

PREOPERATIONAL ENVIRONMENTAL PROGRAMS
FOR THE WASTE ISOLATION PILOT PLANT

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ABSTRACT

Since its inception, the Waste Isolation Pilot Plant (WIPP) project has involved a comprehensive series of environmental programs. The first round of field studies began in 1975 to characterize the local environment and to provide data necessary for the projection of potential environmental impacts. These included ecological surveys and experiments, along with measurements of meteorological and radiological parameters in the vicinity of the site. A second round of preoperational field studies is just starting. The current programs monitor construction-related environmental impacts and quantify baseline levels of radiation and radionuclides along possible release pathways. In 1988, when transuranic wastes arrive, these programs will be replaced by operational programs that monitor the same parameters, but with possible adjustments in sampling intensity. Operational monitoring will persist until 2013, with a few components lasting through the two-year decommissioning period and beyond closure of the facility.

This paper describes and classifies the preoperational environmental programs for the WIPP project. The paper also provides a chronological context for all programs of environmental data acquisition which have been or will be implemented during the period of active institutional control over the site. A time chart is used to illustrate how past and present activities fit into the overall program for environmental surveillance and protection at the WIPP project.

INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) is a research and development facility designed to demonstrate the safe disposal of radioactive wastes generated by the defense activities of the United States Government. Transuranic (TRU) wastes will be emplaced in bedded salt 655 m (2,125 feet) below the surface at a remote location in southeastern New Mexico in an area known as Los Medanos. Defense high level waste experiments will also be conducted in the bedded salt. The facility, which is operated by the Department of Energy (DOE), is scheduled to receive TRU waste beginning in October 1988.

Considering that WIPP represents a promising technology for the permanent isolation of radioactive wastes, it is essential to document the environmental impacts as thoroughly as possible. This has resulted in a carefully formulated program for environmental protection, the goal of which is to obtain all the information necessary to protect the health and safety of the public and to preserve the quality of the environment.

The importance of an effective and credible environmental protection program

has been recognized from the outset, and has resulted in an extensive series of ecological and radiological surveys, along with numerous other environmental studies and measurements. Field studies began in 1975 with the identification of the Los Medanos area as the preferred location for the WIPP, and will continue throughout the operational lifetime of the plant. Some aspects of the environmental surveillance program will extend beyond the decommissioning and closure of the facility. One goal of this paper is to describe the various environmental surveillance programs, particularly those which have already taken place or which are in progress as part of the preoperational monitoring effort.

It is also important to document those lessons which are learned in the process of developing the technically sound and economically realistic methods of environmental surveillance. Thus, another goal of this paper is to demonstrate how past, present, and future environmental programs are classified by discipline and by their chronological role in the long-term program of environmental protection at the WIPP project. The value of such an overview and classification effort is to provide a

framework for ensuring that all appropriate environmental parameters are under surveillance, for estimating the budgetary requirements of environmental programs, and for anticipating the impacts of decisions regarding the status of future environmental data acquisition activities.

CLASSIFICATION OF ENVIRONMENTAL PROGRAMS

The environmental field programs for the WIPP project can be classified into three major program elements:

1) The Radiological Program Element includes programs which measure levels of radiation and radionuclides in the environment. Included are baseline (preoperational) surveys in the vicinity of the site, especially along the potential release pathways. Also included are operational programs, wherein radiological parameters are monitored at the most likely detection points, and post-operational programs, wherein a few key parameters are measured on an intermittent basis long after closure of the facility.

2) The Ecological Program Element consists of inventories, experiments, and monitoring programs in the Los Medanos Ecosystem which encompasses the site. This includes the initial surveys and experiments to assess potential environmental impacts. Also included are more recent efforts to detect and evaluate construction-related or operational impacts of the facility on the surrounding ecosystem, as well as special studies of organisms with noteworthy roles in the local ecosystem or in radionuclide pathways.

3) The Environmental Program Element includes those data acquisition programs which do not directly involve radiological measurements or ecological studies. Included are programs monitoring meteorological conditions, water and air quality parameters, or cultural, sociological, and visual resources. These programs address regulatory standards, facilitate the interpretation of data from concurrent programs, and refine the understanding of the role of a facility such as WIPP in the environment.

A DESCRIPTIVE CHRONOLOGY OF PROGRAMS FOR THE ACQUISITION OF ENVIRONMENTAL DATA

Figure 1 is a chronological overview of programs for the acquisition of environmental data at the WIPP project. The programs in each of the three major program elements (radiological, environmental, and ecological), are plotted relative to major WIPP project milestones, which provide a frame of reference.

