EEG-49
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PREOPERATIONAL RADIATION SURVEILLANCE OF THE WIPP PROJECT BY EEG DURING 1990

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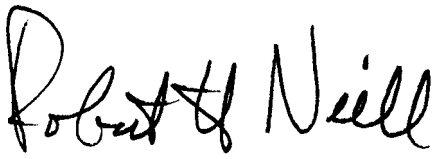
FOREWORD

The purpose of the Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the Waste Isolation Pilot Plant (WIPP) Project to ensure protection of the public health and safety and the environment. The WIPP Project, located in southeastern New Mexico, is being constructed as a repository for permanent disposal of transuranic (TRU) radioactive wastes generated by the national defense programs. The EEG was established in 1978 with funds provided by the U.S. Department of Energy (DOE) to the State of New Mexico. Public Law 100-456, the National Defense Authorization Act, Fiscal Year 1989, Section 1433, assigned EEG to the New Mexico Institute of Mining and Technology and continued the funding from DOE under contract DE-AC04-79AL10752 as DE-AC04-89AL58309.

EEG performs independent technical analyses of the suitability of the proposed site; the design of the repository, its planned operation, and its long-term integrity; suitability and safety of the transportation systems; suitability of the Waste Acceptance Criteria and the generator sites' compliance with them; and related subjects. These analyses include assessments of reports issued by the DOE and its contractors, other federal agencies and organizations, as they relate to the potential health, safety and environmental impacts from WIPP. Another important function of EEG is independent environmental monitoring of background radioactivity in air, water, and soil, both on-site and in surrounding communities.



Robert H. Neill
Director

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ENVIRONMENTAL EVALUATION GROUP FILING GUIDE

AGBL - WIPP Agreements, Bills, and Lawsuits

AGOR - Agencies and Organizations

DCOF - Design, Construction, and Operation of Facility

ERAM - Environmental Radiation Monitoring

PROF - Professional Services

PUBS - Publications

QA - Quality Assurance

SARW - Safety Analysis for WIPP

TECH - Technical Subjects

TPA - Test Phase Activities

TRPT - Transportation

WACC - Waste and Container Characterization

WPCV - WIPP Site Characterization and Validation

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EXECUTIVE SUMMARY

The purpose of the EEG preoperational monitoring program is to document the existing concentrations of selected radionuclides in various environmental samples in the vicinity of the WIPP site. The basic methodology for conducting environmental surveillance of the WIPP facility has been developed (Spiegler 1984). This report represents a continuation of the baseline data previously reported in EEG-43 and EEG-47. Such radionuclide baseline data are important in order to determine whether WIPP operations will affect concentrations of these radionuclides in the environment. EEG data are consistent with similar data previously reported by DOE during the preoperational phase of WIPP.

Since late 1985, the EEG has collected 1,608 air particulate samples, 174 water samples, 15 biota samples, and nine soil/ sediment samples. A total of 4,848 specific radionuclide analyses were performed on these samples.

As expected, observed concentrations of U-238 daughter radionuclides were not in equilibrium with the parent radionuclide in water samples. This observation is consistent with differential radionuclide mobility in the environment. Ra-226 and Ra-228 were reported in a number of water samples in concentrations similar to those previously published by EEG and DOE.

In a continuing effort to determine lower limits of detection, EEG provided the contractor laboratory with unused (blank) air filters for radiochemical analysis. Data from these analyses were used to calculate lower limits of detection (LLD) for air samples based upon procedure blanks rather than instrument counting blanks. Similar water blanks have also been submitted for analysis but these data are incomplete for use in LLD calculations.

Radionuclide concentrations in soil and biota samples were consistent with other data reported by EEG and DOE in the WIPP environment.

1.0 INTRODUCTION

The purpose of the Environmental Evaluation Group's (EEG) monitoring program at the Waste Isolation Pilot Plant (WIPP) is to establish baseline measurements of radionuclide concentrations in the environment surrounding the WIPP facility. The EEG surveillance parallels the confirmatory baseline measurements program conducted by the U. S. Department of Energy's (DOE) prime contractor.

The WIPP project is intended to be a repository for disposal of transuranic (TRU) radioactive waste resulting from the defense activities of the United States. The DOE plans to start shipping contact-handled transuranic (CH-TRU) waste to WIPP in 1991 for a 5-year test phase before making a decision in late 1997 that the facility has been shown to be safe for permanent disposal of transuranic waste. The test phase is composed of dry bin-scale tests, wet bin-scale tests, alcove tests, and leachability/ solubility tests. The first of these tests to be conducted at WIPP are the dry bin-scale tests which will require 105 CH-TRU waste bins (630 drums).

The WIPP mission is to dispose of up to 176,000 m^3 (6.2 million cubic feet) of CH-TRU waste and 7,080 m^3 (250,000 cubic feet) of remote-handled (RH-TRU) waste (U.S.D.O.E. 1990a). The total radioactivity from CH-TRU waste at WIPP will be about 1.14×10^7 curies (Ci) including a maximum of 5.1×10^6 Ci from RH-TRU waste (N.M. and U.S.D.O.E. 1984). Under authorizing legislation (Public Law 96-164), the WIPP facility is exempt from U. S. Nuclear Regulatory Commission (NRC) regulations.

The U. S. Environmental Protection Agency (EPA) Standards, 40 CFR Part 191, "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High Level and Transuranic Radioactive Waste," were promulgated in November 1985 and apply

to the WIPP. Subpart A of 40 CFR 191 limits the combined annual radiation dose to the public to 25 millirems to the whole body and 75 millirems to any critical organ from waste emplacement and storage operations at DOE disposal facilities which are not regulated by NRC. Subpart B of 40 CFR 191 establishes performance standards for long-term containment and releases of radioactivity to the accessible environment. Subpart B was vacated by the First Circuit Court of Boston in June of 1987 on the grounds that the regulation was less stringent than the requirements of the Clean Water Act of 1971 and failed to follow the Administrative Procedure Act. Subsequently, the State of New Mexico and DOE signed an agreement in July 1987 to continue assessment of potential compliance with the vacated standard until a new one is promulgated.

The Environmental Evaluation Group established a preoperational environmental monitoring program in 1984 under terms of the July 1981 Consultation and Cooperation (C & C) Agreement and the December 1982 Supplemental Stipulated Agreement. The National Defense Authorization Act (Public Law 100-456) authorized continued funding of the EEG's environmental monitoring program. Data contained in this report are a continuation of the preoperational monitoring baseline studies outlined in Spiegler (1984) and reported in Kenney et al. (1990) and in Kenney and Ballard (1990). EEG plans to continue environmental monitoring during the operational phase as well as the pre-operational phase.

The Department of Energy provided EEG access to independent fixed air samplers (FAS) in the filtered and unfiltered exhaust air effluent from the repository in October of 1990. Baseline samples are now being collected from this effluent air stream and data will be reported in the next annual environmental report in 1992.

2.0 ENVIRONMENTAL SETTING OF THE WIPP SITE

The WIPP facility is located in Eddy County in southeastern New Mexico, approximately 42 km (26 mi) east of Carlsbad (Figure 1). The facility is located on a sandy plain at an elevation of 1,040 m (3,410 ft) above sea level. Prominent natural features near the facility include Livingston Ridge and Nash Draw, about 8 km (5 mi) west of the facility. Nash Draw is a shallow, dog-bone shaped drainage course between 8 km (5 mi) and 18 km (11 mi) in width, characterized by surface impoundments of brine water (Figure 2). Livingston Ridge is a bluff that marks the eastern edges of Nash Draw. Other prominent features of the region include the Pecos River, located about 22 km (14 mi) west of the facility, and the Carlsbad Caverns National Park about 68 km (42 mi) west-southwest of the WIPP facility.

Chaturvedi and Channell (1985) suggest that the two major discharge points for waters from the Rustler Formation are into the Pecos River in an area known as Malaga Bend and into Laguna Grande de la Sal. The Laguna Grande de la Sal receives flow from several springs along the margin of the lake. Potentiometric contours for various zones within the Rustler point to the Laguna Grande de la Sal as a secondary discharge point for the Rustler waters. Because the Rustler Formation lies directly above the Salado Formation which contains the WIPP repository, EEG includes water samples from the discharge of the Rustler Formation areas in the radionuclide baseline program.

The nearest population centers include the village of Loving (population 1,500), located 29 km (18 mi) southwest of the facility, and the city of Carlsbad (population 28,400), located 42 km (26 mi) west of the facility. Other towns within an 80 km (50 mi) radius include Artesia, Eunice, Hobbs, Jal, and Lovington.

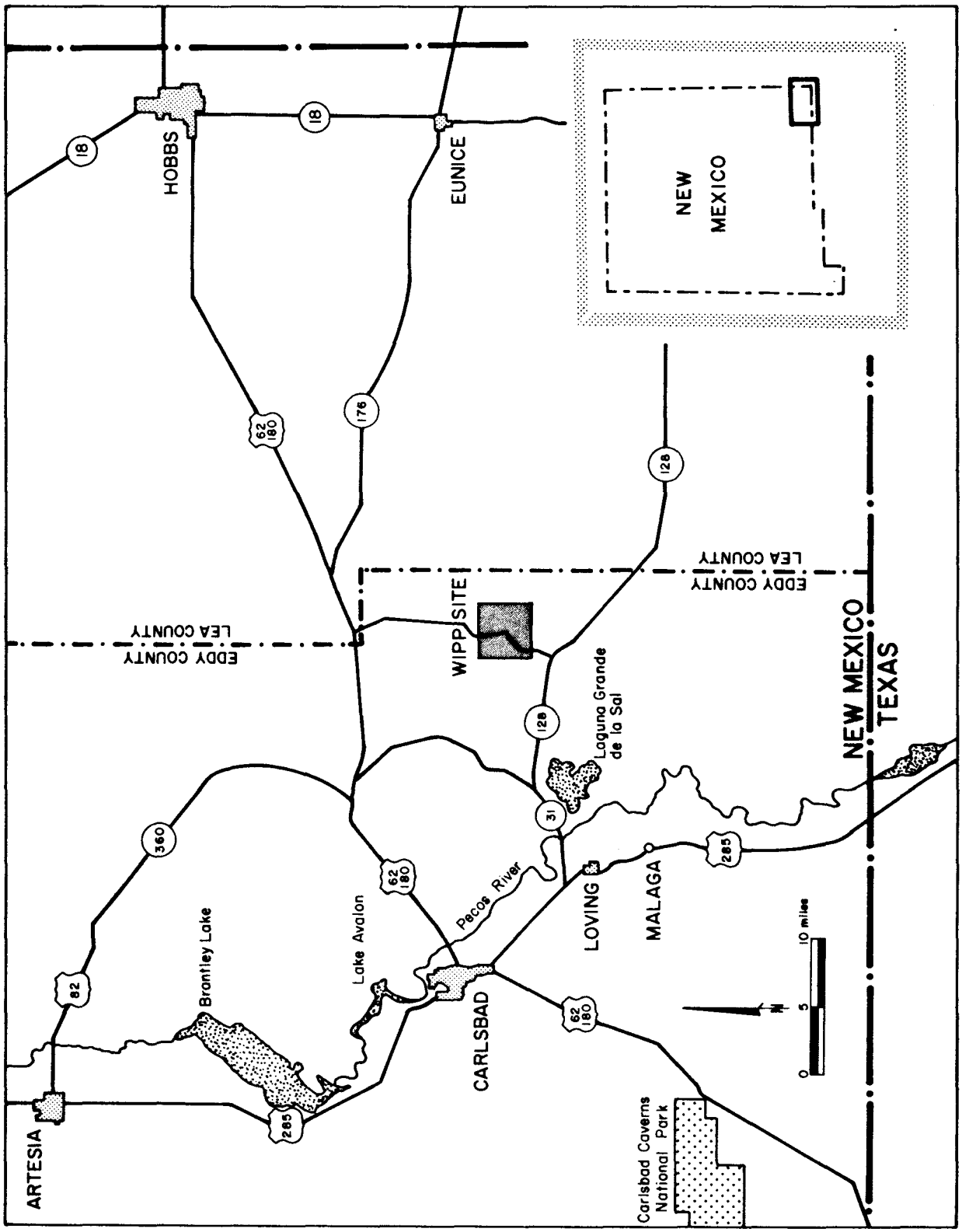

Figure 1. Location of the WIPP Site

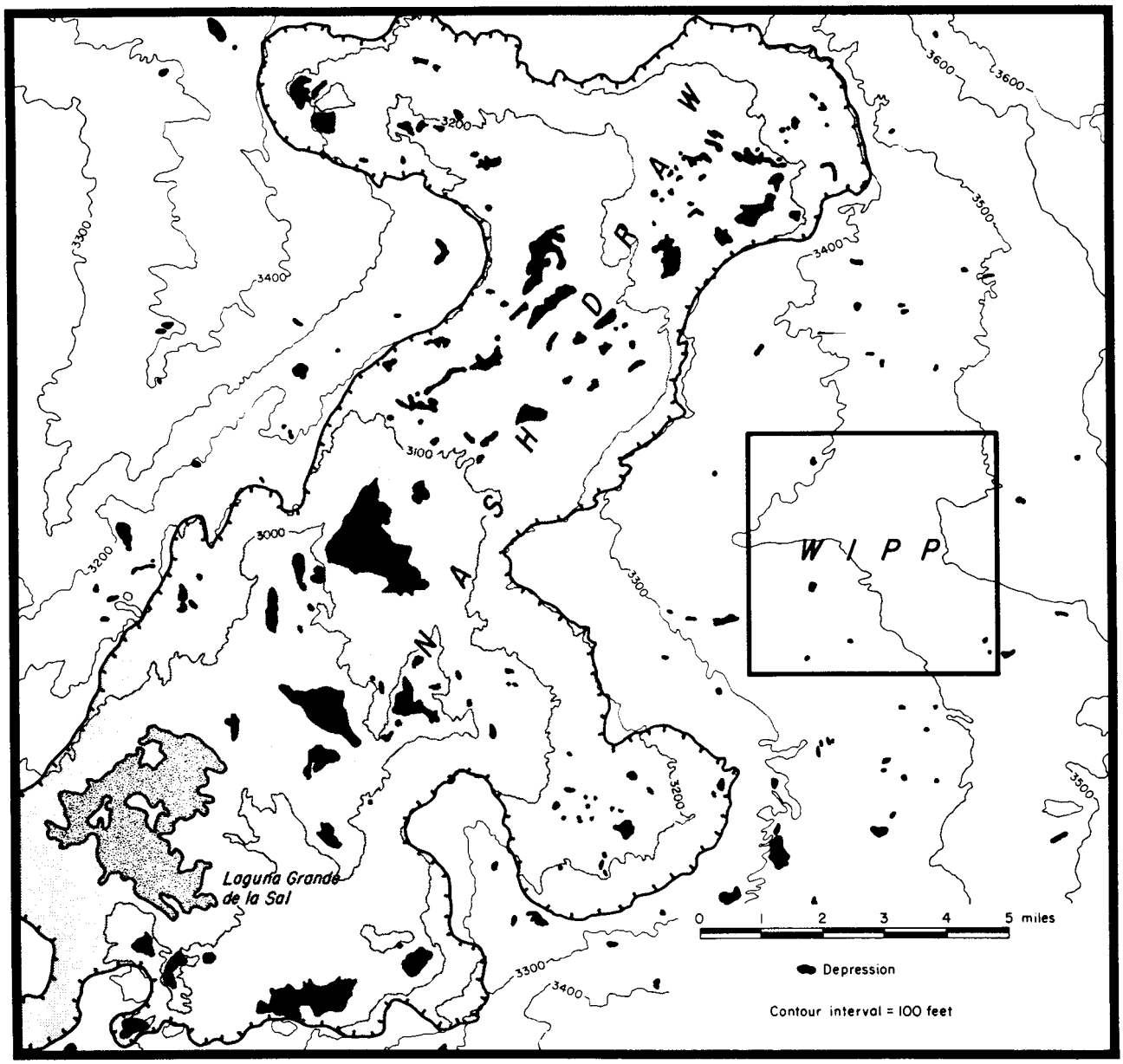

Figure 2. Nash Draw and Depressions Near the WIPP Site, Based on USGS Nash Draw Quadrangle, 15 Minute Series

The climate in the region of the facility is semi-arid with an average annual precipitation of 280 to 300 mm (11 to 13 in). Much of the precipitation falls during intense thunderstorms in the spring and summer. Winds are generally from the southeast with an average speed of 14 km/hr (8.8 mi/hr).

Surface structures of the facility are located in sections 20 and 21 of township 22 south, range 21 east, N.M.P.M., in Eddy County, New Mexico. The surface areas around WIPP are divided into several zones (U.S.D.O.E. 1990a) as indicated in Figure 3. Zone I, located in sections 20 and 21 of township 22 south, range 31 east, has an area of 14 ha (35 acres) and contains most of the surface structures associated with WIPP. It is enclosed by a chain link fence and patrolled by security guards to maintain restricted access. The secured area boundary surrounds Zone I and is marked with a barbed wire fence. Zone II is the next larger subdivision of the facility although there are no surface markers to identify this zone. Zone II is 728 ha (1,800 acres) in size and represents the maximum extent of the area available for underground development. The WIPP outermost facility boundary, which encompasses 16 square miles, provides a one mile buffer area around Zone II and contains 4,144 ha (10,240 acres or 16 sections) and is known as the WIPP site.

Three ranches (Mills, Smith, and Mobley) have property in the vicinity of the WIPP facility. The Mills ranch headquarters is located 5.6 km (3.5 mi) south-southwest of the facility center, the Smith headquarters is 8.8 km (5.5 mi) west-northwest of the facility, and the Mobley ranch is 9.6 km (6 mi) southwest of the facility. The Mills ranch uses water from "house" and "barn" wells for stock and domestic uses. Water is provided to the Smith ranch from pipelines used by IMC Fertilizer, Inc. (IMCF) and New Mexico Potash Corporation. These pipelines draw from wells completed in the Capitan Reef Formation and the Ogallala Formation, respectively. Mobley ranch uses water hauled from various public water supply systems for domestic use while

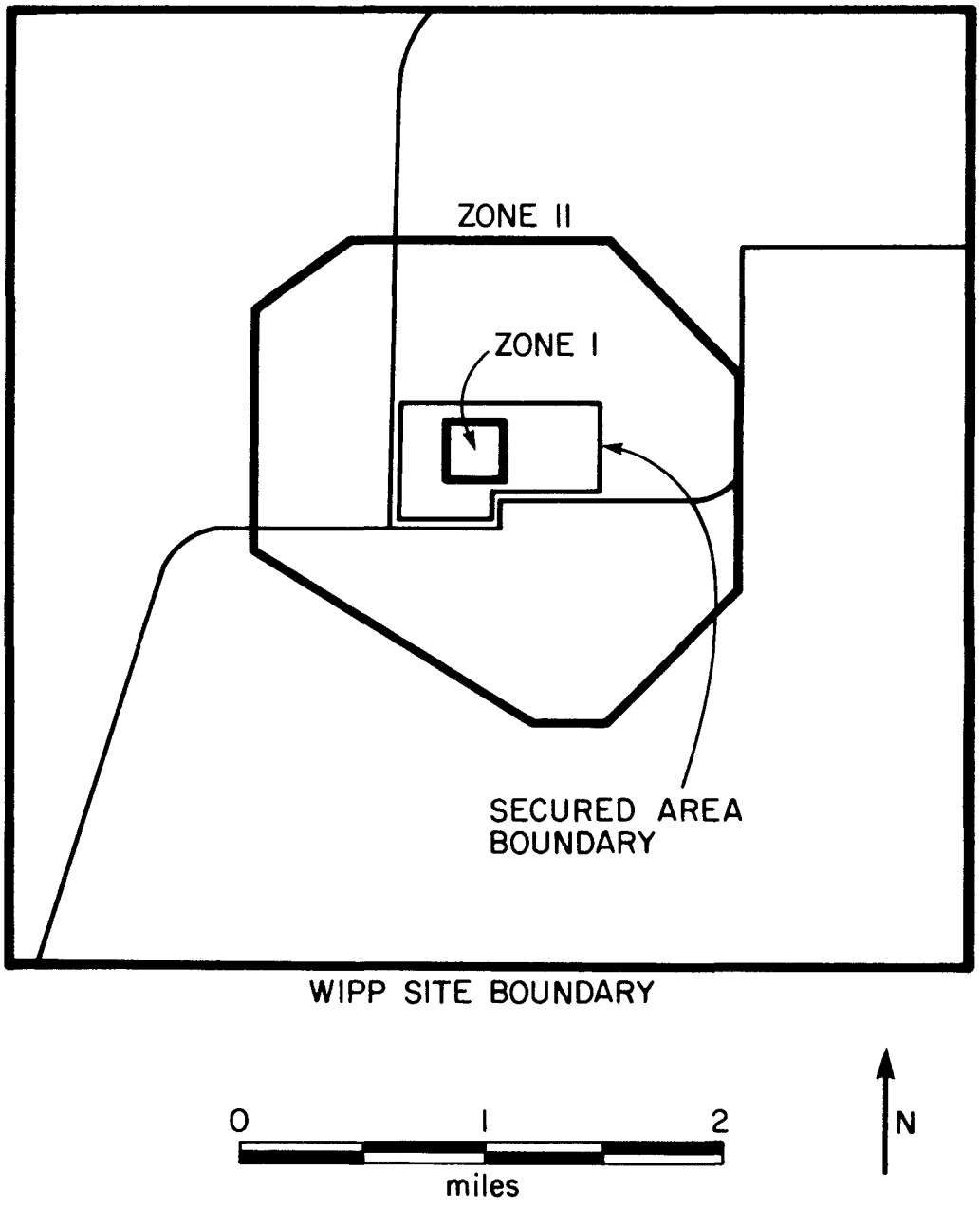

Figure 3. Zones at the WIPP Site

stock water is obtained from "Mobley Well," located near the ranch headquarters about 10 km (6 mi) from the facility. All ranches in the area of WIPP use rain catchment ponds for stock water in addition to water produced from wells.

DOE has purchased all potash leases within the 16 sections comprising the WIPP facility. However, there are two active oil and gas leases in the southwest corner of the WIPP site, one in the north-half of section 31 and one in the south-half of section 31, township 22 south, range 31 east. These two oil and gas leases are at depths greater than 6,000 feet and are part of the James ranch unit currently operated by Bass Enterprises. In 1982, Bass Enterprises drilled a wildcat well just south of the WIPP site, on section 6, township 23 south, range 31 north, with intent to deviate north into section 31. That well was completed to a depth of 4,596 meters (15,078 ft) into the Atoka Formation under section 31. The impact of drilling additional wells into this lease and the continued production of gas from the existing well are not yet known.

Although there are no dairies near the WIPP facility, a large amount of alfalfa is grown in the Pecos Valley between Roswell and Malaga, New Mexico. The alfalfa crop is used in cattle feeding operations mainly in New Mexico and Texas. Cotton and pecans are the other major crops grown in the Pecos Valley.

