected representatives from the three Consortium universities, the two national laboratories, selected environmental organizations, and selected industrial organizations, works with the Liaison & Technology Officer and the Director to provide advice, information, and liaison to identify key external linkages and promote relationships. This board advises on agency and industry needs, mechanisms to build relationships, and status of key environmental variables including technology state-of-the-art and practice.

Each of the major functions are supervised by Technical Heads, who report to the Director.

Industrial participation is built into the program as part of the Advisory Board. In addition, industrial participation is included in the Industrial Affiliation Program and the Teleconference Educational Program. Sponsorship is continually sought for specific programs that satisfy the criteria listed previous, i.e., technical excellence and relevance to the Consortium's purpose.

In the fourth year it is anticipated that the program organization will be modified to streamline the administration and to give each academic institution a bigger identity, as shown in Figure 3. The modification is in the operations part of the organization. Under this modified organization, the staff functions for the major activities of education, technology development and technology transfer will be under the direction of Associate and Assistant Directors reporting to the Director of WERC. These individuals will coordinate these activities within the WERC members. At the same time each of the academic consortium members will have an operational head who will spearhead and coordinate all WERC activities within that academic institute. This organization assures central coordination of activities, while at the same time, provides a "champion" at each of the institutes for routine operations as well as creation of new initiatives.

The Carlsbad Environmental Monitoring & Research Center and the Environmental Fellows Program are separate programs reporting administratively to the Director of WERC.

Coordination and collaboration are facilitated by the WERC organization.

Student Participation

The undergraduate and graduate student programs reach over 30,000 students. The students participation in the various educational programs is as follows:

	UNM	NMSU	NCC	NMIMT
Undergraduate (Fall 1992)				
Degree & Research	57	177		45
Graduate (Fall 1992)				
Degree & Research	68	39		25
Non-Degree	84			
Associate Degree (Fall 1992)		64	10	

Other Remote Site Enrollment, Undergraduate and Graduate Spring 1992 and Fall 1992): 135

Design Competition

All Universities 85 in 1991; over 200 in 1992; expected 300 in 1993 from U.S. and Mexico

Teleconference

1000 + professionals

Pre-college

All programs = over 2000

Graphically, the student involvement is shown by the following figures.

Figure 1. WERC Contractual Organization

Figure 2. WERC Operational Organization

Figure 3. Modified WERC operational Organization

Figure 4. Student Enrollment

Figure 5. WERC Instructional Television Sites in New Mexico

Figure 6. WERC Teleconference Sites in the United States

Figure 7. New Mexico High Schools Involved with WERC

The program is only three years old but has been so successful as to receive the following awards that are usually received only by long-established programs:

1) An award to the overall WERC program by the National Society of Professional Engineers as an outstanding engineering achievement for 1991.

2) The WERC Teleconference series was presented an award for outstanding advanced level training and continuing education at the Telecon II Conference and the outstanding distance learning program by the Teleconference Magazine.

TABLE 1

EXECUTIVE BOARD MEMBERS
1991-1992

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TABLE 1 (continued)

EXECUTIVE BOARD MEMBERS
1991-1992

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TABLE 2

EXAMPLES OF TECHNOLOGY DEVELOPMENT

- **Building Material From Wastes**
  Developed a process for converting fly ash and other wastes (including toxic wastes) to non-toxic building block, in conjunction with TIDE, Inc.

- **Nuclear Waste Repository Ventilation System Studies**
  Characterized the effect of salt and simulated severe pressure (tornado) conditions on the structural strength of the filters for design of the WIPP site ventilation system, in collaboration with Los Alamos and Sandia National Laboratories.

- **Treatment of Waters Contaminated with BTX and Heavy Metals Using Tailored Zeolites**
  Developed a unique process to modify natural zeolites available in New Mexico for use as adsorbing agents to remove benzene, toluene, xylene, chromium and lead from contaminated water, in collaboration with Texaco.

- **Minimization and Remediation of DOE Nuclear Waste Problems Using Selective Actinide Chelators**
  Developed effective process using organic chelators for the selective binding of radioactive highly toxic actinide ions such as plutonium from process waste streams and soils, in collaboration with Los Alamos National Laboratory.

- **Public Opinions and Nuclear Waste Management: Tracking Change Over Time in Public Risk Perceptions**
  Nation-wide surveys have assessed the risks perceived from nuclear and other technologies, along with measures of beliefs, attitudes, and perceptions leading to communication strategies for DOE and National Laboratories.

- **Mobility of Radioactive Colloid Particles in Ground Water**
  Developed a remediation technology for removal of radioactive colloids from the soil and ground water at Los Alamos National Laboratory.

- **Enhancement of Solar Photocatalytic Detoxification by Adsorption of Porphyrins onto TIO_2 Substrates**
  Developed photosensitizers to enhance destruction of toxic compounds in contaminated waste streams, in collaboration with Sandia National Laboratories.

- **Slurry-Phase Bioremediation of Production Pit Sludges**
  Developed and demonstrated technology of microbiological treatment of wastewater and sludges associated with oil production, together with Yates Petroleum.

- **Pipeline Leak Detection System for Oil Spills Prevention**
  Developed instrumentation system to monitor petroleum pipelines for evidence of leaking in collaboration with Lynx Petroleum.