Acquisition of Radiological Data

Radiological data at the WIPP site were first collected by Sandia National Laboratories (SNL) in 1976. This program involved measurements with a continuous exposure-rate meter and thermoluminescent dosimeters (TLDs), and to a lesser extent

with high volume particulate samplers. The goal was to establish a preliminary database on radiation levels around the site and to provide information for the Final Environmental Impact Statement (FEIS)¹.

The program terminated in 1980 except for dosimetry, which is still in place as part of an effort to correlate the performance characteristics of the Sandia TLDs to the performance characteristics of TLDs which were recently installed by the WIPP Technical Support Contractor (TSC) as part of the Radiological Baseline Program (RBP). Seven quarterly dosimeters from each of the two programs are at identical locations, making it possible to compare the measurements obtained by the two kinds of TLD packets, which are somewhat differently configured. The overlap between the dosimetry programs provides valuable continuity in the radiological database.

The Radiological Baseline Program will begin collecting data in June 1985 (except for the dosimetry effort mentioned above). The goal of the RBP is to compile a comprehensive baseline for radiation and radionuclides in the environment; thus, the program contains several components, including sampling and analysis of aerosols, soils, water, bottom sediments, and biotic tissue, as well as measurements of ambient radiation. Program details are discussed in a later section.

All elements of the RBP will be maintained in the Operational Radiation Monitoring Program (ORMP), the beginning of which corresponds roughly with the first receipt of wastes. The gradual transition between the RBP and ORMP will involve adjustments in the intensity of sampling which correspond to the different requirements of the two programs. The goal of operational monitoring is to detect any radiological impacts of the WIPP facility. Operational data will be reported in the context of a statistically rigorous comparison with preoperational data.

Operational radiation monitoring will continue until wastes are not longer being received at the WIPP. Post-operational monitoring will be most intense during the two years that the facility is being decommissioned (disassembled, decontaminated, and reclaimed), with some periodic sampling continuing indefinitely at the WIPP site. This long-term effort will involve sampling and analysis of radionuclide levels in groundwater, surface water, and key organisms approximately once every five years.

Also included in the Radiological Program Element are milestones for the Gnome project, in which a 3.1-kiloton nuclear device was detonated in 1961 at a depth of 400 meters at a site 12.6 kilometers southwest of the center of the WIPP site. The Gnome project, which was conducted by the Atomic Energy Commission as part of the plowshare program², was followed by an extensive decontamination and radiation monitoring effort³. In recognition of the

