

THE ACHIEVEMENTS OF A UNIVERSITY-NATIONAL LABORATORY WASTE-MANAGEMENT EDUCATION & RESEARCH CONSORTIUM

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ABSTRACT

This paper presents the results and current status of a consortium of three universities and two national laboratories for an Education and Research program on waste-management and environmental restoration. The program sponsored by the U.S. Department of Energy has been in effect for one year and has achieved significant progress towards establishing:

- undergraduate, graduate and associate degree programs involving environmental management,
- a satellite TV network
- a professional development teleconference series,
- research programs at the leading edge of technology training multi-disciplinary students,
- research laboratories for analyses, testing, and student training
- technology transfer programs,
- outreach programs, including pre-college and minority education.

INTRODUCTION

Efficient and safe management of nuclear, hazardous and solid waste is an increasingly critical national issue. Further, it is a broad multidisciplinary 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 NMSU, the University of New Mexico (UNM), the New Mexico Institute of Mining & Technology (NMIMT), the Los Alamos National Laboratory and the Sandia National Laboratories.

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 by the three Consortium universities resulting in graduate, undergraduate, and associate degrees with concentration in environmental management. The term waste management is used in a broad sense throughout this paper and includes all aspects of environmental management and environmental restoration.
2. A professional development teleconference series for industry and government.

3. Research programs at the leading edge, providing training to students and information to faculty feeding into the education programs.
4. Education and research at the campuses, as well as from three field sites.
5. Ties with other multidisciplinary university facilities.
6. Ties with two National Laboratories located in New Mexico.
7. Technology transfer and education via an existing fiber optic network, a proposed satellite link, and an existing state-wide extension program.
8. An outreach program to interest others, especially pre-college students, and minority students, in environmental management.

A description of this program has been presented earlier (1-3). This paper updates the earlier presentations and describes the current status and achievements of the program.

EDUCATIONAL COURSES

In the first year, WERC successfully set up the following educational programs:

1. An undergraduate option or concentration in Environmental Engineering with a major in one of the engineering fields noted below.
2. Master of Science degree options in Chemical, Civil, Geological, Mechanical, Mining, Petroleum, or Nuclear

Engineering with special emphasis on the Management of Radioactive, Hazardous, and Solid Waste

3. A two-year Engineering Technology Associate degree program in fields relevant to nuclear and hazardous waste technology
4. A series of professional development intensive courses presented through interactive satellite video to laboratories, industry, and federal agencies throughout the country

The Consortiums first major task in education was to set up the curriculum and establish undergraduate degrees accredited by ABET at the Consortium universities in the engineering fields noted below. This resulted in options leading to a minor in Waste Management offered by the departments noted below:

	<u>NMSU</u>	<u>UNM</u>	<u>NMIMT</u>
Agricultural Engineering	X		
Chemical Engineering	X	X	
Civil Engineering	X	X	
Electrical Engineering	X	X	
Geological Engineering	X		X
Mechanical Engineering	X	X	X
Nuclear Engineering		X	
Petroleum Engineering		X	X
Mining & Metallurg. Engr.			X

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.

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.

Planning was started for an Associate Degree program in nuclear and hazardous materials technology closely patterned after the accredited engineering technology programs offered on the main campus of NMSU at Las Cruces. Thus, 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 plans to use the WIPP facility in conjunction with the New

Mexico State University Carlsbad Campus as the training facilities. Graduates of this program will be 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. A Director has been selected and the program will be started by mid 1991.

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 with the objective of presenting an overview of 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. 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. Three courses are being transmitted in Fall 1990 and 6 - 8 courses are planned for subsequent semesters.

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 a desire to pursue a career in the environmental field. In the first year approximately 37 fellowships were awarded to undergraduate students and an equal number of graduate students were awarded research assistantships. We are in the process of expanding the fellowships via support from industrial organizations. In the next year or two we will double the number of fellowships.

