OVERVIEW

Current Program Status

History and Focus

The Carlsbad Environmental Monitoring and Research Program (CEMRP) was established in 1991 with a grant from the U.S. Department of Energy (DOE). The primary goals of the CEMRP are to:

- Establish a permanent center of excellence to anticipate and respond to emerging health and environmental needs, and
- Develop and implement an independent health and environmental monitoring program in the vicinity of the DOE Waste Isolation Pilot Plant (WIPP), and make the results easily accessible to all interested parties.

The Carlsbad Environmental Monitoring & Research Center (CEMRC) is a division of the College of Engineering at New Mexico State University (NMSU). Under the terms of the grant from DOE, the design and conduct of research for environmental monitoring at the WIPP are carried out independently of the DOE, and the production and release of resulting reports do not require DOE review or approval. A brief history of the CEMRC is presented in Appendix A.

The CEMRC is operated as a research institute within NMSU, supported through grants and service contracts. The CEMRC's primary objectives are to:

- Provide for objective, independent health and environmental monitoring;
- Conduct research on environmental phenomena, with particular emphasis on natural and anthropogenic radionuclide chemistry;
- Provide advanced training and educational opportunities;
- Develop improved measurement methods, procedures and sensors; and
- Establish a health and environmental database accessible to all sectors.

Key Activities for Success

The following is a summary of progress and status for nine key enabling activities that are necessary to achieve the goal of establishing and developing the CEMRC. Activities to achieve the second goal of monitoring in the vicinity of the WIPP are presented in the following section (WIPP Environmental Monitoring Project).

1. Assemble a team of highly qualified research scientists and support staff capable of carrying out current and future projects.

At the end of 2001, the CEMRC employed 25 personnel (Table 1). Two scientific positions, including the Director, were open and under recruitment.

2. Create state-of-the-art laboratory facilities capable of supporting advanced studies in areas of scientific specialization.

In January 1997, the CEMRC was relocated to Light Hall, a new 26,000 ft^2 laboratory and office facility constructed adjacent to the NMSU-Carlsbad campus. The CEMRC's scientific activities are organized into major areas of specialization, with corresponding assignment of staff roles and responsibilities. Although some of the CEMRC's projects involve only one or two of the program areas, all of the program areas collaborate in carrying out the WIPP Environmental Monitoring project, and this type of integrative research is also applied to some newly funded projects. The five scientific program areas include (1) radiochemistry, (2) environmental chemistry, (3) informatics and modeling, (4) internal dosimetry, and (5) field programs. Detailed descriptions of each program area and associated facilities and instrumentation are presented on the CEMRC web site at http://www.cemrc.org.

3. Establish effective liaisons with leading research groups and laboratories to facilitate shared services and collaborative research.

In response to the need for expanding the CEMRC research role, the Center has developed a partnership with Los Alamos

National Laboratory (LANL) to conduct actinide chemistry research for WIPP. Complimentary research with another division of LANL in 2001 has addressed ecological issues related to the Yucca Mountain assessment.

Program needs for external laboratory services declined in 2001, but some sub-contractual agreements were maintained to provide specific specialized services or analyses (Appendix B). The NMSU Fishery and Wildlife Science Department also continued to provide support to the CEMRC through loan of a boat used in lake sampling activities. With respect to collaborative research, sixteen of the publications and presentations by CEMRC staff during 2001 were co-authored with external colleagues, and ten of the CEMRC's proposed and existing new projects involve collaboration with other departments or institutions.

4. Establish an independent advisory body of scientists to provide expert guidance and consultation to CEMRC staff in the focus areas of CEMRC research.

The Scientific Advisory Board (SAB) for the CEMRC is composed of one scientific expert in each of the CEMRC's five scientific areas of specialization (Appendix C). Two SAB members visited the CEMRC during 2001 to review their individual program areas and provide expert guidance and consultation to the program leaders. The program leaders used the SAB observations and recommendations in structuring specific developmental goals, new experiments and methods improvements. Program leaders provided SAB members with follow-up reports prior to each SAB member's visit during 2001. The term of service for SAB members is usually two years; the current members for 2001-2002 terms are listed in Appendix C.