Geologically, the WIPP repository horizon is situated at a depth of 655 m (2,150 ft) below land surface in the Permian age Salado Formation (Figure 4). The Salado is a 610 m (2,000 ft) thick bedded-salt formation overlain by the Rustler Formation. The Rustler Formation consists of anhydrite and siltstone beds and contains two water-bearing zones, the Magenta and Culebra Dolomites, at 170 m (568 ft) and 205 m (672 ft) below land surface, respectively. Each of these is approximately 7.5 m (25 ft) thick. Transport in the water-bearing units of the Rustler Formation represents the main potential hydrologic

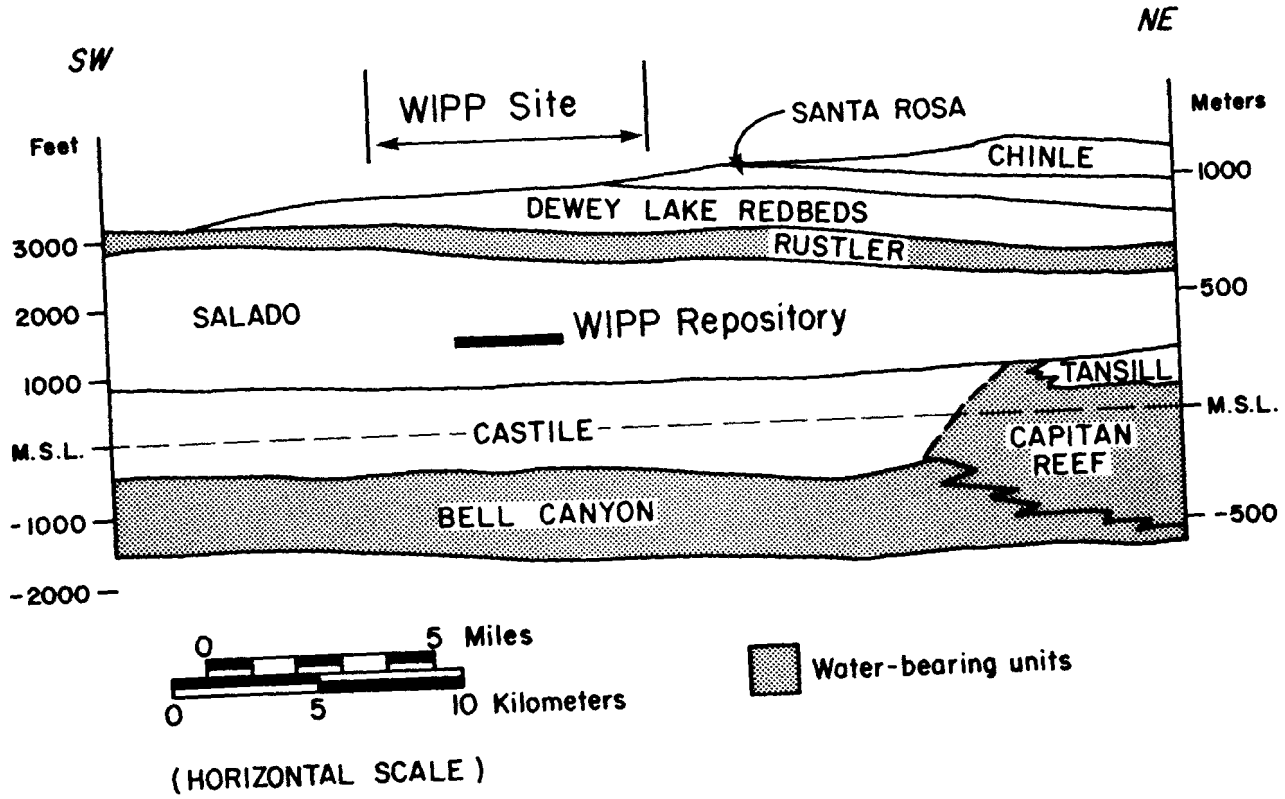

Figure 4. Stratigraphy at the WIPP Site

pathway to the biosphere from the repository. The Culebra Dolomite is considered to be the most important hydrologic pathway for release calculations because it is the most transmissive unit in the area. The most recent interpretation (Lappin and Hunter 1989) of the Culebra freshwater-head data indicates a southerly flow across the WIPP site with southwesterly flow occurring south of the site. Radiological baseline data for the Culebra and the less productive Magenta Dolomite are being collected because of their importance to long-term release scenarios.

3.0 SUMMARY OF THE PREOPERATIONAL PROGRAM

The EEG implemented a preoperational environmental surveillance plan (Spiegler 1984) to establish baseline data on potential exposure pathways as summarized in Table 1. A high priority continues to be assigned to air sampling and analysis because of the potential for accidents which could result in an airborne release. The air sampling system deployed by EEG provides some potential for early detection of releases and subsequent atmospheric dispersion. The preoperational environmental surveillance program includes sampling of other environmental pathways such as groundwater, surface water, public drinking water, biota, soil, and sediment. Radiochemical analyses of environmental samples are performed for the long-lived radionuclides Pu-238, Pu-239+240, Am-241 (plus the naturally-occurring radionuclides U, Th, Ra) and long-lived fission products, such as Cs-137 and Sr-90, which are found in small amounts in the WIPP waste.

3.1 Air Surveillance

The exhaust air effluent from the underground mine is not continuously filtered because of the large air flow rate required for mine safety. Provisions have been made to filter exhaust

Table 1. EEG Preoperational Radiological Surveillance Program

ENVIRONMENTAL MEDIUM	LOCATION	SAMPLING/ ANALYSIS FREQUENCY	PARAMETER
Air	Offsite High Volume Air Sampler 4 Locations Offsite	Weekly/ Quarterly Composite	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Cs-137, Sr-90, Th-228, Th-230, Th-232, Ra-226, Ra-228
	Onsite Low Volume Air Sampler 3 Locations Onsite	Continuous/ Quarterly Composite	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Cs-137, Sr-90, Th-228, Th-230, Th-232, Ra-226, Ra-228
Surface Water	Pecos River 2 Locations Laguna Grande de La Sal Surface Stock Tanks 5 Locations	Annually/ Annually	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Groundwater	22 Wells	Annually/ Annually	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Municipal Drinking Water	4 Systems	Annually/ Annually	gross alpha, gross beta Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Soil and Sediment	3 Sites	Annually/ Annually	gross alpha, gross beta, Pu-238, Pu-239+240, Cs-137, Sr-90, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Biota	2 Specimens*	Annually/ Annually	Pu-238, Pu-239+240, Am-241, Tritium, Cs-137

*Sampling performed by DOE

Table 1 (Cont). EEG Preoperational Radiological Surveillance Program

ENVIRONMENTAL MEDIUM	LOCATION	SAMPLING/ ANALYSIS FREQUENCY	PARAMETER
Facility Effluents			
Air	2 Underground Ventilation Exhaust (Sta. A & B)	Continuously	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Cs-137, Sr-90, Th-232, Th-230, Th-228, Ra-226, Ra-228
Sewage	1 Lagoon	Semiannually	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Storm Water Runoff	WIPP Zone I	Annually	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232

air through the HEPA filters should a release be detected. The pressure drop across the high efficiency particulate air (HEPA) filters is large and would result in much lower exhaust air flow rates. Hence, there is the potential for chronic, unfiltered, low-level releases of TRU contaminants during the emplacement or retrieval process. Acute releases could result from accidents prior to the shifting of exhaust air through the HEPA filters.

To detect acute releases, the first level of air sampling (excluding the effluent air sampling to be done in the exhaust ducts at Stations A and B) occurs inside of Zone I of the facility in the predominant downwind direction. Air samples are collected using continuously operated low volume air samplers (LVAS) which collect air particulates on 102 mm (4 in) diameter borosilicate microfiber filters at a rate of 142 l/min (5 ft^3/min). A typical sampling period lasts for seven days which provides a sample volume of approximately 1.4 x 10^6 liters (5 x 10^4 ft^3). The sample volume is then used in the calculations to determine radionuclide activity concentration, LLD, and analytical error.

The air sample filter is located at a distance equal to or greater than the height of the instrument housing in an upward facing, non-directional configuration. The filter is protected from rain and snow degradation through the use of a rain shield described by Liu and Pui (1980). Wind tunnel test performed with sampling devices using the rain shield design indicate high aspiration efficiency with little dependence on wind speed (Liu and Pui 1980).

Air sampling is accomplished by strategic placement of LVAS within WIPP Zones I and II (Figure 5). The LVAS designated as S-1 is located approximately 225 m (740 ft) northwest of the underground exhaust stack within the Zone I boundary. The S-1 sampler is approximately 90 m (300 ft) from the north line (FNL) of Zone I and 150 m (500 ft) from the east line (FEL) of Zone I.

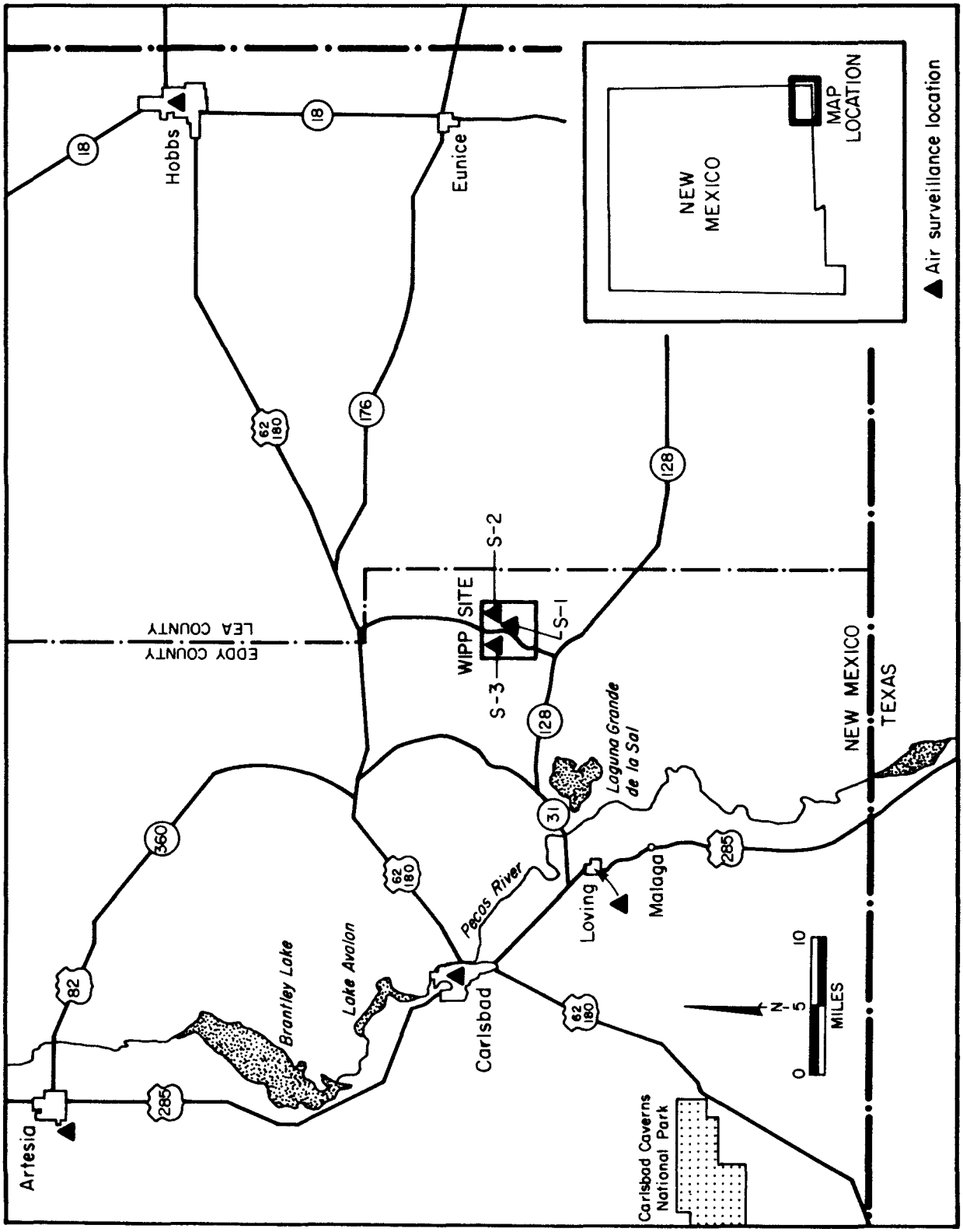

Figure 5. Air Sampling Locations

It should be noted that the S-1 LVAS was not operated during the first and second quarters of 1990 due to construction activity near the sampler. The LVAS designated as S-2 is located approximately 500 m (1,600 ft) northeast of the WIPP exhaust shaft and unit S-3 is located approximately 1,000 m (3,300 ft) northwest of the WIPP exhaust shaft (Figure 6).

Low volume air samplers are also continuously operated in Artesia, Carlsbad, Hobbs, and Loving, New Mexico (Figure 7). The LVAS in Artesia is located near the west end of Jaycee Park near the intersection of 26th and Dr. R. W. Harper Drive (township 22S, range 25E, section 24). The Carlsbad LVAS is located near the intersection of McKay Street and Guadalupe Street (township 22S, range 27E, section 6). The Loving LVAS is located near the intersection of 5th Street and Elm Street (township 23S, range 28E, section 21). The LVAS in Hobbs is located near the intersection of Dalmont Street and Snyder Street (township 18S, range 38E, section 34). The air samplers are located on rooftops in Carlsbad, Hobbs, and Loving to provide required security for the samplers.

It should be noted that from 1985 until January 1, 1990, high volume air samplers (HVAS) were used in the air sampling program in these communities. As the expected time of TRU waste receipt approached, the HVAS which were operated once every sixth day were replaced with continuously operated LVAS systems in each community. The change in sampling hardware provides for continuous air sampling in the population centers near the WIPP facility.

3.2 Water Surveillance

Groundwater samples are collected from water-bearing zones of the Santa Rosa, Dewey Lake Redbeds, Culebra Dolomite Member of the Rustler, Magenta Dolomite Member of the Rustler, Bell Canyon, and Capitan Reef formations. Water samples from 12 WIPP observation

Figure 6. Typical WIPP Site Low Volume Air Sampling Station (S-2)

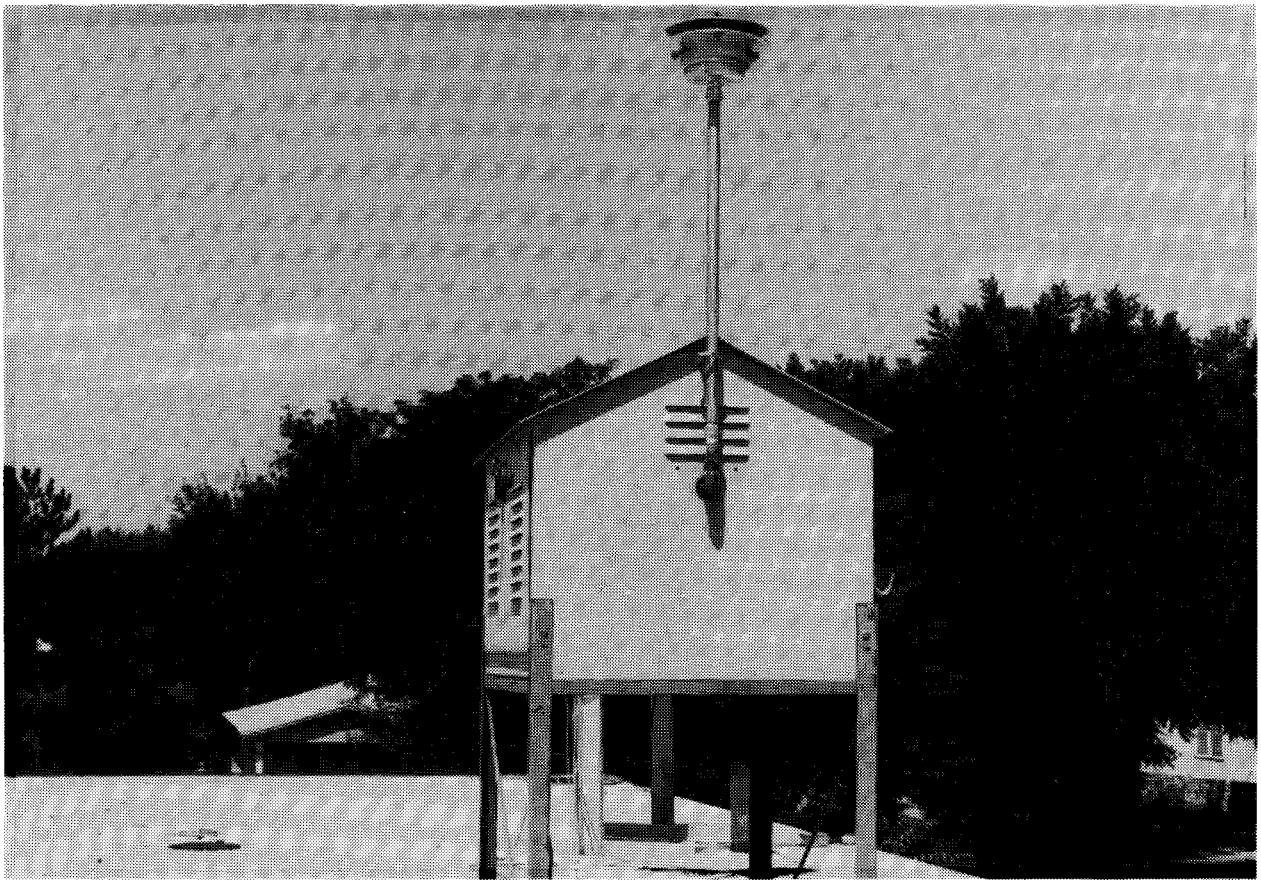

Figure 7. Typical Community Low Volume Air Sampling Station (Carlsbad)

wells are collected by DOE and provided to EEG as splits from their sample (Figure 8). The samples accepted by EEG are then sent to the contract laboratory for radiochemistry. The location and formation sampled is indicated for each well in Table 2.

Surface water samples are collected by EEG staff. In all cases, water samples are collected with the aliquot designated for radiochemical analysis being acidified with nitric acid to reduce the pH to less than 2.0. Samples designated for tritium determination are collected in 240 mL glass containers with conical-shaped polyethylene caps to prevent ambient air entrapment with the sample. Surface water, groundwater, public drinking water, storm water, and WIPP wastewater samples are sent to a private contractor laboratory for radiochemical analysis. The radiochemical analyses for all water samples are reported in Tables A9-A12 of Appendix A.

Interpretation of the groundwater chemistry data are discussed by Chapman (1988). The major ion data are useful in determining flow paths in the water-bearing units above the level of the WIPP repository. Data on the concentrations and distribution of thorium, radium, and uranium may be used to help predict the mobility of similar radionuclides in the hydrogeochemical setting at WIPP. Flow path and radionuclide mobility information are useful for analyzing release scenarios to determine if WIPP complies with long-term disposal requirements contained in EPA regulations (40 CFR Part 191). Radionuclide data collected from groundwater samples will become part of the data base used to evaluate long-term performance of the repository, providing documentation of pre-waste levels for later comparison.

The surface water surveillance program consists of routine sampling of eight locations by EEG staff as shown in Figure 9. Water collected from the Pecos River in Carlsbad provides radionuclide baseline data and a comparison for similar data from the Pierce Canyon area of the Pecos about 19 km (12 mi)

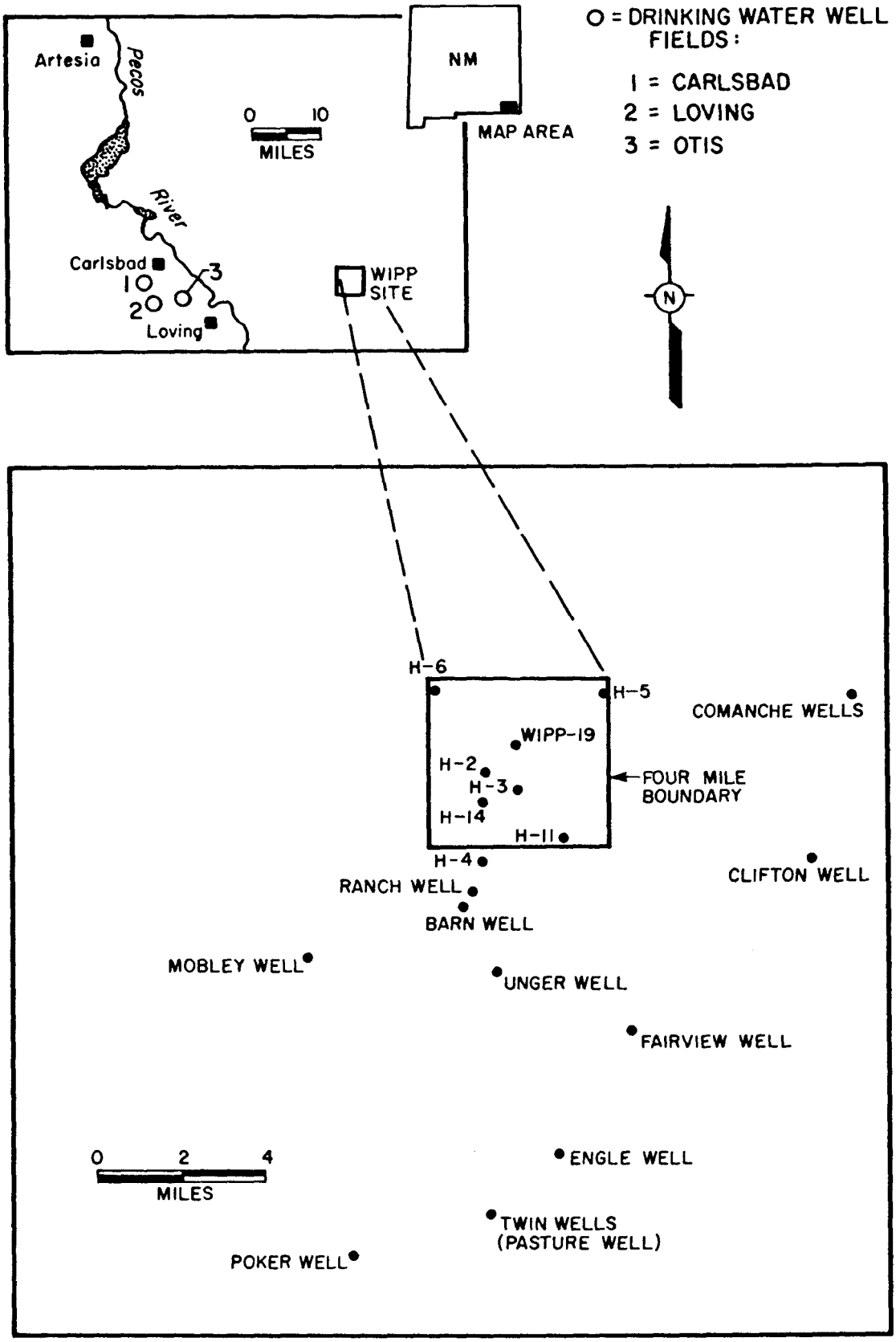

Figure 8. Groundwater Sampling Locations

Table 2. Active Groundwater Sampling Locations

WELL I.D.	TOWNSHIP	RANGE	SECTION	DISTANCE FROM SECTION LINE (FT)	FORMATION SAMPLED
Barn	23S	31E	7	Not Available	Dewey Lake Redbeds[2]
Clifton	23S	32E	3	Not Available	Santa Rosa[2]
Comanche	22S	32E	14	Not Available	Santa Rosa[2]
Engle	24S	32E	4	240.00 FSL[1] 1500.00 FEL[1]	Culebra Dolomite[2]
Fairview	23S	32E	26	Not Available	Dewey Lake Redbeds[2]
Mobley	21S	32E	31	Not Available	Culebra Dolomite[2]
Poker	24S	30E	12	Not Available	Culebra Dolomite[2]
Ranch	23S	31E	7	Not Available	Dewey Lake Redbeds[2]
Twin (Pasture)	24S	31E	17	Not Available	Dewey Lake Redbeds[4]
Unger	23S	31E	17	Not Available	Dewey Lake Redbeds[2]
H-2C	22S	31	29	637.15 FNL[1] 1708.62 FWL[1]	Not Available
H-3B1	22S	31E	29	2085.31 FSL[1] 138.10 FEL[1]	Magenta Dolomite[2]
H-3B3	22S	31E	29	2022.35 FSL[1] 217.30 FEL[1]	Culebra Dolomite[2]
H-4B	23S	31E	5	498.47 FNL[1] 632.54 FWL[1]	Culebra Dolomite[2]
H-4C	23S	31E	5	446.36 FNL[1] 717.89 FWL[1]	Magenta[1]

Table 2 (Continued). Active Groundwater Sampling Locations

WELL I.D.	TOWNSHIP	RANGE	SECTION	DISTANCE FROM SECTION LINE (FT)	FORMATION SAMPLED
H-5B	22S	31E	15	1008.30 FNL[1] 236.22 FEL[1]	Culebra Dolomite[3]
H-5C	22S	31E	15	1005.55 FNL[1] 134.95 FEL[1]	Magenta Dolomite[3]
H-6B	22S	31E	18	196.34 FNL[1] 322.96 FWL[1]	Culebra Dolomite[2]
H-6C	22S	31E	18	281.06 FNL[1] 374.47 FWL[1]	Magenta[2]
H-11B3	22S	31E	33	1501.70 FSL[1] 105.20 FEL[1]	Culebra Dolomite[2]
H-14	22S	31E	29	372.60 FSL[1] 562.40 FWL[1]	Culebra Dolomite[2]
WIPP-19	22S	31E	20	2286.50 FNL[1] 12.70 FEL[1]	Culebra Dolomite[2]

[1] From Gonzales (1989)
[2] From Randall (1988)
[3] From Uhland (1987)
[4] From Uhland (1986)