WERC CONTRACTUAL ORGANIZATION

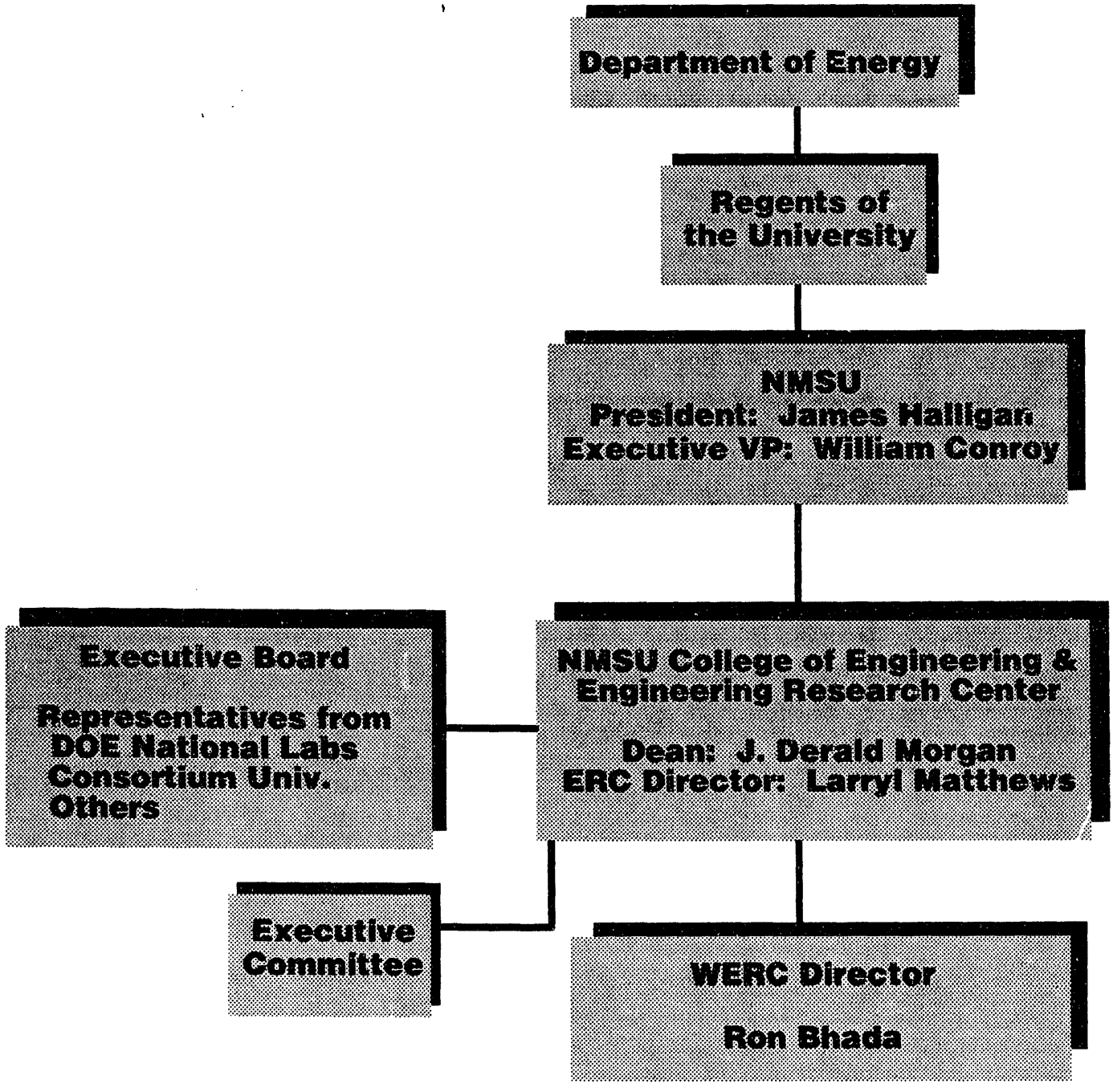


FIGURE 1

WERC OPERATIONAL ORGANIZATION

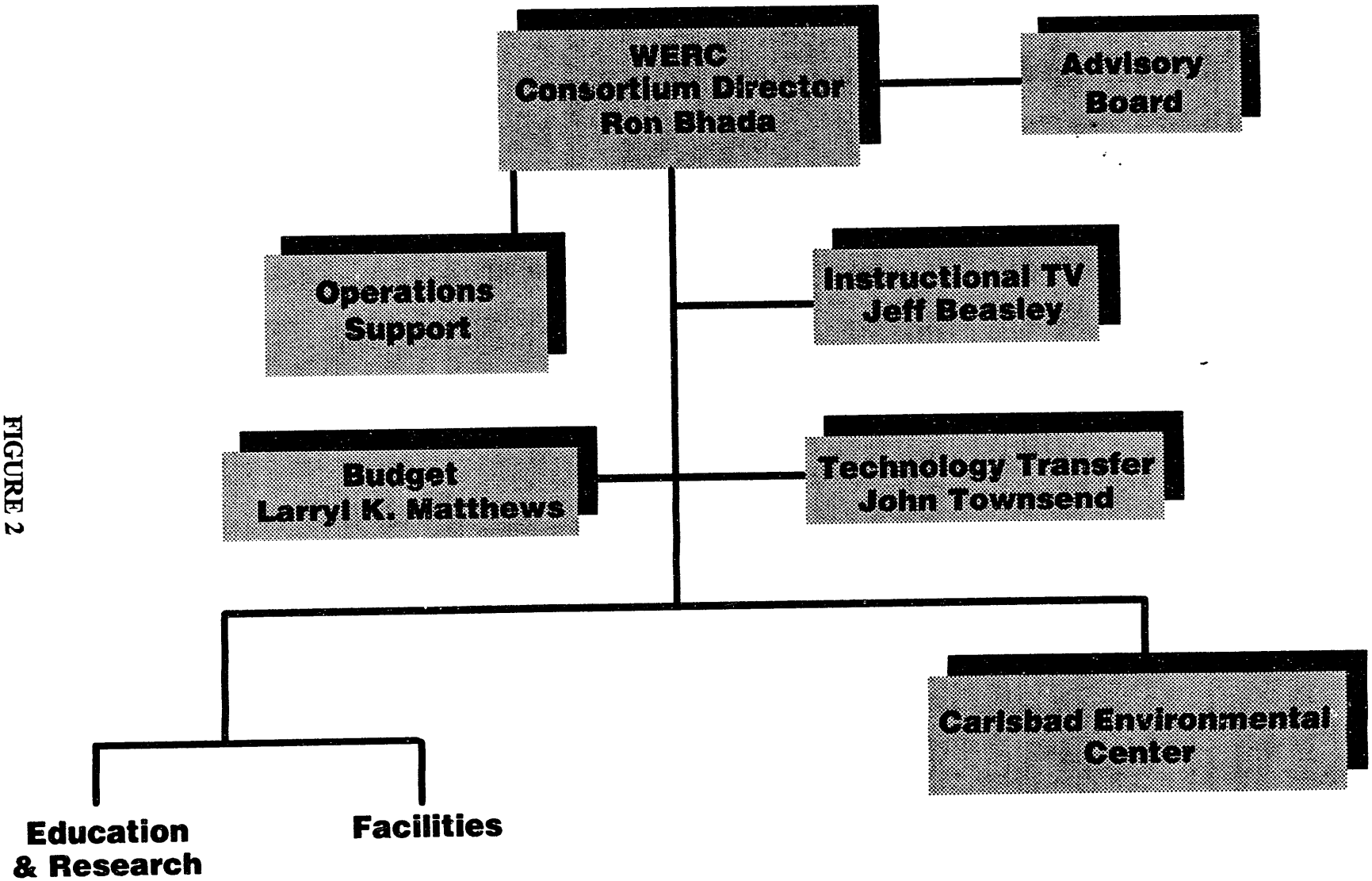


FIGURE 2

MODIFIED WERC OPERATIONAL ORGANIZATION

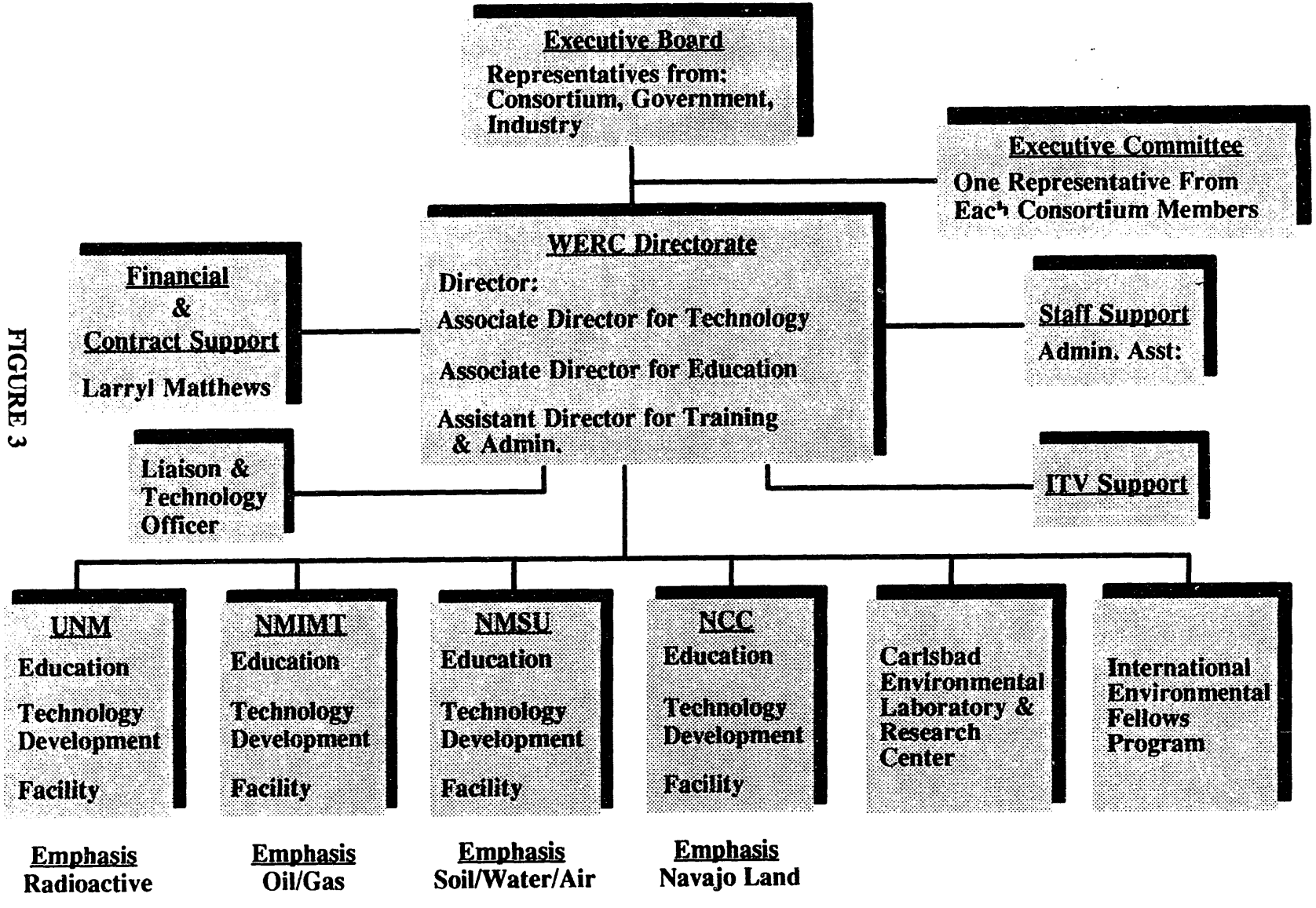


FIGURE 3

STUDENTS IN WERC PROGRAM

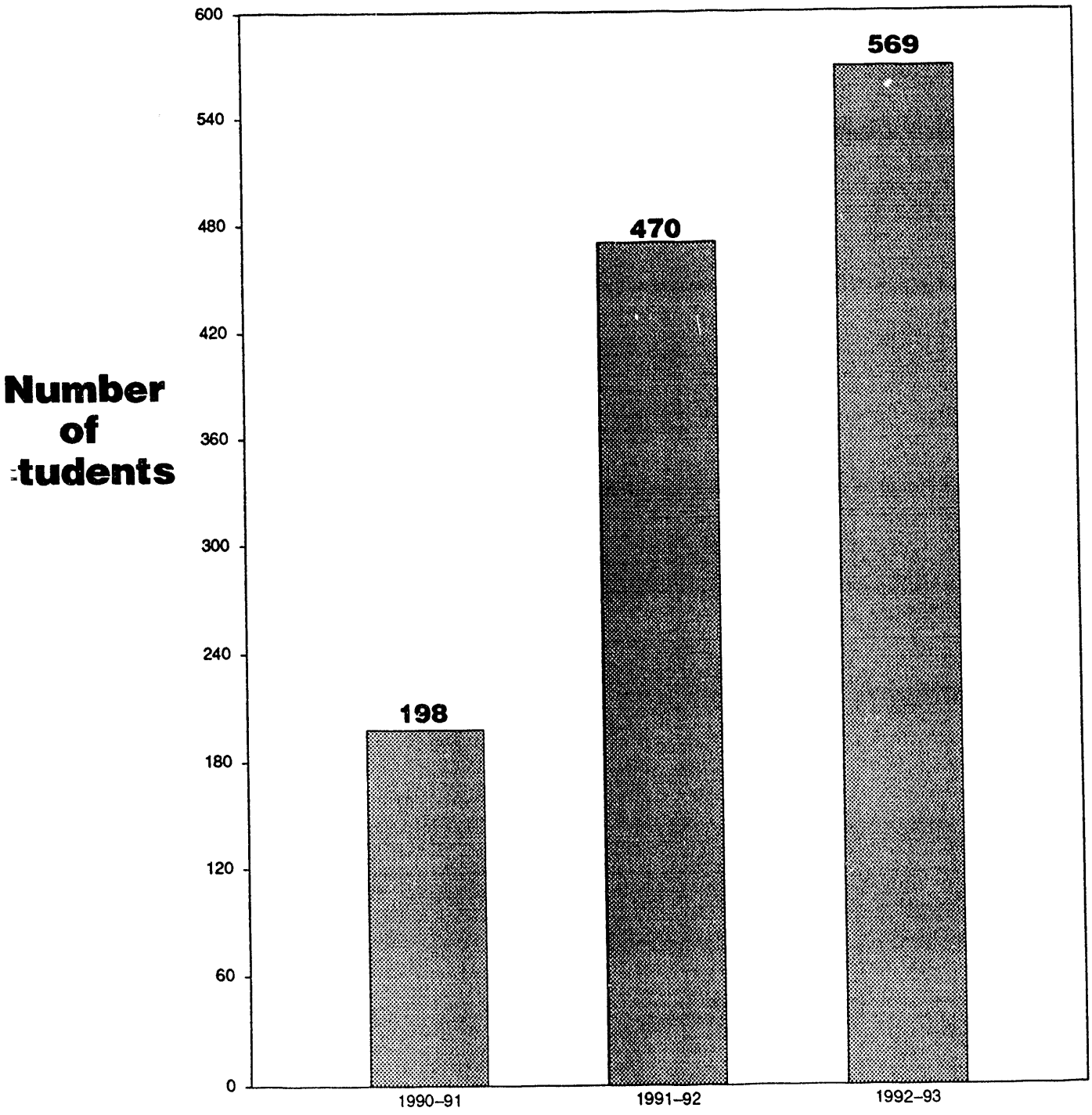


FIGURE 4

WERC–INSTRUCTIONAL TELEVISION SITES IN NEW MEXICO

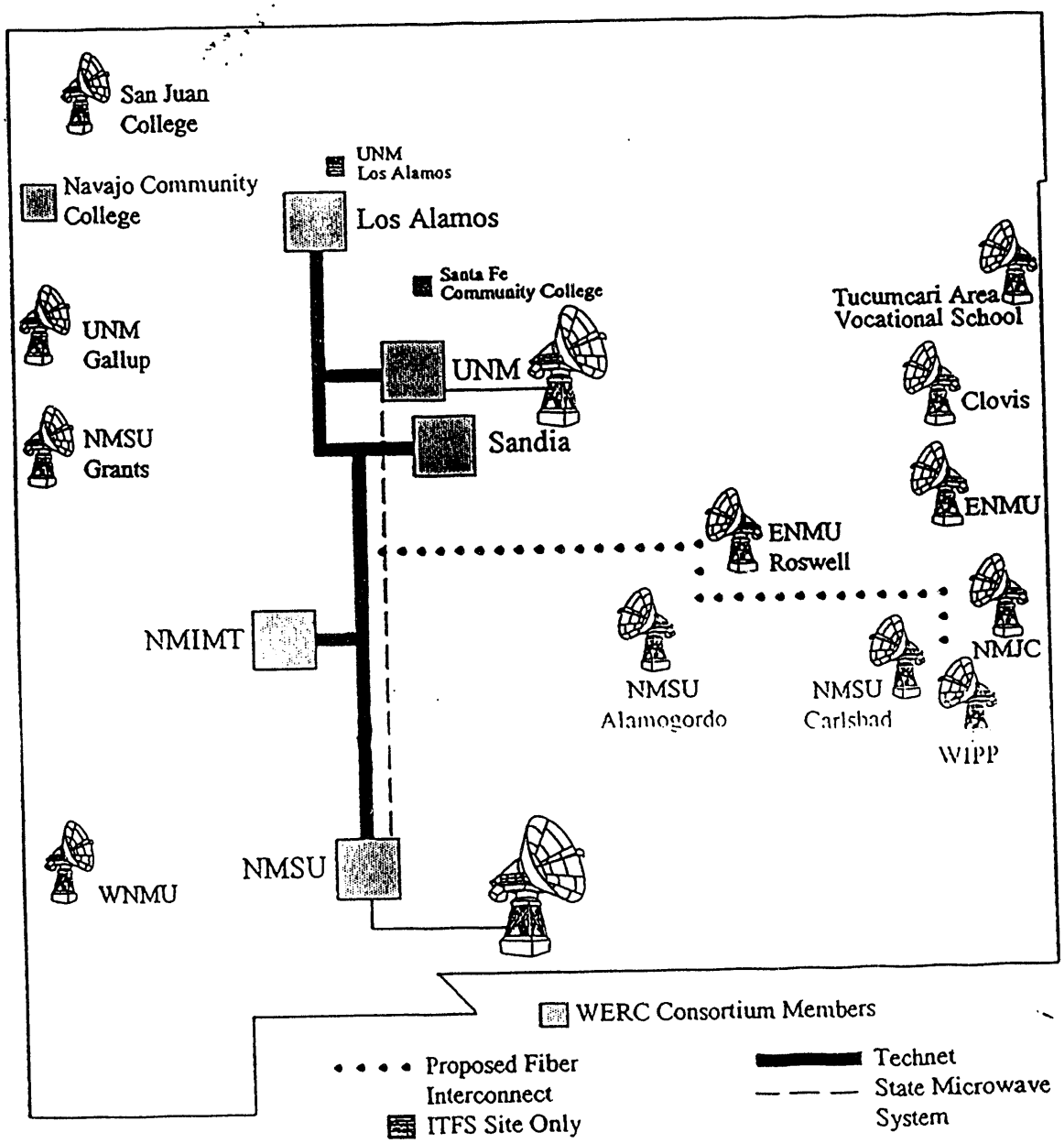


FIGURE 5

WERC TELECONFERENCE SITES IN UNITED STATES

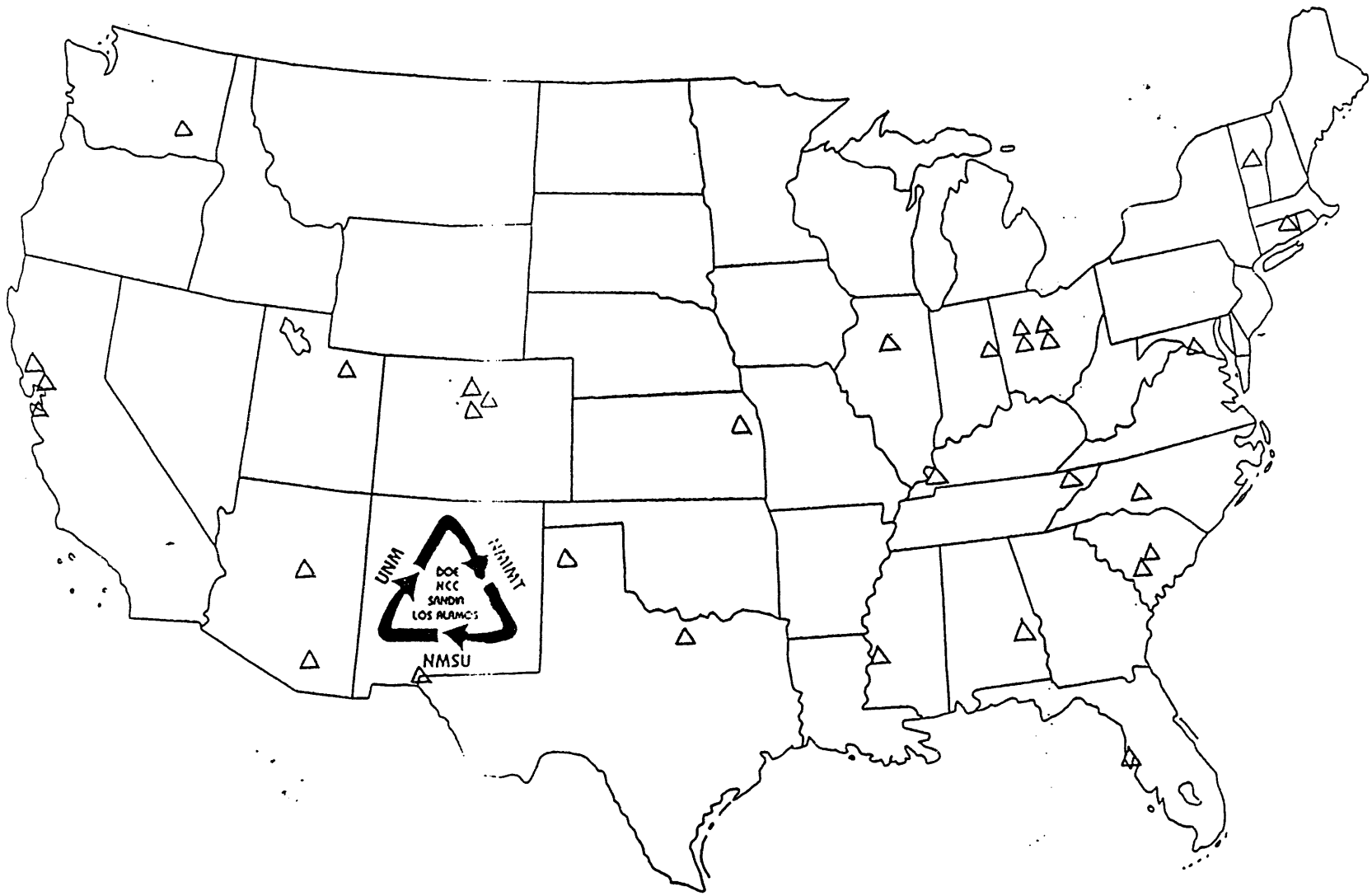


FIGURE 6

NM HIGH SCHOOLS INVOLVED WITH WERC

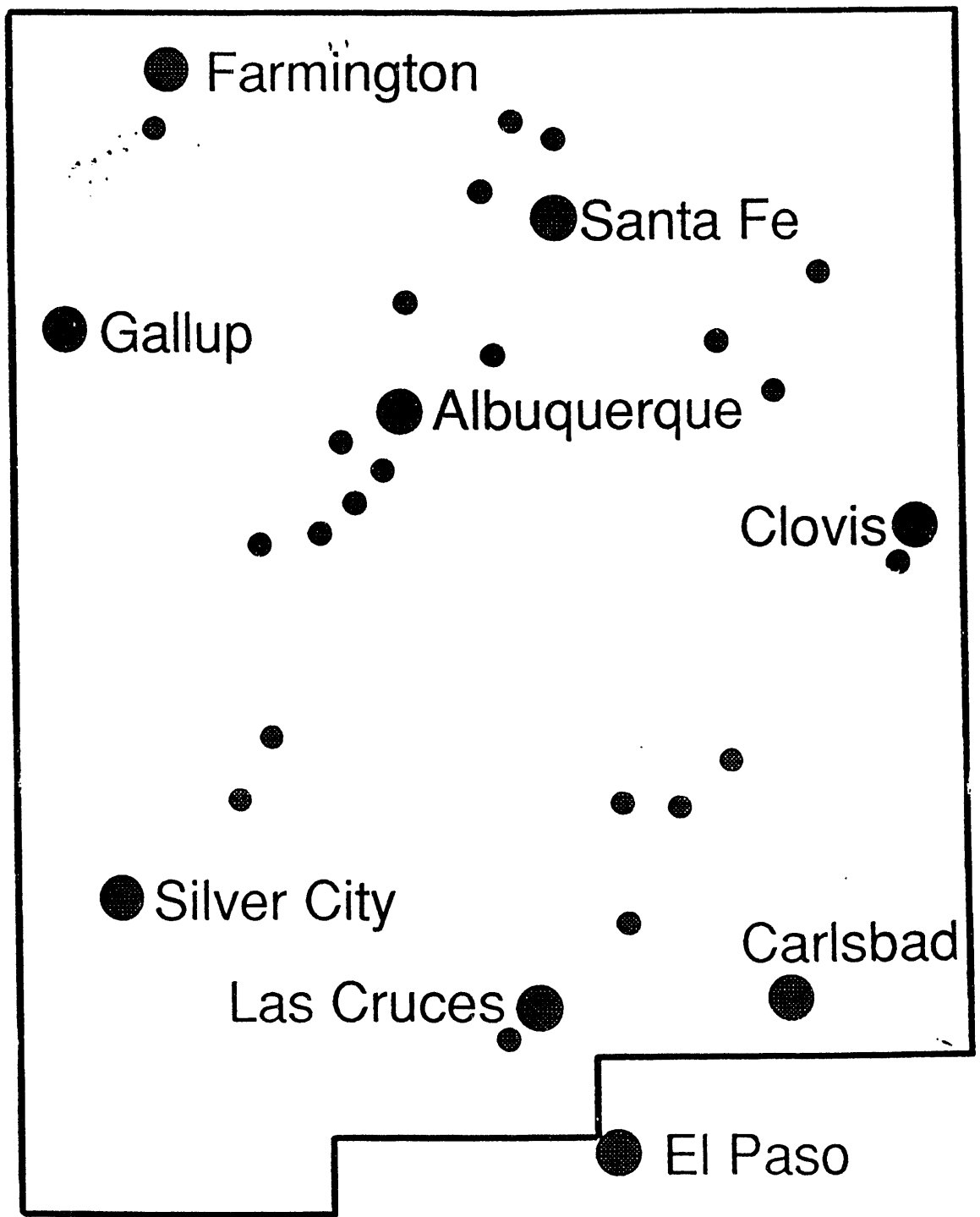


FIGURE 7

INTRODUCTION

Background

Efficient and safe management of nuclear, hazardous, and solid waste is an increasingly critical national issue. Further, it is a broad multi-disciplinary issue that cannot be addressed by any one entity or organization, but requires a collaborative effort between multiple organizations with diverse expertise and experience.

In February, 1990, the Secretary of Energy, James Watkins approved a cooperative agreement for a waste (management) education and research consortium program with New Mexico State University (NMSU) and the U.S. Department of Energy (DOE). This program known by the acronym, "WERC" includes NMSU, the University of New Mexico (UNM), the New Mexico Institute of Mining and Technology (NMIMT), Navajo Community College, the Los Alamos National Laboratory and the Sandia National Laboratories.

Mission

The mission of the program is to expand the nation's capability to address issues associated with the management of hazardous, radioactive and solid waste, specifically:

- To provide a national resource of education and technology development programs.
- To develop and transfer new technologies and use these to train students.
- To increase human expertise and sensitivity to issues.

Objectives

The program is designed to provide an integrated approach to the national need via the following:

1) Education in waste management to reach thousands of students by the three Consortium universities and the affiliate college resulting in graduate, undergraduate, and associate degrees with concentration in environmental management. (The term waste or environmental management is used in a broad sense throughout this paper and includes all aspects of environmental management and environmental restoration.)

2) Professional development via teleconference for industry and government.

3) Technology development programs at the leading edge, providing training to students and information to faculty feeding into the education programs.

4) Education and technology development at the campuses, as well as from four field sites.

5) Ties with other multidisciplinary university facilities.

6) Ties with two National Laboratories (Los Alamos & Sandia) located in New Mexico, the Oak Ridge Associated Universities and others.

7) Technology transfer and education via an existing fiber optic network, a satellite link, and an existing state-wide extension program.

8) An outreach program of special interest to pre-college students, communities and business and government leaders throughout the United States.

This report summarizes the accomplishments and status at the end of the third year.

EDUCATION VIA COURSES

Providing quality education in efficient and safe management of hazardous, radioactive, and solid wastes requires a multi-disciplinary approach. Through the integrated capabilities of its members, the Waste-management Education and Research Consortium (WERC) has established itself as a world-class center for expanding the nation's capabilities to address current and future environmental issues. Relevant background and experience is offered in numerous disciplines including: environmental engineering, environmental science, environmental health, environmental law, public policy, economics, risk assessment, hazardous materials handling, etc. The primary goal of the Consortium is to provide educational opportunities to all levels serving the environmental field. The current status is noted below, together with plans for the future.