The Program Review Board (PRB) for the CEMRC consists of a minimum of three members selected by the NMSU College of Engineering administration (Appendix C). Members of the PRB are directors or former directors of leading environmental research centers with histories of long-term success in sponsored research. Because of major changes in direction of CEMRC's science program, and a change in its leadership, the annual PRB meeting has been postponed until late 2002.

5. Establish a program of administration to ensure effective operation of the CEMRC.

In July 2001, Dr. Marsha Conley, CEMRC director, retired. Mr. Joel Webb was appointed Director of CEMRC in February 2002. Dr. George Hidy acted as an interim director during the search for the new permanent director. Current administrative staff includes a director, an assistant to the director, a buyer specialist, a technical/facility specialist, a quality assurance manager, a word processing specialist, and an administrative secretary. Cumulative funding from the DOE for the CEMRP totaled approximately $25 million through 1 October 2001. Cumulative expenditures by the CEMRP for the same period totaled approximately $23 million (Fig. 1). Proposed new DOE funding for the 2002 Federal fiscal year is approximately $2.9 million. Combined with carryover funds, the projected CEMRP 2002 budget is approximately $3.1 million.

Formal tracking of CEMRP project schedules and milestones is conducted for current studies, as noted in later sections. Regularly scheduled work sessions for scientific program planning and problem solving are used to define goals and track progress. Administrative and individual program area staff also have regularly scheduled review and planning sessions. During 2001, significant accomplishments and events were reported in quarterly summaries provided to the DOE, NMSU, SAB and PRB.

6. Publish research results and create a database management system to provide access to information generated by the CEMRC.

CEMRC staff authored or co-authored 12 presentations at international, national and regional scientific meetings and 18 papers were published, are in press, or have been submitted for publication in peer-reviewed scientific journals and books during 2001 (Appendix D). A cumulative list of

publications by CEMRC staff since 1996 is presented on the CEMRC web page.

The CEMRC issued a 2000 report that presented extensive data on radionuclides, non-radioactive constituents and other basic environmental parameters from the WIPP Environmental Monitoring project. This report and other CEMRC information are available via the CEMRC web site, and data tables referenced in this report are also presented on the web site at http://www.cemrc.org. Also included as part of the website are samples collected and analyzed since the most recent Center report.

7. Establish regional, national and international outreach and collaboration.

During 2001, the CEMRC hosted 5 colloquia presented by visiting scientists (Appendix E). Each colloquium was advertised locally, resulting in participation by representatives from local scientific, educational, technical and natural resource management organizations, as well as the general public. Consistent with the Center's efforts to become recognized as an international center of research excellence, CEMRC also hosted 3 visiting scientists in 2000/2001. Mr. Hongbin Wang, a Ph.D. student at the Institute of Earth Environment, Xi'an, People's Republic of China worked in the environmental chemistry laboratory for 11 weeks developing and then using ion chromatographic methods to analyze Chinese loess samples. Mr. Wang is currently in the process of finishing his dissertation, which will be based to a large degree on the results obtained at CEMRC. Sponsored by the Worldbank Loan Project, Dr. Apichai Shuprisha, of the Department of Physiology at Prince of Songkla University, Thailand, received a week of training in the EC laboratory, and he also accompanied the field team on several sampling trips. The primary purpose of Dr. Shuprisha's visit to CEMRC was to obtain hands-on training for using IC techniques to monitor and evaluate water and air quality in Thailand. Ms. Tracy Jue, Idaho National Environmental Laboratory (DOELAP) spent a one-month practicum at CEMRC to obtain training on the routine operation of a lung and whole body counter from the internal dosimetry staff. The CEMRC was involved in many other outreach activities including presentations for local civic and professional groups and exhibits for various school and community events (Appendix F). As described in a later section, over 600 volunteers from the local community have participated in the "Lie Down and Be Counted" project. In addition, CEMRC scientists provided leadership in a variety of professional and scientific organizations and meetings (Appendix G).

During 2001, the CEMRC distributed 1 issue of its newsletter, *The Monitor*. The newsletter summarized progress achieved in the various laboratory projects, and provided general information about the CEMRC. Over 2500 copies of this newsletter were distributed to local residents and regular recipients of CEMRC reports.

