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OPERATIONAL RADIATION SURVEILLANCE OF THE WIPP PROJECT BY EEG DURING 1999

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FOREWORD

The purpose of the New Mexico Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the Waste Isolation Pilot Plant (WIPP) Project to ensure the protection of the public health and safety and the environment. The WIPP Project, located in southeastern New Mexico, became operational in March 1999 for the 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 original contract DE-AC04-79AL10752 through DOE contract DE-ACO4-89AL58309. The National Defense Authorization Act for Fiscal Year 1994, Public Law 103-160, and the National Defense Authorization Act for Fiscal Year 2000, Public Law 106-65, continued the authorization.

EEG performs independent technical analyses of the suitability of the proposed site; the design of the repository, its operation, and its long-term integrity; suitability and safety of the transportation systems; suitability of the Waste Acceptance Criteria and the compliance of the generator sites 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 the independent environmental monitoring of radioactivity in air, water, and soil, both on-site and off-site.

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TABLE OF CONTENTS

Page

FOREWORD . . . iii

EEG STAFF . . . iv

ACKNOWLEDGMENTS . . . v

LIST OF TABLES . . . viii

LIST OF FIGURES . . . viii

LIST OF APPENDICES . . . ix

ACRONYMS . . . x

EXECUTIVE SUMMARY . . . xi

1.0 INTRODUCTION . . . 1

2.0 PREOPERATIONAL BASELINE . . . 2
- 2.1 Strontium-90 Measurements . . . 3

3.0 OPERATIONAL MONITORING RESULTS . . . 3
- 3.1 TLD Data . . . 5

4.0 DISCUSSION OF RESULTS . . . 5
- 4.1 Comparison to the EEG Preoperational Baseline . . . 5
- 4.2 Comparison to the Operational Results from Other Organizations . . . 6
- 4.3 Comparison to the EPA Standard . . . 7

5.0 PROBLEM OF WATER IN THE EXHAUST SHAFT . . . 9

6.0 CONCLUSIONS . . . 9

REFERENCES . . . 15

APPENDICES . . . 17

LIST OF EEG REPORTS . . . 47

LIST OF TABLES

Page

Table 1. Mean EEG Preoperational Baseline 2

Table 2. Results of Specific Radionuclide Monitoring in the Operational Phase 4

Table 3. Comparison of Measured Concentrations to the Standards 8

LIST OF FIGURES

Page

Figure 1. Baseline and 1999 Effluent Air Concentrations of ^{241}Am, $^{239/240}$Pu, and ^{238}Pu 11

Figure 2. Baseline and 1999 Ambient Air Concentrations of ^{241}Am, $^{239/240}$Pu, and ^{238}Pu 11

Figure 3. Baseline and 1999 Concentrations of ^{241}Am, $^{239/240}$Pu, and ^{238}Pu in Drinking Water . . 12

Figure 4. Baseline and 1999 Concentrations of ^{241}Am, $^{239/240}$Pu, and ^{238}Pu in Surface Water . . . 12

Figure 5. Baseline and 1999 Concentrations of ^{241}Am, $^{239/240}$Pu, and ^{238}Pu in Groundwater 13

Figure 6. Baseline and 1999 Concentrations of ^{137}Cs in Effluent Air and Ambient Air 13

Figure 7. Baseline and 1999 Concentrations of ^{137}Cs in Drinking Water, Surface Water and Groundwater 14

Figure 8. 1999 Concentrations of ^{90}Sr in Air and Water 14

LIST OF APPENDICES

APPENDIX A. AIR SAMPLE DATA 17
Table A1. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Station A Samples During 1999 18
Table A2. ^{90}Sr Concentrations in Station A Samples During 1999 19
Table A3. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Station B Samples During 1999 20
Table A4. ^{90}Sr Concentrations in Station B Samples During 1999 21
Table A5. ^{241}Am Concentrations in LVAS Samples During 1999 22
Table A6. $^{239/240}Pu$ Concentrations in LVAS Samples During 1999 23
Table A7. ^{238}Pu Concentrations in LVAS Samples During 1999 24
Table A8. ^{137}Cs Concentrations in LVAS Samples During 1999 25
Table A9. ^{90}Sr Concentrations in LVAS Samples During 1999 26
Figure A1. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Station A Samples During 1999 18
Figure A2. ^{90}Sr Concentrations in Station A Samples During 1999 19
Figure A3. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Station B Samples During 1999 20
Figure A4. ^{90}Sr Concentrations in Station B Samples During 1999 21
Figure A5. ^{241}Am Concentrations in LVAS Samples During 1999 22
Figure A6. $^{239/240}Pu$ Concentrations in LVAS Samples During 1999 23
Figure A7. ^{238}Pu Concentrations in LVAS Samples During 1999 24
Figure A8. ^{137}Cs Concentrations in LVAS Samples During 1999 25
Figure A9. ^{90}Sr Concentrations in LVAS Samples During 1999 26

APPENDIX B. WATER SAMPLE DATA 27
Table B1. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Groundwater During 1999 28
Table B2. ^{137}Cs and ^{90}Sr Concentrations in Groundwater During 1999 29
Table B3. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Surface Water During 1999 30
Table B4. ^{137}Cs and ^{90}Sr Concentrations in Surface Water During 1999 31
Table B5. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Drinking Water During 1999 32
Table B6. ^{137}Cs and ^{90}Sr Concentrations in Drinking Water During 1999 33
Figure B1. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Groundwater During 1999 28
Figure B2. ^{137}Cs and ^{90}Sr Concentrations in Groundwater During 1999 29
Figure B3. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Surface Water During 1999 30
Figure B4. ^{137}Cs and ^{90}Sr Concentrations in Surface Water During 1999 31
Figure B5. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Drinking Water During 1999 32
Figure B6. ^{137}Cs and ^{90}Sr Concentrations in Drinking Water During 1999 33

APPENDIX C. MATRIX BLANK DATA 35
Table C1. Matrix Blank Results For the 1999 Sampling Period 37

APPENDIX D. TLD DATA 39
Table D1. Average Dose by TLD in 1999 41

APPENDIX E. SAMPLE COLLECTION LOCATIONS 43
Figure E1. Groundwater Sampling Locations 45
Figure E2. Surface Water Sampling Locations 46

ACRONYMS

Am	Americium
Bq	Becquerel
CFR	Code of Federal Regulations
Cs	Cesium
CEMRC	Carlsbad Environmental Monitoring and Research Center
DOE	U. S. Department of Energy
DQO	Data quality objective
EEG	Environmental Evaluation Group
EPA	U. S. Environmental Protection Agency
ICRP	International Commission on Radiological Protection
LVAS	Low volume air sampler
mrem	Millirem
NCRP	National Council on Radiation Protection and Measurements
NESHAPS	National Emission Standards for Hazardous Air Pollutants
Pu	Plutonium
RH	Remote handled
Sr	Strontium
TLD	Thermoluminescent dosimeter
WID	Waste Isolation Division of Westinghouse Government Services Group
WIPP	Waste Isolation Pilot Plant

EXECUTIVE SUMMARY

The Environmental Evaluation Group (EEG) has measured the levels of ^{241}Am, ^{238}Pu, $^{239/240}Pu$, ^{137}Cs, and ^{90}Sr in samples of air and water collected at and in the vicinity of the U. S. Department of Energy's Waste Isolation Pilot Plant (WIPP) during 1999. WIPP received the first shipment of waste in March 1999, and is now operational. The EEG has compared these levels to those measured in the preoperational phase, prior to receipt of waste, as well as to the results of other monitoring organizations and to the U. S. Environmental Protection Agency (EPA) dose standards established for WIPP at 40 CFR 191, Subpart A, and, by agreement, at 40 CFR 61, Subpart H.

Based on these analyses and applying a test for significant differences described in Chapter 4 of Taylor (1987), the EEG concludes that

a) levels of the measured radionuclides in the environment around WIPP during 1999 are not different from the preoperational baseline levels,
b) the measured levels are similar to those measured by other organizations, where direct comparisons can be made, and
c) no measurable radiation dose to the public resulted from WIPP operations during 1999, relative to the estimated preoperational baseline dose.

1.0 INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) is an underground repository near Carlsbad in southeast New Mexico, owned and operated by the U. S. Department of Energy (DOE) for the purpose of safely disposing of waste materials generated by the nation's nuclear weapons production programs. These waste materials are contaminated with varying levels of transuranic radionuclides, principally isotopes of plutonium and americium. Since 1978, the Environmental Evaluation Group (EEG) has been responsible for independent technical oversight of the DOE's activities at WIPP. Since 1985, this responsibility has included on-site and off-site monitoring of transuranic radionuclides and fission products in air, soil, and water. Prior to the opening of WIPP, the purpose of these monitoring efforts was to establish a baseline for comparison with future measurements. The EEG's program for conducting radiation surveillance of the WIPP project has been fully described in Kenney et al. (1990), Kenney and Ballard (1990), Kenney (1991), Kenney (1992), Kenney (1994), Kenney et al. (1998), and Kenney et al. (1999). The radionuclides measured by the EEG in this program account for more than 98% of the potential public radiation dose from WIPP operations (DOE 1996).

The first shipment of waste arrived at WIPP in late March 1999 and EEG published its final preoperational report in October 1999, covering results of the surveillance program for 1996 through 1998 (Kenney et al. 1999). The present report is the EEG's first operational monitoring report and contains results obtained from sample collections and other activities since the beginning of WIPP's operational phase. This report also makes the following comparisons:

1. Compares EEG operational results to the preoperational baseline measured by EEG and reported in the above-referenced preoperational reports,

2. Compares EEG operational results to the results of other organizations engaged in environmental monitoring at and around the WIPP site, where direct comparisons can be made, and

3. Compares EEG operational results to the U.S. Environmental Protection Agency's (EPA) standards governing the operation of WIPP; namely, 40 CFR 191, Subpart A and 40 CFR 61 Subpart H, adopted by agreement between DOE and EPA.

The procedures established for the preoperational phase and the overall goals of the program are unchanged, unless noted herein.

2.0 PREOPERATIONAL BASELINE

A summary of the concentrations of ^{241}Am, ^{238}Pu, $^{239/240}$Pu, and ^{137}Cs measured by EEG in air and water at and in the vicinity of the WIPP site for the six-year period prior to storage of waste appears in Table 1. The data in Table 1 are the means and standard deviations of the results found in the appendices of Kenney et al. (1998) and Kenney et al. (1999). The uncertainties in Table 1 represent the $2\sigma_m$, or approximately 95%, confidence level of the means. The units are nano-Becquerels (10^{-9} Becquerels)-per-cubic-meter (nBq/m^3) for air and milli-Becquerels (10^{-3} Becquerels)-per-liter (mBq/L) for water. The number of measurements in each data set are given in parentheses. For water samples, if the calculated results were less than 0.1 mBq/L, the results were rounded to zero. Of 730 measurements, 18 were found to be statistical outliers by the Grubbs test (Taylor 1987), and were not included.

Table 1. Mean EEG Preoperational Baseline

Radionuclide	Effluent Air (nBq/m^3)	Ambient Air (nBq/m^3)	Drinking Water (mBq/L)	Surface Water (mBq/L)	Ground Water (mBq/L)
^{241}Am	25 ± 172 (n = 18)	23 ± 89 (n = 78)	-0.1 ± 1.3 (n = 17)	0 ± 1.8 (n = 30)	0.3 ± 2.4 (n = 32)
$^{239/240}$Pu	25 ± 195 (n = 20)	23 ± 56 (n = 88)	0 ± 0.7 (n = 17)	-0.1 ± 0.7 (n = 34)	0.1 ± 1.4 (n = 36)
^{238}Pu	36 ± 215 (n = 19)	6 ± 62 (n = 90)	0.1 ± 0.8 (n = 18)	0 ± 1.0 (n = 31)	0.1 ± 1.5 (n = 34)
^{137}Cs	730 ± 7800 (n = 23)	60 ± 2460 (n = 104)	20 ± 45 (n = 5)	22 ± 130 (n = 8)	-30 ± 110 (n = 10)

2.1 Strontium-90 Measurements

Analytical procedures for the measurement of ^{90}Sr were developed and tested shortly before WIPP began operations, and ^{90}Sr results do not appear in the preoperational baseline table. However, at the present time, no ^{90}Sr is present in the WIPP stored inventory (WWIS 2000), nor is it expected to be present in WIPP waste until WIPP begins to accept remote-handled (RH) waste in 2002. Therefore, for the purpose of comparison with future measurements, ^{90}Sr measurements made in 1999 and 2000 will be used to establish the ^{90}Sr baseline, unless ^{90}Sr is found to be present in received waste at an earlier time.