The degree programs started in Fall 1990 at all three universities. The undergraduate enrollment in the first semester was about 200 students and the graduate about 50. These students range from freshman to graduate students. Our estimate is that we will be awarding 200-300 degrees with the environmental concentration (or minor) in the first 4 years of the program, leveling off at about 100 each year.

RESEARCH TRAINING

The research scope of the Center is broad-based and is designed to include all areas of radioactive, hazardous, and solid waste management and environmental restoration. The first 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 process started with solicitation of proposals. The selection of projects to fund was made by a panel of experts based on the following criteria:

1. Does the proposal have technical merit, a sound approach and the potential to advance the state-of-the-knowledge?
2. Are graduate and undergraduate education already an integral part of the contemplated research? Are students involved in the research? Will the research feed into the education courses?
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 and to train students?
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?

In the first round we received 87 preproposals. After initial discussions with the investigators, these were screened down to 57 full proposals. Twenty-seven of these were selected for funding and the projects were started in February 1990. These covered a range of waste management issues as shown in the table at the end of the paper. All but one of these projects have principal investigators from at least two universities and a national laboratory.

A second round of 61 proposals were received in September 1990. Following an evaluation as above, 34 were chosen for funding in 1991.

It is too early to predict the impact of the research. However several of the projects are already showing promise for meaningful applications. It is our objective that in 2 - 3 years, commercial technologies 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 three universities and the two national laboratories.

RESEARCH AND TESTING FACILITIES

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

1. The Soil-Water-Air Testing and Research Facility (SWAT) on the NMSU campus at Las Cruces is functional and is currently providing analytical services in the

areas of toxic and hazardous waste management 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 toxic and hazardous waste management and environmental restoration projects. The laboratory is equipped for physical, inorganic, organic and bacterial analysis of soil, water, air and plants.

2. The Radioactive Experimental Facility at Carlsbad (CREF) has the role of exploratory development and research associated with transuranic waste isolation. Furthermore, it provides support for monitoring WIPP activities and for instrumenting experimental activities planned by other facilities. By combining aboveground 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 the place to build experiments, instrument experiments, calibrate instruments and monitor results from experiments that depend upon exposure to chemical, thermal and radiation environments only available at the WIPP site.
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 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. There are several production units (pumps) in place, although only one is operating at present. An injection plant, equipped with one injection pump, is available also.

It is particularly important to note that each of the facilities has an educational component and a technology transfer component. Each of the facilities will be used to provide short courses and instructional TV courses as part of their mission. Another educational mission of the facilities is to train people in all aspects environmental restoration of handling, monitoring and management of all types of waste. The SWAT laboratory is almost fully operational. The other two are partially operational with equipment being installed and being checked out.

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 and an Advisory Board composed of representatives from top management of government, industrial and environmental organiza-

tions have been formed and functioning for the purpose of directing the program.

- Continual dialogue has been started with industry and the National Laboratories 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.
- Research 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.
- An eleven part professional development teleconference series has been developed on topics of interest to participants from government and industrial organizations. This series is being transmitted via the satellite system throughout the U.S.
- Highlights of operation for each laboratory facility are reported in an annual report. These reports are published and widely distributed.
- About 30 technical papers have been presented and published on the various aspects of this program. This

includes progress in the education program, the laboratory operations, and the research results.

- A limited number of organizations have joined the Consortium's Industrial Affiliation Program and the program is being expanded to others.
- Planning is under way to use the university's extension program for technology transfer.

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 research results. These seminars, meetings, and workshops are held at various locations, including the three Consortium university campuses, the National Laboratories and the three field laboratory sites.