8. Procure additional research grants and service contracts from external sources.

CEMRC scientists generated 23 proposals, pre-proposals and contract modifications during 2001 (Appendix H). Important among these is the new contract with LANL of $704,975 for actinide chemistry research. New funding and amendments were achieved on nine projects totaling over $2,225,000, six proposals are pending, and ten proposals were not funded. A total of 12 projects (external to the CEMRP) were in progress during 2001, with a combined value over $1.5 million. These projects represent a wide array of activities, and they have resulted in significant expansion and diversification of the scientific program. During 1996-2001, CEMRC has received funding from a total of 11 different federal and private sponsors.

9. Implement programs to offer visiting scientists training in specialized research techniques and methodologies and to involve CEMRC resources and personnel in providing educational opportunities for students nationwide.

During 2001, two undergraduate students worked in laboratory aide and technician positions at the CEMRC; these positions provide training and basic skills development

relevant to the position assignments. Two CEMRC scientists hold Graduate Faculty appointments at NMSU. CEMRC staff presented 1 invited seminar for the NMSU Department of Fishery & Wildlife Sciences, and 6 major presentations and special programs were provided for student groups (Appendix F).

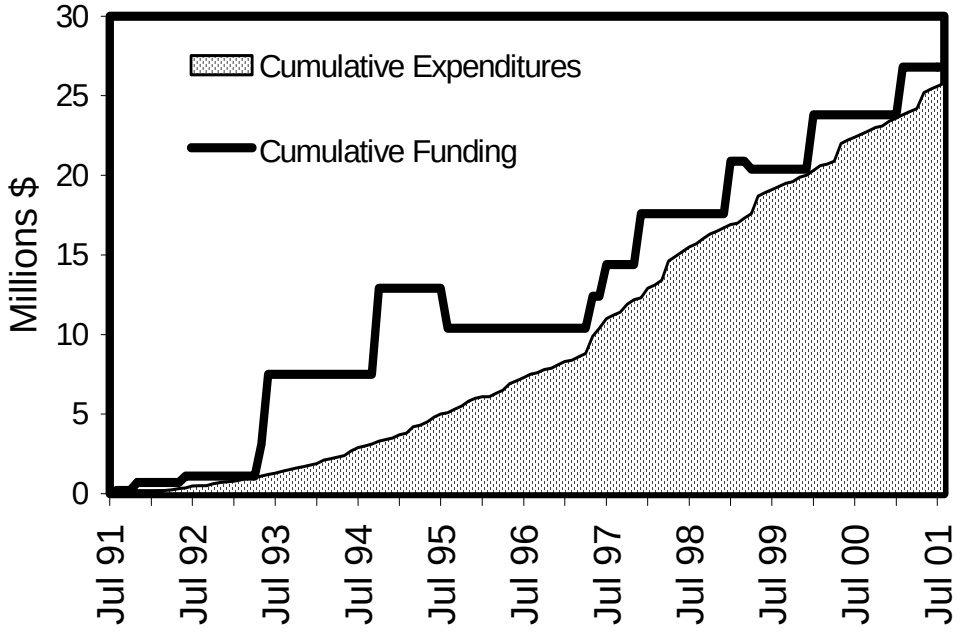

Figure 1. History of CEMRP Funding and Expenditures

Table 1. Listing of CEMRC Staff as of 31 December 2001

Name	Position
Arimoto, Richard	Senior Scientist-Environmental Chemistry
Brown, Becky	Assistant to the Director
Cook, Diana	Administrative Secretary I
Fraire, Joe	Assistant Scientist-Radiochemistry
Ganaway, David	Assistant Scientist-Field Programs; Chemical Hygiene Officer
[a]Hidy, George	Interim Director
Khaing, Hnin	Specialist
Kirchner, Thomas	Senior Scientist-Informatics & Modeling
Lippis, Joe	Technical/Facility Specialist
McCauley, Sharyl	Quality Assurance Manager
McNutt, Damon	Programmer Analyst II
Moir, Deborah	Senior Scientist-Radiochemistry
Monk, James	Associate Health Physicist
Nesbit, Curtis	Associate Health Physicist
Sage, Sondra	Assistant Scientist-Environmental Chemistry
Schloesslin, Carl	Assistant Scientist-Radiochemistry
Schloesslin, Cheryl	Assistant Scientist-Environmental Chemistry
Schoep, David	Science Specialist-Internal Dosimetry
Spruiell, Roy	Programmer Analyst II
Stewart, Barry	Associate Scientist-Radiochemistry
Stroble, Carolyn	Buyer Specialist I
Walthall, Mark	Senior Scientist-Environmental Science
[b]Webb, Joel	Manager, Program Development; Radiation Safety Officer
York, Larry	Technician II-Radiochemistry
Young, Karen	Word Processing Specialist

[a]Interim term ended January 31, 2002
[b]Assumed permanent Director position on February 1, 2002

WIPP Environmental Monitoring Project

Project Concept

As defined in the original grant, the purpose of the WIPP EM project is to establish and maintain independent environmental research and monitoring in the vicinity of the WIPP and to make the results easily accessible to all interested parties. This project was implemented during the WIPP pre-disposal phase, and is now continuing during the operational (disposal) phase. The WIPP EM project is organized and carried out independent of direct oversight by DOE, and the project does not provide data to any regulatory body to meet the compliance demonstration requirements applicable to the WIPP. Analytical results and interpretations from the WIPP EM are published by CEMRC to inform the public and particularly the environmental science community.