3.0 OPERATIONAL MONITORING RESULTS

The results of air effluent and environmental monitoring during the operational phase are summarized in Table 2. The values in Table 2 are the means and $2\sigma_m$ standard deviations of the means for the operational phase data in Appendices A and B of this report. The Table 2 values for effluent air at Station A do not include the first quarter of 1999 because the sample volume collected at Station A in the first quarter did not meet the environmental monitoring program's data quality objective (DQO) which requires that the volume be at least 50% of a nominal value for the sampling system. For nominal collection of a quarterly composite sample at Station A, the DQO is 3700 m^3. As shown in Tables A1 and A2 of Appendix A, the sample volume was 1746 m^3 for the first quarter, primarily because of sampling problems caused by the presence of water droplets in the exhaust airstream. This problem is further discussed in Section 5.0.

Table 2. Results of Specific Radionuclide Monitoring in the Operational Phase

Radionuclide	Effluent Air Station A Station B (nBq/m^3)	Ambient Air (nBq/m^3)	Drinking Water (mBq/L)	Surface Water (mBq/L)	Ground Water (mBq/L)
^{241}Am	43 ± 156 -60 ± 80	6.6 ± 46	0.21 ± 0.10	0.10 ± 1.62	0.05 ± 1.74
$^{239/240}$Pu	18 ± 92 20 ± 35	13 ± 17	0.22 ± 0.37	0.17 ± 0.34	0.47 ± 0.88
^{238}Pu	45 ± 17 25 ± 13	-3 ± 27	-0.31 ± 0.18	-0.16 ± 0.31	0.13 ± 1.46
^{137}Cs	NA NA	110 ± 1650	40 ± 90	21 ± 87	-36 ± 98
^{90}Sr	2300 ± 6900 570 ± 2450	930 ± 1760	-1.1 ± 12.0	5.8 ± 31.3	12.5 ± 31.3

One of the measurements reported in Table B2 of Appendix B - ^{137}Cs in Otis drinking water - exceeded the action level defined by Corley et al. (1981) and adopted by EEG in the preoperational reports for comparison of individual measurements to the baseline. The action level approximately represents the upper 95% confidence limit of the mean of the baseline measurements and serves to identify sample results requiring investigation. The determination of ^{137}Cs is an instrumental measurement, subject to interferences from any natural or man-made radionuclide emitting gamma-rays at energies higher than the 662-keV gamma-ray emitted in the decay of ^{137m}Ba, the short-lived daughter of ^{137}Cs. No specific factor has been identified as a cause of the elevated ^{137}Cs in Otis drinking water, but, as Figure B6 shows, the level is only slightly higher than that of Carlsbad drinking water, which does not exceed the action level. As indicated in Table 3, it does not represent a significant public health concern and, since no ^{137}Cs has been included in the WIPP stored inventory (WWIS 2000), it cannot have resulted from WIPP operations.

Appendix C contains the results of the matrix blanks analyzed with the samples from the 1999 sample collection period. All sample measurements in this report were blank-corrected, meaning the average result of the blank analyses from Table C1 was subtracted from the corresponding sample result.

3.1 TLD Data

In 1998 and 1999 EEG deployed environmental thermoluminescent dosimeters (TLDs) at selected points along the WIPP exclusive use boundary for the purpose of providing a direct assessment of WIPP's compliance with the 40 CFR 191 Subpart A dose standard (Kenney et al. 1999). Average external dose measurements as determined by TLDs during 1999 are reported in Appendix D. The average quarterly dose during 1999 was 18.9 mrem/quarter ± 7.1 mrem/quarter (2σ) and the calculated annual dose averaged 75.6 mrem/year ± 14.2 mrem/year (2σ). The calculated quarterly lower limit of detection was 11.8 mrem/quarter (Rodgers 1998). An event yielding a single quarterly dose of 25 mrem would be easily detected. However, chronic exposures near 6.25 mrem/quarter (25 mrem/year) would be below the sensitivity of the TLD measurement system.

4.0 DISCUSSION OF RESULTS

4.1 Comparison to the EEG Preoperational Baseline

Tables 1 and 2 are summarized and compared graphically in Figures 1 through 8 on the following pages. The bars in Figures 1 through 8 represent the upper and lower 95% limits and the horizontal dash inside each bar is the mean value. In Figure 8, ^{90}Sr concentrations in air should be read from the left-hand Y scale, and those in water should be read from the right-hand Y scale. The gamma spectrometer was being repaired during the time Station A and B samples were being analyzed, therefore results for ^{137}Cs in effluent air samples were not obtained. A negative bias exists in the measurement of ^{238}Pu in drinking water and, to a lesser extent, in surface water for this data set. Other water samples run immediately after these did not show a negative bias.

The source of this bias has not been identified, but, as shown in Figures 3 and 4, the 1999 distributions lie wholly within the baseline distribution.

Using the methods in Chapter 4 of Taylor (1987), one of the measurements in Table 2 - $^{239/240}$Pu in surface water - was found to differ from the preoperational baseline. Inspection of the $^{239/240}$Pu results in Table B3 revealed that the highest value, and the one with the greatest difference from the baseline mean, was the result for Laguna Grande. Laguna Grande is a highly concentrated brine and only a small volume (typically 100 to 150 milliliters) can be taken for analysis by EEG's standard procedure. Normalization for the small volume magnifies small errors or biases which may be present in the result. If the Taylor method is applied to the surface water results, absent the Laguna Grande value, the results do not differ significantly from the baseline.

4.2 Comparison to the Operational Results from Other Organizations

Radiological surveillance monitoring of WIPP is also being conducted by the Westinghouse Waste Isolation Division (WID) and the Carlsbad Environmental Monitoring and Research Center (CEMRC). Where direct comparisons are possible, it is useful to compare monitoring data among the three organizations. Operational data from the WID monitoring program were unavailable at the time of the preparation of this report. On its Internet web site, the CEMRC has published measurements of ^{238}Pu in Station A (effluent air) samples for the second, third, and fourth quarters of 1999. The mean and $2\sigma_m$ standard deviation of these measurements is -9 ± 62 nBq/m^3. Using methods in Chapter 4 of Taylor (1987), this is not statistically different from the EEG value for Station A in Table 2 of 45 ± 17 nBq/m^3.

At present, no other direct comparisons can be made.

4.3 Comparison to the EPA Standard

The dose standards applied by the U. S. Environmental Protection Agency to WIPP operations are found in 40 CFR 191 Subpart A and, following a memorandum of understanding (MOU) between DOE and EPA (EPA&DOE 1995), 40 CFR Part 61, the National Emission Standards for Hazardous Air Pollutants, or NESHAPS. Respectively, these are annual committed-effective-dose-equivalents to the highest-risk individual of 25 mrem and 10 mrem. The NESHAPS standard applies to effluent airborne releases only. Comparisons to EPA standards in this and future operational reports will be relative to NESHAPS for airborne facility effluent measurements, and 40 CFR 191 Subpart A for all other measurements.

Comparisons of concentration measurements to a dose standard require appropriate conversions. In the preoperational reports, EEG applied the methods found in NCRP 123 (NCRP 1996) to measurements of facility effluent air, sampled at Station A (Kenney et al. 1999) and reported that its analytical methodology provided sufficient sensitivity to detect releases which could potentially result in doses to the highest-risk individual of a few percent of the standard. In its guidance for the application of 40 CFR 191, Subpart A (EPA 1997), EPA recommends the use of CAP88PC (Parks 1992) for estimating doses both to populations and to the individual at highest risk, based on effluent measurements made at a point of release, and the EEG will follow the EPA's recommendation for this and future reports.

For measurements made at a receptor location, such as for ambient air or water samples versus a point-of-release location, a simpler dose-conversion factor can be used. These measurements satisfy EPA's expectation, stated in its guidance, that other media would be monitored to verify the air release scenario as the only credible one. For these measurements, the EEG used the dose-conversion factors in Federal Guidance Report No. 11 (Eckerman 1988) and assumed intakes of 730 liters/year of water and 8400 m^3/year of air, based on the International Commission on Radiological Protection Report (ICRP) No. 23 "reference man" (ICRP 1975).

The dose estimates obtained from these conversions were then expressed as a percentage of the appropriate standard and the results appear in Table 3, with the total of the individual isotopic dose contributions in the next-to-last row. If operational measurements were unavailable, as in the case of the missing ^{137}Cs values for effluent air, the baseline values were substituted.

Table 3. Comparison of Measured Concentrations to the Standards

Applicable Standard→	NESHAPS (10 mrem)	40 CFR 191 (25 mrem)	40 CFR 191 (25 mrem)	40 CFR 191 (25 mrem)	40 CFR 191 (25 mrem)
Radionuclide	Effluent Air Station A Station B	Ambient Air	Drinking Water	Surface Water	Ground Water
^{241}Am	<0.01% <0.01%	<0.01%	(0.06±0.03)%	(0.03±0.46)%	(0.01±0.50)%
$^{239/240}$Pu	<0.01% <0.01%	<0.01%	(0.06±0.10)%	(0.05±0.10)%	(0.13±0.25)%
^{238}Pu	<0.01% <0.01%	<0.01%	(-0.08±0.04)%	(-0.04±0.08)%	(0.03±0.37)%
^{137}Cs	<0.01% (Baseline)	<0.01%	(0.16±0.36)%	(0.08±0.34)%	(-0.14±0.39)%
^{90}Sr	<0.01% <0.01%	<0.01%	(-0.01±0.14)%	(0.06±0.35)%	(0.14±0.35)%
Total	<0.01% <0.01%	<0.01%	(0.19±0.40)%	(0.18±0.69)%	(0.18±0.85)%
Baseline Total	<0.01%	(0.02±0.10)%	(0.08±0.50)%	(0.06±0.80)%	(0.02±0.98)%

For a further comparison with the baseline, the preoperational measurements were converted to doses in the same way and totaled. The results appear in the last row of Table 3. Again, using the methods in Chapter 4 of Taylor (1987), the total calculated doses from measurements during WIPP operations in 1999 are not different from the corresponding baseline doses. For this comparison, the ^{90}Sr dose estimate was subtracted from the operational total, since the baseline total does not include ^{90}Sr.

5.0 PROBLEM OF WATER IN THE EXHAUST SHAFT

Since 1995, video inspections of the WIPP air exhaust shaft have shown water seeping into the shaft through cracks in the concrete liner. Water droplets are entrained in the exhaust airflow, enter the Station A sampling line, and wet the sampling filters. A detailed description of the problem of water leakage in the exhaust shaft was provided in EEG-73 (Kenney et al. 1999). A brief account of the status of resolving this issue at the time of publication of this report is given here. As described in Section 2.5 of the Kenney report, the source of water seeping in the shaft appears to be the groundwater which has saturated the sandstones and the mudstones of the lower Santa Rosa and upper Dewey Lake Redbeds Formations at a depth approximately 15 meters below the ground surface in a large area in the central part of the WIPP site.

Since 1995, the EEG has observed that salt and moisture in the exhaust shaft intermittently causes the loss of airflow through the sampling filter at Station A. Reduced airflow adversely affects sample collection efficiency (Chavez et al. 1997) and necessitates frequent filter changes. The DOE is considering various remedies to minimize water in-leakage in the exhaust shaft. Proposals include grouting the shaft, de-watering the "perched" aquifer in the area of the shaft by pumping, or mitigating water infiltration from the surface by lining the evaporation ponds or diverting the water off-site. The DOE is conducting a feasibility study. Meanwhile, the DOE has designed an alternative air sampling location, designated as Station D, at the bottom of the exhaust shaft. Preliminary testing of Station D began in August 2000. Once the air sampler is operational, EEG anticipates a period of comparison between Stations A and D.

6.0 CONCLUSIONS

The results of EEG's radiation surveillance of the WIPP project during 1999 show that operations at the site during 1999 did not result in detectable releases of radionuclides to the environment. Where direct comparisons can be made, the EEG results are similar to the results of other organizations engaged in radiation surveillance at WIPP. The sensitivity of EEG's methods is such that releases from the air exhaust shaft, resulting in a dose to the highest-risk individual of less than 0.01% of the standard, would have been detected. However, the validity of this conclusion is strongly dependent on samples collected from the effluent airstream being representative of the amount actually released. As discussed in Kenney et al. 1999, and in the previous section of this report, the inflow of water to the exhaust shaft limits EEG's ability to consistently collect a representative sample at Station A.

Finally, an evaluation of the results of environmental sampling at various locations around the site relative to the applicable EPA radiation dose standards shows that the estimated dose to an individual residing year-round at a sampled location during 1999 is not different from the baseline dose before WIPP became operational. From this, the EEG concludes that WIPP operations during 1999 did not result in measurable doses to the public.