Note: FNL = feet from north line of section
FEL = feet from east line of section
FSL = feet from south line of section
FWL = feet from west line of section

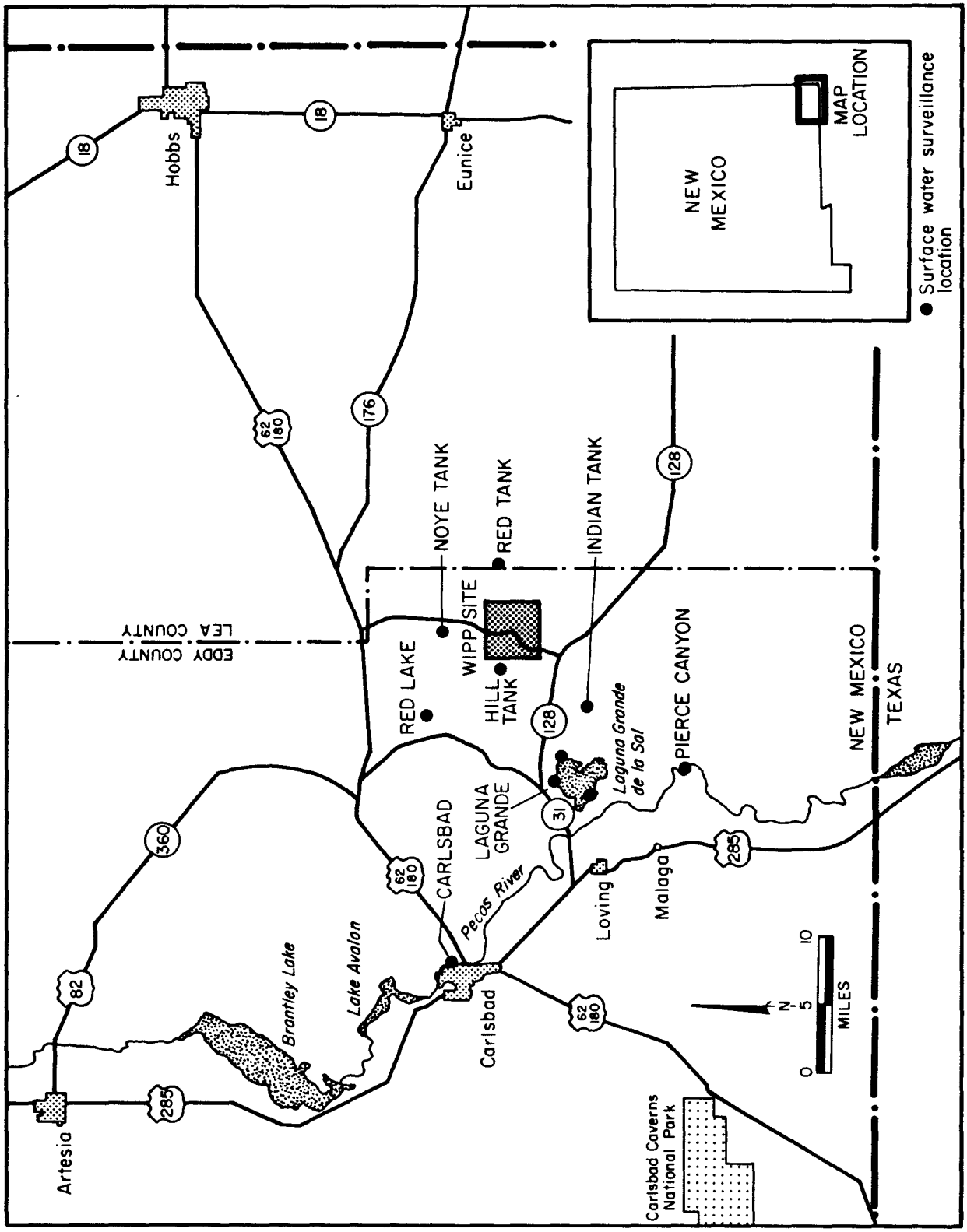

Figure 9. Surface Water Sampling Locations

downstream from Carlsbad. Mercer (1983) suggests that saturated zones in the Rustler Formation discharge to the Pecos River near Malaga Bend, about a mile upstream of where the river enters Pierce Canyon. Because of the role of the Rustler Formation as a hydrologic pathway, preoperational data from these regions are important. Radionuclide baseline data are collected from surface water in Laguna Grande de la Sal which is located 13 km (8 mi) southwest of the WIPP facility. The saline lake is in the storm water drainage from the facility and is a discharge point for shallow groundwater in Nash Draw. Because particulates in air emissions from WIPP operations would be expected to fall onto the area watershed, water samples are collected from five nearby rain catchment basins used for stock and game watering and from storm water runoff from the Zone I area of the facility. Radiochemical data from surface water samples are presented in Table A9 of Appendix A.

New Mexico Regulations Governing Water Supplies (N.M.H.E.D. 1989) establish a maximum contaminant level (MCL) for Sr-90 at 8 pCi/l, tritium at 20,000 pCi/l, gross alpha at 15 pCi/l, and Ra-226+228 at 5 pCi/l in public community water supply systems. EEG collects and analyzes samples from the Carlsbad, Loving/Malaga, Otis, and WIPP water supply systems (Figure 8) to monitor compliance with these MCLs. Radionuclide data obtained during this report period from these public community drinking water systems did not exceed these MCLs and are presented in Table A12 of Appendix A.

Mercer (1983) summarized chemical analyses performed by the U. S. Geological Survey on samples from wells drilled for WIPP. Simpson et al. (1985) reported a wide variety of radionuclide analyses of surface and groundwater in the Delaware Basin in an investigation of the mobility of radionuclides in high-chloride environments.

Field and laboratory results from DOE's water quality sampling program are available in Uhland and Randall (1986), Uhland et al. (1987) and Randall et al. (1988). Interpretation of data from groundwater in the Culebra Dolomite Member of the Rustler formation is discussed in Chapman (1988) and Ramey (1985).

3.3 Soil and Sediment Surveillance

Soil and sediment in the area of WIPP contain a record of deposited radioactive fallout from past atmospheric nuclear weapons testing as well as surface contamination from Project Gnome. Cs-137 was one radionuclide identified in the area of the Gnome site during an aerial gamma survey (Berry 1989) which was conducted as a part of WIPP baseline studies. It is believed that a certain amount of this deposited fallout may become resuspended in air particulates under certain atmospheric and soil conditions. Because WIPP TRU waste contain some of the fission products found in fallout, these data are an important component of the environmental baseline data set. Soil sampling stations are located near each air sampling location within Zone II at WIPP, Indian Tank, Laguna Grande de la Sal, and the Pecos River at Pierce Canyon (Figure 9). In addition, soil samples are routinely available to EEG as split samples from the DOE soil sampling program. Radionuclide data obtained from soil samples collected during this report period are contained in Table A13 of Appendix A.

3.4 Biota Surveillance

Potential ecosystem transport processes at WIPP include the atmospheric dispersion and subsequent contamination of soil, surface water, and vegetation surrounding the WIPP facility. Although inhalation is the predominant exposure pathway to man, ingestion of game, livestock, or fish that had access to the contaminated environment could also provide a pathway for human exposure (Till 1983).

EEG biotic samples are received as split samples from the DOE environmental program. Biotic samples are sent to a private laboratory for radiochemical analyses as described in Table 1. Radiochemical data from analysis of biota samples are presented in Table A14 of Appendix A.

3.5 WIPP Effluent Surveillance

The two major effluent streams at the WIPP facility are exhaust air from the underground repository waste area and sewage effluent. Unfiltered air is normally exhausted at approximately 201 m^3/s (425,000 ft^3/min) through an exhaust shaft to the environment. The EEG is routinely collecting samples from a fixed air sampler (FAS) which collects particulates from the unfiltered exhaust air at the top of the exhaust shaft (Station A) before the air is discharged to the environment (Figure 10). Samples from Stations A and B are sent to a private laboratory for radiochemical analysis after initial screening in the EEG laboratory. Although EEG began collecting filters from these FAS locations in October 1990, the methodology has not been finalized. The analytical suite determined radiochemically is the same as that indicated for air filters in Table 1. Underground exhaust air will be diverted through high efficiency particulate air filters located on the surface if the continuous air monitors (CAM) in the underground area or in the exhaust shaft near the surface (Station A) detect a significant radioactive release. Air passed through the HEPA filters would then be exhausted to the environment at a rate of 28.3 m^3/s (60,000 ft^3/min) through an alternate exhaust duct (Station B). EEG will collect samples from a second FAS located at Station B. Samples collected from Station B will be analyzed as described above for Station A samples. EEG will not operate a CAM at either Station A or B because it is DOE's responsibility to advise of an alarm or accident situation.

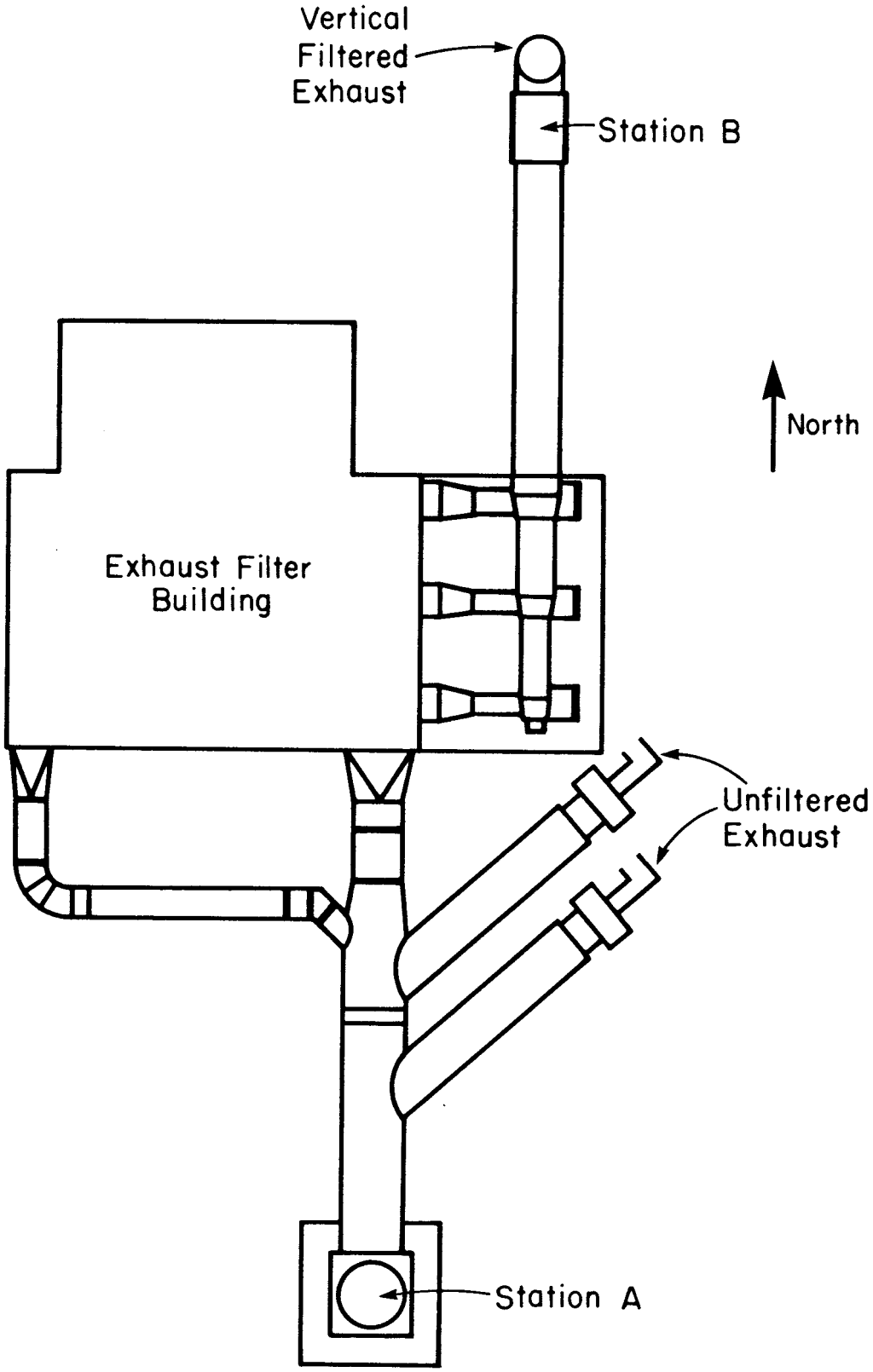

Figure 10. Location of Stations A & B

In order to determine the total amount of radioactivity released from the underground at WIPP in the event of an accident, it is necessary to operate FAS units at both Stations A and B. First, contamination could potentially be released to the environment through the exhaust stacks just beyond Station A before CAM alarms initiate HEPA filtration. Hence, a FAS at Station A is essential. Second, Station B is sampled with a FAS to quantify any releases which might be discharged from the underground to the environment through leakage or failure of the HEPA filtration system and otherwise verify that no further discharge occurred once the bypass valves close. Through analysis of filters from Stations A and B, EEG should have enough data to determine the extent of any significant release through the repository exhaust.

Air exhausted from the Waste Handling Building will be double HEPA-filtered continuously before discharge to the environment. DOE will maintain CAM systems and FAS systems in the exhaust duct from this facility (Station C). However, due to the low probability of a release through this redundant HEPA-filtered discharge, EEG will not operate a FAS in this exhaust system.

Secondary effluent streams from the WIPP facility are sewage effluent and storm water runoff from Zone I. The WIPP sewage treatment plant consists of two lined solar evaporation ponds in parallel followed by lined effluent treatment ponds in parallel with final discharge to an unlined absorption bed. Although DOE procedures indicate that potentially contaminated water from waste handling operations will not be introduced into the WIPP sewage system, preoperational monitoring includes sampling of effluent contained in the lined evaporation ponds. Analytical data from radiochemical analyses performed on sewage effluent and storm water samples are contained in Table A11 of Appendix A.

4.0 DISCUSSION OF FINDINGS

Radiochemical analyses of environmental samples, presented in Appendix A, are required to identify specific radionuclides present in the preoperational WIPP environment. Radiochemical analysis of composite air, water, biota, soil, and sediment samples are performed by a private contractor laboratory. Gross alpha and gross beta activity levels in samples of water and soil were determined using proportional counting systems. Analyses were preceded by one or more chemical separations.

The equations used by EEG's contractor laboratory in reporting individual radionuclide activity concentrations and counting error at the 95 percent confidence level are presented below. The activity concentration for most radionuclides was calculated by the following equation:

$$\text{Radionuclide Activity Conc.} = \frac{\text{(Net CPM)}}{\text{(E) (V) (Rc) (Rs) } (K_1)\ (K_2)}$$

Where:

Radionuclide Activity Conc. = μCi/ml
Net Counts per minute (cpm) = gross cpm - background cpm
E = Counting efficiency (counts per disintegration)
V = Sample volume or weight (ml or g)
Rc = Fractional chemical yield of carrier
Rs = Fractional average recovery for standards
K_1 = 3.7 X 10^4 disintegrations/second/μCi
K_2 = 60 seconds/minute

The 2 sigma analytical error was calculated from the following equation:

$$\text{Analytical Error} = \frac{1.96\ [(S/D_s) + (B/D_b)]^{1/2}}{\text{(E) (V) } (R_c)\ (R_s)\ (K_1)\ (K_2)}$$

Where:

Analytical Error = μCi per volume unit (ml or g)

1.96 = Factor to achieve 95 percent confidence level

S = Sample gross count rate

B = Blank counts

D_s = Sample counting time in minutes

D_b = Blank counting time in minutes

R_c = Fractional chemical yield of carrier

R_s = Fractional average recovery for standards

E = Counting efficiency (counts per disintegration)

V = Volume of sample (ml or g)

K_1 = 3.7×10^4 disintegrations per second per microcurie

K_2 = 60 seconds per minute

The EEG contract laboratory routinely reports a lower limit of detection (LLD-C) for each analysis based on the results of a periodic determination of the background of the counting instrument but without other factors of the analytical chemical separation process. The contract laboratory's LLD-C can be summarized as follows:

$$LLD\text{-}C = (4.66)(S_b)/(K_1)(E)(V)(Y)(e)^{(-\lambda)(\Delta t)}$$

Where:

4.66 = Factor to achieve 95% confidence

LLD-C = lower limit of detection (microcurie/milliliter) based upon instrument background alone

S_b = standard deviation of instrument bkg (cps)

E = counting efficiency (cps/dps)

V = sample volume (cc)

Y = fractional yield of radiochemistry

K_1 = 3.7×10^4 disintegrations per second per microcurie

λ = decay constant

Δt = elapsed time, collection to count

This formulation of the LLD-C for a single measurement is intended to follow the guidance of the HASL Procedures Manual (U.S.D.O.E. HASL-300) and similar sources.

However, a survey of the radiochemical data from environmental samples collected between 1985 and 1988 (Kenney et al. 1990) found that Cs-137 was reported at a concentration of 3.3 E-9 μCi/ml (LLD-C = 2.0 E-9 μCi/ml) in water from the Rustler Formation. The sample in question was collected from an environmental media and under geophysical conditions that would make it highly unlikely that the sample would contain fallout Cs-137 at the concentration reported. It appears that the high Cs-137 concentration was the result of incomplete potassium (K-40) precipitation followed by a beta count which attributed the activity to Cs-137. The error might have been prevented through the use of a proper procedure blank with similar high potassium brine content.

An independent computation of LLD based upon Nuclear Regulatory Commission (NRC) Regulatory Guide 4.14 (U.S.N.R.C. 1980) is used in this report. To realize the conditions for which the formula for calculating LLD is applicable in a given analytical measurement, one of the following requirements should be met:

a) The value of the standard deviation of repeated measurements of appropriate procedure blanks (S_b) must be well known from theoretical considerations and knowledge of the measurement system stability, or

b) The standard deviation be determined under current conditions from a series of replicate measurements on a stable dependable well-known blank. The restated definition of LLD is:

$$LLD = (4.66)(S_b)/(K_1)(E)(V)(Y)(e)^{(-\lambda)(\Delta t)}$$

Where:

LLD = the lower limit of detection (microcurie per milliliter) based upon measurements of a stable well-known blank

S_b = the standard deviation of repeated measurements of appropriate procedure blanks (cps)

E = the counting efficiency (counts per disintegration)

V = the sample volume (milliliters)

Y = the fractional radiochemical yield (when applicable)

$K_1 = 3.7 \times 10^4$ disintegrations per second per microcurie

λ = the radioactive decay constant for the particular radionuclide

Δt = the elapsed time between sample collection and counting

It is clear that a procedure for determining S_b based solely on the observed counts in a detector with a blank sample (or no sample at all) would be subject to a systematic error if the analytic procedure itself added counts to the background in addition to electronic noise, background radiation penetrating the detector shield, etc. The most reliable source of data with which to estimate S_b in such cases is data from a blank "sample" which is a quantity of the environmental medium (air sample filter or water) devoid of the activity of interest. Suitable blanks of this sort have been submitted to the contractor laboratory for analysis in the past. At the time of this report, enough data of this sort has accumulated to begin to estimate air sample LLDs on this basis (Table 3).

Due to the lack of sufficient data from blank water samples (procedure blanks), LLDs based upon the above equation were not calculated by EEG for water sample data and, therefore, the contractor's LLD-Cs continue to be reported here.

One important objective of the EEG's preoperational environmental surveillance program is to better understand the radionuclide concentration values and lower limits of detection in environmental samples associated with the WIPP facility. In

TABLE 3. RADIONUCLIDE LLD DATA (AIR FILTERS)

RADIONUCLIDE	NUMBER OF BLANKS	MEAN CONCENTRATION pCi/FILTER COMPOSITE	STANDARD DEVIATION (Sb)	LLD AT pCi/FILTER COMPOSITE 95% CONFIDENCE
STRONTIUM-90	16	0.31	1.91	8.90
PLUTONIUM-239+240	16	0.04	0.25	1.17
AMERICIUM-241	16	0.23	0.30	1.40
CESIUM-137	16	1.18	2.37	11.04
RADIUM-226	16	0.40	0.82	3.82
RADIUM-228	16	0.42	2.27	10.58
PLUTONIUM-238	16	-0.32	0.61	2.84
THORIUM-228	16	0.09	0.43	2.00
THORIUM-230	16	0.44	0.75	3.50
THORIUM-232	16	0.28	0.44	2.05

a method consistent with the format outlined in NRC Regulatory Guide 4.14 (1980), EEG reports all environmental radionuclide concentrations as values, including values less than the lower limit of detection (LLD) or less than zero.

4.1 Air Data

Gross alpha and gross beta data are summarized in Figures B1-B7 of Appendix B and presented in Tables B1-B7 of Appendix B. Nondestructive measurements of gross alpha and gross beta activity were performed on air samples in the EEG laboratory in Carlsbad, New Mexico. Following a minimum of 170 hours of decay, gross alpha activity of air filters averaged 1.53 E-15 μCi/ml and gross beta activity averaged 1.97 E-14 μCi/ml. These average activities are consistent with data reported in EEG-47 (Kenney et al. 1990), EEG-48 (Kenney and Ballard 1990), and DOE preoperational data (Reith et al. 1986, Banz et al. 1987, Flynn 1988, Flynn 1989, and U.S.D.O.E. 1990b).

Analytical radiochemistry data obtained from composites of air filter samples are contained in Tables A1-A8 of Appendix A. As discussed previously, the LLD values are calculated using activity data from procedure blanks. Radiochemistry data are consistent with previously reported data collected as part of the DOE preoperational baseline program.

4.2 Water Data

Radiochemistry data provided by the contract laboratory are presented in Table A9 through A12 of Appendix A. Table 4 is a tabulation of the number of instances where the WIPP samples exceed the lower limit of detection (LLD or LLD-C). The LLD-Cs reported for all water data are those provided by the contract laboratory and are based upon a standard deviation of instrument background as discussed previously. As additional procedure blanks are provided to the laboratory for analysis, the data base

TABLE 4. SUMMARY OF RADIOCHEMICAL DATA GREATER THAN LLD OR LLD-C

ANALYSIS	GROUNDWATER*		SURFACE WATER*		SOIL & SEDIMENT*		BIOTA*		PUBLIC WATER*		LOW VOLUME AIR SAMPLE		EFFLUENT WATER*	
	NO.>LLDc	TOTAL	NO.>LLDc	TOTAL	NO.>LLDc	TOTAL	NO.>LLDc	TOTAL	NO.>LLDc	TOTAL	NO.>LLD	TOTAL	NO.>LLDc	TOTAL
GROSS ALPHA	0	3	1	7	0	4		NA	0	4	0	26	1	2
GROSS BETA	0	3	5	7	2	4		NA	1	4	0	26	1	2
Cs-137	0	3	0	7	0	4	0	1	0	4	0	26	0	2
Pu-238	0	3	0	7	0	4	0	1	0	4	0	26	0	2
Pu-239+240	0	3	0	7	1	4	0	1	0	4	0	26	0	2
Am-241	0	3	0	7		NA	0	1	0	4	0	26	0	2
Sr-90	0	3	0	7	0	4		NA	0	4	0	26	0	2
Ra-226	3	3	5	7		NA		NA	0	4	0	26	1	2
Ra-228	1	3	0	7		NA		NA	0	4	0	26	0	2
U-238	3	3	3	7	3	4		NA	4	4		NA	1	2
U-235	1	3	1	7	0	4		NA	0	4		NA	0	2
U-233+234	3	3	2	7	3	4		NA	4	4		NA	1	2
Th-232	0	3	1	7	4	4		NA	0	4	0	26	1	2
Th-230	0	3	0	7	4	4		NA	0	4	0	26	1	2
Th-228	0	3	1	7	2	4		NA	0	4	0	26	0	2
TRITIUM	0	3	0	7		NA	0	1	0	4		NA	0	2

will be used to calculate LLDs based upon the above method derived from the formula in NUREG Guide 4.14 (U.S.N.R.C. 1980).

Radionuclides from the uranium, thorium, and radium decay chains were reported above the LLD-C, which is consistent with previous work by EEG (Kenney et al. 1990, Kenney and Ballard 1990) and DOE (Reith et al. 1986, Banz et al. 1987, Flynn 1988, and Flynn 1989).