A detailed description of the WIPP EM concepts, sampling design and baseline studies is presented on the CEMRC web page. The following is a summary of 2000-2001 activities for each major environmental medium in the WIPP EM. It is important to note that mixed waste was first received by the WIPP on 9 September 2000. The results summarized in this report cover samples collected through November 2001.

Based on the radiological analyses of monitoring phase samples (collected since 26 March 1999) completed to date for area residents and for selected aerosols, soils, drinking water and surface water, there is no evidence of increases in radiological contaminants in the region of the WIPP that could be attributed to releases from the WIPP. In most cases, levels of radiological and non-radiological analytes measured in 2001 were within the range of baseline levels measured previously by CEMRC for the targeted analytes.

Aerosols

Aerosol particle sampling is conducted at five locations, with samplers operating continuously at each location. The locations include a port inside the WIPP exhaust shaft, a site approximately 0.1 km northwest (downwind) of the WIPP exhaust shaft (On Site station), a site approximately 1 km northwest (downwind) of the WIPP (Near Field station), a site approximately 19 km southeast (upwind) of the WIPP (Cactus Flats station) (Fig. 2), and a site located in Hobbs, NM approximately 75 km northeast of the WIPP.

Continuous sampling of aerosol particles was conducted through July 2001 using the same instruments, frequencies and locations as were previously established in the baseline phase. Analyses of all particle samples collected through July 2001 for both radiological and non-radiological constituents were completed and are reported herein. Web site posting of results of radiological and non-radiological analyses of particle samples collected in the WIPP exhaust shaft (FAS) began in July 1999, and are updated weekly. A summary of the 2001 data is also presented herein.

During the period July 2000 - September 2001, minor changes were implemented to improve the aerosol particle sampling design. These changes include (1) standardizing the height of all sampler intakes at the On Site, Near Field and Cactus Flats stations to 4.3 meters, with one meter between sampler intakes and underlying solid surfaces; (2) addition of a high volume TSP sampler at a location approximately 75 km northeast of the WIPP site, in Hobbs, New Mexico; (3) elimination of collection of $PM_{2.5}$ and PM_{10} low-volume samples for inorganic analyses and (4) modification of low-volume sample collection periods from two, two-day and one three-day cycle each week, to one three-day and one four-day cycle each week.

Soils

Soil sampling is conducted within a 166 km^2 area centered on the WIPP operations facility, and at a comparable area encompassing the Cactus Flats aerosol sampling station. Within each of these two areas, samples are collected at 16 locations positioned in concentric rectangular grids

(Fig. 2). During 2001, two soil samples were collected at each of the 32 locations during January-February. One soil sample of each pair was analyzed and the other was archived.