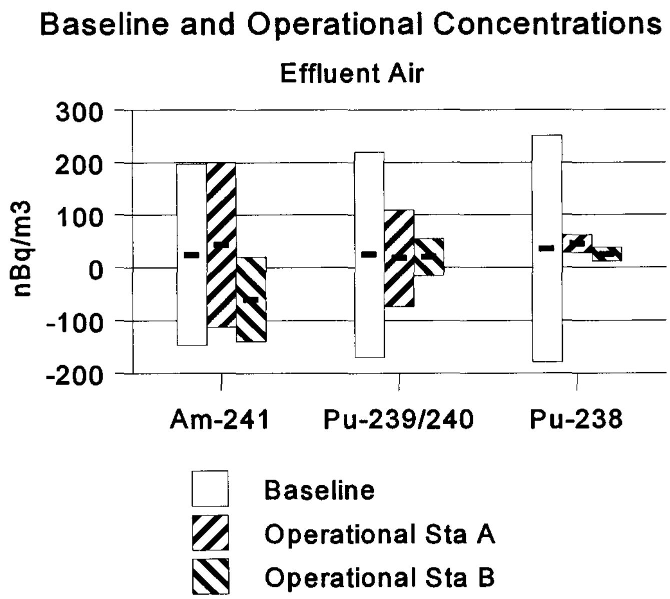

Figure 1. Baseline and 1999 Effluent Air Concentrations of ^{241}Am, $^{239/240}$Pu, and ^{238}Pu

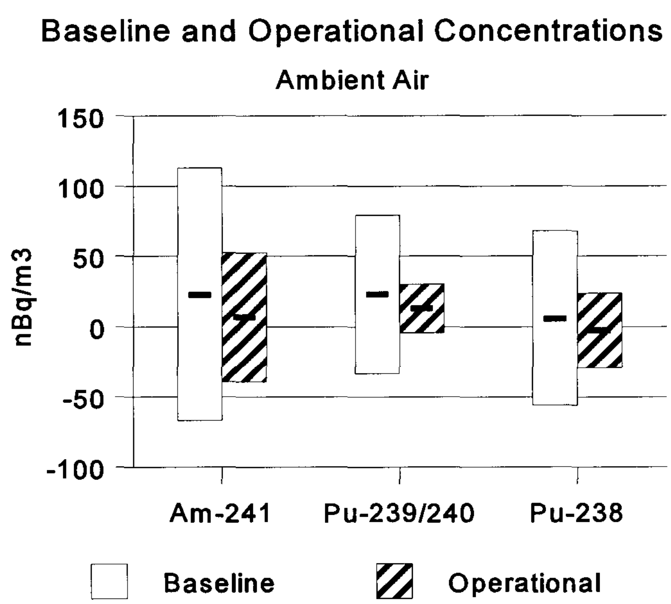

Figure 2. Baseline and 1999 Ambient Air Concentrations of ^{241}Am, $^{239/240}$Pu, and ^{238}Pu

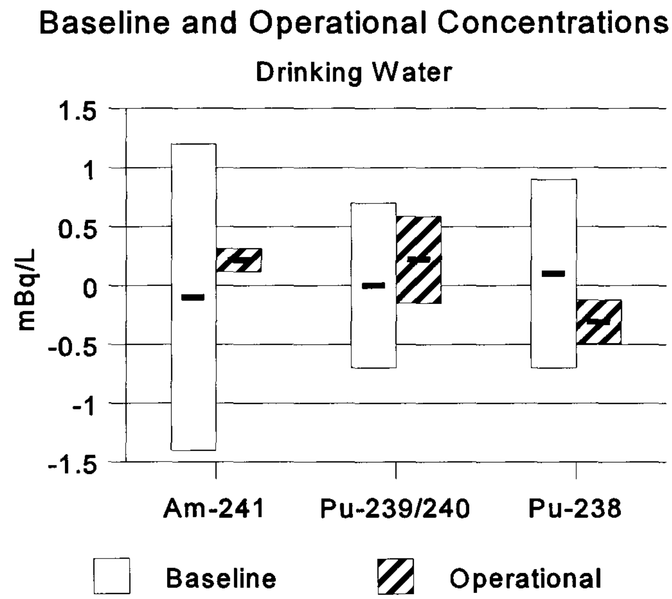

Figure 3. Baseline and 1999 Concentrations of ^{241}Am, $^{239/240}$Pu, and ^{238}Pu in Drinking Water

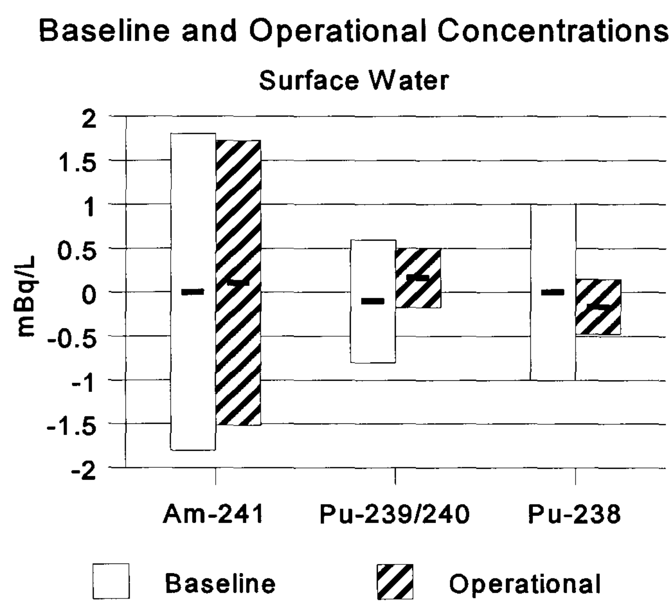

Figure 4. Baseline and 1999 Concentrations of ^{241}Am, $^{239/240}$Pu, and ^{238}Pu in Surface Water

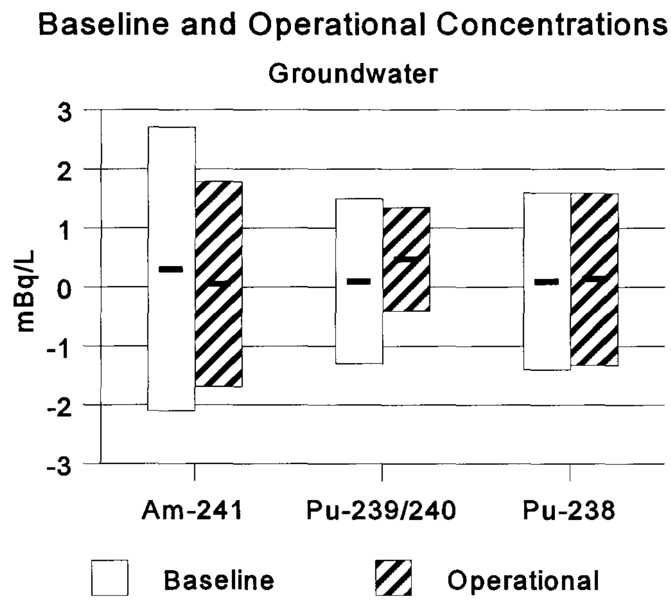

Figure 5. Baseline and 1999 Concentrations of ^{241}Am, $^{239/240}Pu$, and ^{238}Pu in Groundwater

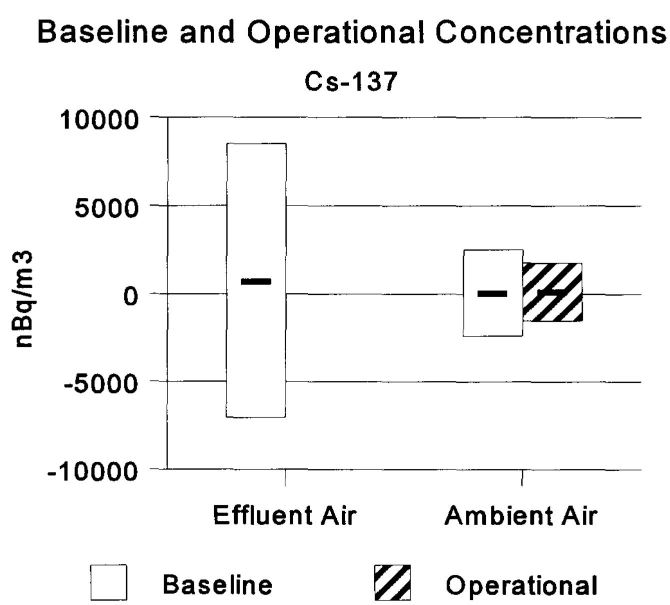

Figure 6. Baseline and 1999 Concentrations of ^{137}Cs in Effluent Air and Ambient Air

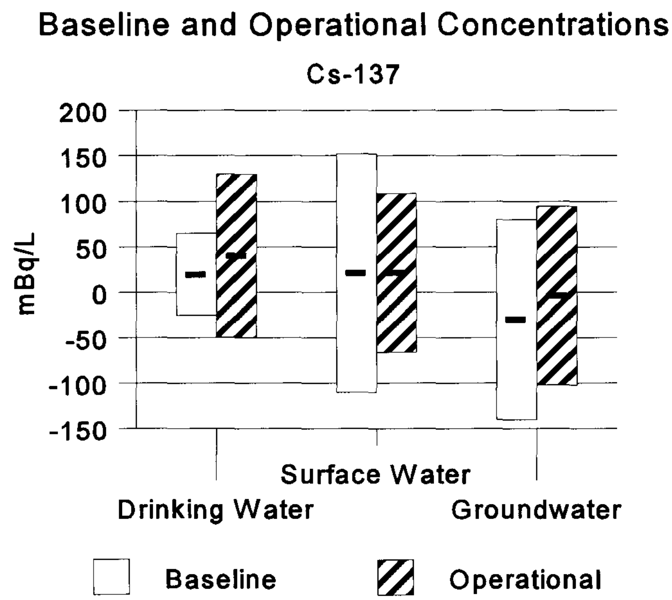

Figure 7. Baseline and 1999 Concentrations of ^{137}Cs in Drinking Water, Surface Water and Groundwater

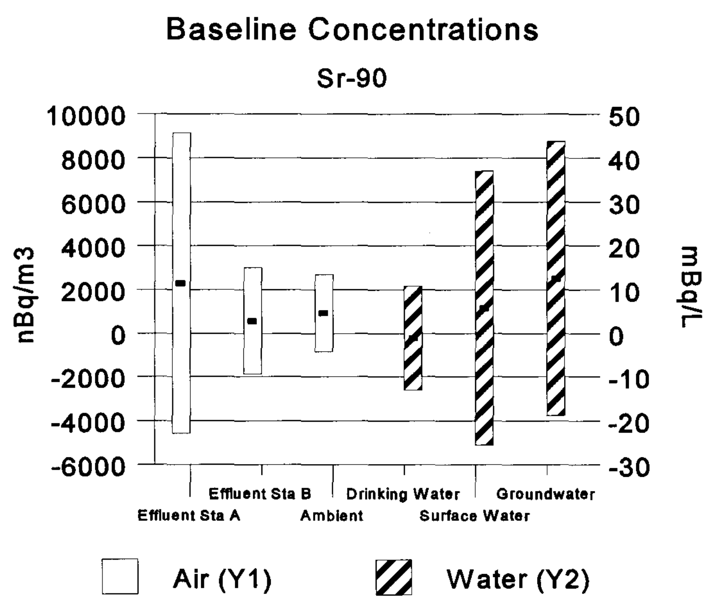

Figure 8. 1999 Concentrations of ^{90}Sr in Air and Water

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APPENDIX A. AIR SAMPLE DATA

Table A1. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Station A Samples During 1999

SAMPLE DATE	SAMPLE VOLUME (m^3)	^{241}Am CALCULATED CONC. (Bq/m^3)	2 SIGMA +/- TPU (Bq/m^3)	$^{239/240}Pu$ CALCULATED CONC. (Bq/m^3)	2 SIGMA +/- TPU (Bq/m^3)	^{238}Pu CALCULATED CONC. (Bq/m^3)	2 SIGMA +/- TPU (Bq/m^3)
1ST 1999	1746 *	1.01e-06	7.78e-07	4.01e-07	7.30e-07	2.59e-07	2.92e-07
2ND 1999	6386	-4.13e-08	2.57e-07	7.07e-08	1.95e-07	4.22e-08	7.10e-08
3RD 1999	7306	5.75e-08	2.15e-07	-7.28e-09	1.64e-07	3.76e-08	5.97e-08
4TH 1999	5123	1.13e-07	3.37e-07	-9.51e-09	2.35e-07	5.42e-08	8.83e-08
		Average	$2\sigma_m$	Average	$2\sigma_m$	Average	$2\sigma_m$
		4.31e-08	1.56e-07	1.80e-08	9.14e-08	4.47e-08	1.71e-08