Educational Programs

Undergraduate Degree Program. This program was started in Fall 90 after careful review of industrial and professional needs. Industry wants professionals to have an in-depth education in a scientific or engineering field combined with specific but multi-disciplinary environmental training. The courses include not just technical curriculum, but each student must also take courses in other areas such as legal, risk analysis and economics. Additionally, each student must take courses from outside the students' home university. The specific details of the minor requirements at NMSU and UNM are described in Appendix A. The courses are reviewed annually and modifications made as necessary. Upon graduation the student has an accredited degree in the field of his choice with a minor in environmental management. The first group of graduates are now in the job market.

Undergraduate Fellowships. Students registered at the three campuses receive fellowship awards ranging between $500-$5000 per year. The fellowships are awarded on the basis of academic merit and the desire to pursue a career in environmental management. The recipients must complete the requirements for the environmental/waste management minor and must gain work experience on a faculty-directed research team of their choice investigating an environmental management problem. Over $100,000 were awarded from both DOE and industry funds in 1992.

Graduate Degree Program. This program was also started in Fall 1990 to satisfy the needs of industry and professionals. Students pursuing graduate degrees (M.S. and Ph.D.) at the member institutions are provided the opportunity to obtain a minor in environmental/waste management. The minor requirements are similar at each campus and are satisfied by completing 8-14 credits of coursework relevant to waste management and environmental restoration. Thus, almost one-half of the students graduate work is in multi-disciplinary environmental areas including a research project or dissertation. The specific details of the

minor requirements are described in Appendix B.

The above program for the minor in environmental management satisfies the need for most of the students. However, there are a small number of students who desire a specific graduate degree in Environmental Engineering. A new program is under development for an interdisciplinary Master's degree in Environmental Engineering. The requirements for this program are shown in Appendix C. This program has students started but will see its full application in the fourth and fifth years after University and State approvals are final.

Certificate Programs. This program has been started for individuals who have previously received a bachelor's and/or graduate degree in appropriate technical fields and wish to obtain a professional environmental management certificate at any of the member institutions. The program is designed for students who desire an updated background in environmental management. Certificate students enroll at the member institutions in the "non-degree" status and pursue a program similar to the minor program. The specific details of the certificate requirements at NMSU and UNM are described in Appendix D.

Associate Degree Program in Radioactive & Hazardous Waste Management. This is a unique program not available anywhere else in the world. After a careful review of 2-year technologist needs, it was identified that an associate degree program is needed for radioactive and hazardous waste management, with emphasis on robotics and safety. An Associate degree program in radioactive and hazardous materials technology started in Fall 1991 at the NMSU-Carlsbad branch campus. The program has been modified as required, including the addition of a 40 hour OSHA course to assist students with on-the-job training. Graduates of this program are prepared for entry level employment as technologists in industries, laboratories, and government agencies concerned with the generation, mining, disposal, transportation, storage, or regulation of hazardous materials. The program is closely patterned after the accredited engineering technology programs offered on the main campus of NMSU. This feature allows students completing the Associate degree requirements to transfer to the engineering technology program. We had projected an initial enrollment of about 30 students and were overwhelmed with over 70 enrolled for Fall 91 and Fall 92. The specific details of the Associate degree requirements are described in Appendix E.