OUTREACH

As the program progressed through its first year, opportunities were identified for reaching out to other groups that could benefit by education and research in the waste management and environmental restoration area. Activities thus started include:

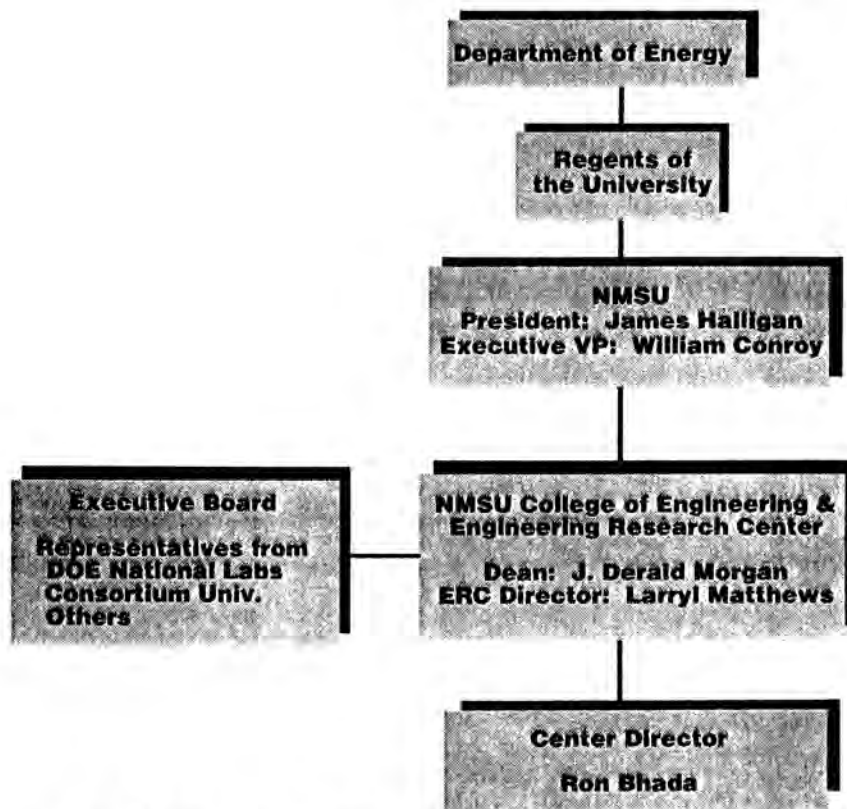


Fig. 1. WERC Funding Flow Through the University Structure.

1. A model program has been started for environmental data observation by pre-college (K-12) students in close co-operation with the Los Alamos National Laboratory.
2. A summer program on environmental engineering was conducted for about 60 high-school teachers and their minority students.
3. Speakers and tours are provided for pre-college students.
4. An environmental design contest has been developed for competition by university students throughout the U.S. A design demonstration is to be held on Earth Day 1991.
5. A laboratory and environmental training program has been started for Native American students at the Navajo Community College at Shiprock, NM.

ORGANIZATION

The organization is as outlined in Figs. 1 and 2. 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 Center. The Executive Board is made up of top management representatives from DOE, the National Laboratories, government and industry, and provides oversight of Center 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 operations are managed by the Director. An Advisory Board, made up of selected representatives from the three Consortium universities, the two national labora-

tories, selected environmental organizations, and selected industrial organizations, worked with the Director to provide advice, information, and ambassadorship 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 (Research & Education, Facilities, Interactive TV) 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 previously, i.e., technical excellence and relevance to the Center's purpose.