** does not meet minimum sample size of ~3700 m^3*

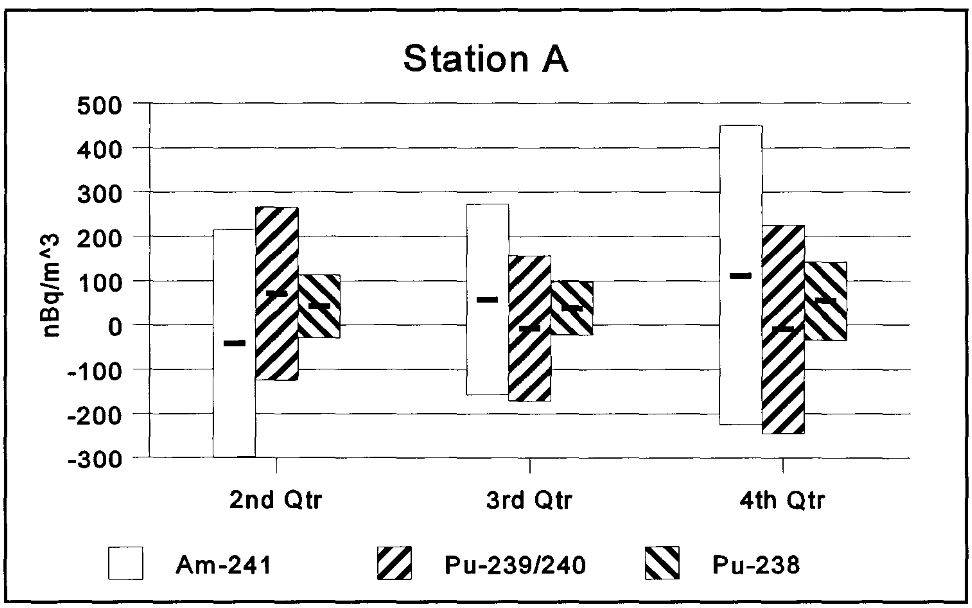

Figure A1. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Station A Samples During 1999

Table A2. ^{90}Sr Concentrations in Station A Samples During 1999

SAMPLE DATE	SAMPLE VOLUME (m^3)	^{90}Sr CALCULATED CONC. (Bq/m^3)	2 SIGMA +/- TPU (Bq/Comp)
1ST 1999	1746*	-2.58e-06	1.93e-05
2ND 1999	6386	4.38e-07	3.77e-06
3RD 1999	7306	1.83e-07	3.21e-06
4TH 1999	5123	6.25e-06	4.94e-06
		Average	$2\sigma_m$
		2.29e-06	6.86e-06

* *does not meet the minimum sample volume of ~3700 m^3*

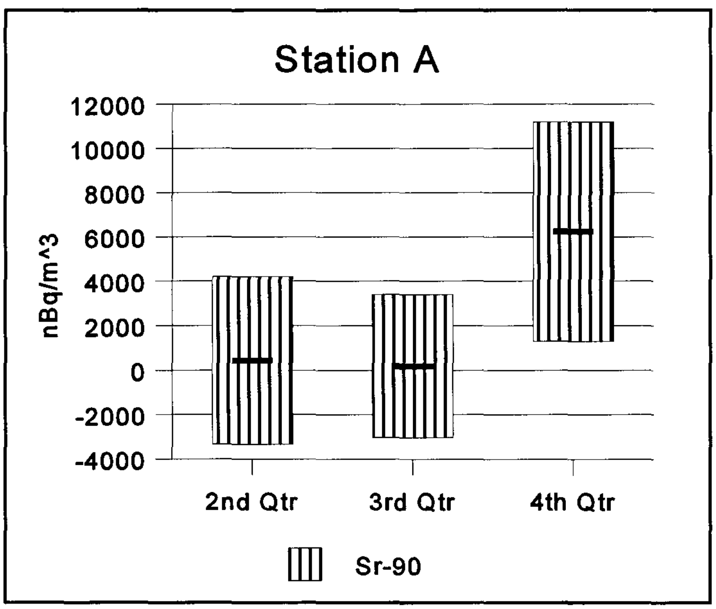

Figure A2. ^{90}Sr Concentrations in Station A Samples During 1999

Table A3. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Station B Samples During 1999

		^{241}Am		$^{239/240}Pu$		^{238}Pu	
SAMPLE DATE	SAMPLE VOLUME (m^3)	CALCULATED CONC. (Bq/m^3)	2 SIGMA +/- TPU (Bq/m^3)	CALCULATED CONC. (Bq/m^3)	2 SIGMA +/- TPU (Bq/m^3)	CALCULATED CONC. (Bq/m^3)	2 SIGMA +/- TPU (Bq/m^3)
1ST 1999	6707	-9.65e-08	1.79e-07	2.33e-09	1.80e-07	1.77e-08	5.76e-08
2ND 1999	6978	-8.46e-09	2.28e-07	3.75e-08	1.77e-07	2.26e-08	6.03e-08
3RD 1999	6732	-8.62e-08	1.08e-07	7.52e-09	1.79e-07	2.64e-08	5.81e-08
4TH 1999	6873	-4.90e-08	1.08e-07	3.15e-08	1.78e-07	3.32e-08	6.09e-08
		Average	$2\sigma_m$	Average	$2\sigma_m$	Average	$2\sigma_m$
		-6.00e-08	8.00e-08	1.97e-08	3.48e-08	2.50e-08	1.31e-08

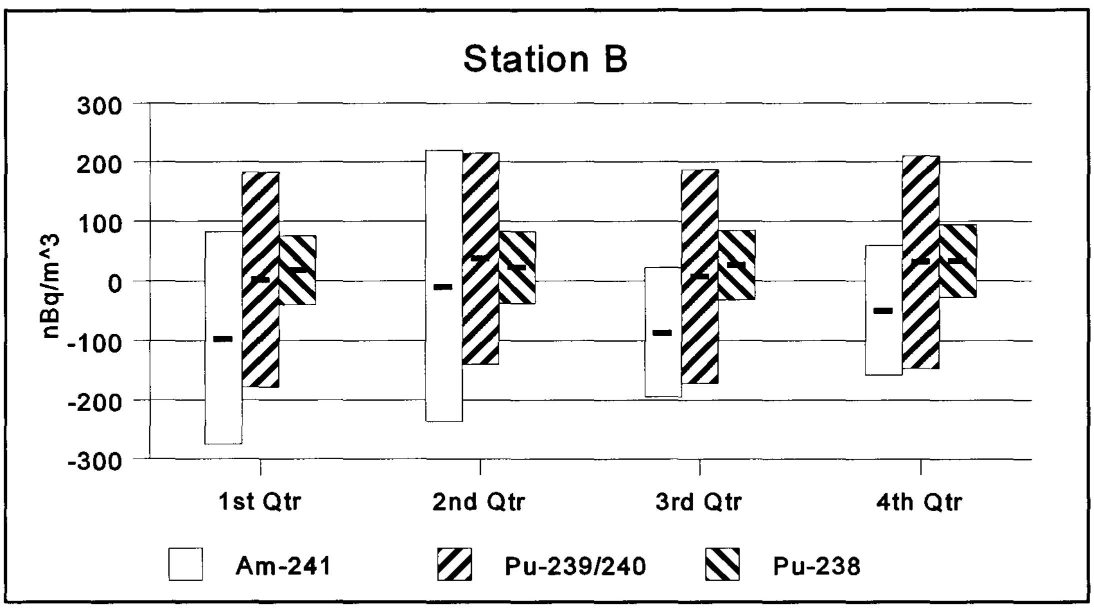

Figure A3. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Station B Samples During 1999

Table A4. ^{90}Sr Concentrations in Station B Samples During 1999

SAMPLE DATE	SAMPLE VOLUME (m^3)	^{90}Sr CALCULATED CONC. (Bq/m^3)	2 SIGMA +/- TPU (Bq/m3)
1ST 1999	6707	1.03e-06	3.51e-06
2ND 1999	6978	6.31e-07	3.47e-06
3RD 1999	6732	1.74e-06	3.99e-06
4TH 1999	6873	-1.14e-06	3.24e-06
		Mean	$2\sigma_m$
		5.65e-07	2.45e-06

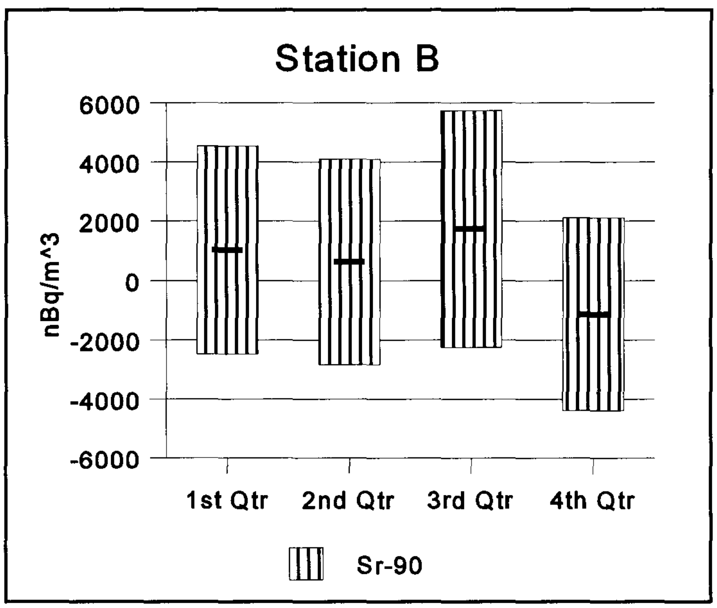

Figure A4. ^{90}Sr Concentrations in Station B Samples During 1999

Table A5. ^{241}Am Concentrations in LVAS Samples During 1999

LVAS SAMPLE LOCATION	QUARTER SAMPLE COLLECTED	SAMPLE VOLUME (m^3)	AIR CONC. ^{241}Am (Bq/m^3)	2 SIGMA TPU (Bq/m^3)
ARTESIA	1ST 1999	26943	2.81e-08	7.04e-08
CARLSBAD	1ST 1999	29903	8.29e-08	6.95e-08
LOVING	1ST 1999	27386	1.85e-08	7.26e-08
WIPP 1	1ST 1999	26975	2.22e-10	7.02e-08
WIPP 2	1ST 1999	27367	-7.31e-11	6.91e-08
WIPP 3	1ST 1999	28146	7.39e-09	6.63e-08
ARTESIA	2ND 1999	27494	3.30e-08	7.22e-08
CARLSBAD	2ND 1999	29840	2.54e-08	7.04e-08
LOVING	2ND 1999	29295	NA	NA
WIPP 1	2ND 1999	28947	2.11e-09	6.52e-08
WIPP 2	2ND 1999	25717	NA	NA
WIPP 3	2ND 1999	28094	1.06e-08	6.79e-08
ARTESIA	3RD 1999	27375	-1.69e-08	6.67e-08
CARLSBAD	3RD 1999	29661	-1.40e-08	6.19e-08
LOVING	3RD 1999	26760	-5.61e-10	7.01e-08
WIPP 1	3RD 1999	29008	-1.04e-08	6.65e-08
WIPP 2	3RD 1999	27370	-1.26e-08	6.63e-08
WIPP 3	3RD 1999	26754	1.57e-09	7.08e-08
ARTESIA	4TH 1999	28486	-2.11e-08	6.22e-08
CARLSBAD	4TH 1999	32200	-3.35e-09	5.78e-08
LOVING	4TH 1999	30759	1.26e-08	6.20e-08
WIPP 1	4TH 1999	31875	-4.39e-10	5.88e-08
WIPP 2	4TH 1999	30073	NA	NA
WIPP 3	4TH 1999	29961	-4.17e-09	6.29e-08
			Mean	$2\sigma_m$
			6.61e-09	4.56e-08