Navajo Community College (NCC). The program at NCC-Shiprock is intended to address the specific needs for education, training and the environmental problems of the arid Navajo Nation and its Native American population. The program, to be phased in over three academic years, will confer a two-year (Associate of Science) degree in Dryland Environmental Science and Reclamation Technology. The program includes a rigorous curriculum in basic science, environmental courses in hydrogeology, dryland botany, and soil and range sciences, and a summer field or laboratory internship. Graduates of this two-year program are able to gain employment as environmental technicians, or to transfer to baccalaureate programs in a wide range of science and engineering fields. The specific details of the curriculum program requirements are described in Appendix F.

As part of this effort, NCC-Shiprock has also established an Environmental Geochemistry Laboratory called the Navajo Drylands Environmental Laboratory (NDEL). The educational

role of this laboratory will be twofold: (1) to offer professional training in analytical chemistry and environmental science to NCC-Shiprock graduates and (2) to broaden the scope of ground water pollution projects now underway at NCC-Shiprock.

A new broader program for training of Native Americans in Solid Waste Management has been initiated and will have students enrolled by 1994.

Professional Development. WERC had developed advanced technical training for a national and international audience of professionals, scientists, and engineers. There are four methods for conducting this training: 1) workshops; 2) interactive videoconferences; 3) videotapes; 4) on-site custom training. WERC teams together with scientists from national laboratories, industry, government, business and universities to present this training.

Videoconferences are broadcast on satellite to industry, government and university sites across the United States to employers concerned with environmental issues, regulations, and retraining. Two videoconference series have been produced: Hazardous Waste Management, this series is composed of 11 programs and teamed together 60 technical experts; it is now available on videotape (this series won a national award of third place as Best Direct Learning Program, 1991 by the publishers of Teleconference Magazine.); Waste Minimization and Pollution Prevention, an 8 program series which finished on Wednesday, October 21, 1992 (see appendix G). This videoconference training has reached out to approximately 8,000 participants in 38 states. Our audience has been composed of 81 industry sites, military/government installations, and universities, see Appendix H. Participants were encouraged to call questions in to the presenters the day of the program. An inexpensive satellite dish and a telephone is the only equipment necessary to receive the live broadcasts. All topics which have been broadcast are available on 1/2" videotape for use in any standard VCR. This program has been awarded its outstanding Distance Learning Program Award by the Teleconference Journal.

Two new series are underway for 1993: Environmental Risk Management, a 7 part series; and Radioactive Waste Management an 8 part series. WERC is also reaching out to young people with the videoconference format. A 30 minute production by and for high school students on Environmental Risk Awareness will be broadcast to high schools throughout the United States in March, 1993.