Surface Water and Sediments

The WIPP EM incorporates studies at three reservoirs on the Pecos River, which is the major perennial fresh water system closest to the WIPP that has extensive human usage. The three reservoirs are (1) Brantley Lake, located approximately 64 km northwest of the WIPP, (2) Lake Carlsbad, located in Carlsbad and approximately 40 km northwest of the WIPP and (3) Red Bluff Reservoir, located approximately 48 km southwest of the WIPP.

Radiological and non-radiological analyses of 2001 (monitoring phase) surface water and sediment samples are reported herein.

Drinking Water

The WIPP EM studies of ground water focus on the major drinking water supplies used by communities in the WIPP region because these are often perceived by the public as a potential route for contaminants to reach humans. Five community supplies of drinking water (representing three major regional aquifers) are included in routine sampling, including Carlsbad, Loving/Malaga, Otis, Hobbs and a secondary source for Carlsbad. One private water well (representing a fourth aquifer) that is located within 16 km of the WIPP is also sampled.

During 2001, drinking water samples were collected in the spring at five of the six drinking water supplies, and results of radiological and non-radiological analyses are reported herein. The private water well was dry during the 2001 sampling period. The six drinking water supplies will continue to be sampled periodically for selected radiological and inorganic testing.

Biota

Studies of biota for the WIPP EM have focused on native vegetation because the vegetation is consumed by beef cattle, and consumption of beef from cattle pastured in the vicinity of the WIPP could serve as an exposure pathway to humans for contaminants released from the WIPP. During baseline studies, vegetation samples were collected from a total of six species of plants that serve as preferred forage species for cattle during at least some portion of the year. During 1997-1998 baseline studies, vegetation was sampled twice annually during the two major periods of new growth for native vegetation (March-May and August-October). Six samples of each of three species (contingent on availability) were collected during each sampling period from selected sites on the sampling grid surrounding the WIPP (which encompasses the Near Field aerosol sampling station).

Radiochemical analyses of the baseline and initial monitoring phase samples have been held in abeyance pending development of a practical means of preparing samples for analysis. Analytical methods for gamma-ray emitting radionuclides were completed in 2001, and baseline and monitoring results will be presented in 2002.

Human Population

The “Lie Down and Be Counted” (LDBC) project serves as a component of the WIPP EM that directly addresses the general concern about personal exposure to contaminants shared by residents who live near DOE sites. As in other aspects of the WIPP EM, *in vivo* bioassay testing was used to establish a baseline profile of internally-deposited radionuclides in a sample of local residents. The sampling design includes solicitation of volunteers from all segments of the community, with sample sizes sufficient to meet or exceed a 15% range in margin of error for comparisons between major population ethnicity and gender categories as identified in the 1990 census. Radiobioassays of the original volunteer cohort have been ongoing since July 1999. New volunteers will continue to be recruited each year, with a target of 100 new volunteers annually to establish new study cohorts and replacement of volunteer attrition.

Results of the LDBC project through 1 October 2001 are reported herein, and are updated quarterly on the CEMRC web site.

Meteorological Monitoring

Fully automated meteorological stations are operated by the CEMRC at the Near Field aerosol station and the Cactus Flats aerosol

station. Details concerning the sensors and operation of the equipment and a summary of the last year's meteorological patterns are presented herein.

Organization of Monitoring Program

The scheduling and management of sample analyses collected in the WIPP EM project are based on (1) priorities for providing information to the public in a timely manner, (2) relative risks of human exposure to contaminants among the various media sampled, (3) needs for stringent data validation and verification prior to release and (4) time constraints resulting from sample preparation and analysis procedures.

The management plan for the WIPP EM incorporates milestones representing significant products and progress, including both routine sampling and analyses and special studies. Key performance indicators that integrate groups of milestones are identified and reviewed annually to serve as metrics of the successful progress of the project. Completion of 2001 key performance indicators is summarized in Appendix I. Out of seventeen indicators for 2001, 12 were completed on time, 3 were delayed but completed, and 2 were partially completed. Key performance indicators for 2002 have been identified to serve as the basis for the 2002 WIPP EM project schedule (Table 2). Also during 2002, the elements of the monitoring will be reviewed and evaluated as part of the strategic planning for CEMRC activities in the next few years.