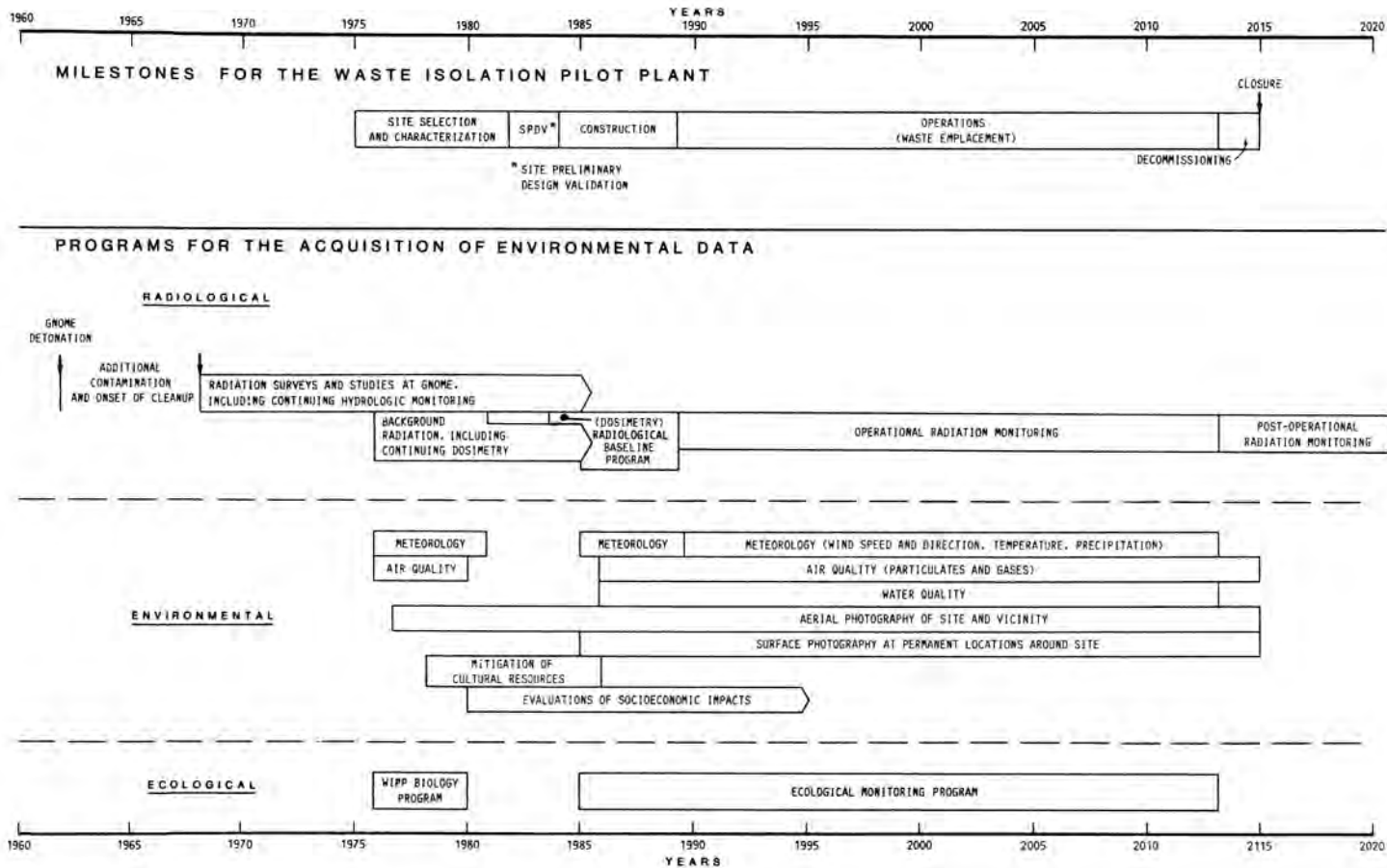


Fig. 1. A chronology of programs for the acquisition of environmental data at the WIPP Project.

proximity of the two sites and the importance of characterizing radiological conditions prior to waste emplacement, relevant data from the Gnome project are being incorporated into the preoperational database for the WIPP.

Acquisition of Environmental Data

Data acquisition in the Environmental Program Element also began in 1976 with measurements of meteorological and air quality parameters by Sandia National Laboratories. These data were collected at the same times and locations as the preliminary radiological data, and are reported in the same series of documents. This program, which provided data for the FEIS¹, was discontinued late in 1980.

Meteorological monitoring was resumed in 1984 with the installation of a temporary system at the site. This will be replaced sometime before operations with a permanent meteorological monitoring station that will interface with the Central Monitoring System (CMS), a computerized instrumentation network which will monitor all key operational parameters at the WIPP facility. The record of meteorological data from the site facilitates the interpretation of data from concurrent monitoring programs. In the future, the CMS will interpret meteorological data to make instantaneous assessments of the consequences of an accidental release, and will provide valuable data for emergency response.

Air quality parameters, including atmospheric gasses and total suspended particulates, will be monitored beginning in June 1985 in order to detect and evaluate effluents from construction and operation. This program will continue throughout operations.

Environmental photography began in November 1978 with the acquisition of semiannual aerial photographs of the WIPP site. Aerial photography went onto a regular schedule in November 1982, after which missions have been and will continue to be flown every six months. Surface photography was initiated in 1984 with the acquisition of 35-mm photographs at each of six permanent monitoring locations adjacent to the site. Conditions at these locations are documented in a panoramic series of eight photographs every six months. The environmental photography program provides an readily interpretable record of visually detectable impacts associated with the project.

Archaeological investigations began at the site in 1978 to identify and evaluate significant archaeological and cultural features. The initial findings were reported in the FEIS¹, although some mitigation efforts continued through 1984.

Studies to investigate potential socioeconomic impacts of the WIPP project on communities in southeastern New Mexico began in 1979. Demographic information was acquired and interviews were conducted in

order to characterize local economies. These data acquisition efforts may continue on an occasional basis throughout operations in order to update assessments of the project's socioeconomic repercussions.