4.3 Soil and Sediment Data

Data obtained from radiochemical analysis of soil samples collected approximately 390 meters (1,280 ft) east, 575 meters (1,900 ft) north, 530 meters (1,740 ft) south, and 775 meters (2,550 ft) west of the WIPP repository exhaust shaft is contained in Table A13 of appendix A. Radionuclides from the uranium and thorium decay chains were frequently detected at concentrations above the contract laboratory's LLD-C. Plutonium 239+240 was reported in one soil sample above the contractor's LLD-C. Detection of plutonium 239+240 in soil and sediment samples has been reported by DOE (Banz et al. 1987).

4.4 Biota Data

Radiochemical data obtained from a split from a DOE collected sample of quail are contained in Table A14 of Appendix A. The quail used in the composite sample were collected in the vicinity of Noye Tank approximately 5 miles north of the WIPP facility. There are no values reported above the contractor laboratory's reported lower limit of detection, which is comparable to previous data found in Kenney et al. (1990), Kenney and Ballard (1990), and historical data collected by Bradshaw and Louderbough (1987).

5.0 QUALITY ASSURANCE

Quality assurance (QA) for the purposes of this report is defined as the use of standardized practices and procedures to assure that the highest level of quality is maintained for the data. The QA program consists of an ongoing comparison of analytical data with previous data collected by EEG and other organizations, review of radiochemical quality control, submission of blank and duplicate samples, recognized reference standards, and the use of accepted practices for sample acquisition, handling and analysis.

The procedures used for sample acquisition, handling, and screening are contained in the Environmental Evaluation Group's Environmental Procedures Manual (EPM). This manual is based upon widely recognized procedures such as American Public Health Association (1971), U. S. Environmental Protection Agency (1989), and Corley et al. (1981).

The Environmental Evaluation Group's contract laboratory for radiochemical analysis of environmental samples maintains a separate QA program. The major components of the contractor program include periodic calibration of counting instruments using standards traceable to the National Institute of Standards Technology, routine determination of chemical yields, and frequent assessment of the quality of reagents. The contractor laboratory participates in the Crosscheck Laboratory Intercomparison Program, which is administered by the Environmental Protection Agency, and the U. S. Department of Energy Quality Assessment Program.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The data contained in this report represent a continuation of the establishment of a baseline of radionuclide concentrations in certain critical environmental media on and in the vicinity of

the WIPP facility. The data found in this report closely parallel those found in previous reports generated for the WIPP site (Reith et al. 1986, Banz et al. 1987, Flynn 1988, Flynn 1989, Kenney et al. 1990, and Kenney and Ballard 1990) in terms of preoperational levels of the primordial and fallout radionuclides in the WIPP environment.

As more "procedure blank" data become available from the analysis of air filter blanks and water blanks, more realistic lower limits of detection (LLDs) can be calculated. However, other problems associated with measuring very low levels of radionuclides in the environment will continue. One purpose of conducting environmental baseline measurements is to better understand these uncertainties before waste arrives at the WIPP facility.

Although EEG has been collecting air particulate samples from the underground effluent air, the methodology is still under development. These data will be a part of future environmental reports.

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APPENDIX A

Note: Counting Error is 1.966 σ (95% Confidence Level)

TABLE A1. RADIOCHEMICAL DATA FROM COMMUNITY AIR SAMPLES. FIRST QUARTER 1990.

ARTESIA, NEW MEXICO

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-3.8E-17	3.5E-16	7.5E-16
PLUTONIUM-239, 240	0.00E+00	9.42E-18	8.85E-17
AMERICIUM-241	-1.88E-17	2.82E-17	3.21E-16
CESIUM-137	6.6E-17	3.7E-16	1.4E-15
RADIUM-226	-9.4E-18	1.1E-16	3.2E-16
RADIUM-228	1.6E-16	9.2E-16	1.5E-15
PLUTONIUM-238	0.00E+00	9.42E-18	2.34E-16
THORIUM-228	3.8E-17	4.7E-17	1.6E-16
THORIUM-230	6.6E-17	6.6E-17	3.4E-16
THORIUM-232	6.6E-17	4.7E-17	1.7E-16

CARLSBAD, NEW MEXICO

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	4.8E-16	4.0E-16	7.9E-16
PLUTONIUM-239, 240	0.00E+00	9.92E-18	9.32E-17
AMERICIUM-241	2.97E-17	5.95E-17	3.38E-16
CESIUM-137	1.2E-16	4.0E-16	1.4E-15
RADIUM-226	3.0E-17	1.2E-16	3.4E-16
RADIUM-228	1.5E-16	8.8E-16	1.6E-15
PLUTONIUM-238	9.92E-18	9.92E-18	2.46E-16
THORIUM-228	3.0E-17	4.0E-17	1.7E-16
THORIUM-230	1.1E-16	7.9E-17	3.6E-16
THORIUM-232	3.0E-17	3.0E-17	1.8E-16

HOBBS, NEW MEXICO

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	2.8E-16	2.8E-16	5.8E-16
PLUTONIUM-239, 240	0.00E+00	7.28E-18	6.84E-17
AMERICIUM-241	0.00E+00	2.91E-17	2.48E-16
CESIUM-137	5.1E-17	3.2E-16	1.1E-15
RADIUM-226	-5.8E-17	9.5E-17	2.5E-16
RADIUM-228	-2.0E-16	6.3E-16	1.2E-15
PLUTONIUM-238	7.28E-18	7.28E-18	1.80E-16
THORIUM-228	2.9E-17	2.9E-17	1.3E-16
THORIUM-230	8.7E-17	5.8E-17	2.6E-16
THORIUM-232	2.2E-17	2.2E-17	1.3E-16

LOVING, NEW MEXICO

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	6.4E-16	6.1E-16	1.2E-15
PLUTONIUM-239, 240	1.53E-17	1.53E-17	1.43E-16
AMERICIUM-241	-3.05E-17	4.58E-17	5.20E-16
CESIUM-137	-3.1E-17	6.4E-16	2.2E-15
RADIUM-226	3.1E-17	2.0E-16	5.2E-16
RADIUM-228	-1.1E-15	1.5E-15	2.5E-15
PLUTONIUM-238	1.53E-17	1.53E-17	3.78E-16
THORIUM-228	2.0E-16	1.1E-16	2.7E-16
THORIUM-230	4.3E-16	1.5E-16	5.5E-16
THORIUM-232	2.0E-16	9.2E-17	2.7E-16

TABLE A2. RADIOCHEMICAL DATA FROM COMMUNITY AIR SAMPLES. SECOND QUARTER 1990.

ARTESIA, NEW MEXICO

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	3.3E-17	2.2E-16	4.4E-16
PLUTONIUM-239, 240	0.00E+00	5.53E-18	5.20E-17
AMERICIUM-241	-5.53E-18	2.21E-17	1.89E-16
CESIUM-137	-4.4E-17	2.2E-16	8.0E-16
RADIUM-226	5.5E-18	7.2E-17	1.9E-16
RADIUM-228	3.3E-16	6.6E-16	8.9E-16
PLUTONIUM-238	0.00E+00	5.53E-18	1.37E-16
THORIUM-228	5.0E-17	4.4E-17	9.7E-17
THORIUM-230	1.0E-16	6.6E-17	2.0E-16
THORIUM-232	5.0E-17	3.9E-17	1.0E-16

CARLSBAD, NEW MEXICO

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	9.7E-17	2.6E-16	5.2E-16
PLUTONIUM-239, 240	0.00E+00	6.46E-18	6.08E-17
AMERICIUM-241	1.94E-17	3.23E-17	2.20E-16
CESIUM-137	-1.0E-16	2.8E-16	9.4E-16
RADIUM-226	0.0E+00	8.4E-17	2.2E-16
RADIUM-228	1.9E-16	7.1E-16	1.0E-15
PLUTONIUM-238	0.00E+00	6.46E-18	1.60E-16
THORIUM-228	2.6E-17	3.2E-17	1.1E-16
THORIUM-230	9.7E-17	5.8E-17	2.3E-16
THORIUM-232	3.2E-17	2.6E-17	1.2E-16

HOBBS, NEW MEXICO

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	0.0E+00	2.3E-16	4.9E-16
PLUTONIUM-239, 240	6.19E-18	6.19E-18	5.82E-17
AMERICIUM-241	-6.19E-18	2.47E-17	2.11E-16
CESIUM-137	-4.3E-17	2.8E-16	9.0E-16
RADIUM-226	6.2E-18	7.4E-17	2.1E-16
RADIUM-228	3.3E-16	5.8E-16	1.0E-15
PLUTONIUM-238	0.00E+00	6.19E-18	1.53E-16
THORIUM-228	4.9E-17	3.7E-17	1.1E-16
THORIUM-230	4.9E-17	4.3E-17	2.2E-16
THORIUM-232	3.1E-17	2.5E-17	1.1E-16

LOVING, NEW MEXICO

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-2.5E-17	2.2E-16	4.9E-16
PLUTONIUM-239, 240	6.19E-18	6.19E-18	5.82E-17
AMERICIUM-241	2.47E-17	3.09E-17	2.11E-16
CESIUM-137	1.4E-16	2.5E-16	9.0E-16
RADIUM-226	1.2E-17	7.4E-17	2.1E-16
RADIUM-228	4.8E-16	5.2E-16	1.0E-15
PLUTONIUM-238	0.00E+00	6.19E-18	1.53E-16
THORIUM-228	4.3E-17	3.1E-17	1.1E-16
THORIUM-230	4.9E-17	4.3E-17	2.2E-16
THORIUM-232	5.6E-17	3.1E-17	1.1E-16

TABLE A3. RADIOCHEMICAL DATA FROM COMMUNITY AIR SAMPLES. THIRD QUARTER 1990.

ARTESIA, NEW MEXICO

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	1.8E-16	3.6E-16	5.1E-16
PLUTONIUM-239, 240	6.34E-19	6.34E-19	5.96E-17
AMERICIUM-241	6.34E-19	2.54E-18	2.16E-16
CESIUM-137	2.0E-16	2.6E-16	9.2E-16
RADIUM-226	-1.2E-16	2.2E-16	2.2E-16
RADIUM-228	2.1E-16	2.8E-16	1.0E-15
PLUTONIUM-238	6.34E-19	1.90E-18	1.57E-16
THORIUM-228	5.7E-17	3.2E-17	1.1E-16
THORIUM-230	9.5E-17	4.4E-17	2.3E-16
THORIUM-232	5.1E-17	3.2E-17	1.1E-16

CARLSBAD, NEW MEXICO

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	2.1E-16	5.2E-16	5.5E-16
PLUTONIUM-239, 240	2.77E-18	1.39E-18	6.52E-17
AMERICIUM-241	-1.39E-18	1.39E-18	2.36E-16
CESIUM-137	9.0E-17	2.7E-16	1.0E-15
RADIUM-226	-6.9E-17	2.4E-16	2.4E-16
RADIUM-228	-1.7E-16	3.1E-16	1.1E-15
PLUTONIUM-238	0.00E+00	1.39E-18	1.72E-16
THORIUM-228	4.2E-17	2.1E-17	1.2E-16
THORIUM-230	9.0E-17	4.2E-17	2.5E-16
THORIUM-232	3.5E-17	2.8E-17	1.2E-16

HOBBS, NEW MEXICO

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	1.7E-16	2.5E-16	4.4E-16
PLUTONIUM-239, 240	5.48E-19	5.48E-19	5.15E-17
AMERICIUM-241	-1.10E-18	1.10E-18	1.87E-16
CESIUM-137	1.2E-16	2.0E-16	8.0E-16
RADIUM-226	-2.6E-16	2.7E-16	1.9E-16
RADIUM-228	2.0E-16	2.1E-16	8.8E-16
PLUTONIUM-238	-1.10E-18	1.10E-18	1.36E-16
THORIUM-228	3.3E-17	2.2E-17	9.6E-17
THORIUM-230	7.1E-17	3.3E-17	2.0E-16
THORIUM-232	2.7E-17	2.2E-17	9.9E-17

LOVING, NEW MEXICO

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	8.6E-17	2.4E-16	4.9E-16
PLUTONIUM-239, 240	0.00E+00	6.12E-19	5.75E-17
AMERICIUM-241	-1.22E-18	1.22E-18	2.09E-16
CESIUM-137	9.2E-17	2.0E-16	8.9E-16
RADIUM-226	-2.2E-16	3.1E-16	2.1E-16
RADIUM-228	-3.1E-16	3.1E-16	9.8E-16
PLUTONIUM-238	0.00E+00	1.22E-18	1.52E-16
THORIUM-228	3.7E-17	2.4E-17	1.1E-16
THORIUM-230	5.5E-17	3.1E-17	2.2E-16
THORIUM-232	1.8E-17	1.8E-17	1.1E-16

TABLE A4. RADIOCHEMICAL DATA FROM COMMUNITY AIR SAMPLES. FOURTH QUARTER 1990.

ARTESIA, NEW MEXICO

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	4.5E-17	2.2E-16	5.1E-16
PLUTONIUM-239, 240	0.00E+00	6.38E-19	5.99E-17
AMERICIUM-241	1.28E-18	1.91E-18	2.17E-16
CESIUM-137	-5.7E-17	2.2E-16	9.3E-16
RADIUM-226	-5.7E-17	9.6E-17	2.2E-16
RADIUM-228	7.7E-17	2.0E-16	1.0E-15
PLUTONIUM-238	1.28E-18	3.19E-18	1.58E-16
THORIUM-228	3.8E-17	2.6E-17	1.1E-16
THORIUM-230	8.9E-17	3.8E-17	2.3E-16
THORIUM-232	3.2E-17	2.6E-17	1.1E-16

CARLSBAD, NEW MEXICO

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-1.4E-16	1.4E-16	4.6E-16
PLUTONIUM-239, 240	1.15E-18	1.73E-18	5.42E-17
AMERICIUM-241	1.15E-18	5.77E-18	1.97E-16
CESIUM-137	-2.3E-17	2.1E-16	8.4E-16
RADIUM-226	0.0E+00	8.7E-17	2.0E-16
RADIUM-228	6.3E-17	1.3E-16	9.3E-16
PLUTONIUM-238	0.00E+00	2.88E-18	1.43E-16
THORIUM-228	5.8E-17	2.9E-17	1.0E-16
THORIUM-230	7.5E-17	3.5E-17	2.1E-16
THORIUM-232	3.5E-17	2.3E-17	1.0E-16

HOBBS, NEW MEXICO

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-7.7E-17	2.2E-16	4.7E-16
PLUTONIUM-239, 240	4.74E-18	4.14E-18	5.57E-17
AMERICIUM-241	2.96E-18	1.78E-18	2.02E-16
CESIUM-137	1.2E-16	2.3E-16	8.6E-16
RADIUM-226	-3.6E-17	8.9E-17	2.0E-16
RADIUM-228	6.5E-17	2.1E-16	9.5E-16
PLUTONIUM-238	0.00E+00	2.96E-18	1.47E-16
THORIUM-228	6.5E-17	3.0E-17	1.0E-16
THORIUM-230	1.1E-16	3.6E-17	2.1E-16
THORIUM-232	2.4E-17	1.8E-17	1.1E-16

LOVING,NEW MEXICO

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-5.7E-17	2.1E-16	5.7E-16
PLUTONIUM-239, 240	0.00E+00	7.14E-19	6.71E-17
AMERICIUM-241	0.00E+00	1.43E-18	2.43E-16
CESIUM-137	0.0E+00	2.4E-16	1.0E-15
RADIUM-226	1.1E-16	1.1E-16	2.4E-16
RADIUM-228	6.4E-17	2.1E-16	1.1E-15
PLUTONIUM-238	-1.43E-18	2.85E-18	1.77E-16
THORIUM-228	4.3E-17	2.9E-17	1.2E-16
THORIUM-230	1.1E-16	4.3E-17	2.6E-16
THORIUM-232	2.1E-17	2.1E-17	1.3E-16

TABLE A5. RADIONUCLIDE DATA FROM WIPP SITE AIR SAMPLES. FIRST QUARTER 1990.

S2-WIPP SITE

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-1.4E-16	2.6E-16	5.4E-16
PLUTONIUM-239, 240	6.79E-18	6.79E-18	6.39E-17
AMERICIUM-241	-6.79E-18	2.72E-17	2.32E-16
CESIUM-137	-7.5E-17	3.1E-16	9.9E-16
RADIUM-226	-4.1E-17	8.2E-17	2.3E-16
RADIUM-228	2.0E-16	6.8E-16	1.1E-15
PLUTONIUM-238	0.00E+00	6.79E-18	1.68E-16
THORIUM-228	4.8E-17	4.8E-17	1.2E-16
THORIUM-230	7.5E-17	6.1E-17	2.4E-16
THORIUM-232	3.4E-17	3.4E-17	1.2E-16

S3-WIPP SITE

NUCLIDE	ACTIVITY uCi/ml	ANALYTICAL ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-1.4E-16	2.3E-16	5.2E-16
PLUTONIUM-239, 240	0.00E+00	6.49E-18	6.11E-17
AMERICIUM-241	-1.30E-17	2.60E-17	2.21E-16
CESIUM-137	-1.9E-16	2.8E-16	9.4E-16
RADIUM-226	-6.5E-18	7.8E-17	2.2E-16
RADIUM-228	2.6E-16	5.5E-16	1.0E-15
PLUTONIUM-238	0.00E+00	6.49E-18	1.61E-16
THORIUM-228	2.6E-17	3.2E-17	1.1E-16
THORIUM-230	7.8E-17	5.2E-17	2.3E-16
THORIUM-232	4.5E-17	2.6E-17	1.2E-16

TABLE A6. RADIONUCLIDE DATA FROM WIPP SITE AIR SAMPLES. SECOND QUARTER 1990.

S2-WIPP SITE

NUCLIDE	ACTIVITY	ANALYTICAL ERROR	LLD
	uCi/ml	uCi/ml	uCi/ml
STRONTIUM-90	-3.9E-17	3.0E-16	4.5E-16
PLUTONIUM-239, 240	5.61E-18	5.61E-18	5.27E-17
AMERICIUM-241	-5.61E-18	2.24E-17	1.91E-16
CESIUM-137	-8.4E-17	2.5E-16	8.2E-16
RADIUM-226	5.0E-17	6.7E-17	1.9E-16
RADIUM-228	1.1E-16	5.1E-16	9.0E-16
PLUTONIUM-238	0.00E+00	5.61E-18	1.39E-16
THORIUM-228	0.0E+00	1.7E-17	9.8E-17
THORIUM-230	-1.1E-17	2.8E-17	2.0E-16
THORIUM-232	5.6E-18	1.1E-17	1.0E-16

S3-WIPP SITE

NUCLIDE	ACTIVITY	ANALYTICAL ERROR	LLD
	uCi/ml	uCi/ml	uCi/ml
STRONTIUM-90	1.5E-17	2.5E-16	5.9E-16
PLUTONIUM-239, 240	7.33E-18	7.33E-18	6.89E-17
AMERICIUM-241	-7.33E-18	2.93E-17	2.50E-16
CESIUM-137	-8.1E-17	2.8E-16	1.1E-15
RADIUM-226	0.0E+00	8.8E-17	2.5E-16
RADIUM-228	1.5E-16	8.1E-16	1.2E-15
PLUTONIUM-238	0.00E+00	7.33E-18	1.82E-16
THORIUM-228	3.7E-17	3.7E-17	1.3E-16
THORIUM-230	1.7E-16	7.3E-17	2.6E-16
THORIUM-232	2.9E-17	2.9E-17	1.3E-16

TABLE A7. RADIONUCLIDE DATA FROM WIPP SITE AIR SAMPLES. THIRD QUARTER 1990.

S1-WIPP SITE

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	5.1E-17	5.1E-16	8.1E-16
PLUTONIUM-239, 240	3.04E-18	3.04E-18	9.52E-17
AMERICIUM-241	-2.03E-18	2.03E-18	3.45E-16
CESIUM-137	2.4E-16	3.6E-16	1.5E-15
RADIUM-226	-2.6E-16	4.5E-16	3.4E-16
RADIUM-228	1.0E-15	4.1E-16	1.6E-15
PLUTONIUM-238	-1.01E-18	2.03E-18	2.51E-16
THORIUM-228	2.0E-17	2.0E-17	1.8E-16
THORIUM-230	8.1E-17	6.1E-17	3.6E-16
THORIUM-232	1.0E-17	3.0E-17	1.8E-16

S2-WIPP SITE

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	1.2E-16	3.7E-16	4.8E-16
PLUTONIUM-239, 240	3.02E-18	1.81E-18	5.68E-17
AMERICIUM-241	-1.21E-18	1.21E-18	2.06E-16
CESIUM-137	2.2E-16	2.7E-16	8.8E-16
RADIUM-226	-1.2E-16	2.5E-16	2.1E-16
RADIUM-228	-1.3E-16	3.4E-16	9.7E-16
PLUTONIUM-238	-6.04E-19	1.21E-18	1.50E-16
THORIUM-228	3.6E-17	2.4E-17	1.1E-16
THORIUM-230	6.0E-17	3.0E-17	2.2E-16
THORIUM-232	1.8E-17	1.8E-17	1.1E-16

S3-WIPP SITE

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	2.3E-16	3.5E-16	4.9E-16
PLUTONIUM-239, 240	6.15E-19	1.23E-18	5.78E-17
AMERICIUM-241	6.15E-19	2.46E-18	2.10E-16
CESIUM-137	1.7E-16	2.3E-16	9.0E-16
RADIUM-226	-9.8E-17	2.8E-16	2.1E-16
RADIUM-228	1.2E-16	2.8E-16	9.9E-16
PLUTONIUM-238	0.00E+00	1.23E-18	1.53E-16
THORIUM-228	1.8E-17	1.8E-17	1.1E-16
THORIUM-230	7.4E-17	3.7E-17	2.2E-16
THORIUM-232	1.2E-17	1.8E-17	1.1E-16

TABLE A8. RADIOCHEMICAL DATA FROM WIPP SITE AIR SAMPLES. FOURTH QUARTER 1990.

S1-WIPP SITE

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-1.3E-16	1.9E-16	5.1E-16
PLUTONIUM-239, 240	6.39E-19	1.92E-18	6.01E-17
AMERICIUM-241	0.00E+00	1.28E-18	2.18E-16
CESIUM-137	-1.9E-17	2.4E-16	9.3E-16
RADIUM-226	1.3E-17	9.6E-17	2.2E-16
RADIUM-228	1.5E-16	2.2E-16	1.0E-15
PLUTONIUM-238	1.28E-18	3.83E-18	1.58E-16
THORIUM-228	3.8E-17	2.6E-17	1.1E-16
THORIUM-230	1.2E-16	4.5E-17	2.3E-16
THORIUM-232	3.8E-17	2.6E-17	1.2E-16

S2-WIPP SITE

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	5.8E-18	2.1E-16	4.6E-16
PLUTONIUM-239, 240	2.32E-18	2.90E-18	5.46E-17
AMERICIUM-241	0.00E+00	1.16E-18	1.16E-18
CESIUM-137	-5.8E-18	2.0E-16	8.5E-16
RADIUM-226	5.2E-17	8.7E-17	2.0E-16
RADIUM-228	1.2E-17	1.6E-16	9.3E-16
PLUTONIUM-238	5.81E-19	3.49E-18	1.44E-16
THORIUM-228	6.4E-17	2.9E-17	1.0E-16
THORIUM-230	6.4E-17	3.5E-17	2.1E-16
THORIUM-232	3.5E-17	2.3E-17	1.0E-16

S3-WIPP SITE

NUCLIDE	ANALYTICAL ACTIVITY uCi/ml	ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	7.6E-17	2.3E-16	3.5E-15
PLUTONIUM-239, 240	0.00E+00	6.32E-19	4.16E-16
AMERICIUM-241	1.26E-18	1.26E-18	1.51E-15
CESIUM-137	8.9E-17	2.5E-16	6.4E-15
RADIUM-226	7.6E-17	1.0E-16	1.5E-15
RADIUM-228	4.4E-16	2.7E-16	7.1E-15
PLUTONIUM-238	-1.26E-18	2.53E-18	1.57E-16
THORIUM-228	1.3E-17	1.9E-17	7.7E-16
THORIUM-230	7.0E-17	3.8E-17	1.6E-15
THORIUM-232	2.5E-17	2.5E-17	8.0E-16

TABLE A9. RADIOCHEMICAL DATA FROM SURFACE WATER SAMPLES.