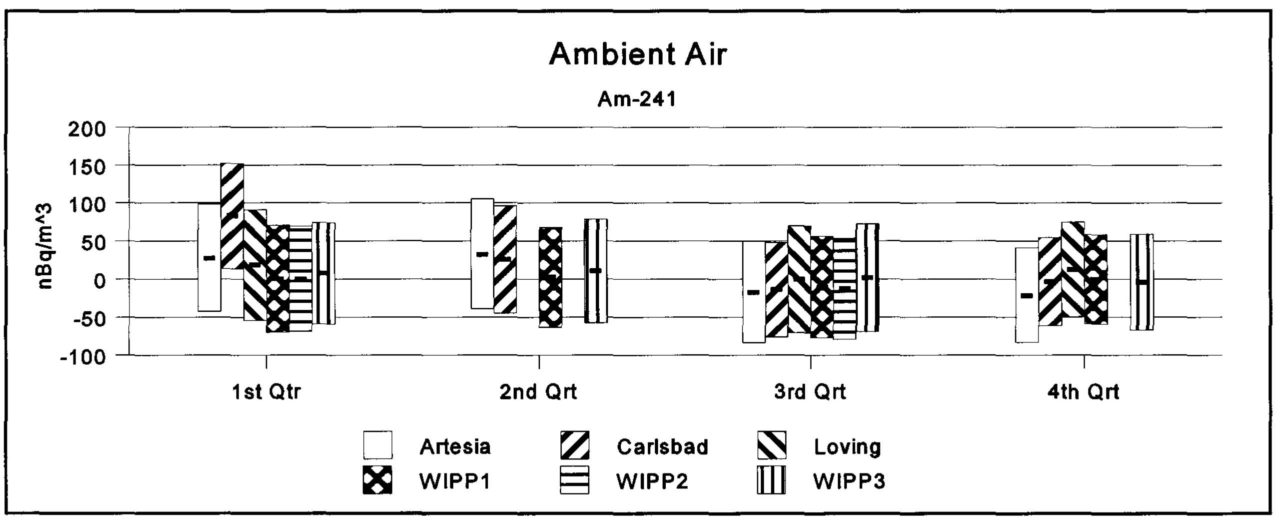

Figure A5. ^{241}Am Concentrations in LVAS Samples During 1999

Table A6. $^{239/240}Pu$ Concentrations in LVAS Samples During 1999

LVAS SAMPLE LOCATION	QUARTER SAMPLE COLLECTED	SAMPLE VOLUME (m^3)	AIR CONC. $^{239/240}Pu$ (Bq/m^3)	2 SIGMA TPU (Bq/m^3)
ARTESIA	1ST 1999	26943	2.23e-08	2.20e-08
CARLSBAD	1ST 1999	29903	1.18e-08	1.61e-08
LOVING	1ST 1999	27386	1.06e-08	1.87e-08
WIPP 1	1ST 1999	26975	1.54e-08	1.89e-08
WIPP 2	1ST 1999	27367	1.50e-08	1.86e-08
WIPP 3	1ST 1999	28146	1.57e-08	1.77e-08
ARTESIA	2ND 1999	27494	2.46e-08	2.02e-08
CARLSBAD	2ND 1999	29840	3.21e-08	2.04e-08
LOVING	2ND 1999	29295	NA	NA
WIPP 1	2ND 1999	28947	2.07e-08	1.91e-08
WIPP 2	2ND 1999	25717	NA	NA
WIPP 3	2ND 1999	28094	2.38e-08	1.88e-08
ARTESIA	3RD 1999	27375	5.70e-09	1.65e-08
CARLSBAD	3RD 1999	29661	4.05e-09	1.57e-08
LOVING	3RD 1999	26760	1.30e-08	1.89e-08
WIPP 1	3RD 1999	29008	5.41e-09	1.63e-08
WIPP 2	3RD 1999	27370	7.16e-09	1.68e-08
WIPP 3	3RD 1999	26754	1.27e-09	1.53e-08
ARTESIA	4TH 1999	28486	NA	NA
CARLSBAD	4TH 1999	32200	NA	NA
LOVING	4TH 1999	30759	NA	NA
WIPP 1	4TH 1999	31875	4.27e-09	1.52e-08
WIPP 2	4TH 1999	30073	4.02e-09	1.44e-08
WIPP 3	4TH 1999	29961	7.58e-09	1.51e-08
			Mean	$2\sigma_m$
			1.29e-08	1.72e-08

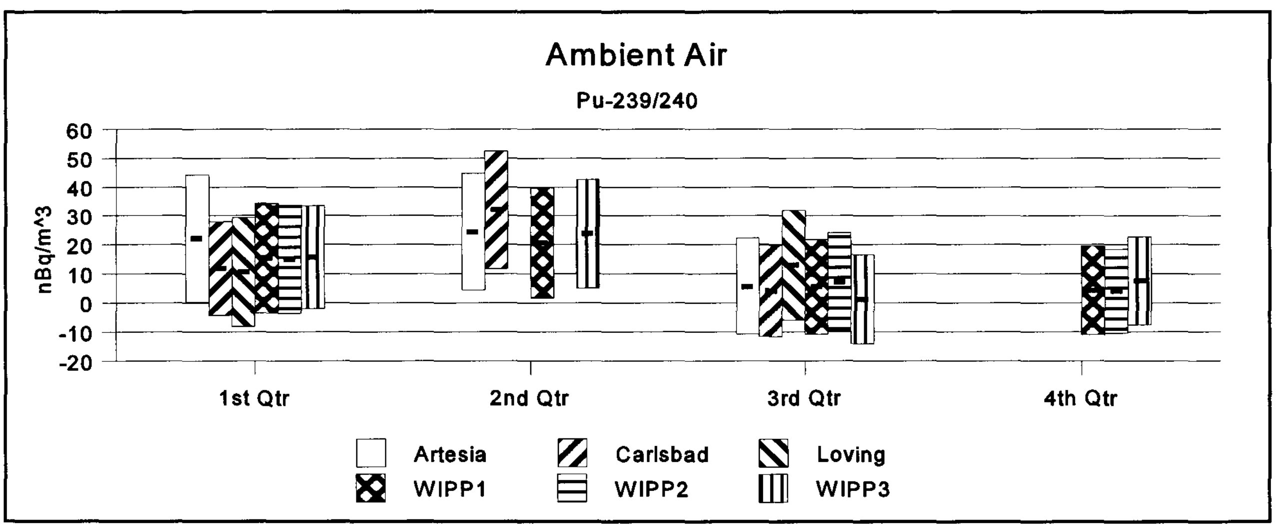

Figure A6. $^{239/240}Pu$ Concentrations in LVAS Samples During 1999

Table A7. [238]Pu Concentrations in LVAS Samples During 1999

LVAS SAMPLE LOCATION	QUARTER SAMPLE COLLECTED	SAMPLE VOL.UME (m^3)	AIR CONC. ^{238}Pu (Bq/m^3)	2 SIGMA TPU (Bq/m^3)
ARTESIA	1ST 1999	26943	1.78e-09	4.70e-08
CARLSBAD	1ST 1999	29903	2.67e-08	4.38e-08
LOVING	1ST 1999	27386	1.02e-08	4.69e-08
WIPP 1	1ST 1999	26975	-1.94e-08	4.42e-08
WIPP 2	1ST 1999	27367	-1.92e-08	4.35e-08
WIPP 3	1ST 1999	28146	1.00e-08	4.51e-08
ARTESIA	2ND 1999	27494	9.46e-09	4.57e-08
CARLSBAD	2ND 1999	29840	-1.13e-08	4.11e-08
LOVING	2ND 1999	29295	NA	NA
WIPP 1	2ND 1999	28947	NA	NA
WIPP 2	2ND 1999	25717	-5.44e-09	4.74e-08
WIPP 3	2ND 1999	28094	1.10e-08	4.49e-08
ARTESIA	3RD 1999	27375	1.82e-08	4.69e-08
CARLSBAD	3RD 1999	29661	-1.26e-08	4.14e-08
LOVING	3RD 1999	26760	-1.10e-08	4.59e-08
WIPP 1	3RD 1999	29008	-1.07e-08	4.22e-08
WIPP 2	3RD 1999	27370	-1.11e-08	4.43e-08
WIPP 3	3RD 1999	26754	-3.70e-09	4.56e-08
ARTESIA	4TH 1999	28486	NA	NA
CARLSBAD	4TH 1999	32200	NA	NA
LOVING	4TH 1999	30759	NA	NA
WIPP 1	4TH 1999	31875	-4.99e-09	3.92e-08
WIPP 2	4TH 1999	30073	-1.08e-08	4.01e-08
WIPP 3	4TH 1999	29961	-1.57e-08	4.00e-08
			Mean	$2\sigma_m$
			-2.56e-09	2.65e-08

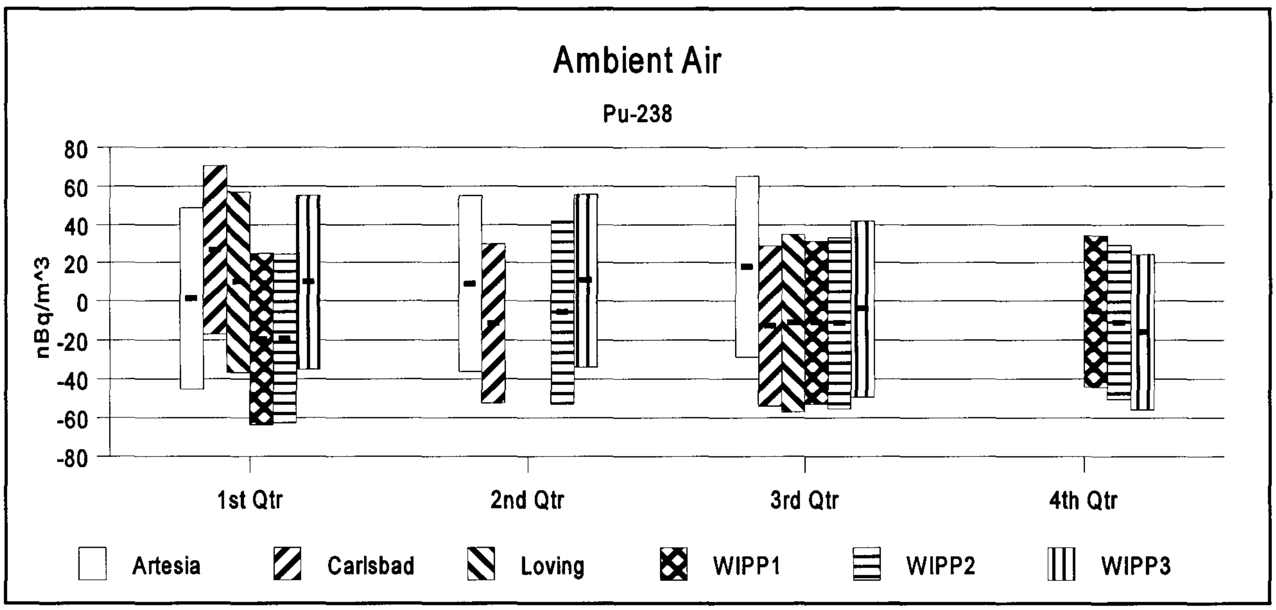

Figure A7. [238]Pu Concentrations in LVAS Samples During 1999

Table A8. [137]Cs Concentrations in LVAS Samples During 1999

LVAS SAMPLE LOCATION	QUARTER SAMPLE COLLECTED	SAMPLE VOLUME. (m^3)	AIR CONC. ^{137}Cs (Bq/m^3)	2 SIGMA TPU (Bq/m^3)
ARTESIA	1ST 1999	26943	-1.71e-06	2.25e-06
CARLSBAD	1ST 1999	29903	1.24e-06	2.07e-06
LOVING	1ST 1999	27386	1.21e-07	2.20e-06
WIPP 1	1ST 1999	26975	-3.49e-07	2.23e-06
WIPP 2	1ST 1999	27367	1.52e-07	2.27e-06
WIPP 3	1ST 1999	28146	-5.27e-07	2.20e-06
ARTESIA	2ND 1999	27494	1.45e-06	2.21e-06
CARLSBAD	2ND 1999	29840	2.08e-07	2.08e-06
LOVING	2ND 1999	29295	NA	NA
WIPP 1	2ND 1999	28947	-4.33e-07	2.18e-06
WIPP 2	2ND 1999	25717	9.25e-07	2.41e-06
WIPP 3	2ND 1999	28094	1.33e-06	2.21e-06
ARTESIA	3RD 1999	27375	9.42e-08	2.25e-06
CARLSBAD	3RD 1999	29661	-5.37e-07	2.02e-06
LOVING	3RD 1999	26760	-3.11e-07	2.24e-06
WIPP 1	3RD 1999	29008	-2.41e-07	2.15e-06
WIPP 2	3RD 1999	27370	3.47e-07	2.21e-06
WIPP 3	3RD 1999	26754	NA	NA
ARTESIA	4TH 1999	28486	NA	NA
CARLSBAD	4TH 1999	32200	NA	NA
LOVING	4TH 1999	30759	NA	NA
WIPP 1	4TH 1999	31875	NA	NA
WIPP 2	4TH 1999	30073	NA	NA
WIPP 3	4TH 1999	29961	NA	NA
			Mean	$2\sigma_m$
			1.10e-07	1.65e-06