Professional Engineering Workshops are providing environmental training via the short course/workshop format. The "Ask the Environmental Experts Workshop" was held in January 1992, following the Hazardous Waste Management videoconference series. Participants from around the country met in Santa Fe, New Mexico to interact with program leaders and presenters. A Second Annual "Ask the Environmental Experts" was held in January 1993, to allow participants to meet the presenters from the Waste Minimization and Pollution Prevention series. This also provided an opportunity to consult with a panel of environmental experts on specific industry or government environmental issues and to give their input to the technical advisors for the Environmental Risk series and the Radioactive Waste Management series. Other environmental workshop topics include: Hydrologic Modeling and Drainage Criteria; Design Workshop for Soil and Groundwater Remediation; Soil Vapor Extraction.

There has been interest expressed concerning these environmental training topics from other countries which include Mexico, Latin America, Canada, Italy, the Commonwealth of Independent States, and the Netherlands. Translations of videotapes are planned. A course in Environmental Engineering Chemistry has recently been sent to a site in Monterrey, Mexico. EPA, through the SCUREF Consortium is possibly funding translation of two environmental programs into Spanish.

New Mexico Native American Pilot Program in Distance Learning; the establishment of receive sites for three Pueblos is soon to be underway which will allow the Pueblo Office of Environmental Protection to conduct meetings and training on specific environmental problems and issues, WERC technical training series, and WERC courses. The three identified Pueblos are San Juan, Santa Ana, and Zuni; they are geographically dispersed across New Mexico. It is hoped that more Pueblo sites will be added in the future.

Educational Aids

Satellite Interactive Television (ITV) System. A major goal of the Consortium is to produce and interchange interactive television courses between the consortium members and to transmit ITV courses across the state, the nation, and international boundaries. This goal is accomplished through a satellite up-link system transmitting under KU band frequency. The Consortium currently transmits six to eight courses and 1-2 special lecture series per semester, a summer research seminar series, and one professional development videoconference course per year. A listing and description of the Fall 1992 and Spring 1993 course offerings is presented in Appendix I. Also, shown in the Appendix is the enrollment trend in the telecourses. The Consortium strives to present a broad range of courses relevant to environmental management including, but not limited to, engineering, science, economics, law, public policy, and management. Established satellite receive sites in New Mexico include: ENMU-Roswell, New Mexico Junior College-Hobbs, NMSU-Carlsbad, Sandia National Laboratories-Albuquerque, San Juan College-Farmington, Tucumcari Area Vocational School, UNM-Gallup, UNM-Los Alamos, and the WIPP Site-Carlsbad. The receive sites are illustrated in Figure 5. The Summer and Fall seminar series is one of many components of the technology transfer function built into the Consortium structure. A schedule of the 1992 seminar series is presented in Appendix J. The seminar was broadcast to numerous sites across the country. The sites that received the 1992 professional development videoconference course are listed in Appendix H.

Pre-College Assistance. Programs which encourage pre-college students to become environmentally conscious and to pursue professional environmental careers are described below.

Summer Institute: In the third year, a week long summer institute was conducted featuring high-school level design problems and focuses on enhancing math/science/engineering education within high schools with emphasis on those having a high population of minority students and teachers. The program is directed at schools throughout New Mexico and the El Paso area. We provided this program to over 50 students and teachers and a similar program will be pursued in the fourth year.

Project SEED: High school students participated in WERC research as interns in

summer, with funding provided by the American Chemical Society.

Students Watching Over Our Planet Earth (SWOOPE): A pilot program of SWOOPE was established in the Las Cruces public schools. This program is part of a program initiated and started by the Los Alamos National Laboratory. The program is designed to teach K-12 students laboratory, field, and data gathering techniques while monitoring water quality in local lakes, ponds, reservoirs, wells, the wastewater treatment plant, tap water, and public facilities. The program's animation specialists are also developing exciting, colorful, animated, interactive, software which teaches K-12 students environmental consciousness. This program will be continued under a separate budget in cooperation with Los Alamos.

Project Earth View: A group of pre-college students developed a video showing the results of a research project. This will be used to interest K-12 students in discoveries related to environmental issues.

Inter-University Design Contests. An environmental design contest for universities across the U.S., as well as Mexico and Canada, is structured to give university student teams an opportunity to compete in a national contest for design and development (technical, economic, public communications, and regulatory aspects) of a bench scale environmental control process. The national competition is held annually at a Consortium university campus on Earth Day. Student teams compete for cash prizes and trophies. The judging team is made up of representatives from industry, academia, and government. The design problem for 1991 focused on management and decontamination of industrial wastewater. Student teams from universities throughout the U.S. competing included the State University of New York at Buffalo, the University of Maryland, and West Virginia University. The 1992 design problem focused on remediation of contaminated soil with 19 university teams participating. This program will be continued in the fourth year and we expect participation to increase again.

Project del Rio. Project del Rio is an international water quality monitoring project along the Rio Grande/Bravo involving high school students in the U.S. and Mexico. The project is designed as a three-week teaching module that can be fit into science and social science classes. Students learn how to conduct a battery of water quality tests, obtain and analyze water quality measurements, and derive a water quality profile for the river. In addition, students are encouraged through classroom discussions to examine the social, political, and cultural dimensions of environmental issues using the Rio Grande/Bravo as an example.

The project provides participating schools with all the equipment and training they need. All of the schools are linked via a computer conference, enabling students at different schools to share data and converse with one another. WERC supports only a portion of Project Del Rio; outside sources provide the majority of funds.

EDUCATION THROUGH TECHNOLOGY DEVELOPMENT

An important result expected of the WERC program is the production of students with advanced degrees who have acquired expertise in waste management and environmental restoration via hands-on independent technology development projects at the leading edge of technology. The technology development projects are intended to provide student and faculty support, laboratory resources, supplies, materials, technical focus, and other ingredients needed to educate the students and assist the faculty in exploring new and innovative techniques that address environmental management problems. Without the support of the technology development program, the quality of the graduate educational experience would be substantially reduced for both students and faculty. Currently, we have over 100 students enrolled in the graduate program and/or involved in the technology development projects.

The scope of technology development is broad-based and is designed to include all areas of radioactive, hazardous, and solid waste management and environmental restoration. The third round of projects for 1992 were selected from proposals submitted by faculty and employees of the consortium members with collaboration from the national laboratories and industry. This process has been improved to place greater emphasis on peer review. This will continue for future years. The projects for the fourth year have been selected in 1992, but will be started in March.

The process started with solicitation of proposals. An evaluation of projects was made by a panel of experts on the following criteria:

1) Are graduate and undergraduate education an integral part of the contemplated research? Are students involved in the research? Will the project contribute to student education?

2) Does the proposal have technical merit, a sound approach and the potential to advance the state-of-the-knowledge?

3) Are the facilities and equipment proposed adequate to accomplish the research contemplated?

4) Does the proposal support the consortium's concept of cooperation among members and/or external federal, state and local research organizations?

5) How well does the research address issues of reduction, storage, transport, disposal, economics, risk assessment, legal and public policy related to waste management and environmental restoration?

6) Do the investigators have the credentials to carry out the research?

7) Does the proposed research have cooperative support from outside sources (e.g. industry, other programs, etc.)?

8) Does the research have the potential for results applicable to issues in a reasonable time frame?

9) Is the budget reasonable for the proposed scope?

The evaluation by the experts was used by a team of WERC constituents to make the final selection of projects to be funded.

In the third round we received 71 proposals. Forty-three of these were selected for funding and the projects were started in March 1992. All of these projects have collaboration from at least two universities and a national laboratory. These covered a range of waste management issues as shown below.

The projects undertaken in 1992 are:

1) A Basin-Wide Analysis of NORM in the Oil and Gas Fields of Southeastern New Mexico
2) Stable Isotope Study of Soil and Ground-Water, WIPP Site New Mexico: Estimation of Recharge to the Rustler Aquifers
3) Adaptive Control of Robots for Environmental Restoration and Waste Management
4) Monitoring Well Location Optimization System for Deployment Decision and Compliance Demonstration
5) Conditional Simulation and Contaminant Flow Modeling: Effects of Linearization and Non-Stationarity
6) Cognitive Mapping of Waste-Related Risks: Comparing Experts to the Public
7) Type-A and Type-B Waste Container Design for On-Site and Off-Site Transportation of Radioactive Waste
8) Recovery of Toxic Heavy Metals from Contaminated Groundwaters
9) Mobility of Radioactive Colloidal Particles in Groundwater
10) Vadose Zone Microbiology: Biomineralization, Chelation, and Bioconcentration of Hazardous Wastes
11) Risk/Benefit Analysis of the Disposal of Mixed Waste
12) Evaluation of Unsaturated Zone Contaminant Transport Models for Waste Management - Phase II
13) A Micro- and Macro- Mechanical Investigation of Creep Mechanisms for the WIPP Rock Salt
14) Assessing Risk Costs for Nuclear Waste Transportation
15) Pipeline Leaks Detection System of Oil Spills Prevention
16) Performance of Rock Reinforcement Systems
17) Improved Encapsulation of Hazardous Wastes Using the TIDE Process
18) Development of Sensors for Waste Management Applications

19) Reforming and Gasification Technology for the Destruction of Wastes
20) Public Opinion and Nuclear Waste Management: Tracking Change Over Time in Public Risk Perceptions
21) Charged Aerosol Scrubber for Air Purification
22) Enhancing Solar Photocatalytic Detoxification: Development and Testing Sensitizers and Catalyst Adsorbed on the TiO_2
23) Oxidative Degradation-Detoxification of Solid Organic Wastes
24) Biodegradation of Benzene, PCE and TCE in Sand Aquifer Microcosms Under Denitrifying, Low Carbon Conditions
25) Slurry-phase Bioremediation of Oilfield Production Pit Sludges
26) Public Attitudes Toward WIPP
27) Deformation Mechanisms of WIPP Backfill
28) Dynamic Modeling for Designing Transportation Packaging Components
29) Unsaturated Flow Through Textural Interfaces in Engineered (Capillary) Barriers
30) Development of Permeable Barriers for Aquifer Restoration
31) Laboratory Validation of New Mathematical Models of Groundwater Pollution Transport Phenomena
32) Nuclear Waste Repository Ventilation System Studies
33) Automated Workcell for Waste Handling Using a Robot and Dexterous Multifingered Gripper
34) Treatment of Waters Contaminated with BTEX and Heavy Metals Using Tailored Zeolites
35) Continuous Monitoring for Spills and Leaks at Waste Storage Facilities Containing Mixed Waste and Priority Organic Pollutants
36) Nuclear Waste Storage Vault Closure Determination
37) Minimization and Remediation of DOE Nuclear Waste Problems Using Selective Actinide Chelators
38) Biocorrosion and Flocculation Measurements in Waste Systems
39) Calibration of Time Domain Reflectometry Instrumentation for the Waste Isolation Pilot Plant Project
40) Remediation of Hazardous Waste Sites by Heap Leaching: Development of Field Scale Relationships
41) Application of Biotechnology in Management of Industrial Wastes Containing Lead or Chromium
42) Biodegradation of Explosives
43) Effective Algorithms for Modeling the WIPP Site

Abstracts of these projects are presented in Appendix K. The full results of these projects are reported in a separate report; examples of some results are shown in Table 2.

