

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 without prior review by DOE.

A detailed description of the WIPP EM concepts, sampling design and baseline studies is presented on the CEMRC web page. The following is a brief summary of 1999-2000 activities for each major environmental medium in the WIPP EM. Mixed waste was first received by the WIPP on 9 September 2000. Since results summarized in this report cover samples collected through June 2000, the results for non-radiological constituents are a continuation of baseline sampling.

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 measured in 2000 were within the range of baseline levels measured by CEMRC for the targeted analytes.

Aerosols

Aerosol sampling is conducted at four 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) and a site approximately 19 km southeast (upwind) of the WIPP (Cactus Flats station) (Fig. 2).

Continuous sampling of aerosols was conducted through June 2000 using the same instruments, frequencies and locations as were previously established in the baseline phase. Analyses of all aerosol samples collected through June 2000 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 aerosol samples collected in the WIPP exhaust shaft (FAS) began in July 1999, and are updated weekly. A summary of these data is also presented herein.

During the period July 2000–June 2001, minor changes are being implemented to improve the aerosol 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 m, with ≥ 1 m between sampler intakes and underlying solid surfaces, (2) addition of a high volume TSP sampler at a location approximately 55 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). For baseline studies at each of the 16 locations in each area, samples were collected during 1998 and 1999 at three randomly selected sites within a 50-m x 50-m area

centered on the location's reference point. The resulting data represented 96 discrete samples that provided estimates of variability at the small-scale (between samples within a 0.0025 km² area), medium-scale (among locations within each 166 km² area) and large-scale (between the two sampling areas located approximately 19 km apart).

During 2000, one soil sample was collected at each of the 32 locations during January-February. The limitation of soil sampling to one period annually is based on the assumption that any input of contaminants to surface soils from WIPP releases would occur via aerosol deposition, and since aerosol sampling is conducted continuously, more frequent soil sampling is not warranted unless there was evidence of a contaminant increase in aerosols.

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 Lake, located approximately 48 km southwest of the WIPP. Results of preliminary studies of selected radionuclides in sediments from Brantley Lake were reported in the CEMRC 1997 Report, and radioanalyses of sediment and surface water samples from all three lakes were reported in the CEMRC 1998 Report. The CEMRC 1999 Report contained results of analyses of the 1999 surface water and sediment samples for non-radiological constituents, analyses of selected alpha-emitting radionuclides in 1998 (baseline) sediment samples, and tests for Pu in 1998 surface water samples.

Radiological analyses of 2000 (monitoring phase) surface water samples were completed and are reported herein. Radiological analyses of 1999 and 2000 sediment samples are in progress and will be reported on the CEMRC web site when completed.

Because of the distance between the WIPP site and these reservoirs, the potential

risk of direct contamination of the reservoirs by releases from the WIPP is relatively low compared to other media, and sampling in subsequent years will continue to be conducted once annually in the summer.

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 initial baseline studies during 1996-1998, drinking water samples were subjected to analyses for over 150 analytes, including those that are regulated under the Safe Drinking Water Act, and contaminants known or suspected to be present in the WIPP wastes. Radioanalyses of drinking water conducted during 1997-1998 (previously reported) were unable to detect Pu or Am in any of the samples collected, using traditional alpha spectrometry. Subsequent analyses by thermal ionization mass spectrometry (TIMS) (a more sensitive radioanalytical technique) were also unsuccessful in detecting Pu in any of the water samples. Based on these results, subsequent radiological analyses have applied standard alpha spectroscopy detection limits achievable with 3-L samples. During 2000, drinking water samples were collected in the spring, and results of radiological and non-radiological analyses are reported herein. The six drinking water supplies will continue to be sampled once annually 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). During late summer 1999, the first monitoring phase samples were collected, consisting of a single sample of several grass species from each of the 32 soil sampling locations.

Radiochemical analyses of the baseline and initial monitoring phase samples will be carried out during 2001, followed by web page posting and inclusion in the CEMRC 2001 Report. No additional vegetation sampling is planned to be conducted until spring 2002.

Additional studies are planned to evaluate the effectiveness of expanding the biota sampling for radionuclides to include arthropods. Arthropods were collected at the Cactus Flats station during spring through fall in 1998 (baseline) and at Near Field and Cactus Flats stations during spring through fall in 1999. Comparative radioanalyses of the samples are planned during 2001 to evaluate the effectiveness of this environmental component in long-term monitoring.

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. The minimum sample size threshold was achieved for the major categories early in 1998, and continued baseline sampling resulted in radiobioassays completed for 367 individuals before the first receipt of waste at the WIPP, reducing margin of error ranges to a maximum of 5-7% for any category. Radiobioassays of the original volunteer cohort began in July 1999 to achieve a complete cohort recount by July 2001. 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 2000 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.