NUCLIDE	INDIAN TANK 09/12/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)	NUCLIDE	RED LAKE 09/12/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)
GROSS ALPHA	0E+00	2E-09	3E-09	GROSS ALPHA	-1E-09	4E-09	7E-09
GROSS BETA	7E-09	3E-09	4E-09	GROSS BETA	3E-08	4E-09	5E-09
URANIUM-233,234	0.0E+00	1.0E-10	1.0E-10	URANIUM-233,234	0.0E+00	1.0E-10	1.0E-10
URANIUM-235	0.0E+00	1.0E-10	1.0E-10	URANIUM-235	0.0E+00	1.0E-10	1.0E-10
URANIUM-238	0.0E+00	1.0E-10	1.0E-10	URANIUM-238	2.0E-10	2.0E-10	1.0E-10
STRONTIUM-90	6.0E-10	4.0E-10	6.0E-10	STRONTIUM-90	4.0E-10	4.0E-10	7.0E-10
PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11	AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11
CESIUM-137	0.0E+00	7.0E-10	1.1E-09	CESIUM-137	-5.0E-10	7.0E-10	1.3E-09
TRITIUM	-1.2E-07	1.5E-07	2.6E-07	TRITIUM	-2.0E-08	1.5E-07	2.6E-07
RADIUM-226	0.0E+00	3.0E-10	2.0E-10	RADIUM-226	2.0E-10	2.0E-10	1.0E-10
RADIUM-228	4.0E-10	7.0E-10	1.1E-09	RADIUM-228	2.0E-10	7.0E-10	1.2E-09
PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11
THORIUM-228	0.0E+00	1.0E-10	1.0E-10	THORIUM-228	1.0E-10	2.0E-10	1.0E-10
THORIUM-230	1.0E-10	1.0E-10	1.0E-10	THORIUM-230	1.0E-10	1.0E-10	1.0E-10
THORIUM-232	0.0E+00	1.0E-10	1.0E-10	THORIUM-232	1.0E-10	1.0E-10	1.0E-10

TABLE A9. RADIOCHEMICAL DATA FROM SURFACE WATER SAMPLES, cont.

NUCLIDE	NOYE TANK 08/01/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)	NUCLIDE	PECOS RIVER AT CARLSBAD 07/31/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)
GROSS ALPHA	4E-09	3E-09	4E-09	GROSS ALPHA	4E-09	2E-08	3E-08
GROSS BETA	9E-09	3E-09	4E-09	GROSS BETA	2E-09	1E-08	2E-08
URANIUM-233,234	0.0E+00	1.0E-10	1.0E-10	URANIUM-233,234	2.3E-09	5.0E-10	1.0E-10
URANIUM-235	0.0E+00	1.0E-10	1.0E-10	URANIUM-235	1.0E-10	1.0E-10	1.0E-10
URANIUM-238	0.0E+00	1.0E-10	1.0E-10	URANIUM-238	1.1E-09	4.0E-10	1.0E-10
STRONTIUM-90	0.0E+00	5.0E-10	8.0E-10	STRONTIUM-90	7.0E-10	5.0E-10	8.0E-10
PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	-1.00E-11	2.00E-11	1.00E-11	AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11
CESIUM-137	0.0E+00	1.3E-09	1.3E-09	CESIUM-137	0.0E+00	1.3E-09	1.3E-09
TRITIUM	-8.0E-08	2.0E-07	3.0E-07	TRITIUM	-7.0E-08	2.0E-07	3.0E-07
RADIUM-226	4.0E-10	5.0E-10	2.0E-10	RADIUM-226	5.0E-10	5.0E-10	2.0E-10
RADIUM-228	1.9E-09	1.3E-09	2.0E-09	RADIUM-228	4.0E-10	8.0E-10	1.4E-09
PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11
THORIUM-228	1.0E-10	1.0E-10	1.0E-10	THORIUM-228	0.0E+00	1.0E-10	1.0E-10
THORIUM-230	1.0E-10	1.0E-10	1.0E-10	THORIUM-230	-1.0E-10	1.0E-10	1.0E-10
THORIUM-232	0.0E+00	1.0E-10	1.0E-10	THORIUM-232	0.0E+00	1.0E-10	1.0E-10

TABLE A9. RADIOCHEMICAL DATA FROM SURFACE WATER SAMPLES, cont.

NUCLIDE	RED TANK 09/12/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)	NUCLIDE	HILL TANK 08/01/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)
GROSS ALPHA	0E+00	3E-09	5E-09	GROSS ALPHA	1E-08	6E-09	7E-09
GROSS BETA	1E-08	3E-09	4E-09	GROSS BETA	2E-08	4E-09	6E-09
URANIUM-233,234	1.0E-10	2.0E-10	1.0E-10	URANIUM-233,234	1.0E-10	1.0E-10	1.0E-10
URANIUM-235	0.0E+00	1.0E-10	1.0E-10	URANIUM-235	0.0E+00	1.0E-10	1.0E-10
URANIUM-238	1.0E-10	1.0E-10	1.0E-10	URANIUM-238	0.0E+00	1.0E-10	1.0E-10
STRONTIUM-90	3.0E-10	4.0E-10	7.0E-10	STRONTIUM-90	4.0E-10	5.0E-10	8.0E-10
PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11	AMERICIUM-241	0.00E+00	3.00E-11	2.00E-11
CESIUM-137	-1.0E-10	6.0E-10	1.0E-09	CESIUM-137	0.0E+00	1.3E-09	1.3E-09
TRITIUM	1.0E-08	1.5E-07	2.6E-07	TRITIUM	-1.3E-07	2.0E-07	3.0E-07
RADIUM-226	3.0E-10	2.0E-10	2.0E-10	RADIUM-226	7.0E-10	5.0E-10	2.0E-10
RADIUM-228	4.0E-10	7.0E-10	1.1E-09	RADIUM-228	1.2E-09	1.9E-09	3.1E-09
PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11
THORIUM-228	1.0E-10	2.0E-10	1.0E-10	THORIUM-228	3.0E-10	1.0E-10	1.0E-10
THORIUM-230	1.0E-10	1.0E-10	1.0E-10	THORIUM-230	1.0E-10	1.0E-10	1.0E-10
THORIUM-232	0.0E+00	1.0E-10	1.0E-10	THORIUM-232	2.0E-10	1.0E-10	1.0E-10

TABLE A9. RADIOCHEMICAL DATA FROM SURFACE WATER SAMPLES, cont.

NUCLIDE	PECOS RIVER AT PIERCE CANYON 07/30/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)
GROSS ALPHA	3E-08	5E-08	2E-07
GROSS BETA	1E-07	7E-08	1E-07
URANIUM-233,234	5.0E-09	7.0E-10	1.0E-10
URANIUM-235	2.0E-10	2.0E-10	1.0E-10
URANIUM-238	2.6E-09	5.0E-10	1.0E-10
STRONTIUM-90	2.0E-10	4.0E-10	7.0E-10
PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11
CESIUM-137	0.0E+00	1.4E-09	1.4E-09
TRITIUM	-4.0E-08	2.0E-07	3.0E-07
RADIUM-226	2.0E-10	7.0E-10	2.0E-10
RADIUM-228	1.2E-09	1.0E-09	1.6E-09
PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11
THORIUM-228	1.0E-10	1.0E-10	1.0E-10
THORIUM-230	0.0E+00	1.0E-10	1.0E-10
THORIUM-232	1.0E-10	1.0E-10	1.0E-10

TABLE A10. RADIOCHEMICAL DATA FROM GROUNDWATER SAMPLES.

NUCLIDE	MOBLEY WELL 10/03/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)	NUCLIDE	H-02c 07/24/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)
GROSS ALPHA	5E-09	3E-08	5E-08	GROSS ALPHA	3E-08	7E-08	1E-07
GROSS BETA	2E-08	2E-08	3E-08	GROSS BETA	5E-08	5E-08	8E-08
URANIUM-233,234	9.6E-09	1.7E-09	1.0E-10	URANIUM-233,234	1.3E-08	1.0E-09	1.0E-10
URANIUM-235	4.0E-10	5.0E-10	1.0E-10	URANIUM-235	1.0E-10	1.0E-10	1.0E-10
URANIUM-238	3.8E-09	9.0E-10	1.0E-10	URANIUM-238	1.6E-09	3.0E-10	1.0E-10
STRONTIUM-90	0.0E+00	4.0E-10	6.0E-10	STRONTIUM-90	1.0E-09	6.0E-10	1.0E-09
PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-239,240	0.00E+00	2.00E-11	1.00E-11
AMERICIUM-241	1.00E-11	1.00E-11	1.00E-11	AMERICIUM-241	0.00E+00	5.00E-11	1.00E-11
CESIUM-137	-1.0E-10	5.0E-10	8.0E-10	CESIUM-137	0.0E+00	1.3E-09	1.3E-09
TRITIUM	-1.3E-07	1.5E-07	2.5E-07	TRITIUM	-1.6E-07	2.0E-07	3.0E-07
RADIUM-226	4.0E-10	3.0E-10	2.0E-10	RADIUM-226	2.0E-08	1.0E-09	2.0E-10
RADIUM-228	1.3E-09	1.3E-09	2.0E-09	RADIUM-228	4.5E-09	1.4E-09	1.9E-09
PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11
THORIUM-228	-1.0E-10	3.0E-10	1.0E-10	THORIUM-228	0.0E+00	1.0E-10	1.0E-10
THORIUM-230	-1.0E-10	3.0E-10	1.0E-10	THORIUM-230	0.0E+00	1.0E-10	1.0E-10
THORIUM-232	-2.0E-10	2.0E-10	1.0E-10	THORIUM-232	0.0E+00	1.0E-10	1.0E-10

TABLE A10. RADIOCHEMICAL DATA FROM GROUNDWATER SAMPLES, cont.

BARN WELL
06/21/90

NUCLIDE	ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)
GROSS ALPHA	2E-09	6E-09	1E-08
GROSS BETA	3E-09	4E-09	7E-09
URANIUM-233,234	2.8E-09	4.0E-10	1.0E-10
URANIUM-235	1.0E-10	1.0E-10	1.0E-10
URANIUM-238	1.2E-09	3.0E-10	1.0E-10
STRONTIUM-90	1.0E-10	6.0E-10	1.1E-09
PLUTONIUM-239,240	0.00E+00	2.00E-11	1.00E-11
AMERICIUM-241	0.00E+00	5.00E-11	2.00E-11
CESIUM-137	0.0E+00	1.4E-09	1.3E-09
TRITIUM	-7.0E-08	2.0E-07	3.0E-07
RADIUM-226	3.0E-10	3.0E-10	2.0E-10
RADIUM-228	3.0E-10	1.1E-09	2.0E-09
PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11
THORIUM-228	0.0E+00	1.0E-10	1.0E-10
THORIUM-230	0.0E+00	1.0E-10	1.0E-10
THORIUM-232	0.0E+00	1.0E-10	1.0E-10

TABLE A11. RADIOCHEMICAL DATA FROM WIPP EFFLUENT WATER SAMPLES.

NUCLIDE	WIPP SEWAGE LAGOON 08/01/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)	NUCLIDE	STORMWATER FROM WIPP FACILITY 07/30/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)
GROSS ALPHA	-3E-09	6E-09	1E-08	GROSS ALPHA	1E-08	3E-09	3E-09
GROSS BETA	4E-08	6E-09	8E-09	GROSS BETA	4E-09	2E-09	4E-09
URANIUM-233,234	3.0E-10	3.0E-10	2.0E-10	URANIUM-233,234	0.0E+00	3.0E-10	1.0E-10
URANIUM-235	0.0E+00	1.0E-10	1.0E-10	URANIUM-235	0.0E+00	1.0E-10	1.0E-10
URANIUM-238	2.0E-10	2.0E-10	1.0E-10	URANIUM-238	0.0E+00	3.0E-10	1.0E-10
STRONTIUM-90	1.0E-10	7.0E-10	1.2E-09	STRONTIUM-90	-5.0E-10	9.0E-10	1.6E-09
PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11	AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11
CESIUM-137	0.0E+00	1.3E-09	1.3E-09	CESIUM-137	0.0E+00	1.3E-09	1.3E-09
TRITIUM	-1.1E-07	2.0E-07	3.0E-07	TRITIUM	-1.5E-07	2.0E-07	3.0E-07
RADIUM-226	0.0E+00	1.0E-09	2.0E-10	RADIUM-226	3.0E-10	5.0E-10	2.0E-10
RADIUM-228	8.0E-10	1.3E-09	2.1E-09	RADIUM-228	3.4E-09	2.4E-09	3.7E-09
PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	1.00E-11	2.00E-11
THORIUM-228	0.0E+00	1.0E-10	1.0E-10	THORIUM-228	1.0E-10	2.0E-10	1.0E-10
THORIUM-230	0.0E+00	1.0E-10	1.0E-10	THORIUM-230	4.3E-09	9.0E-10	2.0E-10
THORIUM-232	0.0E+00	1.0E-10	1.0E-10	THORIUM-232	4.0E-10	3.0E-10	1.0E-10

TABLE A12. RADIOCHEMICAL DATA FROM PUBLIC DRINKING WATER SAMPLES.

	CARLSBAD 07/03/90				LOVING 07/03/90		
NUCLIDE	ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)	NUCLIDE	ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)
GROSS ALPHA	5E-09	4E-09	6E-09	GROSS ALPHA	6E-09	5E-09	7E-09
GROSS BETA	3E-09	3E-09	5E-09	GROSS BETA	5E-09	4E-09	6E-09
URANIUM-233,234	6.0E-10	3.0E-10	1.0E-10	URANIUM-233,234	1.7E-09	5.0E-10	1.0E-10
URANIUM-235	0.0E+00	1.0E-10	1.0E-10	URANIUM-235	0.0E+00	1.0E-10	1.0E-10
URANIUM-238	2.0E-10	2.0E-10	1.0E-10	URANIUM-238	3.0E-10	3.0E-10	1.0E-10
STRONTIUM-90	0.0E+00	6.0E-10	1.0E-09	STRONTIUM-90	0.0E+00	6.0E-10	1.0E-09
PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	0.00E+00	1.00E-11	2.00E-11	AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11
CESIUM-137	0.0E+00	1.3E-09	1.3E-09	CESIUM-137	0.0E+00	1.3E-09	1.3E-09
TRITIUM	4.0E-08	2.0E-07	3.0E-07	TRITIUM	2.1E-07	2.1E-07	3.0E-07
RADIUM-226	4.0E-10	3.0E-10	3.0E-10	RADIUM-226	-1.0E-10	2.0E-10	3.0E-10
RADIUM-228	-1.0E-10	7.0E-10	1.3E-09	RADIUM-228	5.0E-10	6.0E-10	1.0E-09
PLUTONIUM-238	0.00E+00	2.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11
THORIUM-228	0.0E+00	1.0E-10	1.0E-10	THORIUM-228	1.0E-10	1.0E-10	1.0E-10
THORIUM-230	-1.0E-10	2.0E-10	1.0E-10	THORIUM-230	0.0E+00	1.0E-10	1.0E-10
THORIUM-232	0.0E+00	1.0E-10	1.0E-10	THORIUM-232	0.0E+00	1.0E-10	1.0E-10

TABLE A12. RADIOCHEMICAL DATA FROM PUBLIC DRINKING WATER SAMPLES, cont.

NUCLIDE	OTIS 07/03/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)	NUCLIDE	WIPP SITE 07/03/90 ACTIVITY (uCi/ml)	ANALYTICAL ERROR (uCi/ml)	LLD-C (uCi/ml)
GROSS ALPHA	4E-09	7E-09	1E-08	GROSS ALPHA	1E-09	3E-09	4E-09
GROSS BETA	6E-09	5E-09	8E-09	GROSS BETA	5E-09	3E-09	4E-09
URANIUM-233,234	2.4E-09	5.0E-10	1.0E-10	URANIUM-233,234	1.2E-09	3.0E-10	1.0E-10
URANIUM-235	0.0E+00	1.0E-10	1.0E-10	URANIUM-235	0.0E+00	1.0E-10	1.0E-10
URANIUM-238	1.2E-09	4.0E-10	1.0E-10	URANIUM-238	3.0E-10	2.0E-10	1.0E-10
STRONTIUM-90	1.0E-10	5.0E-10	9.0E-10	STRONTIUM-90	-2.0E-10	8.0E-10	1.3E-09
PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-239,240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11	AMERICIUM-241	1.00E-11	1.00E-11	2.00E-11
CESIUM-137	0.0E+00	1.3E-09	1.3E-09	CESIUM-137	0.0E+00	1.3E-09	1.3E-09
TRITIUM	1.0E-07	2.1E-07	3.0E-07	TRITIUM	9.0E-08	2.1E-07	3.0E-07
RADIUM-226	2.0E-10	2.0E-10	3.0E-10	RADIUM-226	1.0E-10	3.0E-10	3.0E-10
RADIUM-228	-1.0E-10	6.0E-10	1.1E-09	RADIUM-228	-7.0E-10	9.0E-10	1.6E-09
PLUTONIUM-238	1.00E-11	2.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	2.00E-11	1.00E-11
THORIUM-228	0.0E+00	1.0E-10	1.0E-10	THORIUM-228	1.0E-10	2.0E-10	1.0E-10
THORIUM-230	1.0E-10	3.0E-10	1.0E-10	THORIUM-230	-2.0E-10	2.0E-10	1.0E-10
THORIUM-232	0.0E+00	1.0E-10	1.0E-10	THORIUM-232	0.0E+00	1.0E-10	1.0E-10

TABLE A13. RADIOCHEMICAL DATA FROM WIPP VICINITY SOIL SAMPLES.

NUCLIDE	390 METERS EAST WIPP AIR EXHAUST 8/1/90 ACTIVITY (uCi/g)	ANALYTICAL ERROR (uCi/g)	LLD-C (uCi/g)	NUCLIDE	575 METERS NORTH WIPP AIR EXHAUST 8/1/90 ACTIVITY (uCi/g)	ANALYTICAL ERROR (uCi/g)	LLD-C (uCi/g)
GROSS ALPHA	8E-06	8E-06	1E-05	GROSS ALPHA	1E-05	8E-06	1E-05
GROSS BETA	7E-06	5E-06	7E-06	GROSS BETA	9E-06	5E-06	7E-06
URANIUM-233, 234	2.0E-07	1.0E-07	1.0E-07	URANIUM-233, 234	1.0E-07	1.0E-07	1.0E-07
URANIUM-235	0.0E+00	1.0E-07	1.0E-07	URANIUM-235	0.0E+00	1.0E-07	1.0E-07
URANIUM-238	2.0E-07	1.0E-07	1.0E-07	URANIUM-238	1.0E-07	1.0E-07	1.0E-07
STRONTIUM-90	-2.0E-07	5.0E-07	9.0E-07	STRONTIUM-90	-3.0E-07	6.0E-07	1.1E-06
PLUTONIUM-239 & 240	1.00E-08	1.00E-08	1.00E-08	PLUTONIUM-239 & 240	0.00E+00	1.00E-08	1.00E-08
CESIUM-137	2.0E-07	1.0E-07	2.0E-07	CESIUM-137	1.0E-07	1.0E-07	1.0E-07
PLUTONIUM-238	-1.00E-08	1.00E-08	1.00E-08	PLUTONIUM-238	-1.00E-08	1.00E-08	1.00E-08
THORIUM-228	0.0E+00	1.0E-07	1.0E-07	THORIUM-228	0.0E+00	1.0E-07	1.0E-07
THORIUM-230	2.0E-07	1.0E-07	1.0E-07	THORIUM-230	2.0E-07	1.0E-07	1.0E-07
THORIUM-232	2.0E-07	1.0E-07	1.0E-07	THORIUM-232	2.0E-07	1.0E-07	1.0E-07

TABLE A13. RADIOCHEMICAL DATA FROM WIPP VICINITY SOIL SAMPLES, cont.

NUCLIDE	530 METERS SOUTH WIPP AIR EXHAUST 8/1/90 ACTIVITY (uCi/g)	ANALYTICAL ERROR (uCi/g)	LLD-C (uCi/g)	NUCLIDE	775 METERS WEST WIPP AIR EXHAUST 8/1/90 ACTIVITY (uCi/g)	ANALYTICAL ERROR (uCi/g)	LLD-C (uCi/g)
GROSS ALPHA	-1E-06	6E-06	1E-05	GROSS ALPHA	6E-06	8E-06	1E-05
GROSS BETA	9E-06	5E-06	8E-06	GROSS BETA	6E-06	5E-06	7E-06
URANIUM-233, 234	2.0E-07	1.0E-07	1.0E-07	URANIUM-233, 234	2.0E-07	1.0E-07	1.0E-07
URANIUM-235	0.0E+00	1.0E-07	1.0E-07	URANIUM-235	0.0E+00	1.0E-07	1.0E-07
URANIUM-238	2.0E-07	1.0E-07	1.0E-07	URANIUM-238	2.0E-07	1.0E-07	1.0E-07
STRONTIUM-90	2.0E-07	6.0E-07	1.0E-06	STRONTIUM-90	-2.0E-07	5.0E-07	9.0E-07
PLUTONIUM-239 & 240	2.00E-08	1.00E-08	1.00E-08	PLUTONIUM-239 & 240	1.00E-08	1.00E-08	1.00E-08
CESIUM-137	0.0E+00	1.0E-07	1.0E-07	CESIUM-137	1.0E-07	1.0E-07	1.0E-07
PLUTONIUM-238	0.00E+00	1.00E-08	1.00E-08	PLUTONIUM-238	-1.00E-08	1.00E-08	1.00E-08
THORIUM-228	2.0E-07	1.0E-07	1.0E-07	THORIUM-228	3.0E-07	1.0E-07	1.0E-07
THORIUM-230	2.0E-07	1.0E-07	1.0E-07	THORIUM-230	2.0E-07	1.0E-07	1.0E-07
THORIUM-232	2.0E-07	1.0E-07	1.0E-07	THORIUM-232	3.0E-07	1.0E-07	1.0E-07

TABLE A14. RADIOCHEMICAL DATA FROM BIOTA SAMPLE.