Acquisition of Ecological Data

An extensive series of ecological studies, known collectively as the WIPP Biology Program, occurred between 1975 and 1981. These studies characterized all facets of the Los Medanos Ecosystem and included some experiments aimed at forecasting potential impacts of WIPP construction and operations. The individual studies, which ranged from one to three years in duration, were conducted by professors and graduate students from six universities in the region. The work was coordinated and reported by Sandia National Laboratories through 1978, then by the Technical Support Contractor for the WIPP project. Data from these studies are summarized in the FEIS¹ and are reported in a series of technical documents, as well as publications in the scientific literature.

Ecological data are now acquired as part of the Ecological Monitoring Program, which was initiated by TSC in 1984 to detect, monitor, and evaluate impacts of construction and operations. A comprehensive set of biotic surveys and studies are conducted adjacent to the site at six permanent plots. Soil properties, vegetation, and vertebrate populations are examined on a periodic basis for evidence of possible impacts of fugitive salt dust or other site-related influences. This program, which is described in some detail in a later section, will continue through operations, with some components (for instance, vegetation surveys) possibly continuing through decommissioning.

PREOPERATIONAL ENVIRONMENTAL PROGRAMS

This section provides additional detail on the objectives and design of two preoperational programs (the Radiological Baseline Program [RBP] and the Ecological Monitoring Program [EMP]) which are just getting started on the WIPP project. These programs differ from their predecessors in that data acquisition emphasizes those components and pathways in the ecosystem where the detection of impacts is most likely. In the case of the RBP, this means monitoring baseline radionuclide levels along potential release pathways, and in the case of the EMP, this means measuring the appropriate ecological parameters at locations where construction-related impacts are most likely to be evident.

Radiological Baseline Program

The goal of the RBP is to establish a comprehensive baseline for levels of radiation and radionuclides in the environment around the WIPP site. Of greatest interest are conditions along the potential release pathways which were identified in the WIPP Safety Analysis

Report (SAR)⁴. Figure 2 illustrates how each pathway is monitored by at least one of the five subprograms of sampling and analysis, and Table I provides a brief description of each subprogram and its components.

Sampling in the RBP extends over a large geographic area, including all of the major towns within 80 km of the site. A detailed program plan has been prepared⁵, although the specific locations and sample sizes are still subject to refinement. Final decisions will depend in part on two motivating factors which have contradictory implications.

First is the need for statistical adequacy, which calls for as many replicate samples as possible. Strictly speaking, replicates should be taken at the same locations at the same times, thus indicating the natural variability in the parameter and in the sampling methodology. This goal dictates that the sampling effort be concentrated upon a few key locations.

Second is the need to detect any unexpected elevations in radiation levels around the site. It is important to discover these occurrences prior to waste emplacement; if unusual radiological