Table 2. Key Monitoring Performance Indicators for the WIPP Environmental Monitoring Project in 2002

Focus Area	Key Performance Indicator
Aerosol particles	Continue concurrent high-volume and low-volume/dichotomous sampling at current four locations through 2002.
Soils	Review sampling program for redesign to facilitate efficient monitoring studies.
Meteorology	Continue concurrent operation of sampling stations at two current sites through 2002.
Drinking water	Review sampling program for redesign to facilitate efficient monitoring studies.
Sediment and surface water	Review sampling program for redesign to facilitate efficient monitoring studies
Human studies	Complete repeat counts for original volunteer cohort, and initial counts for a minimum of 100 new volunteers
	Complete analyses of soil, aerosol, sediment, surface water and drinking water samples (collected through June 2002) by October 2002
	Continue FAS sample analyses to meet weekly and quarterly posting schedule.
Non-radiological analyses	Complete analyses of representative subset of 2002 low-volume aerosol particles, soil, sediment, surface water and drinking water samples within three months after each sample collection
	Continue FAS sample analyses to meet weekly and quarterly posting schedule
Data management and dissemination	Post results of radioanalyses of 2002 and pre-2002 samples within two months after completion of analyses of each set of samples
	Post results of non-radiological analyses of 2002 samples within two months after completion of analyses of each set of samples
	Issue CEMRC 2001 Report; post report and background data to CEMRC web site by May 2002 (web site currently under development)

Management of CEMRC Redirection

The Carlsbad Field Office (CBFO) of DOE has requested CEMRC to investigate whether the Center's direction can become more closely aligned with scientific and analytical activities foreseen by the CBFO to support the safe operation of the WIPP. Specifically, as a functioning deep-geologic repository for nuclear waste, the WIPP requires scientific and analytical services to address specific needs related to regulatory compliance, environmental monitoring, occupational health, waste characterization, repository performance, enhanced operations and the five year re-certification cycle mandated by title 40CFR194. To further develop the CEMRC program, the Center is working closely with the CBFO management to define research and analytical tasks that will address such needs. This redirection permits CEMRC to pursue new research avenues aggressively in partnership with the DOE community in the Carlsbad area.

The new emphasis on research and other environmental services is a logical development for CEMRC in view of the present collection of baseline data in the Carlsbad region. The present data collection serves the Carlsbad community, DOE and the State of New Mexico well in establishing the environmental conditions in the WIPP surroundings. While the monitoring needs to be continued at a reduced level to establish the natural variability of environmental conditions in the region, parallel sampling programs need not overlap one another as they have in the past. The redundancy in WIPP monitoring conducted by different organizations was reviewed in a September 2001 conference organized by CEMRC for CBFO. The conclusions of this conference will assist CEMRC in updating its program for improved effectiveness.

Quality Assurance

The CEMRC is currently subject to the policies, procedures and guidelines adopted by NMSU, as well as state and federal laws and regulations that govern the operation of the University. The CEMRC has adopted a general quality assurance policy (Appendix J) that includes development and implementation of appropriate standards, performance assessment, quality improvement, provision of infrastructure, professional staff development, personal accountability and commitment to compliance.

The CEMRC's quality assurance policy and implementation plans recognize that there are distinctions between standard analytical activities and experimental research settings. For experimental research settings, there are frequently few if any recognized analytical standards or procedures for the analyses of interest, and a major task is to develop such procedures, or to modify the application of standard procedures for new media. Likewise, research sampling designs are typically unique to the underlying scientific hypotheses and may not follow any standardized external formats. Therefore, the quality control measures applied to research contrast with those applied in programs driven by regulatory requirements, where the sampling frequency and methodologies and the analytical procedures typically are spelled out by various compliance guidelines.