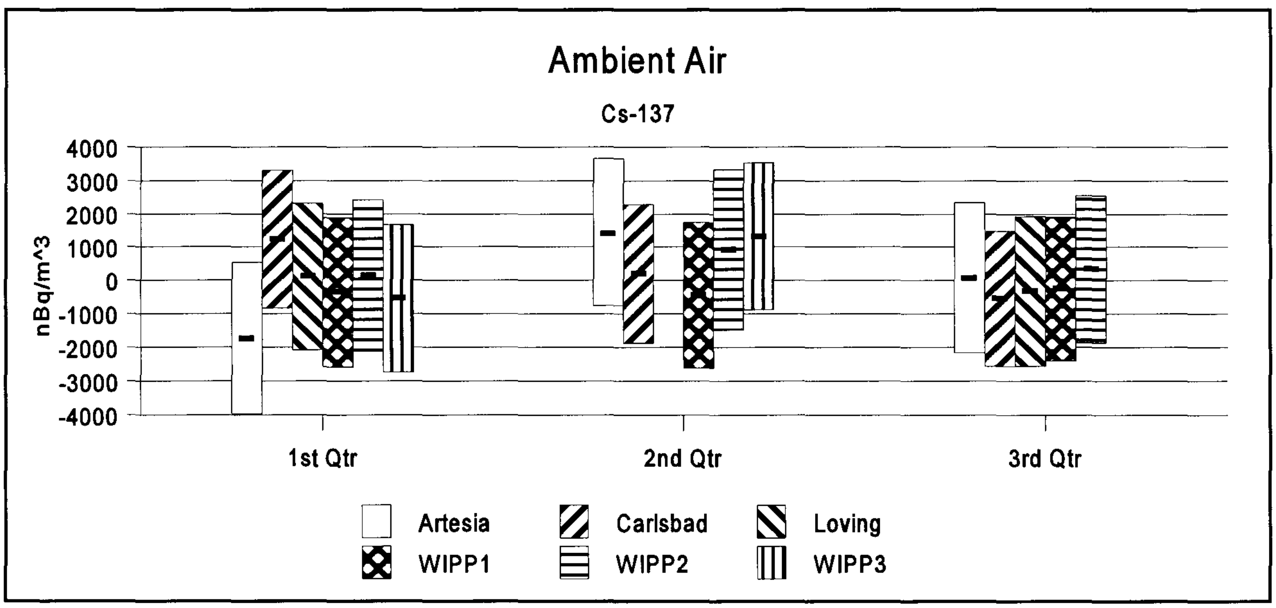

Figure A8. [137]Cs Concentrations in LVAS Samples During 1999

Table A9. ^{90}Sr Concentrations in LVAS Samples During 1999

LVAS SAMPLE LOCATION	QUARTER SAMPLE COLLECTED	SAMPLE VOLUME (m^3)	AIR CONC. ^{90}Sr (Bq/m^3)	2 SIGMA TPU (Bq/m^3)
ARTESIA	1ST 1999	26943	1.23e-06	1.20e-06
CARLSBAD	1ST 1999	29903	1.76e-06	1.12e-06
LOVING	1ST 1999	27386	3.10e-06	1.29e-06
WIPP 1	1ST 1999	26975	1.52e-07	6.93e-07
WIPP 2	1ST 1999	27367	2.35e-06	8.85e-07
WIPP 3	1ST 1999	28146	2.63e-06	8.95e-07
ARTESIA	2ND 1999	27494	4.00e-08	6.18e-07
CARLSBAD	2ND 1999	29840	9.72e-08	5.82e-07
LOVING	2ND 1999	29295	NA	NA
WIPP 1	2ND 1999	28947	4.56e-07	6.85e-07
WIPP 2	2ND 1999	25717	5.83e-07	7.13e-07
WIPP 3	2ND 1999	28094	6.76e-07	7.94e-07
ARTESIA	3RD 1999	27375	-5.11e-09	5.32e-07
CARLSBAD	3RD 1999	29661	6.27e-07	5.15e-07
LOVING	3RD 1999	26760	1.33e-07	5.98e-07
WIPP 1	3RD 1999	29008	1.78e-06	7.69e-07
WIPP 2	3RD 1999	27370	4.42e-07	7.23e-07
WIPP 3	3RD 1999	26754	2.77e-07	6.67e-07
ARTESIA	4TH 1999	28486	6.71e-07	7.56e-07
CARLSBAD	4TH 1999	32200	4.01e-07	6.02e-07
LOVING	4TH 1999	30759	1.69e-06	9.14e-07
WIPP 1	4TH 1999	31875	6.78e-07	7.30e-07
WIPP 2	4TH 1999	30073	6.09e-07	6.33e-07
WIPP 3	4TH 1999	29961	1.02e-06	7.19e-07
			Mean	$2\sigma_m$
			9.30e-07	1.76e-06

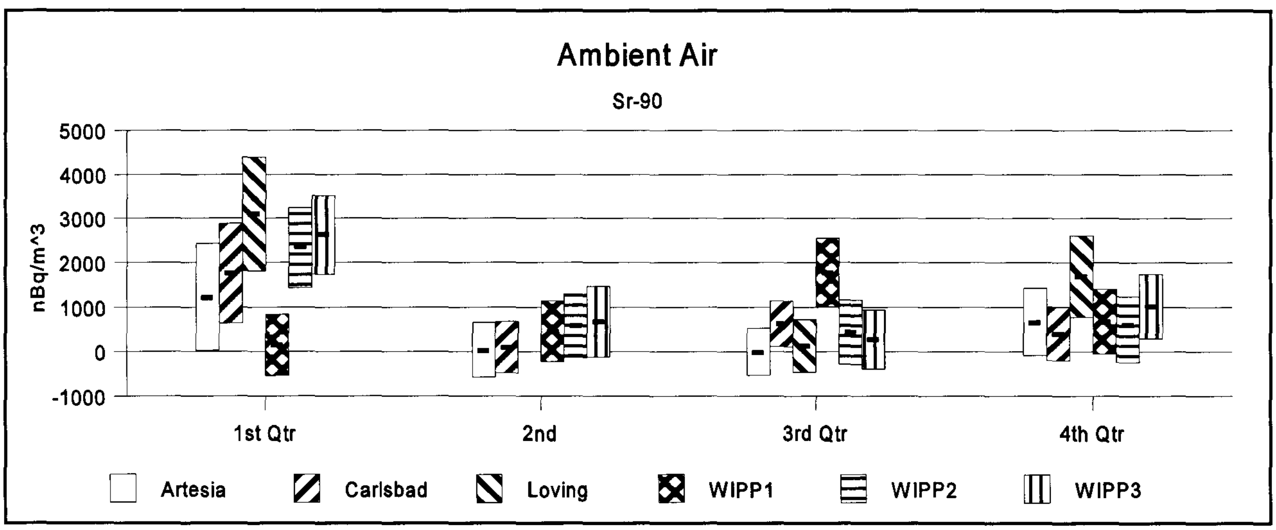

Figure A9. ^{90}Sr Concentrations in LVAS Samples During 1999

APPENDIX B. WATER SAMPLE DATA

Table B1. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Groundwater During 1999

SAMPLE DATE	WATER WELL IDENTIFICATION	^{241}Am ACTIVITY (Bq/l)	TPU 2 SIGMA (Bq/l)	$^{239/240}Pu$ ACTIVITY (Bq/l)	TPU 2 SIGMA (Bq/l)	^{238}Pu ACTIVITY (Bq/l)	TPU 2 SIGMA (Bq/l)
04/08/99	WQSP-3	1.43e-03	3.10e-03	1.09e-03	1.36e-03	-1.65e-04	1.19e-03
04/21/99	WQSP-4	-1.13e-03	2.47e-03	1.04e-03	6.16e-04	-2.64e-04	6.24e-04
05/05/99	WQSP-5	-3.84e-04	2.27e-03	6.55e-05	4.60e-04	NA	NA
05/26/99	WQSP-6A	-5.01e-04	2.25e-03	4.50e-04	6.16e-04	-2.64e-04	6.24e-04
05/19/99	WQSP-6	9.30e-05	2.36e-03	4.36e-04	5.47e-04	1.23e-03	8.47e-04
09/01/99	WQSP-1	-6.80e-05	2.35e-03	2.42e-04	5.66e-04	NA	NA
09/15/99	WQSP-2	9.14e-04	3.64e-03	-1.52e-05	4.72e-04	NA	NA
		Mean	$2\sigma_m$	Mean	$2\sigma_m$	Mean	$2\sigma_m$
		5.06e-05	1.74e-03	4.73e-04	8.80e-04	1.34e-04	1.46e-03

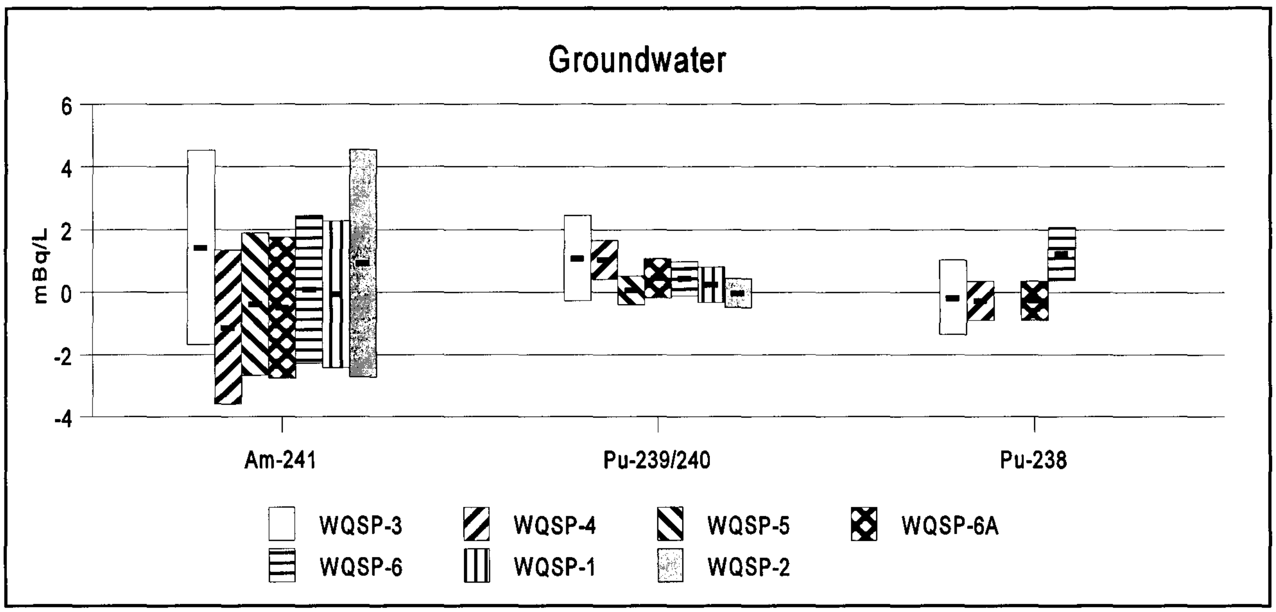

Figure B1. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Groundwater During 1999

Table B2. ^{137}Cs and ^{90}Sr Concentrations in Groundwater During 1999

SAMPLE DATE	WATER WELL IDENTIFICATION	^{137}Cs ACTIVITY (Bq/l)	TPU 2 SIGMA (Bq/l)	^{90}Sr ACTIVITY (Bq/l)	TPU 2 SIGMA (Bq/l)
04/08/99	WQSP-3	-2.71e-02	1.82e-01	2.38e-02	2.84e-02
04/21/99	WQSP-4	4.28e-02	1.84e-01	1.02e-02	2.55e-02
05/05/99	WQSP-5	4.26e-02	1.77e-01	6.00e-03	3.39e-02
05/26/99	WQSP-6A	-1.87e-02	1.78e-01	-1.02e-02	1.03e-01
05/19/99	WQSP-6	4.33e-02	1.72e-01	3.50e-03	4.39e-02
09/01/99	WQSP-1	-8.70e-02	1.78e-01	3.87e-02	3.25e-02
09/15/99	WQSP-2	-2.10e-02	1.75e-01	1.56e-02	4.23e-02
		Mean	$2\sigma_m$	Mean	$2\sigma_m$
		-3.59e-03	9.84e-02	1.25e-02	3.13e-02