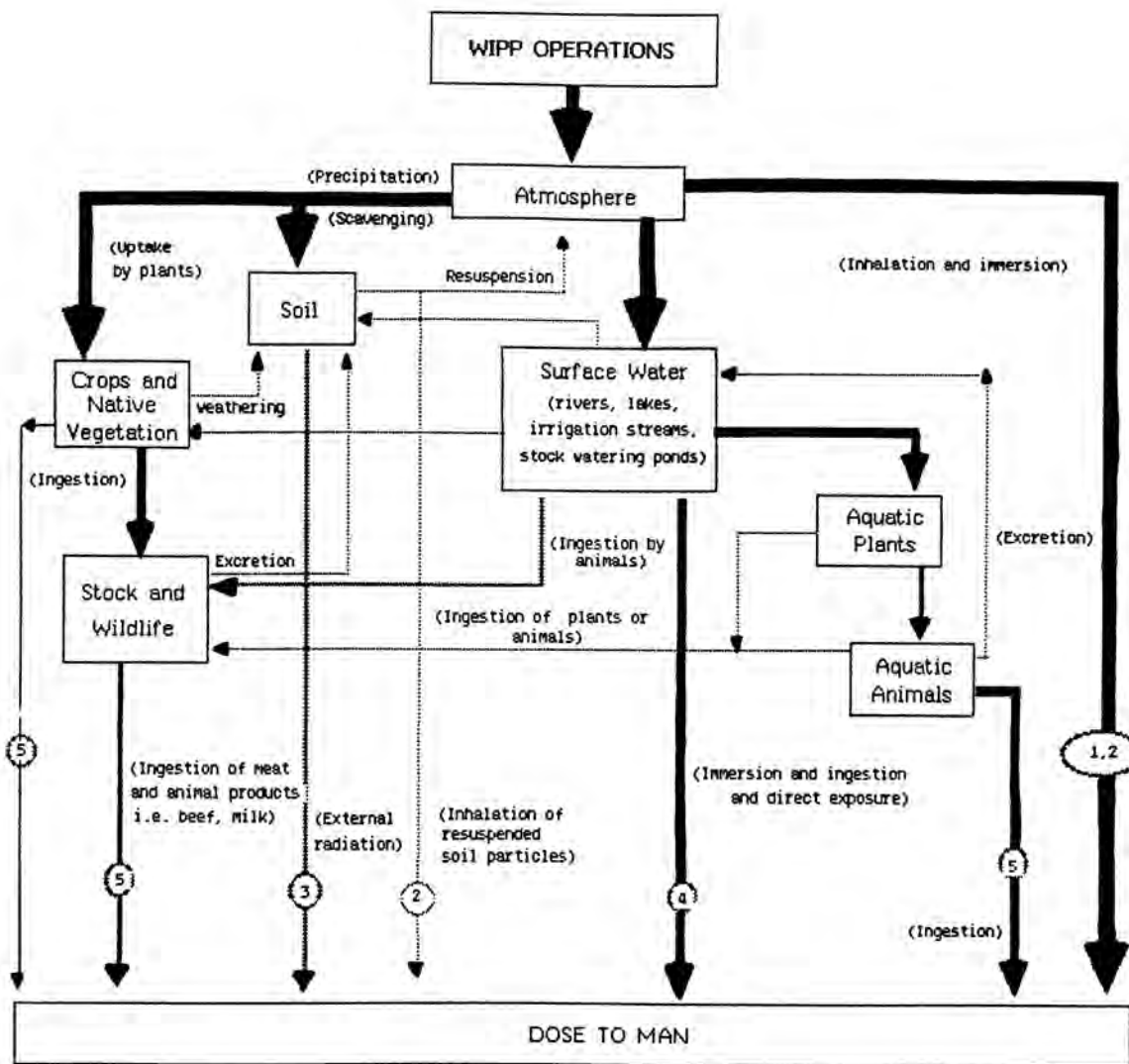


Fig. 2. Possible radionuclide pathways leading from the WIPP site to Man (adapted from the SAR⁴). The line thickness is proportional to the significance of the pathway. The numbers indicate the programs which monitor each pathway.

- 1...Ambient Radiation Baseline
- 2...Aerosol Radiation Baseline
- 3...Soil Radiation Baseline

- 4...Hydrologic Radiation Baseline
- 5...Biotic Radiation Baseline

TABLE I
Descriptions of sampling programs in the Radiological Baseline Program.

AMBIENT RADIATION BASELINE

- Aerial Gamma Survey: A light aircraft will fly low over the WIPP site, the Gnome site, and adjacent transportation corridors to produce a map of gamma radiation.
- Continuous Exposure Rate Measurements: A high pressure ionization chamber will monitor and record background radiation in the vicinity of the WIPP facility.
- Quarterly Dosimetry: Approximately 36 thermoluminescent dosimeters (TLDs) will measure penetrating radiation at locations within 80 kilometers around the site.

AEROSOL RADIATION BASELINE

- Fixed Air Sampling: Air samplers will collect particulates at seven locations; filters will be scanned weekly and composited quarterly for radionuclide analysis.

SOIL RADIATION BASELINE

- Soil Sampling and Analysis: Surface samples will be collected every six months (and deep samples less frequently) from the 36 TLD stations. Samples will be analyzed for radionuclides or archived for deferred analysis.

HYDROLOGIC RADIATION BASELINE

- Surface Water Sampling: Seven water bodies (lakes, rivers, and stockponds) will be sampled and analyzed every six months.
- Bottom Sediment Sampling: Bottom sediments will be sampled and analyzed at one lake and two river locations every six months.
- Groundwater Sampling: Ten wells and one spring will be sampled and analyzed at least twice over the duration of the program.

BIOTIC RADIATION BASELINE

- Vegetation Sampling: Tissues of range plants will be composited and analyzed every six months.
- Non-game Sampling: Quail and rabbit will be collected and analyzed twice during the program.
- Fish Sampling: Catfish will be caught and analyzed on two occasions from a lake northwest of the site.
- Beef Sampling: Liver and muscle tissue of cattle from a ranch near the site will be analyzed for radionuclides.

conditions are detected after wastes have been received, they may be falsely attributed to the WIPP project. This objective dictates sampling as many locations as possible at the expense of statistical replication.

A numerical analysis is underway which addresses these contradictory objectives of preoperational radiological surveillance.