In the WIPP Environmental Monitoring project, the CEMRC's strategy is to develop a set of independent data for a variety of parameters of interest, frequently involving sampling and analytical procedures that are different from those dictated by the regulatory requirements that govern the WIPP's certification and operation. In many cases, these data will target a larger suite of parameters or lower detection limits than are of concern from a regulatory perspective. Although this approach may include some sampling and analyses similar to those conducted by other groups associated with the WIPP, other activities are unique to the CEMRC's projects.

Personnel

Program managers provide training to laboratory and field workers in methodologies, general laboratory protocol, procedures, maintenance routines, and good safety practices. CEMRC laboratory and technical support staff receive specialized training for operation of specific equipment or systems, generally offered through equipment vendors. To support continued professional development, staff members are also provided opportunities for membership and participation in professional organizations, including attendance at conferences and workshops. Access to current scientific literature is provided through a current publications bulletin, a variety of journal subscriptions and inter-library loans.

Regulatory Compliance

To promote good health and safety practices in the laboratories, the CEMRC maintains a Chemical Hygiene Plan and associated training of personnel, in compliance with the requirements of 29 CFR 1910.1450, "Occupational Exposure to Chemical Hazardous Chemicals in Laboratories." A Hazard Communication Plan and associated training are also maintained for all employees, in compliance with requirements of 29 CFR 1910.200. A Chemical Hygiene Officer and Hazard Communications Coordinator are responsible for management of the chemical and laboratory safety programs, including maintenance of chemical inventories, periodic audits and management of any hazardous wastes generated by laboratory activities.

The CEMRC is a conditionally-exempt small quantity generator of hazardous wastes, as defined and regulated under the Resource Conservation and Recovery Act. Hazardous waste thus generated is disposed of through licensed treatment, storage and disposal facilities. Based on current chemical inventories, the CEMRC is exempt from the reporting requirements in Section 313 of the Emergency Planning and Community Right-to-Know Act. The CEMRC has had no spills

of hazardous substances that exceeded the reportable quantity limits under the Comprehensive Environmental Response, Compensation and Liability Act. The CEMRC currently has no air contaminant emissions subject to regulation under the Clean Air Act, and no wastewater discharges subject to regulation under the Clean Water Act beyond normal sanitary sewer discharges.

Use of radioactive materials is governed by the CEMRC's Radioactive Materials License, issued by the New Mexico Environment Department. A Radiation Control Manual and Implementation Plan and associated training are provided for staff who deal with radioactive materials. A Radiation Safety Officer is responsible for management of the radiation safety program, including maintenance of a radioactive materials inventory, periodic radiation contamination surveys, radiation safety audits and management of any radioactive waste generated by laboratory activities. The CEMRC generates a small amount (< 100 lb) of solid, low-level radioactive waste annually, which is disposed of through a licensed commercial disposal facility.

Field Sampling Program Quality Assurance

For the collection of most WIPP EM samples, no external standard procedures are considered completely appropriate for the objectives of the studies. In these cases, customized plans are developed and documented. After the activity is completed, the plan is revised to reflect any departures from the original plan, and documented to file. For most environmental media, the sampling plans combine selected standard procedures with specific adaptations to address scientific objectives of interest. For example, procedures for collection and preservation of samples for compliance with Safe Drinking Water Act requirements are applied to the collection of drinking water and surface water samples, but the locations of sample collection are selected on the basis of other criteria. Likewise, high-volume air samplers are operated to meet an EPA standard of 1.13 $m^3 min^{-1}$, but the frequency of filter replacement is based on optimal loading for radioanalysis.

Sampling procedures used for collection and preparation of environmental samples for the WIPP EM project are described in the individual data summaries that follow. Logbooks are maintained by technical staff in field operations to record locations and other specifics of sample collection, and data on instrument identification, performance, calibration and maintenance. Data generated from field sampling equipment are error-checked by using routine cross checks, control charts and graphical summaries. Original logbooks and field data forms are kept on file in the program manager's office. Most data collected in written form are also entered in electronic files, and electronic copies are crosschecked against the original data forms. All electronic files are backed up daily.

Calibration and maintenance of equipment and analytical instruments are carried out on predetermined schedules coinciding with manufacturer's specifications or modified to special project needs. Calibrations are either carried out by equipment vendors or by CEMRC personnel using certified calibration standards. Records of calibration and maintenance are maintained in instrument-specific files in the program manager's office or laboratory.