Management of WIPP EM Project

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 2000 key performance indicators is summarized in Appendix I. Eleven indicators were completed on time and four indicators were delayed but completed prior to year-end. Four out of 19 indicators were not completed, with 0-90% progress on

each. Key performance indicators for 2001 the 2001 WIPP EM project schedule (Table 2) have been identified to serve as the basis for

Table 2. Key Performance Indicators for 2001

Focus Area	Key Performance Indicator
Aerosols	1. Continue concurrent high-volume and low-volume/dichotomous sampling at current four locations through 2001
	2. Continue collection of daily FAS samples in WIPP exhaust shaft through 2001
Soils	3. Collect samples at current 32 locations during January-February 2001
Meteorology	4. Continue concurrent operation of sampling stations at two current sites through 2001
Drinking water	5. Collect samples from six sources during April-May 2001
Sediment and surface water	6. Collect samples from three reservoirs during June-July 2001
Human studies	7. Complete repeat counts for original volunteer cohort, and initial counts for a minimum of 100 new volunteers
Radioanalyses	8. Complete analyses of subset of pre-2000 vegetation and arthropod samples by October 2001
	9. Complete analyses of soil, aerosol, sediment, surface water and drinking water samples (collected through June 2001) by October 2001
	10. Continue FAS sample analyses to meet weekly and quarterly posting schedule
Non-radiological analyses	11. Complete analyses of representative subset of 2001 low-volume aerosol, soil, sediment, surface water and drinking water samples within three months after each sample collection
	12. Continue FAS sample analyses to meet weekly and quarterly posting schedule
Data management and dissemination	13. Post results of radioanalyses of 2001 and pre-2001 samples within two months after completion of analyses of each set of samples
	14. Post results of non-radiological analyses of 2001 samples within two months after completion of analyses of each set of samples
	15. Issue CEMRC 2000 Report; post report and background data to CEMRC web site by March 2001
	16. Issue newsletters in March and September, 2001
	17. Submit manuscript for publication by March 2001 on baseline characteristics of aerosols

Quality Assurance

The CEMRC is 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 therefore 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 using sampling and analyses 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 and 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 preliminary 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 $1.13 \text{ m}^3\text{min}^{-1}$, 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 cross-checked 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 adapt 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.

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, *Methods 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 2000 (Table 3). 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 1999-2000, the environmental chemistry laboratory conducted analyses under the InterLab WatR™ Pollution WP-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).

Radiochemistry Program Quality Assurance

During 2000, the CEMRC radioanalytical program participated in five rounds of the NIST Radiochemistry Intercomparison Program (NRIP) and achieved traceability for 17 of 18 analyte reports. The radioanalytical program also participated in the DOE Environmental Measurement Laboratory Quality Assurance Program (EML QAP), resulting in “acceptable” ratings for 49 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 $^{239,240}\text{Pu}$ and other actinides. During 2000, new standard procedures were developed and implemented for WIPP EM analyses of high-volume aerosol filters and sediments. Method development will continue for brine and biota during 2001. 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. During 2000, CEMRC participated in DOELAP performance testing for ^{238}Pu , ^{238}U , and fission/activation products in lungs, and passed all performance criteria. CEMRC provides *in vivo* radiobioassay services for WIPP radiation workers, and this program received DOELAP certification in 1999.

During 2000, the CEMRC *in vivo* radiobioassay program participated 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. From the 1998 annual report issued in March 2000, (four quarters in total), CEMRC reported values that were within -1.83% to 4.61% of the ORNL known value for all radionuclides (acceptance criteria at -25% to +50%). Results of tests for the first three quarters of 2000 were also verified by ORNL within -2.7% to 1.8% of known values.

External Laboratory Services

With the exception of data for organic carbon content in FAS air filter samples, all analyses presented herein were carried out by CEMRC laboratories. The organic carbon analyses were provided as a courtesy by the Energy and Environmental Engineering Center of the Desert Research Institute in Reno, Nevada.

Table 3. Inorganic Analyses Conducted at CEMRC

Type of Analyte (Instrument)	Sample Preparation Method by Sample Matrix			
	Air	Drinking & Surface Water	Soil	Sediment
Anions (^a IC)	Filter extraction with ^b DI water and isopropanol	Syringe filtration with direct injection	Aqueous extract	Aqueous extract
Cations (IC)	Filter extraction with DI water and isopropanol			
Hydrides (As, Sb, Se) and Hg (Flow Injection ^c AA)		Syringe filtration with direct injection	Total recoverable	Total recoverable
Trace Elements (^d ICP-MS & AA)	Aqueous extract Total dissolution	Dissolved Total recoverable	Total recoverable	Total recoverable

^aIon chromatograph^bDe-ionized water^cAtomic absorption spectrometer^dInductively-coupled plasma mass spectrometer