It is too early to predict the impact of the projects. However, several of the projects are already showing promise for meaningful applications. It is our objective that in the next two years, commercial technologies will result from this program activity. More important is the practical experience that about 150 faculty members and students are getting from the involvement in the research projects and the exchange of technology between the three universities and the two national laboratories.

LABORATORY FACILITIES

Four facilities have been established to directly interface with the education programs and support WERC researchers. The facilities are capable of training students in the operation and maintenance of analytical equipment. With supervision, students conduct analysis on water, soil, air, and plants to develop analytical skills and learn monitoring aspects of environmental restoration and waste handling. The facilities include:

1) The Soil-Water-Air Testing Facility (SWAT) on the NMSU campus in Las Cruces is providing analytical services in the areas of toxic and hazardous waste to researchers from the universities and other organizations. The laboratory cooperates with different researchers in the acquisition and operation of specialized testing equipment related to waste management and environmental restoration projects. The laboratory is equipped for physical, inorganic, organic, and bacterial analysis of soil, water, air and plants. The demand for services from SWAT is extensive.

2) The Environmental Radioactive Measurement Laboratory (ERML) has the role of exploratory development and research associated with transuranic waste isolation and mixed waste management. It provides support for monitoring WIPP activities and for instrumenting experiments planned by other facilities. By combining above-ground laboratories in proximity to the underground repository, closely monitored, long-term evaluations of isolation strategies can be carried out along with the required control experiments. This facility provides space to build and instrument experiments, calibrate instruments and monitor results that depend upon exposure to chemical, thermal, and radiation environments only available at the WIPP site. Relationships are being developed with the Carlsbad Environmental Monitoring and Research Center (CEMRC) which may lead to ERML focussing more on laboratory experiments at the licensed facility on the UNM campus. CEMRC would then assume the interface role for WERC research at WIPP.

3) The Oil-Water Experimental Facility at Hobbs (HOWE) provides for educational, research, and development programs related to environmental and waste disposal concerns of the petroleum industry. A field laboratory is available which consists of a watered out petroleum reservoir and supporting equipment. The producing formation is approximately 2,000 feet deep and 15 feet thick. There are several production units (pumps) in place, although only one is operating at present. An injection plant, equipped with one injection pump, is also available. The analytical equipment is based at the New Mexico Junior College campus in Hobbs

and at NMIMT.

4) The Navajo Drylands Environmental Facility (NDEL) provides hands-on training with analytical monitoring equipment to students at the Navajo Community College (NCC). The first phase of the laboratory was dedicated on December 5, 1991.

The major equipment in place at WERC facilities is listed in Appendix M. Our strategy for the fourth year will be to focus equipment acquisition at the facilities to those items which have been shown to be in high demand to conduct analyses and those items needed for specific technology development projects.

TECHNOLOGY TRANSFER & COMMUNICATIONS

The technology transfer function of the Consortium is emphasized throughout the entire regimen of its activities. Specific initiatives designed to implement the transfer of learning, as well as technology, are in various stages of proposal and implementation and the major ones are summarized as follows:

1) The Executive Board and Advisory Board composed of representatives from top management of governmental, academia, and private sector industrial and environmental organizations are now operating and are holding their meetings at the appropriate times.

2) Dialogue with industry and the national laboratories continues to grow through briefings, and collaboration among researchers of the various member institutions of the consortium and these national resources. The Industrial Affiliate Program has been revitalized.

3) The educational arm of the consortium has been broadened and strengthened by the advent of the Navajo Dryland Environments Laboratory (NDEL) and the new MS degree in Environmental Engineering.

   The Associate degree program at NMSU-Carlsbad is in operation.

   A new program, the Native American Associate Degree Program on Solid Waste Management, at Navajo Community College, has been started.

   Increased involvement with high school programs is being implemented through a newly proposed design contest which will be part of the Summer Design Institute.

4) Technology development results are being transferred by means of conferences and seminars, and through formal contacts with participants both from government and the private sector. Two major conferences have been held and these have attracted about two hundred participants. Results from each funded project are reported each quarter. Wide area dissemination of these results is accomplished by means of the fiber optic communication network and the satellite uplink system.

5) Videoconferences are broadcast on satellite to industry, government and university sites across the United States to employers concerned with environmental issues, regulations, and retraining. A videoconference series on Waste Minimization and

Pollution Prevention, an 8 program series, finished on Wednesday, October 21, 1992 (see Appendix G). Our audience has been composed of 81 industry sites, military, government installations, and universities, see Appendix H. All topics which have been broadcast are available on 1/2" videotape for use in any standard VCR. This program has been awarded its Outstanding Distance Learning Program Award by the Teleconference Journal. Two new series are underway for 1993: Environmental Risk Management, a 7 part series; and Radioactive Waste Management, an 8 part series. WERC is also reaching out to young people with the videoconference format. A 30 minute production by and for high school students on Environmental Risk Awareness will be broadcast to high schools throughout the United States in March, 1993.

6) Highlights of operation for each consortium facility are presented in the 600 page Annual Research Progress Reports which has been in great demand by researchers and collaborators throughout the country.

7) Over eighty technical papers have been presented and published by WERC investigators and staff personnel covering all of the varied aspects of the program. These presentations have included reports on the progress of the educational initiative, the operations of the Consortium laboratories and the results and progress of research projects.

8) The WERCforce Newsletter is sent out quarterly covering the various activities and updates on the WERC (see Appendix N). Emphasized in the newsletter are the three major areas of the consortium including: Education by Courses; Education by Technology Development; and Technology Transfer. Also included is a letter from the consortium director, Ron Bhada. Announcements and future activities are highlighted throughout each issue. There are approximately 4,000 documented readers of the WERCforce. A new newsletter has been started and issued monthly to keep students informed on WERC and to obtain their feedback.

9) WERC distributed information about its programs at targeted conferences and exhibitions throughout the year with displays and presentations, including: A brochure detailing WERC; the WERCforce newsletter; an information guide on the Interactive Television Courses; a brochure highlighting the Environmental Fellows program; a brochure on WERC education programs; a request for information card; a brochure on WERC hazardous material training; and fact sheets on the WERC laboratories and unique programs. Staff members from WERC were available at the conferences and exhibitions to answer specific questions. In conjunction with the displays and presentations, several videotapes highlighting WERC programs were shown to participants.

10) Several video-tapes were produced this year to highlight the National Environmental Design Contest; the Summer Institute for High School students and teachers; a proposed *in vivo* Bioassay program for the Carlsbad Environmental Monitoring Center; and a complete overview of WERC. These videotapes were

mailed to a targeted audience as well as being available for general distribution. WERC officials have utilized these videotapes in presentations to representatives of government, academia, industry and the general public. The National Environmental Design Contest video has been successful in recruiting more university teams and sponsors for the 3rd Annual Contest which will be held in April, 1993. The news media coverage has been excellent within the state, but limited outside. Several stories have been picked up by the Associated Press and distributed on a three state regional basis. A news story on the Summer Institute was submitted by El Paso television station KTSM to the NBC Nightline news show and was shown throughout Northern Mexico by Channel 26 of Juarez. The National Environmental Design Contest has received national coverage through magazines and newspapers.

11) Planning is underway to expedite technology transfer throughout the State of New Mexico. Hands-on courses which meet the current OSHA training requirements will continue to be presented. Governmental agencies on the state and national level have been very interested. Discussions have been held with the Department of the Interior, BLM, FEMA, NASA, and New Mexico Environment Department, the State Corporation Commission, and various industries in the region. The WERC Advisory Board is continuing to initiate support for this program among potential clients within the private sector.

WERC Recognition

The accomplishments of the WERC have been recognized by numerous groups. In the past 18 months WERC has been highlighted at the following events:

Waste Management 91 Conference-Tucson, AZ	Feb. 91
Waste Management Training Conference-Puerto Rico	Feb. 91
New Mexico Hazardous Waste Conference-Albuquerque, NM	Feb. 91
DOE News Conference, Albuquerque, NM	March 91
Science & Space Technology Expo-Albuquerque, NM	April 91
Hazardous Waste Research Conference-Manhattan, KS	April 91
Second Year Signing Ceremony, Las Cruces, Carlsbad, NM	April 91
WERC National Environmental Design Contest, Las Cruces, NM	April 91
Rotary Club-Las Cruces, NM	May 91
ACHEMA, Frankfurt, GERMANY	June 91
Rotary Club-Las Cruces, NM	June 91
KBIM-TV/"Horizons"-Roswell, NM	June 91
KDBC-TV/"Foresight"-El Paso, TX	June 91
HBCU/MI Curriculum Planning Meeting-Jackson, MS	June 91
Rotary Club-Roswell, NM	July 91
KTSM-TV/"Inside 9 Country"-El Paso, TX	July 91
Kiwanis Club-Albuquerque, NM	July 91
Energy, Natural Resources and Environment Interim Committee of the New Mexico Legislature, Santa Fe, NM	Aug. 91