Environmental Chemistry Program Quality Assurance

The analytical methods employed in the environmental chemistry program at CEMRC are based, when applicable, on various standard procedures (EPA, 1983, M*ethods for Chemical Analysis of Water and Wastes*, EPA/600/4-79-020; EPA, 1997, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*; EPA/SW-846; American Public Health Association, 1981, *Standard Methods for the Examination of Water and Wastewater, 20th Edition*).

For the WIPP EM, an ion chromatograph (IC) was used to determine the concentrations of a suite of major ions in water samples and aqueous extracts of all media sampled during 2001. An atomic absorption spectrometer (AAS) and inductively coupled plasma-mass

spectrometer (ICP-MS) were used to analyze aqueous or acid extracts of samples.

For some matrix/analyte combinations, appropriate external standard procedures do not exist, and CEMRC has developed specialized standard procedures to meet the needs of the WIPP EM. A set of standard operating procedures and a formal quality assurance plan have been developed and implemented for the inorganic analyses performed at CEMRC. A summary of the quality assurance/quality control procedures and results for the environmental chemistry program for WIPP EM studies is presented in Appendix K. As part of CEMRC participation in the National Voluntary Laboratory Accreditation Program during 2000-2001, the environmental chemistry laboratory conducted analyses under the InterLaB WatR™ Pollution WS-58 Proficiency Testing Program sponsored by Environmental Resource Associates. Results for 27 of the reported 30 analytes were rated "acceptable", for an overall rating of "Very Good" (90.3% score).

In July 2001, the Environmental Chemistry Laboratory received accreditation for environmental testing by the American Association for Laboratory Accreditation (A2LA). A2LA is one of the leading lab accreditation bodies in the Americas and the third in the world. A2LA maintains bilateral agreements with the European Cooperation of Accreditation and the Asia-Pacific Laboratory Accreditation Cooperation. Accreditation consists of proficiency testing and on-site assessments, along with meeting the standards of the ISO/IEC 17025-1999 General Requirements of the Competence of Testing and Calibration Laboratories.

Radiochemistry Program Quality Assurance

During 2001, the CEMRC radioanalytical program participated in four rounds of the NIST Radiochemistry Intercomparison Program (NRIP) and achieved traceability for all analytes reported. The radioanalytical program also participated in the DOE Environmental Measurement Laboratory Quality Assurance Program (EML QAP), resulting in "acceptable" ratings for 67 results from glass fiber filters, soil, vegetation and water samples.

CEMRC has undertaken an extensive method development and validation project that began in May 1998, with special emphasis on measures necessary to ensure quantification of background levels of ^{239,240}Pu and other actinides. During 2001, revised standard procedures were developed and implemented for WIPP EM analyses of high-volume aerosol filters and soils/sediments. In addition, ^{241}Pu analysis was newly implemented for high volume air filters and FAS quarterly composite samples. Method development will continue for brine during 2002 as well as ^{90}Sr analysis of many WIPP EM media. A formal quality assurance plan was completed and adopted, and a variety of implementing procedures for radioanalyses in the WIPP EM project were also developed and issued. A summary of general quality assurance/quality control procedures used by the radioanalytical program is presented in Appendix L.

In Vivo Radiobioassay Quality Assurance

In vivo radiobioassays are performed in accordance with a formal quality assurance plan and related documentation that were developed to meet the requirements of the Department of Energy Laboratory Accreditation Program (DOELAP) for Radiobioassay. CEMRC provides *in vivo* radiobioassay services for WIPP radiation workers, and this program received DOELAP certification in 1999.

During 2001, the CEMRC *in vivo* radiobioassay program continued participation in the Intercomparison Studies *In Vivo* Program administered by Oak Ridge National Laboratory (ORNL). This program provides quarterly testing for ^{137}Cs, ^{60}Co, ^{57}Co, ^{88}Y and ^{133}Ba deposited in whole body. For all radionuclides, the percent differences between the values reported by CEMRC and the ORNL known values ranged from -2.7% to 3.6%.