Ecological Monitoring Program

The EMP began in 1984 with the principal goal of detecting construction-related impacts on the Los Medanos Ecosystem. The First Semi-annual Report for the Ecological Monitoring Program⁶ describes the program design, along with sampling procedures and preliminary results. Table II includes brief discussions of each of the subprograms in the EMP.

Most of the surveys and studies in the EMP are conducted at six permanently marked ecological monitoring plots which are relatively near the site. This is because the program is concerned with near-field impacts that may be related to construction, for instance, the deposition of salt from large storage piles on the surface. Furthermore, all of the ecological monitoring plots are in the same vegetation community (oak-sage-mesquite), thus facilitating comparisons between control

plots, which are slightly more than 2 kilometers from the construction area, and experimental plots, which are situated where impacts are most likely (for instance, immediately downwind from the largest salt storage pile).

Unlike the RBP, which aims for a statistically adequate database within three years, the EMP monitors long-term phenomena that may be evidence of chronic or cumulative impacts of the WIPP installation on the surrounding ecosystem. Thus, sampling is performed on an intermittent schedule which will reveal trends or other temporal patterns that may differ between the experimental and control plots. The results of the Ecological Monitoring Program will be reported in a series of semi-annual reports.

One other aspect of the EMP is the flexibility to accommodate special studies. For example, local raptors (hawks, harrriers, falcons, and owls) are being studied in an effort to develop a comprehensive management plan between the Department of Energy and the Bureau of Land Management. The project uses banding, nest surveys, and radio tracking to assess the effects of human activities on raptor populations, particularly on the Harris Hawk, in the Los Medanos Ecosystem. Raptor castings will be analyzed for radionuclides to clarify the radioecological role of these birds.

TABLE II
Descriptions of subprograms in the Ecological Monitoring Program.

ENVIRONMENTAL PHOTOGRAPHY

Aerial Photography: Aerial photographs are taken semi-annually of the WIPP site and access corridors.
Surface Photography: A 360-degree panorama of 35-mm photographs are taken at six permanently marked locations near the facility.

SOIL SAMPLING

Analyses of Chemical Properties: Surface and depth samples are taken semi-annually and analyzed for cations and anions that may indicate salt deposition.

SOIL MICROBIOTIC STUDIES

Assays of Microbial Activity: Flourescein diacetate hydrolysis is used to assay total microbial activity on leaf litter at the six ecological monitoring plots.
Rates of Decomposition: Bags of leaf litter are weighed before and after episodes of exposure to the environment to determine decomposition rates.
Inventories of Microarthropods: Tullgren funnels are used to extract arthropods from leaf litter samples from the six ecological monitoring plots.

VEGETATION SURVEYS

Species Richness: Plant species are inventoried annually at the six plots.
Germination: Seedlings are counted each spring in randomly located 1-meter quadrats at each of the six ecological monitoring plots.
Foliar Cover: Perennial foliar cover is estimated each fall in the random quadrats.

VERTEBRATE SURVEYS

Birds: Breeding birds are censused in late spring using Emlen transects.
Mammals: Mammal populations are monitored with Sherman live traps.
Reptiles: Reptiles are captured in pitfall traps, identified, and released.

AIR QUALITY: Atmospheric gases (CO, NO_x, SO₂, H₂S, and O₃) and total suspended particulates are to be monitored near the facility.

WATER QUALITY: Non-radiological water quality parameters are measured in surface waters and wells near the WIPP site.

METEOROLOGY: Temperature, precipitation, and wind speed and direction are recorded at the WIPP facility.

SUMMARY

The purpose of this paper is to demonstrate how the current round of data acquisition programs fit into the overall program for environmental protection for the WIPP project. The first round of data acquisition, which are best considered "preliminary environmental programs," collected data necessary for the projection of environmental impacts in the Environmental Impact Statement¹. These programs, which were conducted by Sandia National Laboratories and by local universities, acquired a substantial volume of data, although the data were not precisely attuned to the specific characteristics of the WIPP project.

The present round of data acquisition programs, which are regarded as "preoperational environmental programs," are designed to collect data that are more precisely concerned with the known pathways and waste characteristics, and with the projected impacts, of the project. The preoperational programs also differ from the preliminary programs in that they address specific statistical objectives.

All of the component subprograms of the preoperational monitoring effort will be maintained during operational monitoring, although the intensity of sampling may change. This continuity is important because operational data are most meaningful when compared to a similarly configured

preoperational database. The resulting comparisons will then serve to provide a quantitative indication of the nature and extent of the project's environmental impacts, if any.

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