Economic Development Committee of New Mexico Legislature	Aug. 91
Border Development Committee of New Mexico Legislature	Aug. 91
Economic Forum-Albuquerque, NM	Aug. 91
AIChE National Meeting, Pittsburgh, PA	Aug. 91
Environmental Conscious Manufacturing, Albuquerque, NM	Aug. 91
WERC Environmental Design Institute	Aug. 91
Southern New Mexico State Fair	Sept. 91
Hazardous Waste Management Seminar, Carlsbad, NM	Oct. 91
First Class of WERC Environmental Minor Graduates	Dec. 91
Waste Management 92, Tucson, AZ	March 92
ASEE Gulf SW Section, Albuquerque, NM	March 92
1992 Engineering and Technology Conference, Puerto Rico	April 92
American Chemical Society, Albuquerque, NM	June 92
ASEE Conference, Toledo, OH	June 92
European Environmental Prime Minister's Visit, Carlsbad, NM	June 19
Industrial Hazardous Waste Conference, Morgantown, W.V.	July 92
1st WERC Hazardous Material Training, Las Cruces, NM	July 92
Summer Job Placement for WERC students, Albuquerque, NM	July 92
Border Trade Alliance, El Paso, TX	July 92
Summer SEED students, Las Cruces, NM	Aug. 92
ECOMEX Conference, Mexico City, Mexico	Aug. 92
Captain Polymer Project, Las Cruces, NM	Aug. 92
Summer Design Institute, Las Cruces, NM	Aug. 92
World Space Conference, Washington D.C.	Aug. 92
Interim Committee of Radioactive & Hazardous Materials of the New Mexico State Legislature, Santa Fe, NM	Aug. 92
Carlsbad Downtown Lions Club, Carlsbad, NM	Aug. 92
Spectrum 92 Conference, Boise, ID	Aug. 92
WERC Fellowships increase by 50%, Las Cruces, NM	Aug. 92
1st Class of Environmental Fellows, Las Cruces, NM	Sept. 92
WERC PSA's during UNM/NMSU football game, Las Cruces, NM	Sept. 92
WERC Researchers, El Paso, TX	Sept. 92
CEMRC Bio Assay program, Carlsbad, NM	Sept. 92
Governor's Conference on the Environment, Albuquerque, NM	Sept. 92
N.M. Mining Association, Farmington, NM	Sept. 92
Holloman AFB, Environmental Flight Dept., Alamogordo, NM	Sept. 92
DOE Hazardous Materials Conference, Las Vegas, NM	Sept. 92
WERC ITV Safe Drinking Water Act, Albuquerque, NM	Oct. 92
Carlsbad Rotary Club, Carlsbad, N.M.	Oct. 92
WERC Laboratories	Oct. 92
Northern Navajo Fair, Shiprock, N.M.	Oct. 92
Workshop, Council for Chemical Research, Atlanta, GA	Oct. 92
University Environmental Design Contest	Oct. 92
American Nuclear Society	Oct. 92
Oak Ridge Model Conference, Oak Ridge, TN	Oct. 92

This does not include the large number of technical society meetings where WERC investigators have made presentations on research results (see Appendix L).
WERC and DOE have been covered by numerous media outlets in New Mexico, the United States and Mexico including Associated Press wire stories. Through the clipping service, WERC has received over 500 articles printed in news outlets throughout the state. Magazine coverage of WERC has been noted as well. Some of the outlets include:

New Mexico Business Journal
HazTech Transfer Newsletter
Page One Newsletter
Round Table Newsletter
New Mexico Technology Enterprise Forum
Engineering Magazine
Engineering News
DOE News
New Mexico Research & Development Forum
National Sources Directory
Twin Plant News Magazine
Chapter One, AI Chemical Engineering Magazine
Cable News Network (CNN)
Canal Veinte-seis, Juarez, Mexico
Journal of the Air & Waste Management Association

WERC has also received prestigious honors by several different organizations including:

1) The U.S. National Society of Professional Engineers recognized WERC with an outstanding engineering achievement award.

2) The New Mexico State Legislature presented a special recognition certificate to WERC for education achievements.

3) The CEO of WERC has been placed on the Board of the EPA Center for Pollution Prevention at Michigan.

4) Teleconference Magazine awarded 1st place for the Best Distance Learning Program in the 1992 Higher Education Live Programming for the Waste-minimization Teleconference Series.

NEW PROGRAMS INITIATED WITH MAJOR EMPHASIS IN 1993

Four major innovations have been initiated and activated by the Consortium in the last 12-18 months. These are included as additions to the WERC program. They are:

1) The Carlsbad Environmental Monitoring and Research Center (CEMRC)

2) The Environmental Fellows Program

3) The Navajo Dryland Environments Laboratory

4) A First Response Training Academy

All of these outreach activities are significant service activities that enhance WERC's mission. They are the direct result of the expertise and reputation established by WERC.

The Carlsbad Environmental Monitoring and Research Center

The Carlsbad Environmental Monitoring and Research Center (CEMRC) provides a source for an independent data of the environment of the Carlsbad area in order to assist monitoring for the Waste Isolation Pilot Plant (WIPP). While the program was awarded in 1991, its major organization was initiated in 1992. Services available include the capability to perform complete bioassays of representative sampling of residents from the Carlsbad area, the laboratory evaluation of air samples collected during the monitoring near the WIPP site and the establishment and maintenance of an environmental database. Contract services will also be available to both public and private entities that have environmental monitoring requirements and/or a need for bioassay and laboratory analysis capabilities.

A part of the CEMRC mission is the development of student and independent world leadership for the development of methodology, protocols, and sensory apparatus for obtaining, processing, and disseminating environmental data. To attain and maintain the requisite level of intellectual and scientific independence as well as technical competence the program's:

* Long range objectives and policies will be guided by an independent board of directors composed of distinguished faculty from institutions within the Consortium, prominent residents of the State of New Mexico, and nationally recognized experts as needed to balance the representation.

* Daily operations and capabilities will be guided by periodic reviews by a Technical Advisory Committee, composed of the nation's experts in health and

environmental monitoring.

* Research to advance monitoring techniques, protocols, and methodologies will be identified by the program and the requisite research and development projects will be proposed and funded from a portion of the program's operating budget.

  The CEMRC will also provide a unique and invaluable resource for the training of students as well as university faculty members.

* Relationships with public and private entities will be developed which will effect transfers of technology which will result in industrial development based on the results of sound research.

The bioassay facilities at the CEMRC will include a whole body counter, other radiation detection and sampling instrumentation, as well as standard medical diagnostic equipment. In particular, the actual rate of exposure and accumulated radiation dosage of local Carlsbad area residents will be monitored on a regular basis. Some of these measurements are currently being obtained by the Los Alamos National Laboratory at considerable expense to the U.S. Department of Energy (DOE) and do not presently include samples from the local population. In the highly unlikely event of an incident involving radioactivity, the dose and exposure added to the community can be determined by the CEMRC once an adequate primary baseline has been established.

The CEMRC data center will have sufficient computer capacity to collect, organize, and disseminate test results and information to entities of the public and private sectors upon request. Confidential information on specific individuals will not, however, be revealed to the public.

The Environmental Fellows Program

The Environmental Fellows Program has the mission of expanding the world's capability to address those issues associated with the management of hazardous, radioactive, and solid wastes. These tasks are accomplished by:

1) An educational program at the graduate and/or post-doctoral level for selected emerging leaders from around the world.

2) Seminars and conferences featuring the foremost technical experts from the international environmental arena.

3) A technology application component which will allow the participants of the program to utilize their expertise in the search for solutions to the environmental problems which currently beset our world.

4) An optional work experience residency program which will give to the international fellows an opportunity to gain up-to-date practical experience by working with the staff in the National Laboratories for a short time following the

completion of their educational program.

This project is also funded separately, but reports to the Director of WERC, and operates cooperatively with WERC investigators. Currently the program has been started with a group of 12 Fellows selected from Mexico.

NCC Solid-Waste Management Program

A new program on providing solid waste management education has been started at the Navajo Community College. The first students will enter in 1993, with 100 students to be enrolled after the program is fully operational.

This program will utilize the Navajo Dryland Environments Laboratory (NDEL) was formed in 1991 and is developing resources and addressing issues associated with environmental restoration and management of the semi-arid to arid Navajo Nation and the surrounding region in the Four Corners area. The laboratory is currently accomplishing this task through the following educational and research initiatives:

1) NDEL supports field and laboratory research in environmental geology, hydrology, and resource management in addition to serving as an environmental monitoring facility for the eastern Navajo Nation.

2) NDEL is utilized as a training facility for Navajo undergraduate students studying quantitative environmental science.

3) With WERC support, NDEL is participating in the development of a new Associate degree program in Earth and Environmental Sciences (EES) at Navajo Community College in Shiprock. This program includes a rigorous curriculum in basic sciences as well as specialized courses in environmental geology, analytical chemistry, dryland botany, and soil and range sciences in addition to a summer field or laboratory internship.

Graduates of the EES and the Solid Waste Management programs, which are designed in accordance with Navajo educational philosophy, will be able to gain employment as environmental technicians or managers within the Navajo Nation. In addition, these students will be able to transfer to baccalaureate degree programs in a wide range of science and engineering fields at four-year institutions in New Mexico and elsewhere.

The First Response Training Academy

A program has been developed on training of emergency personnel and others to response to situations that may arise (fire, etc.) involving toxic wastes. This academy would provide first response training to emergency personnel in communities throughout New Mexico and possibly at the border.