QUAIL
(FROM NOYE TANK)
Oct.-Nov. 1990

	ACTIVITY (uCi/g)	ANALYTICAL ERROR (uCi/g)	LLD (uCi/g)
PLUTONIUM-239+240	0.00E+00	1.00E-08	1.00E-08
AMERICIUM-241	0.00E+00	1.00E-08	1.00E-08
CESIUM-137	1.0E-07	1.0E-07	1.0E-07
TRITIUM	-8.00E-08	1.70E-07	3.00E-07
PLUTONIUM-238	0.00E+00	1.00E-08	1.00E-08

APPENDIX B

TABLE B1. LVAS DATA. ARTESIA, NEW MEXICO - 1990

SAMPLE DATE	GROSS ALPHA (CPM)	GROSS ALPHA BKG. (CPM)	GROSS BETA (CPM)	GROSS BETA BKG. (CPM)	SAMPLE VOL. (m3)	ALPHA EFF.	BETA EFF.	SAMPLE WEIGHT (g)	NET ALPHA (uCi/ml)	NET BETA (uCi/ml)
01/17/90	0.80	0.23	157.00	143.60	1171	0.23	0.32	0.0329	9.53E-16	1.61E-14
01/31/90	1.03	0.30	145.17	136.20	1127	0.23	0.32	0.0218	1.27E-15	1.12E-14
02/23/90	0.73	0.17	155.93	138.13	1628	0.23	0.34	0.0541	6.74E-16	1.45E-14
02/28/90	1.10	0.20	163.87	138.00	1018	0.23	0.34	0.0256	1.73E-15	3.37E-14
03/08/90	1.30	0.17	160.27	136.97	1634	0.23	0.34	0.0390	1.35E-15	1.89E-14
03/14/90	0.83	0.37	150.73	137.87	1227	0.23	0.34	0.0324	7.34E-16	1.39E-14
03/21/90	0.77	0.07	154.40	136.97	1425	0.23	0.35	0.0318	9.62E-16	1.57E-14
03/28/90	1.13	0.03	143.53	130.33	1389	0.23	0.35	0.0483	1.55E-15	1.22E-14
04/04/90	0.47	0.23	147.83	129.23	1422	0.23	0.35	0.0290	3.31E-16	1.68E-14
04/11/90	1.33	0.13	148.27	128.63	1417	0.23	0.35	0.0448	1.66E-15	1.78E-14
04/19/90	2.30	0.13	157.40	135.10	1623	0.23	0.34	0.0582	2.62E-15	1.82E-14
04/25/90	0.83	0.27	144.30	132.27	1213	0.23	0.34	0.0292	9.04E-16	1.31E-14
05/03/90	1.03	0.23	149.13	131.40	1612	0.23	0.34	0.0563	9.72E-16	1.46E-14
05/10/90	1.23	0.17	153.13	137.03	1458	0.24	0.34	0.0418	1.36E-15	1.46E-14
05/17/90	1.27	0.20	148.23	133.30	1427	0.24	0.34	0.0385	1.41E-15	1.39E-14
05/22/90	1.40	0.27	144.17	133.50	999	0.24	0.34	0.1006	2.12E-15	1.41E-14
05/31/90	1.37	0.30	155.03	130.37	1857	0.24	0.34	0.1417	1.08E-15	1.76E-14
06/04/90	0.87	0.37	146.13	136.77	1016	0.24	0.34	0.0543	9.24E-16	1.22E-14
06/11/90	1.23	0.30	144.07	123.40	1204	0.24	0.34	0.0433	1.45E-15	2.28E-14
06/19/90	0.90	0.47	150.40	128.63	1659	0.24	0.34	0.0596	4.86E-16	1.74E-14
06/25/90	0.90	0.37	143.87	132.77	1178	0.24	0.34	0.0953	8.44E-16	1.25E-14
07/02/90	1.10	0.27	152.13	129.77	1458	0.24	0.34	0.0499	1.07E-15	2.03E-14
07/11/90	1.33	0.13	150.47	129.00	1843	0.24	0.34	0.0570	1.22E-15	1.54E-14
07/17/90	1.03	0.07	139.30	118.93	1212	0.24	0.34	0.0214	1.49E-15	2.23E-14
07/31/90	0.87	0.30	141.97	127.78	1417	0.24	0.34	0.0361	7.55E-16	1.33E-14
08/08/90	0.90	0.17	144.97	123.13	1568	0.23	0.34	0.0142	9.12E-16	1.84E-14
08/13/90	1.27	0.13	148.40	132.77	1051	0.23	0.33	0.0186	2.13E-15	2.03E-14
08/21/90	1.30	0.50	155.23	134.43	1601	0.23	0.33	0.0313	9.78E-16	1.77E-14
08/27/90	1.03	0.27	156.17	139.67	1237	0.23	0.33	0.0205	1.20E-15	1.82E-14
09/04/90	1.40	0.27	166.83	146.43	1634	0.23	0.33	0.0511	1.35E-15	1.70E-14
09/11/90	1.27	0.23	164.10	143.20	1302	0.23	0.33	0.0032	1.56E-15	2.19E-14
09/18/90	0.87	0.30	172.27	159.43	1452	0.23	0.33	0.0256	7.69E-16	1.21E-14
10/02/90	1.07	0.37	186.43	155.23	1413	0.23	0.33	0.0265	9.70E-16	3.01E-14
10/09/90	1.80	0.33	162.70	146.47	1469	0.23	0.33	0.0187	1.96E-15	1.51E-14
10/15/90	1.30	0.30	157.50	134.77	1202	0.23	0.34	0.2168	1.63E-15	2.50E-14
10/23/90	2.53	0.20	173.47	144.73	1611	0.23	0.34	0.0743	2.83E-15	2.36E-14
10/29/90	3.83	0.23	174.97	141.27	1262	0.23	0.33	0.0418	5.59E-15	3.64E-14
11/21/90	2.40	0.17	146.03	110.20	1204	0.23	0.33	0.0265	3.63E-15	4.06E-14
11/28/90	1.17	0.23	132.27	124.87	1621	0.23	0.33	0.0280	1.14E-15	6.23E-15
12/07/90	1.63	0.33	184.47	145.83	1616	0.23	0.33	0.0497	1.58E-15	3.26E-14
12/13/90	1.90	0.20	171.27	146.17	1235	0.23	0.34	0.0258	2.70E-15	2.69E-14
12/20/90	1.84	0.47	164.17	141.53	1437	0.23	0.34	0.0166	1.87E-15	2.09E-14
12/28/90	2.17	0.10	179.83	126.60	1611	0.23	0.34	0.0286	2.52E-15	4.38E-14

TABLE B2. LVAS DATA. CARLSBAD, NEW MEXICO - 1990

SAMPLE DATE	GROSS ALPHA (CPM)	GROSS ALPHA BKG. (CPM)	GROSS BETA (CPM)	GROSS BETA BKG. (CPM)	SAMPLE VOL. (m3)	ALPH EFF.	BETA EFF.	SAMPLE WEIGHT (g)	NET ALPHA (uCi/ml)	NET BETA (uCi/ml)
01/24/90	1.03	0.27	157.07	135.13	1565	0.23	0.32	0.0346	9.51E-16	1.97E-14
02/22/90	1.13	0.17	157.00	138.13	1812	0.23	0.34	0.0710	1.04E-15	1.38E-14
03/02/90	1.80	0.43	161.70	139.33	1582	0.23	0.34	0.0563	1.70E-15	1.87E-14
03/07/90	1.07	0.43	158.20	139.33	878	0.23	0.34	0.0511	1.43E-15	2.85E-14
03/14/90	1.07	0.37	158.53	137.87	1491	0.23	0.34	0.0600	9.20E-16	1.84E-14
03/20/90	1.03	0.07	147.77	136.97	1190	0.23	0.35	0.0389	1.58E-15	1.17E-14
03/28/90	1.17	0.03	145.33	130.33	1568	0.23	0.35	0.0740	1.42E-15	1.23E-14
04/02/90	0.80	0.23	138.36	129.23	1041	0.23	0.35	0.0345	1.07E-15	1.13E-14
04/10/90	1.67	0.13	154.80	128.63	1620	0.23	0.35	0.0570	1.86E-15	2.08E-14
04/15/90	0.73	0.17	142.83	131.37	1039	0.23	0.35	0.0399	1.06E-15	1.42E-14
04/24/90	0.93	0.27	146.90	132.27	1187	0.23	0.34	0.0353	1.08E-15	1.63E-14
05/02/90	1.47	0.23	150.17	131.40	1706	0.23	0.34	0.1006	1.42E-15	1.46E-14
05/10/90	1.83	0.17	158.77	130.63	1611	0.24	0.34	0.0661	1.93E-15	2.31E-14
05/14/90	1.20	0.10	140.90	130.90	782	0.24	0.34	0.0498	2.64E-15	1.69E-14
05/22/90	1.40	0.27	150.20	133.50	1698	0.24	0.34	0.1015	1.25E-15	1.30E-14
05/30/90	1.23	0.23	155.87	138.67	1568	0.24	0.34	0.0686	1.20E-15	1.45E-14
06/07/90	1.00	0.47	149.57	130.30	2600	0.24	0.34	0.1112	3.83E-16	9.82E-15
06/29/90	0.57	0.20	144.37	134.37	618	0.24	0.34	0.0380	1.12E-15	2.14E-14
07/19/90	1.07	0.07	139.67	118.93	1435	0.23	0.34	0.0325	1.36E-15	1.91E-14
07/31/90	1.10	0.30	137.30	127.77	1022	0.23	0.34	0.0226	1.53E-15	1.24E-14
08/10/90	2.07	0.37	154.90	135.57	1952	0.23	0.34	0.0382	1.71E-15	1.31E-14
08/17/90	1.23	0.23	141.50	127.93	1373	0.23	0.33	0.0349	1.43E-15	1.35E-14
08/21/90	0.97	0.23	140.03	127.93	807	0.23	0.33	0.0215	1.80E-15	2.05E-14
08/30/90	2.07	0.23	161.43	128.20	1890	0.23	0.33	0.0676	1.91E-15	2.40E-14
09/06/90	1.20	0.33	160.43	147.70	1423	0.23	0.33	0.0537	1.20E-15	1.22E-14
09/14/90	1.40	0.43	169.87	137.87	1620	0.23	0.33	0.0555	1.17E-15	2.70E-14
09/21/90	0.93	0.37	168.60	158.23	1441	0.23	0.33	0.0247	7.61E-16	9.82E-15
09/28/90	1.30	0.10	181.97	152.57	1456	0.23	0.33	0.0317	1.61E-15	2.76E-14
10/05/90	1.17	0.27	148.33	135.57	1365	0.23	0.33	0.0325	1.29E-15	1.28E-14
10/11/90	0.90	0.40	170.63	151.30	1216	0.23	0.34	0.0298	8.05E-16	2.11E-14
10/19/90	1.83	0.20	182.80	148.20	1641	0.23	0.34	0.0862	1.95E-15	2.79E-14
10/26/90	2.17	0.37	177.97	141.50	1433	0.23	0.33	0.0821	2.46E-15	3.47E-14
11/02/90	3.40	0.23	181.10	141.27	1501	0.23	0.33	0.0870	4.14E-15	3.62E-14
11/09/90	1.77	0.20	166.97	146.60	1430	0.23	0.33	0.0261	2.15E-15	1.94E-14
11/21/90	2.80	0.17	149.10	110.20	1228	0.23	0.33	0.0531	4.19E-15	4.32E-14
11/28/90	1.07	0.23	134.83	124.87	1646	0.23	0.33	0.0529	9.99E-16	8.26E-15
12/07/90	1.43	0.30	153.17	122.43	1406	0.23	0.33	0.0555	1.57E-15	2.98E-14
12/11/90	0.67	0.30	147.13	122.43	979	0.23	0.33	0.0559	7.40E-16	3.44E-14
12/20/90	1.73	0.47	188.37	141.53	1611	0.23	0.34	0.0526	1.53E-15	3.85E-14
12/28/90	2.43	0.10	186.13	126.60	1884	0.23	0.34	0.0475	2.42E-15	4.19E-14

TABLE B3. LVAS DATA. HOBBS, NEW MEXICO - 1990

SAMPLE DATE	GROSS ALPHA (CPM)	GROSS ALPHA BKG. (CPM)	GROSS BETA (CPM)	GROSS BETA BKG. (CPM)	SAMPLE VOL. (m3)	ALPH EFF.	BETA EFF.	SAMPLE WEIGHT (g)	NET ALPHA (uCi/ml)	NET BETA (uCi/ml)
01/08/90	1.33	0.17	153.90	141.27	1174	0.23	0.32	0.0243	1.93E-15	1.51E-14
01/15/90	1.60	0.17	157.77	141.27	1445	0.23	0.32	0.0727	1.94E-15	1.61E-14
01/22/90	0.83	0.23	156.07	138.63	1442	0.23	0.32	0.0263	8.15E-16	1.70E-14
01/29/90	1.10	0.20	154.33	139.70	1411	0.23	0.32	0.0294	1.25E-15	1.46E-14
02/19/90	0.87	0.17	150.97	138.13	1037	0.23	0.34	0.0327	1.32E-15	1.64E-14
02/26/90	1.00	0.20	158.93	138.00	1397	0.23	0.34	0.0463	1.12E-15	1.99E-14
03/06/90	0.70	0.43	163.87	139.23	1605	0.23	0.34	0.0295	3.29E-16	2.03E-14
03/12/90	0.90	0.17	144.13	132.33	1192	0.23	0.34	0.0295	1.20E-15	1.31E-14
03/19/90	0.93	0.07	150.53	136.97	1432	0.23	0.35	0.0400	1.18E-15	1.22E-14
03/27/90	1.17	0.30	151.10	130.80	1611	0.23	0.35	0.0430	1.06E-15	1.62E-14
04/02/90	0.80	0.23	140.07	129.23	1246	0.23	0.35	0.0181	8.96E-16	1.12E-14
04/09/90	1.17	0.13	146.73	128.63	1375	0.23	0.35	0.0409	1.48E-15	1.69E-14
04/16/90	0.97	0.17	156.17	131.37	1412	0.23	0.35	0.0399	1.11E-15	2.26E-14
04/23/90	1.03	0.27	150.63	132.27	1446	0.23	0.35	0.0411	1.03E-15	1.63E-14
04/30/90	1.30	0.23	149.23	138.57	1412	0.23	0.35	0.0450	1.48E-15	9.72E-15
05/07/90	1.07	0.10	144.67	130.00	1413	0.23	0.34	0.0356	1.34E-15	1.38E-14
05/14/90	1.43	0.17	153.10	137.03	1470	0.23	0.34	0.0743	1.68E-15	1.45E-14
05/21/90	1.30	0.20	150.10	133.30	1372	0.24	0.34	0.0569	1.51E-15	1.62E-14
06/04/90	0.93	0.17	137.13	132.57	580	0.24	0.34	0.0379	2.46E-15	1.04E-14
06/11/90	1.27	0.30	141.60	123.40	1454	0.24	0.34	0.0569	1.25E-15	1.66E-14
06/21/90	0.97	0.37	149.80	132.77	1987	0.24	0.34	0.0664	5.67E-16	1.14E-14
06/26/90	0.80	0.20	141.37	134.37	997	0.24	0.34	0.0369	1.13E-15	9.31E-15
07/05/90	1.37	0.13	152.53	124.03	1810	0.24	0.34	0.0666	1.29E-15	2.09E-14
07/09/90	0.53	0.13	139.17	124.03	808	0.24	0.34	0.0317	9.29E-16	2.48E-14
07/16/90	1.20	0.13	148.97	133.10	1420	0.24	0.34	0.0400	1.41E-15	1.48E-14
07/23/90	0.86	0.26	134.63	123.93	1419	0.23	0.34	0.0223	8.28E-16	9.99E-15
07/31/90	0.70	0.30	138.43	127.77	1570	0.23	0.34	0.0265	4.99E-16	9.00E-15
08/07/90	0.73	0.17	141.13	132.77	1425	0.23	0.34	0.0217	7.70E-16	7.77E-15
08/14/90	1.50	0.27	142.50	129.53	1447	0.23	0.33	0.0278	1.66E-15	1.22E-14
08/20/90	0.83	0.23	142.50	127.93	1188	0.23	0.33	0.0166	9.89E-16	1.67E-14
08/28/90	1.57	0.27	157.00	139.67	1658	0.23	0.33	0.0397	1.54E-15	1.43E-14
09/05/90	1.30	0.27	167.93	146.43	1622	0.23	0.33	0.0486	1.24E-15	1.81E-14
09/10/90	0.93	0.30	154.10	138.10	1027	0.23	0.33	0.0275	1.20E-15	2.13E-14
09/17/90	0.97	0.30	172.27	159.43	1424	0.23	0.33	0.0462	9.22E-16	1.23E-14
09/24/90	1.07	0.10	171.30	152.57	1421	0.23	0.33	0.0213	1.34E-15	1.80E-14
10/01/90	1.77	0.37	180.57	155.23	1412	0.23	0.33	0.3050	1.94E-15	2.45E-14
10/08/90	1.17	0.33	166.07	146.47	1397	0.23	0.33	0.0241	1.18E-15	1.92E-14
10/16/90	1.90	0.20	179.57	148.20	1635	0.23	0.34	0.0462	2.04E-15	2.54E-14
10/23/90	2.43	0.20	175.03	144.73	1483	0.23	0.34	0.0576	2.94E-15	2.71E-14
10/30/90	4.80	0.23	187.07	141.27	1407	0.23	0.33	0.0567	6.36E-15	4.44E-14
11/05/90	1.87	0.23	160.77	141.27	1211	0.23	0.33	0.0320	2.65E-15	2.20E-14
11/20/90	2.93	0.33	183.73	143.23	1371	0.23	0.33	0.0339	3.71E-15	4.03E-14
11/27/90	1.13	0.17	129.37	110.20	1449	0.23	0.33	0.0370	1.30E-15	1.81E-14
12/04/90	1.30	0.23	137.97	124.87	1431	0.23	0.33	0.0606	1.46E-15	1.25E-14
12/13/90	2.93	0.20	181.20	146.17	1812	0.23	0.34	0.0794	2.95E-15	2.56E-14
12/19/90	1.23	0.20	168.90	146.17	622	0.23	0.34	0.0211	3.24E-15	4.84E-14
12/27/90	1.07	0.47	171.27	130.37	1659	0.23	0.34	0.0381	7.08E-16	3.27E-14

TABLE B4. LVAS DATA. LOVING, NEW MEXICO - 1990

SAMPLE DATE	GROSS ALPHA (CPM)	GROSS ALPHA BKG. (CPM)	GROSS BETA (CPM)	GROSS BETA BKG. (CPM)	SAMPLE VOL. (m3)	ALPH EFF.	BETA EFF.	SAMPLE WEIGHT (g)	NET ALPHA (uCi/ml)	NET BETA (uCi/ml)
02/07/90	1.37	0.43	159.93	139.33	1214	0.23	0.34	0.0539	1.52E-15	2.25E-14
02/21/90	0.83	0.17	151.93	138.13	1460	0.23	0.34	0.0611	8.85E-16	1.25E-14
02/28/90	0.77	0.20	157.63	138.00	1407	0.23	0.34	0.0544	7.93E-16	1.85E-14
03/13/90	0.87	0.37	149.93	137.87	1231	0.23	0.34	0.0291	7.96E-16	1.29E-14
03/19/90	0.80	0.07	149.33	136.97	1241	0.23	0.35	0.0361	1.15E-15	1.28E-14
04/03/90	0.53	0.23	136.27	129.23	765	0.23	0.35	0.0172	7.68E-16	1.18E-14
04/10/90	1.23	0.13	149.17	128.63	1459	0.23	0.35	0.0556	1.48E-15	1.81E-14
04/18/90	0.80	0.17	156.00	131.37	1602	0.23	0.35	0.0620	7.70E-16	1.98E-14
04/27/90	1.07	0.27	150.07	132.27	1801	0.23	0.34	0.0591	8.70E-16	1.31E-14
05/02/90	0.57	0.13	148.93	138.57	1039	0.23	0.34	0.0548	8.30E-16	1.32E-14
05/08/90	1.47	0.10	148.10	130.00	1188	0.23	0.34	0.0320	2.26E-15	2.02E-14
05/15/90	1.33	0.10	141.57	130.90	1475	0.24	0.34	0.0790	1.57E-15	9.58E-15
05/24/90	1.90	0.27	159.33	133.50	1817	0.24	0.34	0.1154	1.68E-15	1.88E-14
05/29/90	0.77	0.30	152.93	138.67	1012	0.24	0.34	0.0481	8.72E-16	1.87E-14
06/07/90	1.67	0.30	147.17	123.40	1780	0.24	0.34	0.0923	1.44E-15	1.77E-14
06/12/90	0.90	0.30	136.63	123.40	997	0.24	0.34	0.0362	1.13E-15	1.76E-14
06/19/90	0.83	0.47	143.37	128.63	1415	0.24	0.34	0.0603	4.77E-16	1.38E-14
06/28/90	1.47	0.20	155.03	134.37	1903	0.24	0.34	0.1089	1.25E-15	1.44E-14
07/05/90	1.10	0.13	149.33	124.03	1426	0.24	0.34	0.0642	1.28E-15	2.35E-14
07/19/90	0.77	0.07	131.47	118.93	611	0.23	0.34	0.0134	2.24E-15	2.72E-14
07/26/90	0.97	0.30	134.43	129.93	1428	0.23	0.34	0.0213	9.19E-16	4.18E-15
08/03/90	1.13	0.17	138.93	132.77	1540	0.23	0.34	0.0307	1.22E-15	5.30E-15
08/10/90	1.03	0.37	151.17	135.57	1465	0.23	0.34	0.0260	8.82E-16	1.41E-14
08/17/90	1.33	0.23	141.47	127.93	1393	0.23	0.33	0.0315	1.55E-15	1.33E-14
08/24/90	1.07	0.47	155.13	138.53	1369	0.23	0.33	0.0305	8.58E-16	1.66E-14
08/30/90	1.57	0.27	172.00	146.43	1282	0.23	0.33	0.0498	1.99E-15	2.72E-14
09/07/90	1.33	0.27	156.77	136.23	1567	0.23	0.33	0.0515	1.33E-15	1.79E-14
09/13/90	1.20	0.57	168.73	141.73	1265	0.23	0.33	0.0381	9.75E-16	2.91E-14
09/19/90	0.50	0.30	167.80	159.43	1179	0.23	0.33	0.0207	3.32E-16	9.69E-15
09/28/90	1.03	0.10	185.10	152.57	1814	0.23	0.33	0.0348	1.00E-15	2.45E-14
10/12/90	1.17	0.40	161.87	142.63	1449	0.23	0.33	0.0335	1.04E-15	1.81E-14
10/19/90	1.47	0.20	179.47	148.20	1363	0.23	0.34	0.0641	1.82E-15	3.04E-14
10/25/90	2.27	0.20	177.17	144.73	1279	0.23	0.34	0.0435	3.17E-15	3.36E-14
11/01/90	3.60	0.23	189.60	141.27	1426	0.23	0.33	0.0592	4.63E-15	4.63E-14
11/08/90	1.80	0.23	159.07	141.27	1437	0.23	0.33	0.0334	2.14E-15	1.69E-14
11/21/90	2.47	0.17	154.40	110.20	1189	0.23	0.33	0.0403	3.79E-15	5.07E-14
11/28/90	1.07	0.23	136.20	124.87	1677	0.23	0.33	0.0534	9.81E-16	9.22E-15
12/06/90	1.87	0.33	184.47	145.83	1421	0.23	0.33	0.0743	2.12E-15	3.71E-14
12/14/90	2.30	0.20	192.07	146.17	1527	0.23	0.34	0.0605	2.69E-15	3.98E-14
12/20/90	1.00	0.47	165.97	141.53	1244	0.23	0.34	0.0214	8.34E-16	2.60E-14

TABLE B5. LVAS DATA WIPP SITE-1 1990

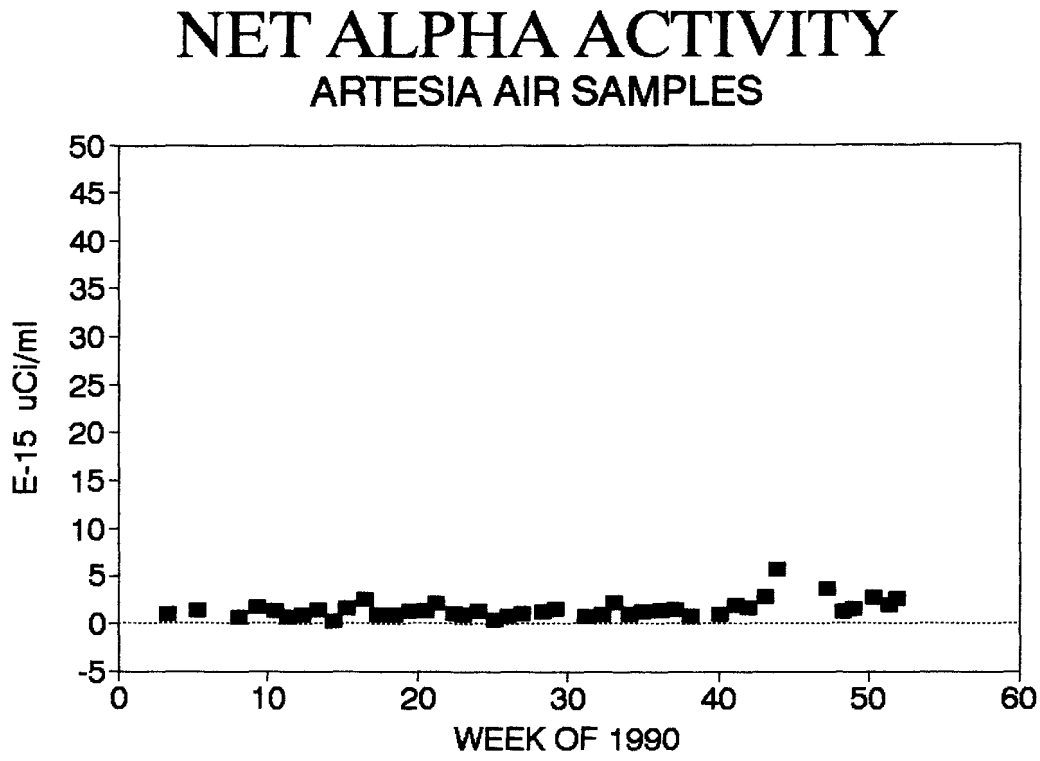
SAMPLE DATE	GROSS ALPHA (CPM)	GROSS ALPHA BKG. (CPM)	GROSS BETA (CPM)	GROSS BETA BKG. (CPM)	SAMPLE VOL. (m3)	ALPH EFF.	BETA EFF.	SAMPLE WEIGHT (g)	NET ALPHA (uCi/ml)	NET BETA (uCi/ml)
08/01/90	0.57	0.30	136.27	125.93	1239	0.23	0.34	0.0165	4.27E-16	1.11E-14
08/16/90	0.80	0.27	139.60	129.53	1398	0.23	0.33	0.0154	7.43E-16	9.83E-15
08/22/90	1.30	0.47	152.73	138.53	1227	0.23	0.33	0.0170	1.33E-15	1.58E-14
09/06/90	1.03	0.27	158.27	146.43	1610	0.23	0.33	0.2920	9.25E-16	1.00E-14
09/14/90	1.70	0.30	176.27	159.43	1618	0.23	0.33	0.0326	1.69E-15	1.42E-14
09/21/90	0.77	0.37	170.77	158.23	1420	0.23	0.33	0.0105	5.52E-16	1.21E-14
09/27/90	0.97	0.10	182.43	152.57	1220	0.23	0.33	0.0092	1.40E-15	3.34E-14
10/05/90	0.97	0.17	183.03	154.87	1621	0.23	0.33	0.0198	9.66E-16	2.37E-14
10/12/90	1.60	0.30	157.43	134.77	1387	0.23	0.34	0.0315	1.84E-15	2.17E-14
10/19/90	3.07	0.20	177.23	144.73	1315	0.23	0.34	0.0501	4.28E-15	3.28E-14
10/26/90	3.43	0.13	145.13	114.50	1382	0.23	0.33	0.0459	4.68E-15	3.03E-14
11/09/90	1.43	0.33	162.70	143.23	1420	0.23	0.33	0.0304	1.52E-15	1.87E-14
11/20/90	2.47	0.33	176.90	143.23	1151	0.23	0.33	0.0226	3.64E-15	3.99E-14
11/27/90	1.07	0.17	125.73	110.20	1422	0.23	0.33	0.0182	1.24E-15	1.49E-14
12/04/90	1.33	0.33	169.00	145.83	1394	0.23	0.33	0.0301	1.40E-15	2.27E-14
12/11/90	0.97	0.40	166.20	143.73	1393	0.23	0.33	0.0293	8.02E-16	2.20E-14
12/21/90	2.03	0.47	166.73	130.37	1894	0.23	0.34	0.0300	1.59E-15	2.54E-14
12/27/90	1.93	0.10	166.30	126.60	1271	0.23	0.34	0.0184	2.82E-15	4.14E-14