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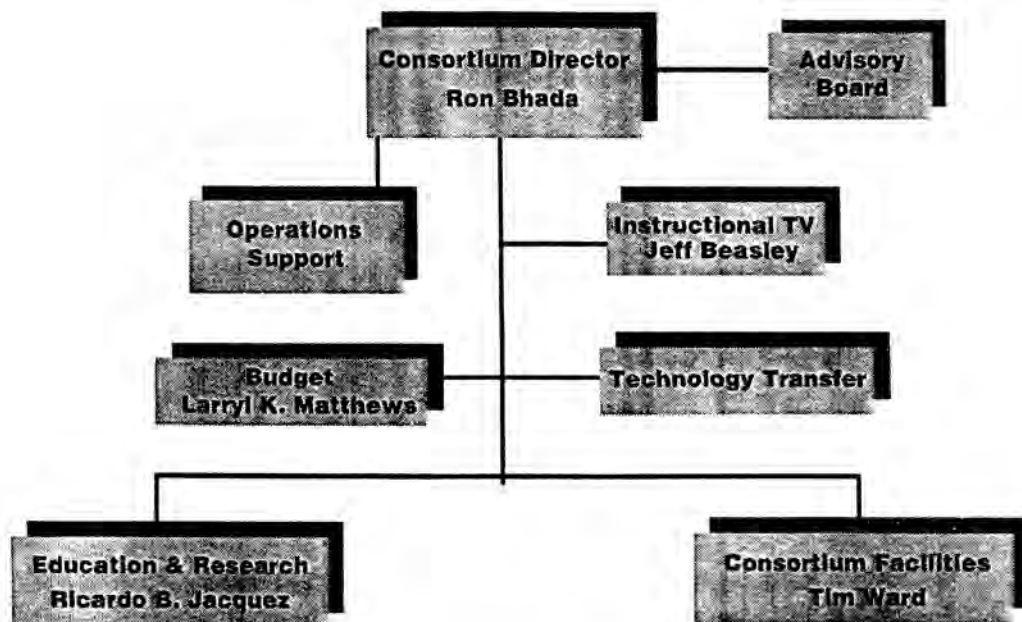


Fig. 2. WERC Operational Organization.

TABLE I
Descriptive Titles of Research Projects Undertaken in 1990

1. Evaluation of the Legal, Economic, and Institutional Issues Associated with the Transportation and Disposal of Hazardous and Nuclear Wastes and other Solid Wastes Across State Boundaries
2. Assessing Risk Costs for Nuclear Waste Transportation
3. Application of Biotechnology in Management of Industrial Wastes Containing Toxic Metals
4. Treatment of Water Contaminated with BTX, and Heavy Metals Using Tailored Zeolites
5. Development of Permeable Barriers for Aquifer Restoration
6. Development of Actinide Selective Adsorbents and Sensors for Waste Minimization and Monitoring
7. Biodegradation of Explosives Wastes
8. Recovery of Toxic Heavy Metals from Contaminated Groundwaters
9. Remediation of Hazardous Waste Sites by Heap Leaching
10. Vados Zone Microbiology: Biomineralization, Chelation, and Bioconcentration of Mixed Hazardous Waste
11. Reforming and Gasification Technology for the destruction of Wastes
12. Development of Novel Technology for Characterization of Supercritical Water Oxidation Process: Hydrothermal Flames
13. Enhancement of Solar Photocatalytic Detoxification: Dev. & Testing of Sensitizers & Catalysts Absorbed onto TIO₂
14. Laboratory Validation of New Mathematical Methods of Groundwater pollution Transport Phenomena
15. Slurry-Phase Bioremediation of Oilfield Production Pit Sludges
16. Treatment of Oilfield Produced Water for improved Waste Management
17. A Study to Identify and Evaluate the Geochemical Behavior of Uranium Tailings Leachate in the Subsurface
18. Minimization and Remediation of DOE Nuclear Waste Problems Using High Selectivity Actinide Chelators
19. Mobility of Radioactive Colloidal Particles in Groundwater
20. Nuclear Waste Storage Vault Closure Determination
21. Design of Compact Microsensors for Monitoring Organic Contaminants
22. Development of Sensors for Waste Management Applications
23. Nuclear Waste Repository Ventilation System Studies
24. Design of Operator Interfaces for Hazardous Waste Removal Systems
25. Robust control of Manipulators and Telerobots Handling Hazardous Waste
26. Development of Constrained Motion Control for Robot Handling of Hazardous Waste
27. Dynamic Modeling for Designing Transportation Packaging Components