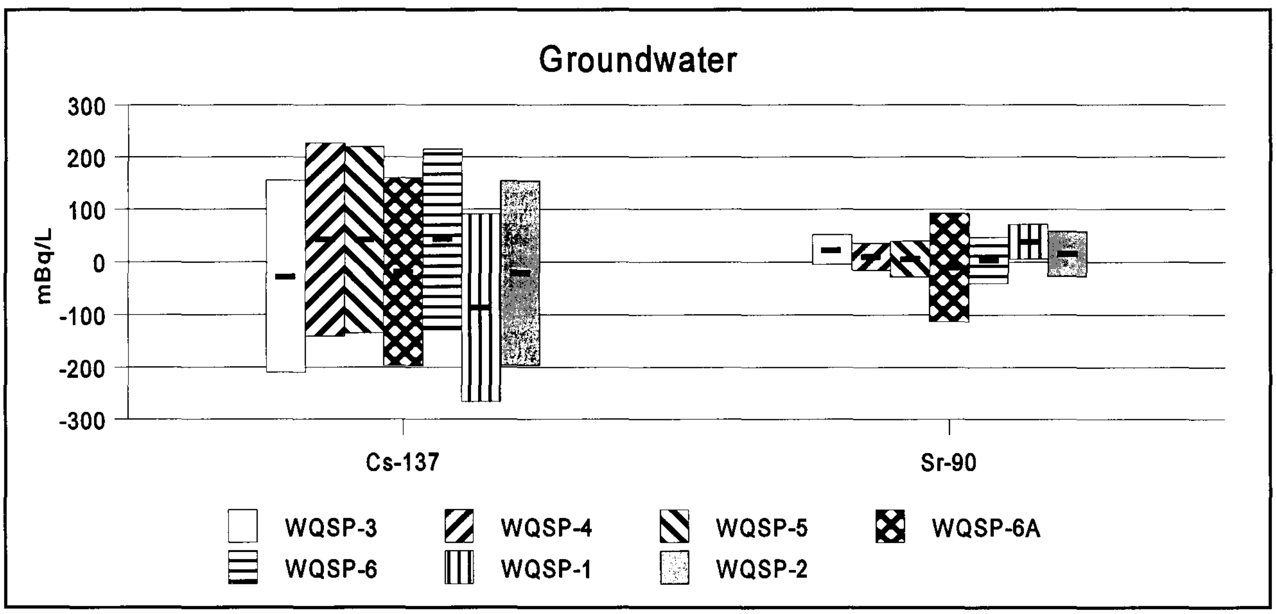

Figure B2. ^{137}Cs and ^{90}Sr Concentrations in Groundwater During 1999

Table B3. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Surface Water During 1999

SAMPLE DATE	SAMPLE SITE	^{241}Am ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)	$^{239/240}$Pu ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)	^{238}Pu ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)
06/10/99	INDIAN TANK	5.44e-04	2.35e-03	2.62e-04	5.87e-04	-5.03e-04	5.84e-04
06/17/99	WIPP EFFLUENT	-3.14e-04	2.27e-03	2.98e-04	5.38e-04	-2.61e-04	5.63e-04
07/09/99	PECOS @ PIERCE	9.10e-05	2.30e-03	-5.41e-05	4.71e-04	0.00e+00	6.57e-04
07/13/99	PECOS @ CBD	-1.67e-04	2.31e-03	2.03e-04	5.02e-04	-1.35e-04	5.79e-04
08/20/99	RED TANK	3.64e-04	2.35e-03	2.88e-04	5.67e-04	-5.70e-05	6.58e-04
08/20/99	NOYA TANK	-7.98e-04	2.24e-03	2.72e-05	4.63e-04	-1.28e-04	5.92e-04
08/20/99	HILL TANK	-6.45e-04	2.30e-03	-6.06e-05	4.77e-04	-1.29e-04	6.23e-04
11/16/99	LAGUNA GRANDE	1.75e-03	4.17e-03	3.64e-04	1.52e-03	-9.80e-05	2.01e-03
		Mean	$2\sigma_m$	Mean	$2\sigma_m$	Mean	$2\sigma_m$
		1.03e-04	1.62e-03	1.66e-04	3.39e-04	-1.64e-04	3.12e-04

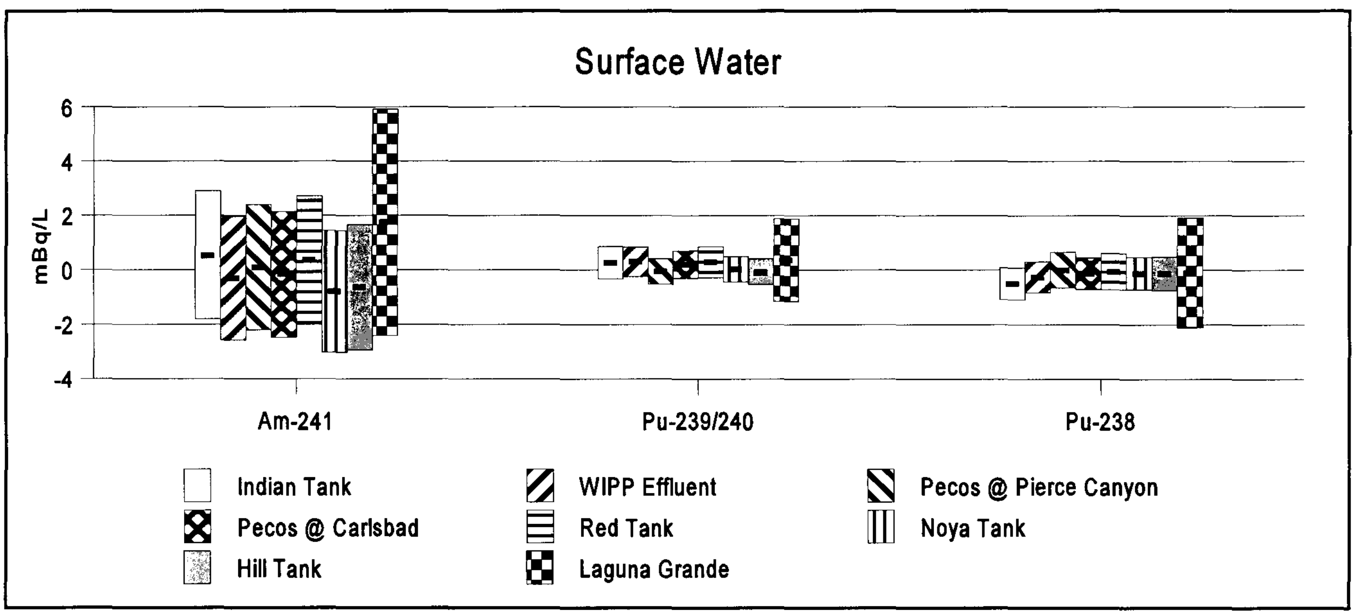

Figure B3. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Surface Water During 1999

Table B4. ^{137}Cs and ^{90}Sr Concentrations in Surface Water During 1999

SAMPLE DATE	SAMPLE SITE	^{137}Cs ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)	^{90}Sr ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)
06/10/99	INDIAN TANK	-4.50e-02	1.73e-01	1.72e-02	8.13e-02
06/17/99	WIPP EFFLUENT	3.49e-02	1.73e-01	-2.70e-03	1.93e-02
07/09/99	PECOS @ PIERCE	-3.58e-02	1.73e-01	-3.30e-03	2.10e-02
07/13/99	PECOS @ CBD	4.00e-02	1.71e-01	6.00e-04	2.49e-02
08/20/99	RED TANK	6.87e-02	1.71e-01	-6.00e-04	2.06e-02
08/20/99	NOYA TANK	-1.30e-03	1.72e-01	-3.00e-04	1.95e-02
08/20/99	HILL TANK	4.57e-02	1.73e-01	-5.30e-03	2.10e-02
11/16/99	LAGUNA GRANDE	6.36e-02	2.05e-01	4.05e-02	1.01e-01
		Mean	$2\sigma_m$	Mean	$2\sigma_m$
		2.14e-02	8.73e-02	5.76e-03	3.13e-02

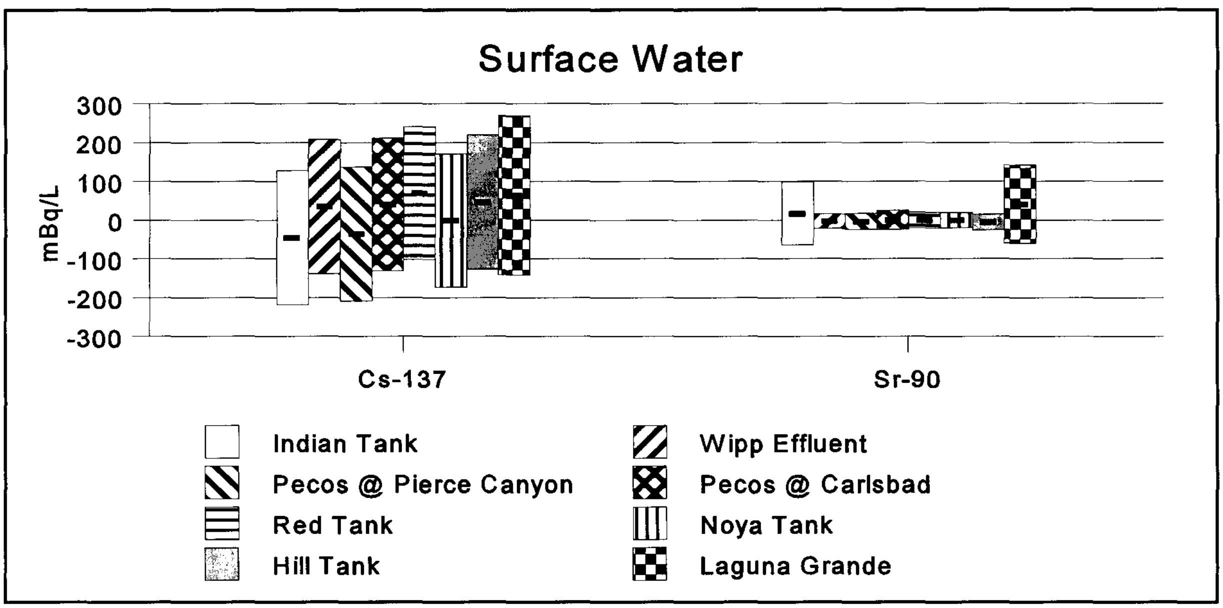

Figure B4. ^{137}Cs and ^{90}Sr Concentrations in Surface Water During 1999

Table B5. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Drinking Water During 1999

SAMPLE DATE	PUBLIC WATER SUPPLY SYSTEM	^{241}Am ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)	$^{239/240}Pu$ ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)	^{238}Pu ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)
06/11/99	OTIS WSS	1.42e-04	2.32e-03	7.05e-05	4.99e-04	-4.46e-04	5.57e-04
06/11/99	CARLSBAD WSS	2.34e-04	2.31e-03	4.72e-04	5.71e-04	-2.59e-04	5.57e-04
07/09/99	LOVING WSS	2.54e-04	2.35e-03	9.65e-05	4.84e-04	-2.61e-04	5.63e-04
07/15/99	WIPP WSS	2.24e-04	2.33e-03	2.31e-04	5.59e-04	-2.63e-04	6.21e-04
		Mean	$2\sigma_m$	Mean	$2\sigma_m$	Mean	$2\sigma_m$
		2.14e-04	9.85e-05	2.18e-04	3.67e-04	-3.07e-04	1.85e-04

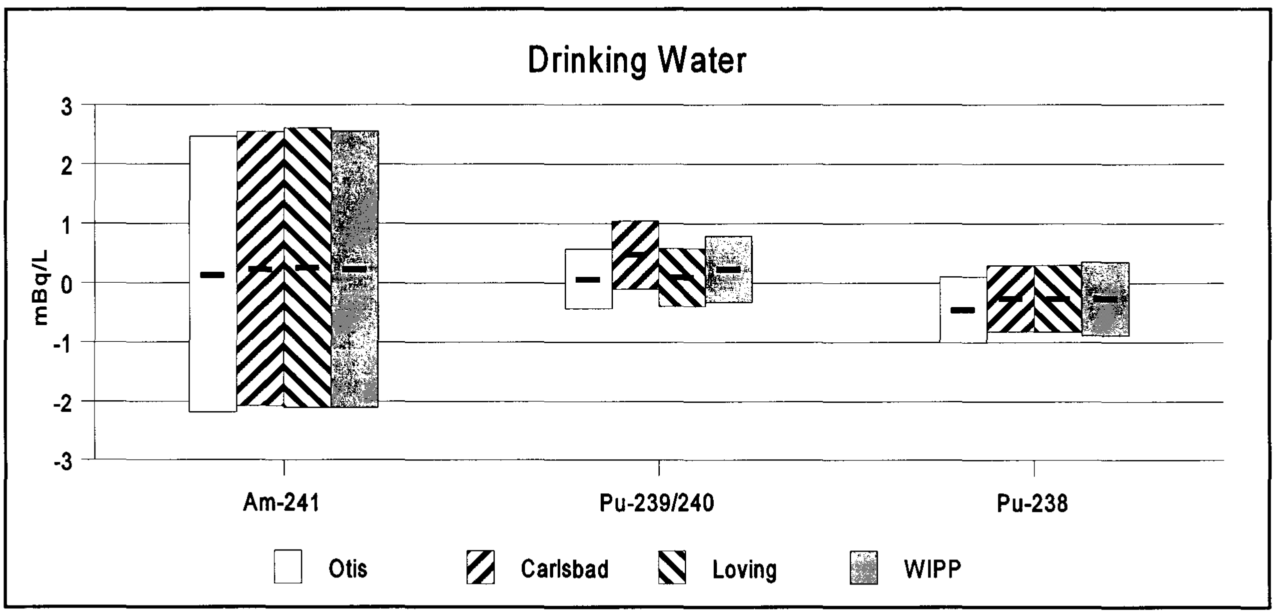

Figure B5. ^{241}Am, $^{239/240}Pu$, and ^{238}Pu Concentrations in Drinking Water During 1999