TABLE B6. LVAS DATA WIPP SITE-2 1990

SAMPLE DATE	GROSS ALPHA (CPM)	GROSS ALPHA BKG. (CPM)	GROSS BETA (CPM)	GROSS BETA BKG. (CPM)	SAMPLE VOL. (m3)	ALPHA EFF.	BETA EFF.	SAMPLE WEIGHT (g)	NET ALPHA (uCi/ml)	NET BETA (uCi/ml)
01/09/90	1.30	0.17	154.03	141.27	1272	0.23	0.32	0.0180	1.74E-15	1.41E-14
01/15/90	1.37	0.73	155.53	140.63	1185	0.23	0.32	0.0370	1.06E-15	1.77E-14
01/22/90	1.00	0.27	154.50	139.03	1396	0.23	0.32	0.0130	1.02E-15	1.56E-14
01/29/90	0.87	0.20	156.93	139.70	1376	0.23	0.32	0.0147	9.53E-16	1.76E-14
02/20/90	1.33	0.17	150.60	138.13	1219	0.23	0.34	0.0272	1.86E-15	1.35E-14
02/27/90	0.93	0.20	153.30	138.00	1370	0.23	0.34	0.0252	1.04E-15	1.48E-14
03/06/90	1.13	0.43	161.30	139.33	1409	0.23	0.34	0.0150	9.73E-16	2.07E-14
03/14/90	1.17	0.37	150.43	137.87	1635	0.23	0.34	0.0320	9.58E-16	1.02E-14
03/20/90	0.53	0.07	150.47	136.97	1228	0.23	0.35	0.0200	7.34E-16	1.42E-14
03/29/90	1.47	0.03	144.10	130.33	1841	0.23	0.35	0.0305	1.53E-15	9.62E-15
04/03/90	0.60	0.23	136.07	133.17	967	0.23	0.35	0.0099	7.50E-16	3.86E-15
04/11/90	1.17	0.13	154.77	128.63	1619	0.23	0.35	0.0236	1.26E-15	2.08E-14
04/18/90	1.50	0.27	155.30	131.03	1231	0.23	0.34	0.0255	1.96E-15	2.61E-14
04/24/90	1.07	0.23	144.23	131.40	1206	0.23	0.34	0.0175	1.36E-15	1.41E-14
05/01/90	1.00	0.23	148.67	131.40	1432	0.23	0.34	0.0422	1.05E-15	1.60E-14
05/09/90	1.03	0.27	150.60	129.27	1575	0.23	0.34	0.0240	9.45E-16	1.79E-14
05/16/90	0.97	0.10	147.83	130.90	1363	0.24	0.34	0.0406	1.20E-15	1.65E-14
05/23/90	1.03	0.27	165.03	133.50	1438	0.24	0.34	0.0529	9.92E-16	2.90E-14
05/31/90	1.23	0.37	150.93	136.77	1617	0.24	0.34	0.0394	9.98E-16	1.16E-14
06/06/90	1.07	0.17	146.87	132.57	1201	0.24	0.34	0.0461	1.41E-15	1.58E-14
06/13/90	1.23	0.30	140.83	123.40	1319	0.24	0.34	0.0265	1.32E-15	1.75E-14
06/20/90	1.17	0.27	145.47	130.00	1432	0.24	0.34	0.0279	1.18E-15	1.43E-14
06/27/90	1.03	0.20	152.63	134.37	1434	0.24	0.34	0.0458	1.09E-15	1.69E-14
07/05/90	0.97	0.20	142.50	130.83	1638	0.24	0.34	0.0440	8.82E-16	9.44E-15
07/11/90	0.77	0.13	146.93	124.03	1111	0.24	0.34	0.0401	1.08E-15	2.73E-14
07/18/90	0.33	0.23	145.43	129.63	1126	0.23	0.34	0.0155	1.74E-16	1.86E-14
08/01/90	0.67	0.30	135.60	125.93	1461	0.23	0.34	0.0187	4.96E-16	8.77E-15
08/09/90	1.27	0.33	142.50	124.83	1483	0.23	0.34	0.0149	1.24E-15	1.58E-14
08/16/90	1.77	0.23	143.77	127.93	1411	0.23	0.33	0.0124	2.14E-15	1.53E-14
08/22/90	0.97	0.27	152.50	133.23	1180	0.23	0.33	0.0128	1.16E-15	2.23E-14
08/29/90	0.90	0.27	155.10	139.67	1439	0.23	0.33	0.0229	8.57E-16	1.46E-14
09/06/90	1.40	0.27	164.00	146.43	1586	0.23	0.33	0.0255	1.40E-15	1.51E-14
09/13/90	1.53	0.43	170.50	137.87	1351	0.23	0.33	0.0249	1.60E-15	3.30E-14
09/21/90	0.73	0.27	164.57	160.07	1565	0.23	0.33	0.0108	5.76E-16	3.93E-15
09/27/90	1.07	0.10	181.57	152.57	1206	0.23	0.33	0.0019	1.57E-15	3.28E-14
10/05/90	1.37	0.27	160.40	135.57	1603	0.23	0.33	0.0195	1.34E-15	2.11E-14
10/12/90	1.03	0.40	160.83	142.63	1350	0.23	0.33	0.0136	9.14E-16	1.84E-14
10/18/90	1.50	0.20	173.17	148.20	1111	0.23	0.34	0.0271	2.29E-15	2.98E-14
10/26/90	3.67	0.13	157.13	114.50	1606	0.23	0.33	0.0331	4.32E-15	3.62E-14
11/02/90	4.70	0.23	186.57	141.27	1433	0.23	0.33	0.0276	6.11E-15	4.31E-14
11/09/90	1.80	0.33	165.20	143.23	1425	0.23	0.33	0.0092	2.02E-15	2.10E-14
11/20/90	2.77	0.33	192.70	143.23	1355	0.23	0.33	0.0194	3.53E-15	4.98E-14
11/27/90	1.07	0.17	130.10	110.20	1441	0.23	0.33	0.0189	1.22E-15	1.88E-14
12/04/90	1.23	0.23	138.00	124.87	1340	0.23	0.33	0.0262	1.46E-15	1.34E-14
12/11/90	1.43	0.40	166.87	143.73	1371	0.23	0.33	0.0252	1.47E-15	2.30E-14
12/19/90	2.17	0.47	185.00	141.53	1574	0.23	0.34	0.0205	2.11E-15	3.66E-14
12/27/90	1.57	0.10	175.93	126.60	1605	0.23	0.34	0.0216	1.79E-15	4.07E-14

TABLE B7. LVAS DATA WIPP SITE-3 1990

SAMPLE DATE	GROSS ALPHA (CPM)	GROSS ALPHA BKG. (CPM)	GROSS BETA (CPM)	GROSS BETA BKG. (CPM)	SAMPLE VOL. (m3)	ALPH EFF.	BETA EFF.	SAMPLE WEIGHT (g)	NET ALPHA (uCi/ml)	NET BETA (uCi/ml)
01/02/90	1.60	0.17	173.53	141.27	1431	0.23	0.32	0.0180	1.96E-15	3.17E-14
01/09/90	1.53	0.17	154.03	141.27	1355	0.23	0.32	0.0200	1.98E-15	1.33E-14
01/15/90	1.00	0.73	151.70	140.63	1235	0.23	0.32	0.0360	4.23E-16	1.26E-14
01/22/90	0.87	0.27	155.67	139.03	1293	0.23	0.32	0.0110	9.09E-16	1.81E-14
01/29/90	0.87	0.20	153.53	139.70	1468	0.23	0.32	0.0179	8.89E-16	1.33E-14
02/20/90	0.73	0.17	152.23	138.13	1244	0.23	0.34	0.0241	8.92E-16	1.50E-14
02/27/90	1.10	0.20	155.97	138.00	1387	0.23	0.34	0.0229	1.27E-15	1.72E-14
03/06/90	0.77	0.43	159.07	139.33	1409	0.23	0.34	0.0129	4.63E-16	1.86E-14
03/14/90	1.10	0.37	154.17	137.87	1586	0.23	0.34	0.0257	9.05E-16	1.36E-14
03/20/90	1.47	0.07	151.53	136.97	1245	0.23	0.35	0.0183	2.20E-15	1.51E-14
03/29/90	0.30	0.03	146.67	130.33	1744	0.23	0.35	0.0266	2.99E-16	1.21E-14
04/03/90	1.17	0.23	142.03	129.23	993	0.23	0.35	0.0099	1.84E-15	1.66E-14
04/11/90	1.67	0.13	152.20	132.27	1643	0.23	0.34	0.0220	1.83E-15	1.61E-14
04/18/90	0.40	0.27	151.83	131.03	1370	0.23	0.34	0.0242	1.91E-16	2.01E-14
05/16/90	1.27	0.20	147.27	133.30	1014	0.24	0.34	0.0360	1.97E-15	1.83E-14
05/23/90	1.67	0.27	150.30	133.50	1423	0.24	0.34	0.0426	1.85E-15	1.56E-14
05/31/90	0.83	0.30	150.87	130.37	1362	0.24	0.34	0.0326	7.35E-16	1.99E-14
06/06/90	1.00	0.10	142.80	131.20	1618	0.24	0.34	0.0388	1.04E-15	9.50E-15
06/13/90	1.30	0.47	145.70	128.63	1172	0.24	0.34	0.0231	1.33E-15	1.93E-14
06/20/90	1.33	0.20	145.03	130.30	1329	0.24	0.34	0.0262	1.60E-15	1.47E-14
06/27/90	1.20	0.20	149.43	134.37	1441	0.24	0.34	0.0420	1.30E-15	1.38E-14
07/05/90	1.03	0.13	149.43	124.03	1391	0.24	0.34	0.0335	1.21E-15	2.42E-14
07/19/90	0.60	0.07	127.07	118.93	1633	0.23	0.34	0.0057	6.40E-16	6.60E-15
07/25/90	0.67	0.17	132.50	120.87	578	0.23	0.34	0.0073	1.69E-15	2.67E-14
08/01/90	0.77	0.30	143.73	127.77	1082	0.23	0.34	0.0159	8.45E-16	1.96E-14
08/09/90	0.93	0.33	142.20	124.00	1413	0.23	0.34	0.0124	8.32E-16	1.71E-14
08/16/90	1.00	0.23	143.00	127.93	1543	0.23	0.33	0.0114	9.73E-16	1.33E-14
08/22/90	0.90	0.50	147.27	134.43	1383	0.23	0.33	0.0115	5.66E-16	1.27E-14
08/29/90	1.23	0.27	156.70	139.67	1204	0.23	0.33	0.0192	1.57E-15	1.93E-14
09/06/90	1.30	0.43	167.53	138.90	1425	0.23	0.33	0.0255	1.19E-15	2.74E-14
09/13/90	1.33	0.50	167.37	146.00	1610	0.23	0.33	0.0245	1.01E-15	1.81E-14
09/21/90	0.93	0.27	171.97	160.07	1412	0.23	0.33	0.0098	9.25E-16	1.15E-14
09/27/90	1.47	0.10	177.40	152.57	1579	0.23	0.33	0.0094	1.70E-15	2.15E-14
10/05/90	1.40	0.27	153.00	135.57	1562	0.23	0.33	0.0198	1.42E-15	1.52E-14
10/11/90	1.10	0.40	168.93	151.30	1140	0.23	0.33	0.0091	1.20E-15	2.11E-14
10/26/90	2.83	0.37	171.73	141.50	1331	0.23	0.34	0.0231	3.62E-15	3.01E-14
11/02/90	3.93	0.23	191.73	141.27	1433	0.23	0.33	0.0263	5.06E-15	4.81E-14
11/09/90	1.83	0.20	164.07	146.60	1417	0.23	0.33	0.0079	2.25E-15	1.68E-14
11/20/90	2.90	0.33	184.87	143.23	1351	0.23	0.33	0.0201	3.73E-15	4.21E-14
11/27/90	1.13	0.23	121.97	124.87	1677	0.23	0.33	0.0157	1.05E-15	-2.4E-15
12/04/90	1.80	0.33	174.97	145.83	1362	0.23	0.33	0.0263	2.11E-15	2.92E-14
12/11/90	1.97	0.20	170.33	146.17	1233	0.23	0.34	0.0267	2.81E-15	2.60E-14
12/19/90	1.53	0.20	177.53	146.17	1633	0.23	0.34	0.0195	1.60E-15	2.54E-14
12/28/90	1.63	0.10	171.40	126.60	1672	0.23	0.34	0.0191	1.79E-15	3.55E-14



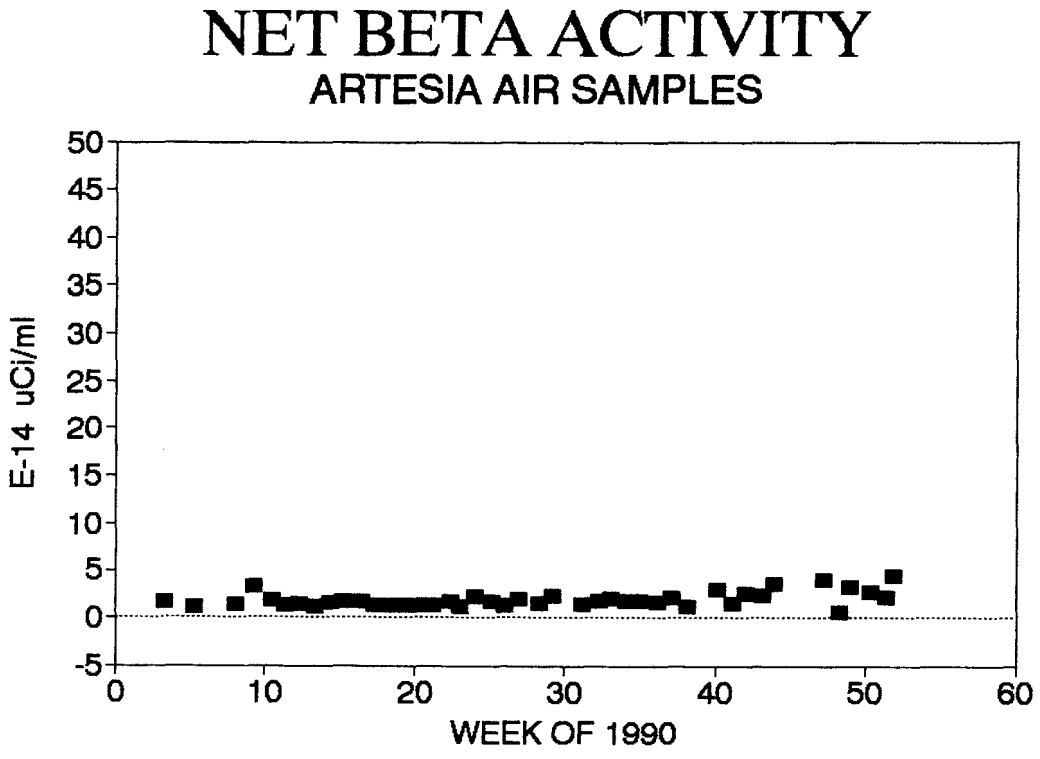
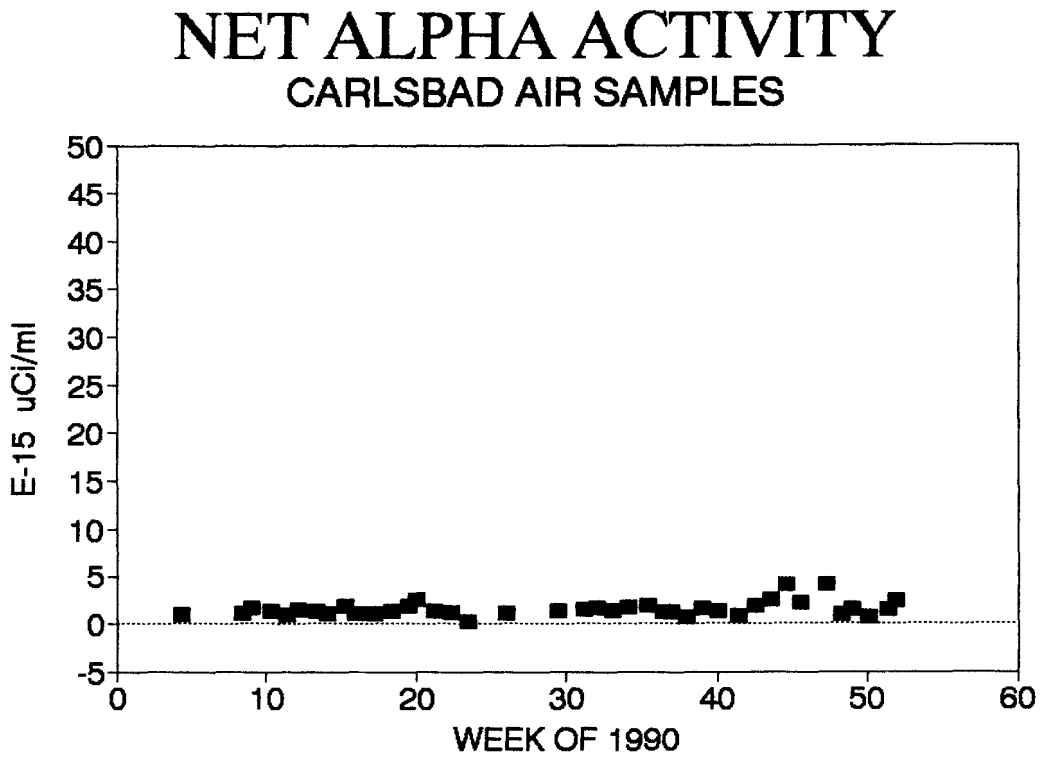


Figure B1. Net Alpha and Beta Activity-Air Samples-Artesia-1990



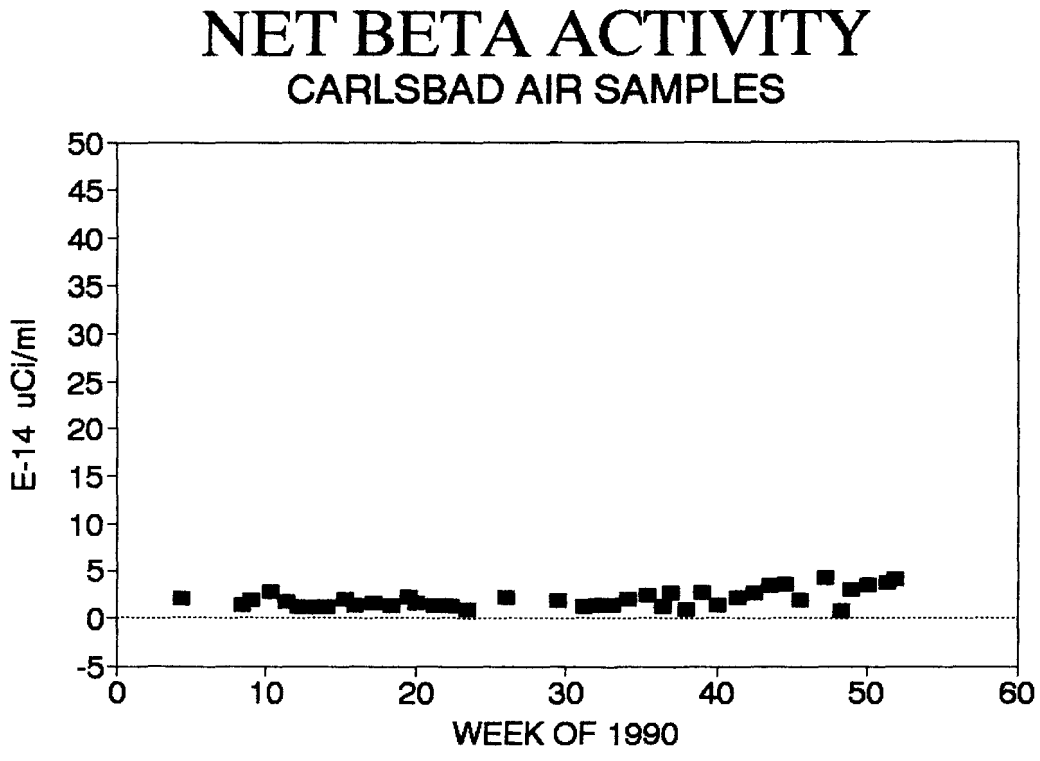
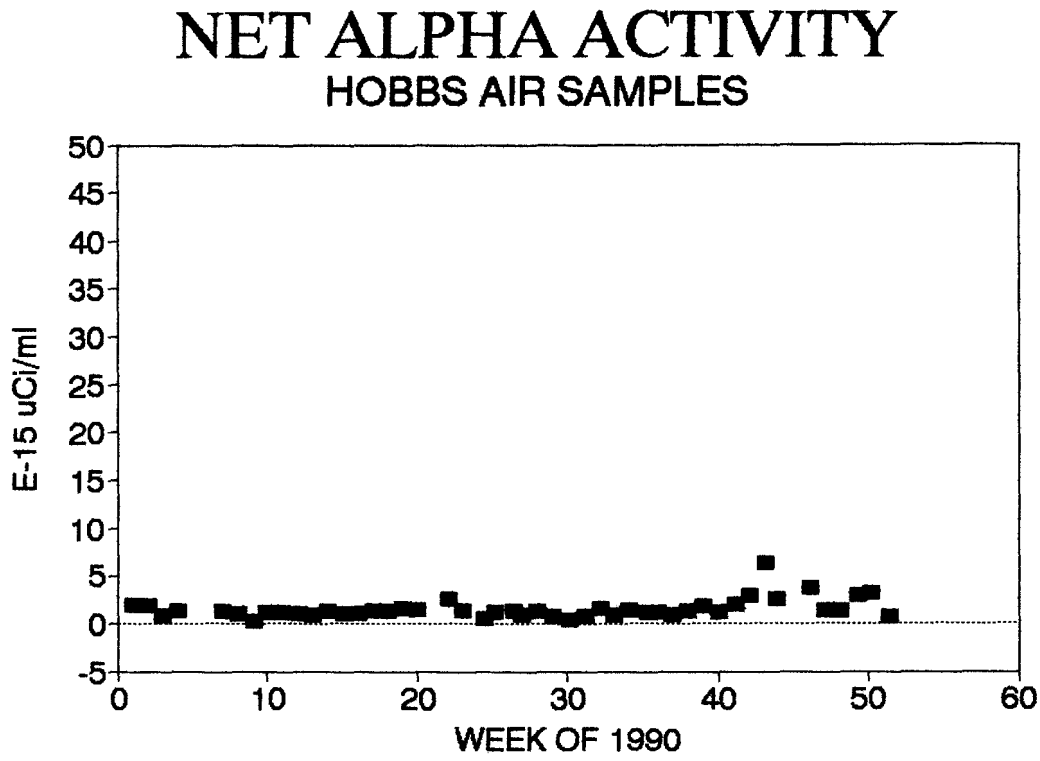