PERFORMANCE CRITERIA

We have set up criteria to measure the performance of our program to serve the customers shown on the following page. These have been set up for several different forms of measurement as follows:

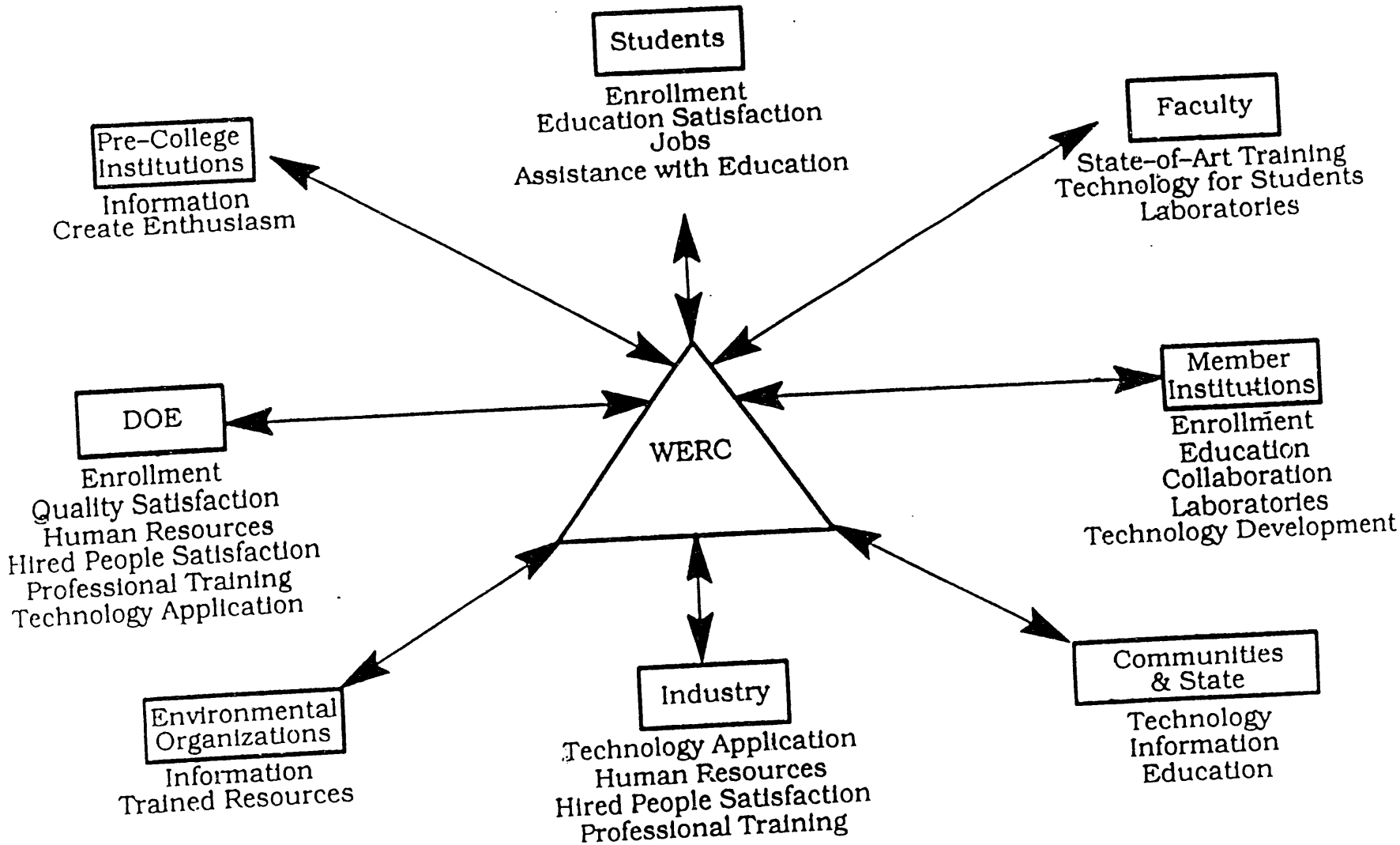
1) Event-related measurements, comparing target dates of events with actual dates of completion.

2) Quantitative data measurement comparing initially project achievement (e.g. student enrollment) with actual achievement.

3) Survey type of measurements relying on feedback from customers and users of WERC, e.g., feedback from industry on graduates from WERC.

The following pages show the customer base of WERC, the measurement criteria set up to serve the needs of our customers and the completions to date.

Customer Base



MILESTONE RELATED PERFORMANCE
KEY MEASUREMENTS

		Date Target	Date Actual
Set Up a Unified Administrative System and Qualified Team Modified System.		4/90 4/93	3/90
UG & G Degree Program			
- Approved		7/90	7/90
- Started With Students		8/90	8/90
		8/91	8/91
		8/92	8/92
		8/93	
Fellowships			
- Established		5/90	5/90
- Awarded		8/90	8/90
		8/91	8/91
		8/92	8/92
		8/93	
Interactive Televised Courses (ITV)			
- System in Place		7/90	8/90
- Courses Transmitted		8/90	8/90
		8/91	8/91
		8/92	8/92
		8/93	
Professional Teleconference Series			
- Program Developed		1/91	1/91
- Series Transmitted	-first	2/91	3/91
	-second (Waste Min)	2/92	2/92
	-third (Risk & RWM)	2/93	2/93
Inter-University Design Contest			
- Organized		10/90	11/90
- Held		4/91	4/91
		4/92	4/92
		4/93	
K-12 Summer Institute		8/91	8/91
		8/92	8/92
		8/93	

MILESTONE RELATED PERFORMANCE KEY MEASUREMENTS

	Date Target	Date Actual
Associate Degree		
- Approved	5/91	2/91
- Started With Students	8/91	8/91
	8/92	8/92
	8/93	
Technology Development		
- Selection Process	2/90	12/89
- Start First Projects	3/90	5/90
	3/91	6/91
	3/92	4/92
	3/93	
Technology Reports - Final	2/91	2/91
	2/92	5/92
	5/93	
Teaching/Technology Laboratories		
- Initiated	9/90	9/90
Industrial Affiliate Program		
- Initiated	9/90	9/90
- Operational	2/91	4/91
- Upgraded	4/93	
Newsletter Initiated	9/90 and repeated quarterly	9/90
Seminars/Briefings Initiated	8/90	9/90

MILESTONE RELATED PERFORMANCE
KEY MEASUREMENTS

Data Base Started	6/93	
Placement with National Labs	6/91	6/91
	6/92	6/92
	6/93	
New Outreach Programs	2/92 and annually	10/91
SWM Program		
Initial Staff on Board	5/93	
Curriculum Selected	7/93	
Students Initially Enrolled	8/93	
First Semester Completed	12/93	

KEY QUANTITATIVE MEASUREMENTS

Measurement	Projection	Actual
Number of Undergraduate Students		
Fall 1990	30	200+
Fall 1991	250	250+
Fall 1992	300	279
Fall 1993	300	
Number of Graduate Students		
Fall 1990	10	15
Fall 1991	30	50+
Fall 1992	50	216
Fall 1993	50	
Number in Associate Program		
Fall 1991	30	63
Fall 1992 and beyond	50	70+
Faculty Members Teaching		
Fall 1990	100	100+
Fall 1991 and beyond	140	140+
ITV Courses		
Number in Fall 1990	3	3
Number in Fall 1991	6	8
Enrollment in Fall 1990	50	150+
Enrollment in Fall 1991	250	300+
Percent Underrepresented Minorities	25%	25%+
ITV to Communities		
In New Mexico by 1992	10	15
In US in 1994	15	
Teleconference Series		
Institutions Enrolled	40	48
Professionals Enrolled	500	1000+
Measurement Laboratories		
Number Operational		
1990-91	3	3
1991-92	3	4

KEY QUANTITATIVE MEASUREMENTS

Measurement	Projection	Actual
EPA Certification		
1992-93	1	In progress
Inter-University Design Contest		
University Teams - 1991	5+	7
University Teams - 1992	12	19
University Teams - 1993	25	
University Teams - 1994	30	
Summer Institute		
Students & Teachers	54	54
Underrepresented Minorities	40%	50%+
Undergraduate Scholarships		
1990-92	40	50+
1992-93	50	70+
1993-94	60	
SWOOPE		
Students Participating in Las Cruces	500	750+
Pre-college Information Sent/Presented to	200	400+
Professional/Technical Presentations		
1990-91	30	30+
1991-92	60	60+
1992-93	80	80+
1993-94	90	
Newsletters		
1990-91	2	4
1991-92	3	4
1992-93	4	8
1993-94	4	

KEY QUANTITATIVE MEASUREMENTS

Measurement	Projection	Actual
Technology Development Projects		
Number of Projects:		
1990-91	25	27
1991-92	30	33
1992-93	35	43
1993-94	35	
Technology Development		
Number of Students Educated:		
1990-91	25	75+
1991-92	50	75+
1992-93	50	100+
1993-94	50	
Number of Faculty Trained:		
1990-91	40	60+
1991-92	50	70+
1992-93	50	85+
1993-94	50	
Number of Collaborators:		
1990-91	25	26
1991-92	30	33
1992-93	35	44
1993-94	50	
Technology Realized to Large Scale Use		
1993-94	1	
1994-95	2	
Technology Development Conferences		
Number in:		
1990-91	1	1
1991-92	2	2
1992-93	2	2
1993-94	2	

KEY QUANTITATIVE MEASUREMENTS

Measurement	Projection	Actual
Number of Students Graduated/Certified		
1990-91	0	1
1991-92	20	30
1992-93	30	
1993-94	40	
1994-95	50	
2000	100	
Number of Graduates Employed in Environmental Area		
1990-91	0	1
1991-92	15	30
1992-93	20	
1993-94	30	
1994-95	40	
2000	100	
Number of Summer Jobs for WERC Students		
1990-91	5	5+
1991-92	10	20
1992-93	20	
1993-94	40	
1994-95	60	
High School Participants Enrolling In University Environment Programs		
1991-92	2	2+
1992-93	10	10
1993-94	20	
1994-95	20	
New Major Programs Started		
1991-92	1	1*
1992-93	1	2**
1993-94	1	
1994-95	1	

KEY QUANTITATIVE MEASUREMENTS

Measurement	Projection	Actual
Information to Communities/State		
Number of Inquiries Satisfied:		
1991-92	2	3
1992-93	4	6+
1993-94	6	
1994-95	8	
Number of Students in SWM		
1993-94	10	
1994-96	50	
1995-96	100	

*Carlsbad Environmental Monitoring & Research Center
**Environmental Fellows Program and Solid Waste Management Program at NCC

PERFORMANCE SURVEYS

	Target Date	Actual Date
Students in Program		
Survey Completed	6/93	
Actions Completed	12/93	
Students Graduated		
Survey Completed	6/93	
Actions Completed	12/93	
Industry with Graduates		
Survey Completed	6/93	
Actions Completed	12/93	
Professional Development Customers		
Survey Completed	1/92	1/92
Actions Completed	3/92	3/92
Pre-college Institutions		
Survey Completed	9/93	
Actions Completed	2/94	
Advisory Board		
Feedback	4/92	4/92
Actions	7/92	7/92
Faculty		
Survey Completed	12/93	
Actions Completed	6/94	
Laboratory Customers		
Survey Completed	6/93	
Actions Completed	12/93	
Other Universities		
Survey Completed	9/93	
Actions Completed	2/94	

DATE
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6/10/93