Figure B2. Net Alpha and Beta Activity-Air Samples-Carlsbad-1990



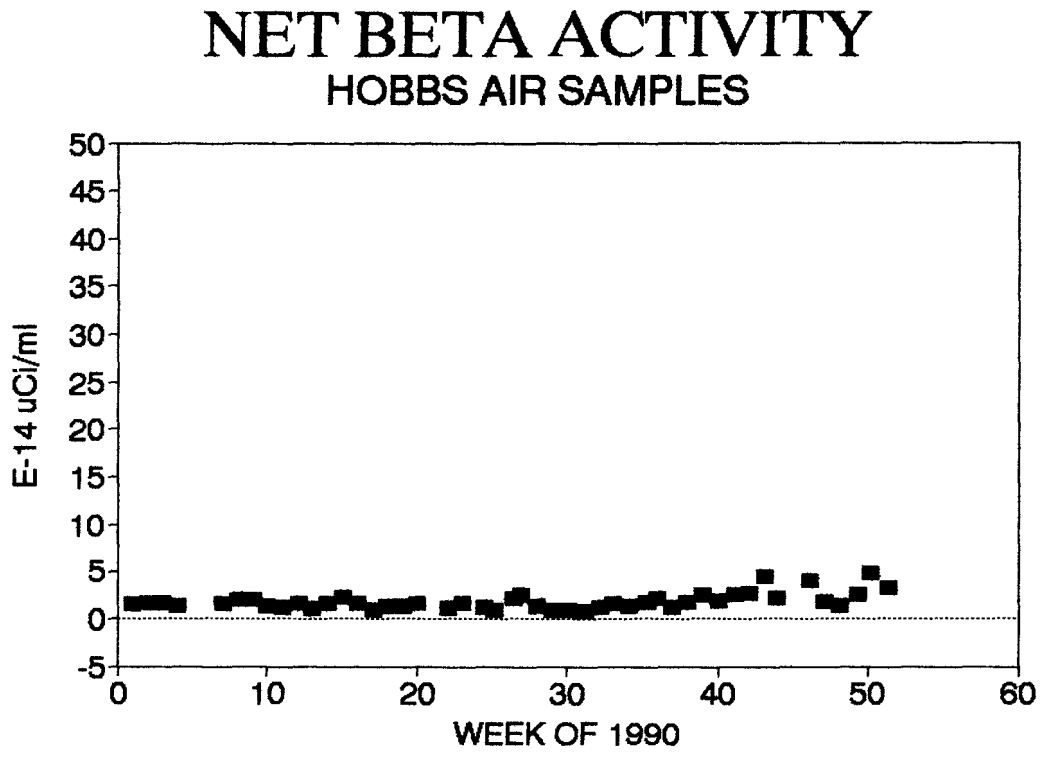
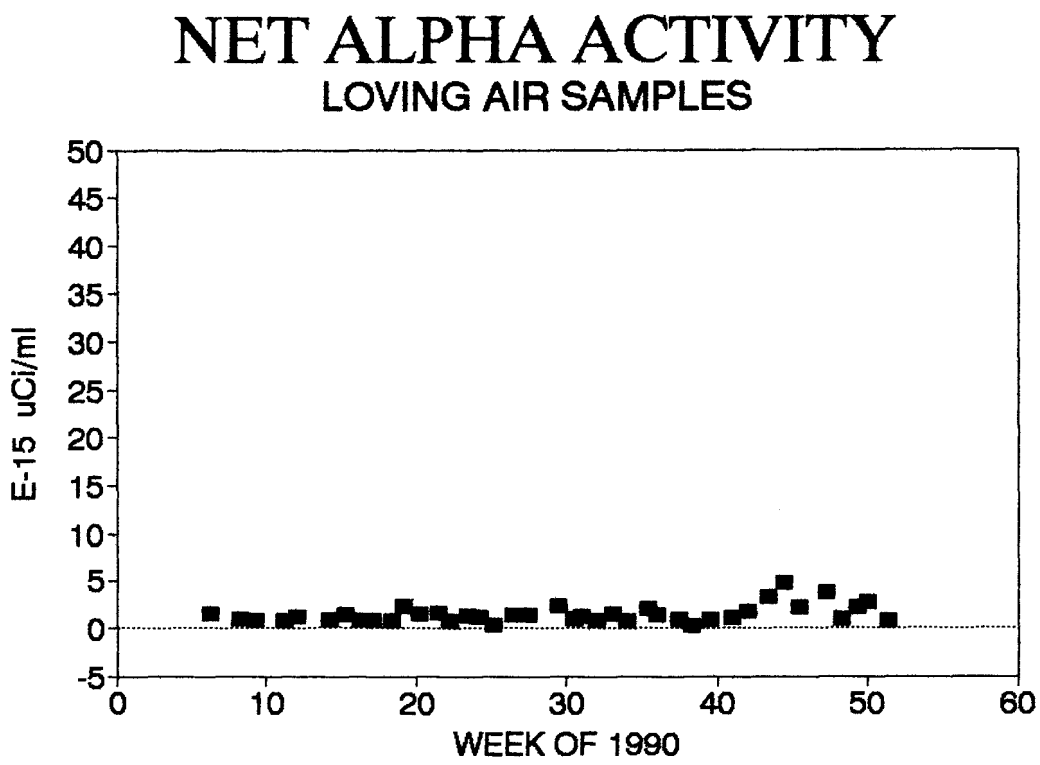


Figure B3. Net Alpha and Beta Activity-Air Samples-Hobbs-1990



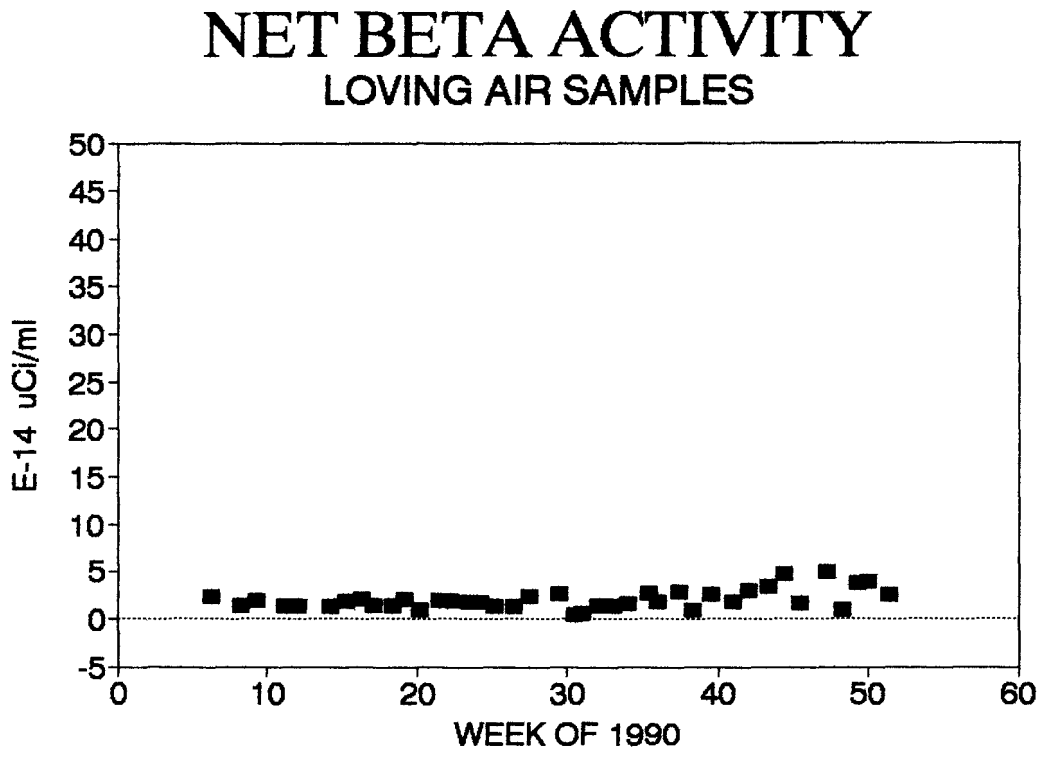
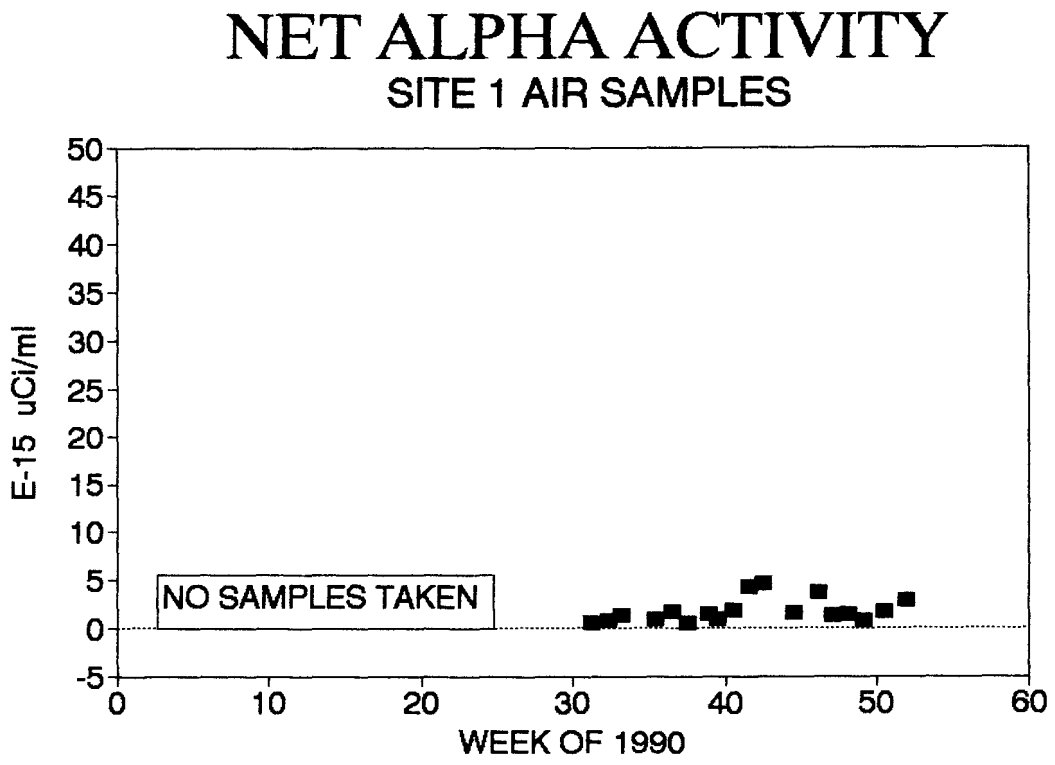


Figure B4. Net Alpha and Beta Activity-Air Samples-Loving-1990



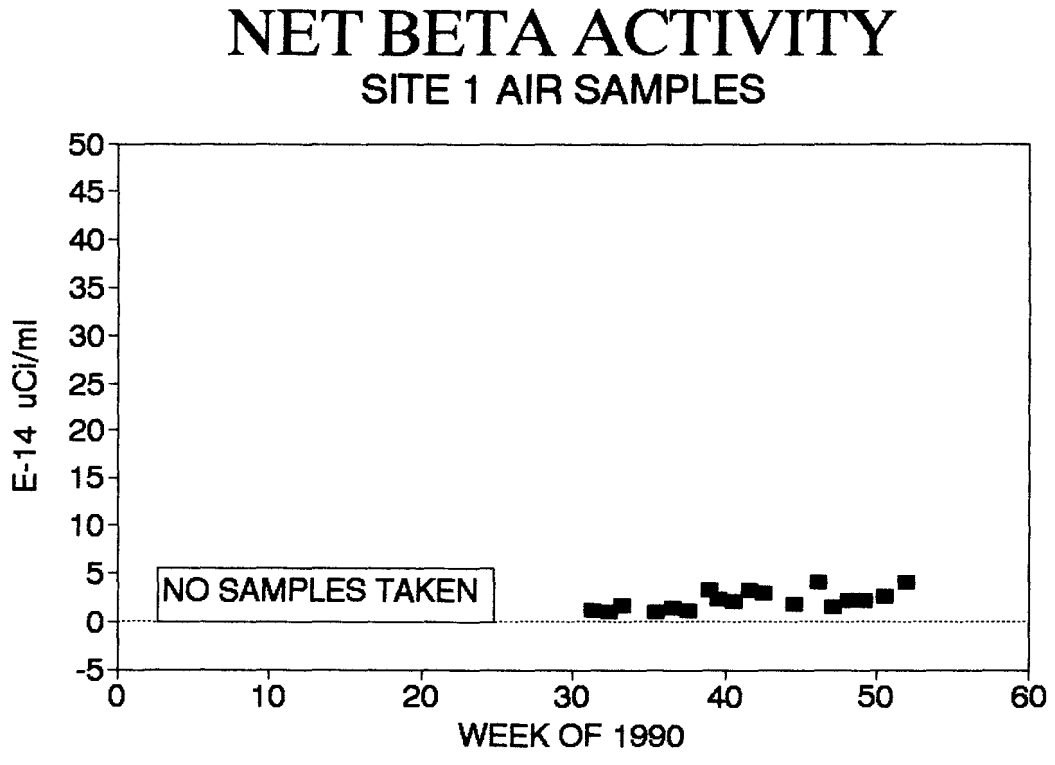
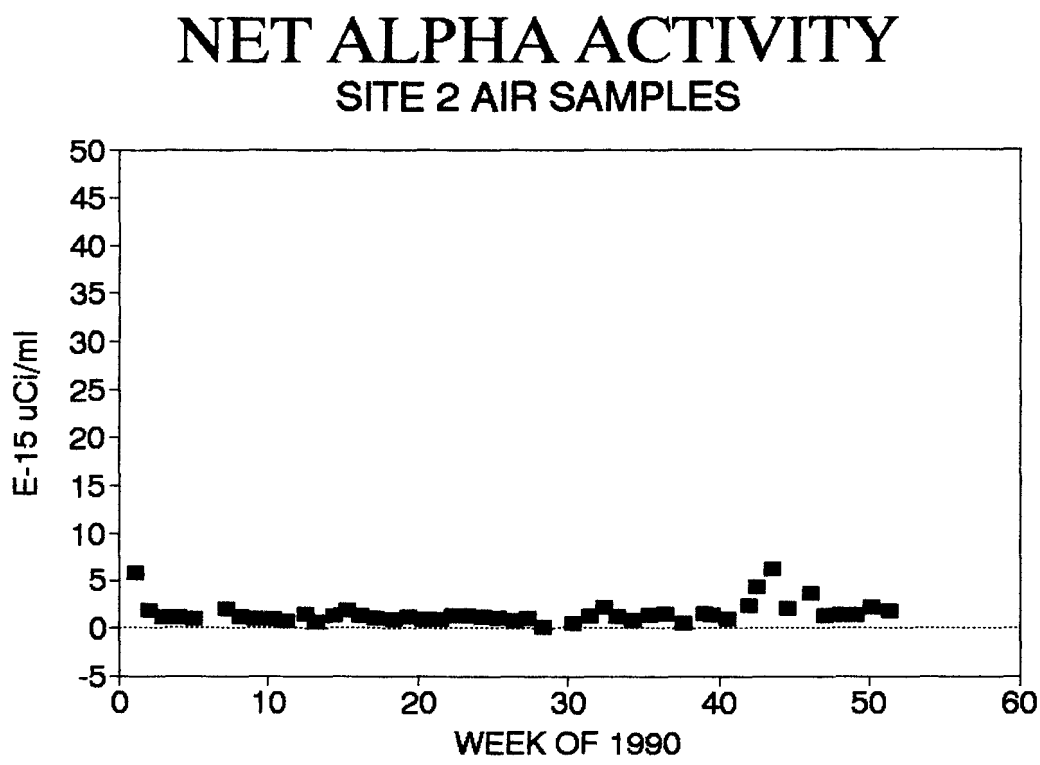


Figure B5. Net Alpha and Beta Activity-Air Samples-Site 1 WIPP-1990



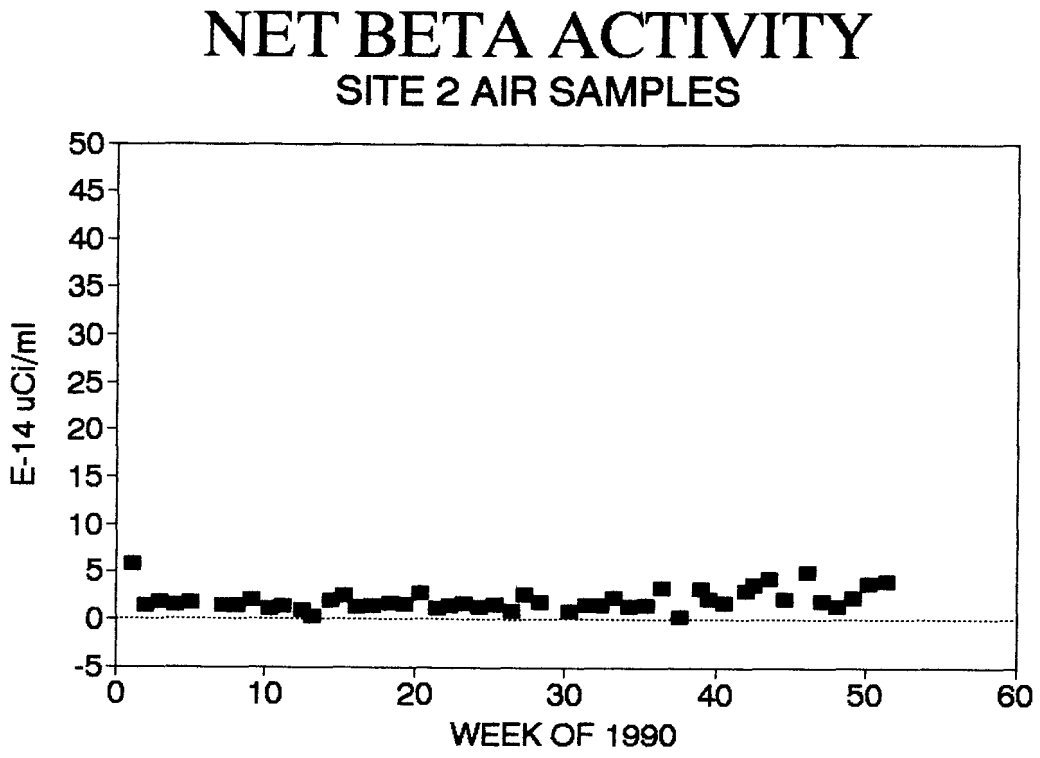
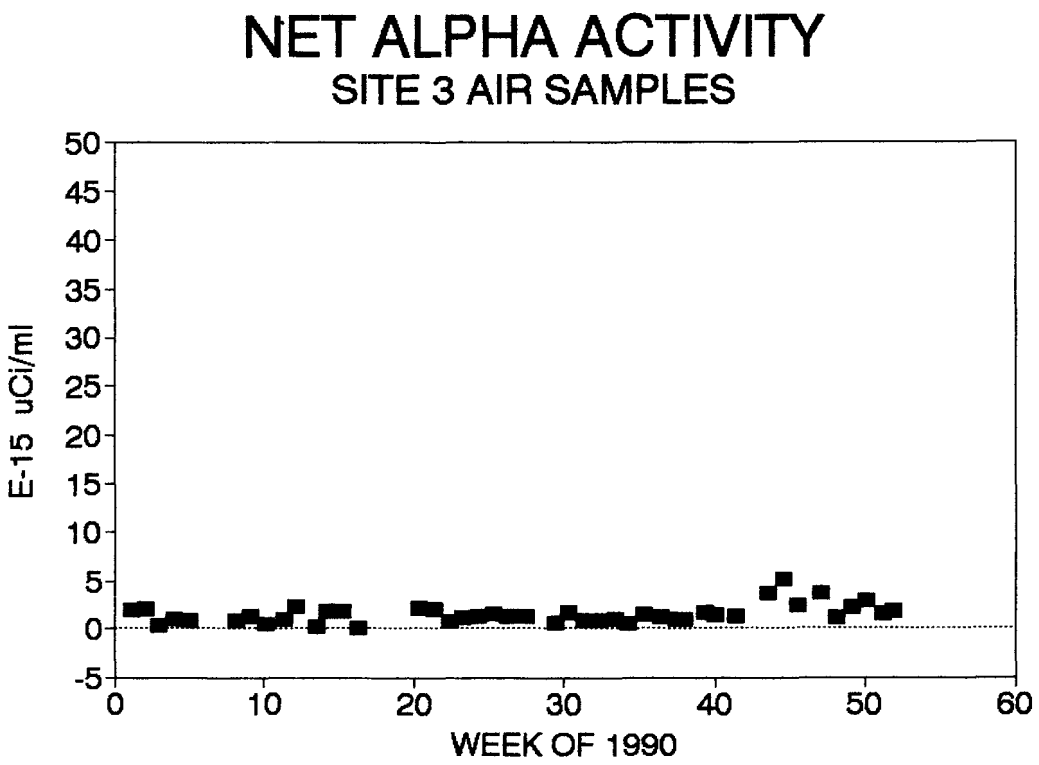


Figure B6. Net Alpha and Beta Activity-Air Samples-Site 2 WIPP-1990



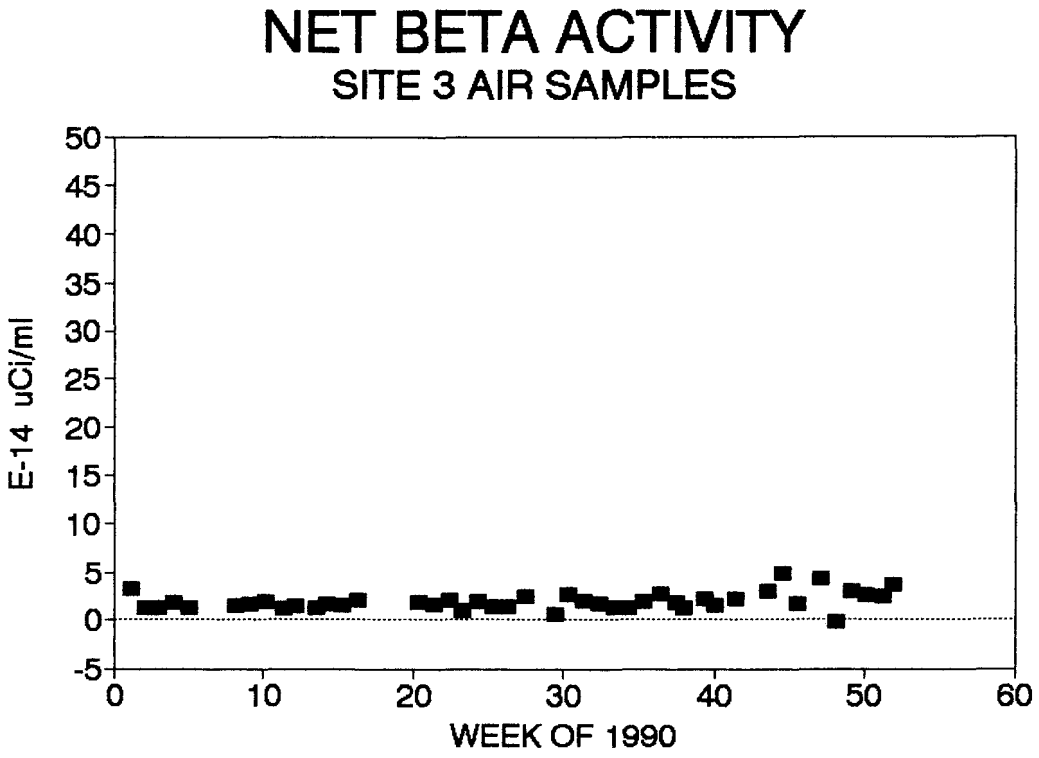


Figure B7. Net Alpha and Beta Activity-Air Samples-Site 3 WIPP-1990