Table B6. ^{137}Cs and ^{90}Sr Concentrations in Drinking Water During 1999

SAMPLE DATE	PUBLIC WATER SUPPLY SYSTEM	CS-137 ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)	SR-90 ACTIVITY (Bq/l)	TPU 2 SIGMA (+/-)
06/11/99	OTIS WSS	7.87e-02*	1.75e-01	-2.10e-03	2.41e-02
06/11/99	CARLSBAD WSS	5.04e-02	1.73e-01	7.10e-03	2.40e-02
07/09/99	LOVING WSS	NA	NA	-7.40e-03	1.89e-02
07/15/99	WIPP WSS	-9.00e-03	1.73e-01	-1.90e-03	2.25e-02
		Mean	$2\sigma_m$	Mean	$2\sigma_m$
		4.00e-02	8.95e-02	-1.08e-03	1.20e-02

**exceeds action level*

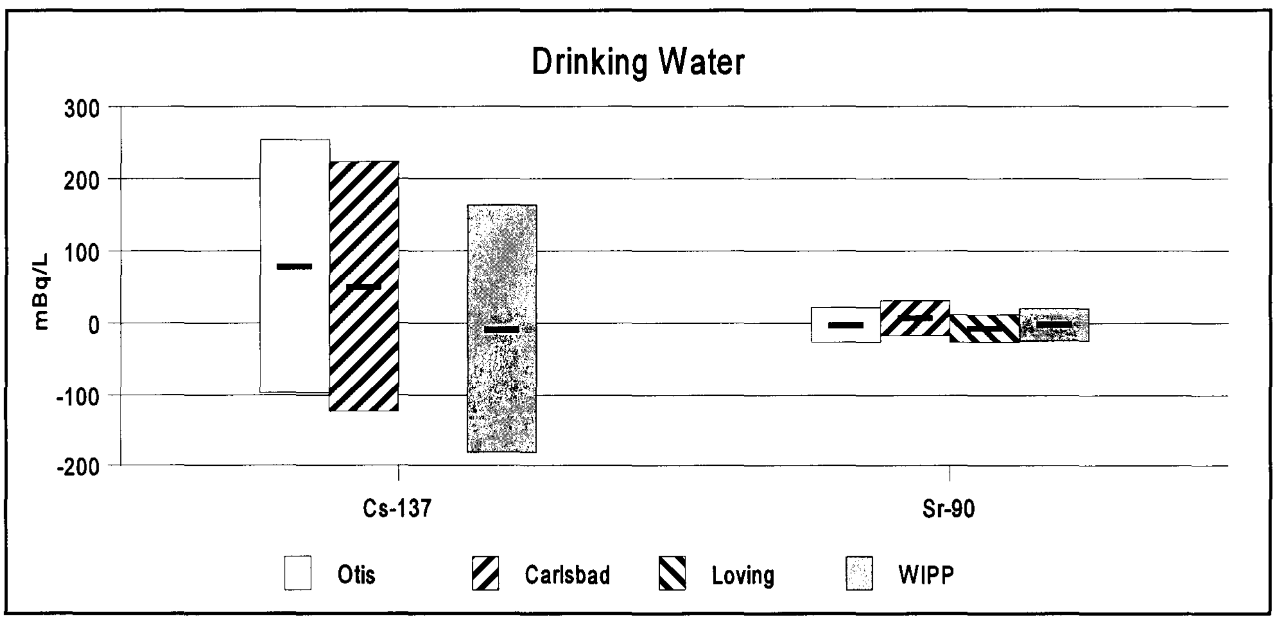

Figure B6. ^{137}Cs and ^{90}Sr Concentrations in Drinking Water During 1999

APPENDIX C. MATRIX BLANK DATA

Table C1. Matrix Blank Results For the 1999 Sampling Period

Matrix Blank ID	**^{241}Am**	**$^{239/240}Pu$**	**^{238}Pu**	**^{137}Cs**	**^{90}Sr**
FAS (Effluent)	Bq/composite	Bq/composite	Bq/composite	Bq/composite	Bq/composite
FMB-990406	9.00e-04	-4.50e-04	-4.50e-04	1.80e-02	5.50e-03
FMB-000209	NA	7.30e-04	-1.20e-04	NA	1.80e-02
FMB-000306	1.20e-03	9.10e-06	-1.80e-04	NA	2.00e-03
Mean	1.05e-03	9.64e-05	-2.50e-04		8.50e-03
$2\sigma_m$	4.24e-04	1.19e-03	3.52e-04		1.68e-02
LVAS (Ambient)	Bq/composite	Bq/composite	Bq/composite	Bq/composite	Bq/composite
LMB-990305	8.60e-04	0.00e+00	3.80e-04	-1.70e-03	8.40e-03
LMB-990907	1.70e-03	2.80e-04	1.10e-03	-3.50e-02	1.30e-02
LMB-990930	2.50e-04	5.60e-05	1.10e-04	2.20e-02	-1.00e-04
LMB-991208	4.00e-04	3.50e-04	7.40e-04	4.40e-03	-4.40e-03
LMB-000110	1.10e-03	NA	NA	NA	-2.90e-03
Mean	8.62e-04	1.72e-04	5.83e-04	-2.58e-03	2.80e-03
$2\sigma_m$	1.16e-03	3.39e-04	8.62e-04	4.77e-02	1.51e-02
Water	Bq/L	Bq/L	Bq/L	Bq/L	Bq/L
WMB-990505	5.50e-04	-1.20e-04	6.00e-05	1.60e-02	-1.00e-02
WMB-990615	6.10e-04	5.00e-04	2.30e-04	-1.40e-01	1.10e-02
WMB-990707	1.20e-03	7.50e-05	8.30e-05	-3.60e-02	-1.90e-03
WMB-990809	1.10e-03	2.00e-05	4.10e-05	-7.40e-02	1.30e-02
WMB-990813	3.10e-04	8.50e-05	1.70e-04	-6.00e-03	8.40e-03
WMB-990719	1.80e-03	-1.70e-04	2.00e-05	-1.00e-01	7.60e-03
WMB-990930	5.30e-04	7.80e-06	7.80e-04	1.80e-02	3.90e-03
WMB-991122	1.10e-04	1.50e-04	3.40e-04	-1.50e-01	1.20e-02
Mean	7.76e-04	6.85e-05	2.16e-04	-5.90e-02	5.50e-03
$2\sigma_m$	1.10e-03	4.08e-04	5.05e-04	1.34e-01	1.58e-02

APPENDIX D. TLD DATA

Table D1. Average Dose by TLD in 1999

TLD Badge Number	Average Quarterly Dose (mrem/qtr)	2-σ Uncertainty (mrem/qtr)	Annual Dose (mrem/yr)	2-σ Uncertainty (mrem/yr)
1	17.5	7.1	69.8	14.1
2	19.8	6.7	79.0	13.5
3	18.6	7.5	74.2	15.0
4	19.8	7.3	79.0	14.5
5	19.1	6.7	76.3	13.4
6	18.4	8.0	73.5	15.9
7	19.3	5.7	77.0	11.3
8	18.3	9.1	73.0	18.1
9	19.8	6.7	79.0	13.4
11	19.2	7.4	76.6	14.8
12	18.7	6.1	74.6	12.2
13	18.7	7.3	74.7	14.6

APPENDIX E. SAMPLE COLLECTION LOCATIONS

APPENDIX E
SAMPLE COLLECTION LOCATIONS

Detailed descriptions of the sampling locations are found in the preoperational reports, but are summarized in this Appendix.

Fixed Air Samplers (Effluent)

Two fixed air samplers are currently operating in the WIPP air effluent stream and one is about to come on-line. The two currently operating are Station A, located at the top of the air exhaust shaft and sampling the unfiltered exhaust, and Station B, located downstream of the HEPA filtration building, through which underground exhaust air can be diverted, if necessary. The third location is called Station D and is located underground, near the base of the exhaust shaft.

Low-Volume Air Samplers (Ambient)

Three low-volume air samplers are located on or close to the site, as listed below:

1. Approximately 225 meters northwest of the exhaust shaft (WIPP1),
2. Approximately 500 meters northeast of the exhaust shaft (WIPP2), and
3. Approximately 1000 meters northwest of the exhaust shaft (WIPP3).

Three additional low-volume air samplers are located in Artesia, Carlsbad, and Loving - the three population centers closest to the WIPP site and located on the main WIPP transportation routes.

Groundwater

Seven wells collect groundwater samples from the water-bearing zones of the Dewey Lake Redbed Formation , the Culebra dolomite member of the Rustler Formation, and the Capitan Reef Formation. Their approximate locations appear in Figure E1.

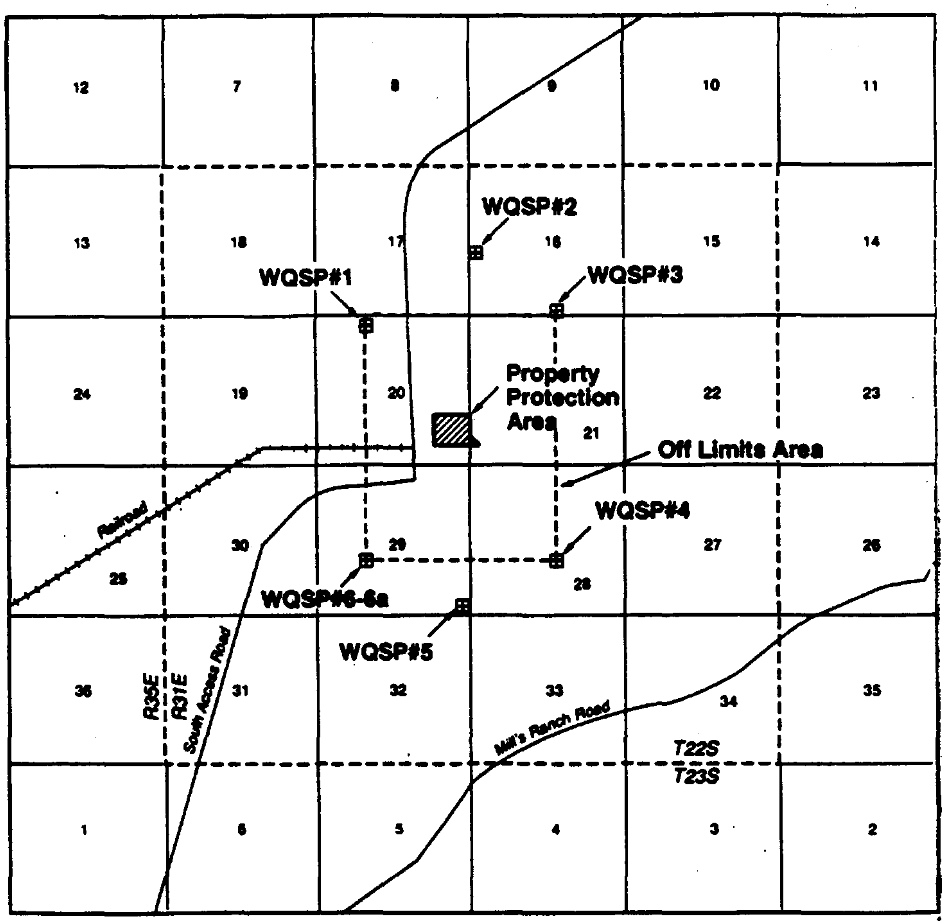

Figure E1. Groundwater Sampling Locations

Surface Water and Drinking Water

Surface water samples are collected at eight locations, shown in Figure E2. No water was collected during 1999 from Red Lake. Drinking water samples are collected from the public water supply systems at the WIPP site and the communities of Carlsbad, Loving, and Otis. Otis does not appear in the figure. Otis is a small community on the south edge of Carlsbad.

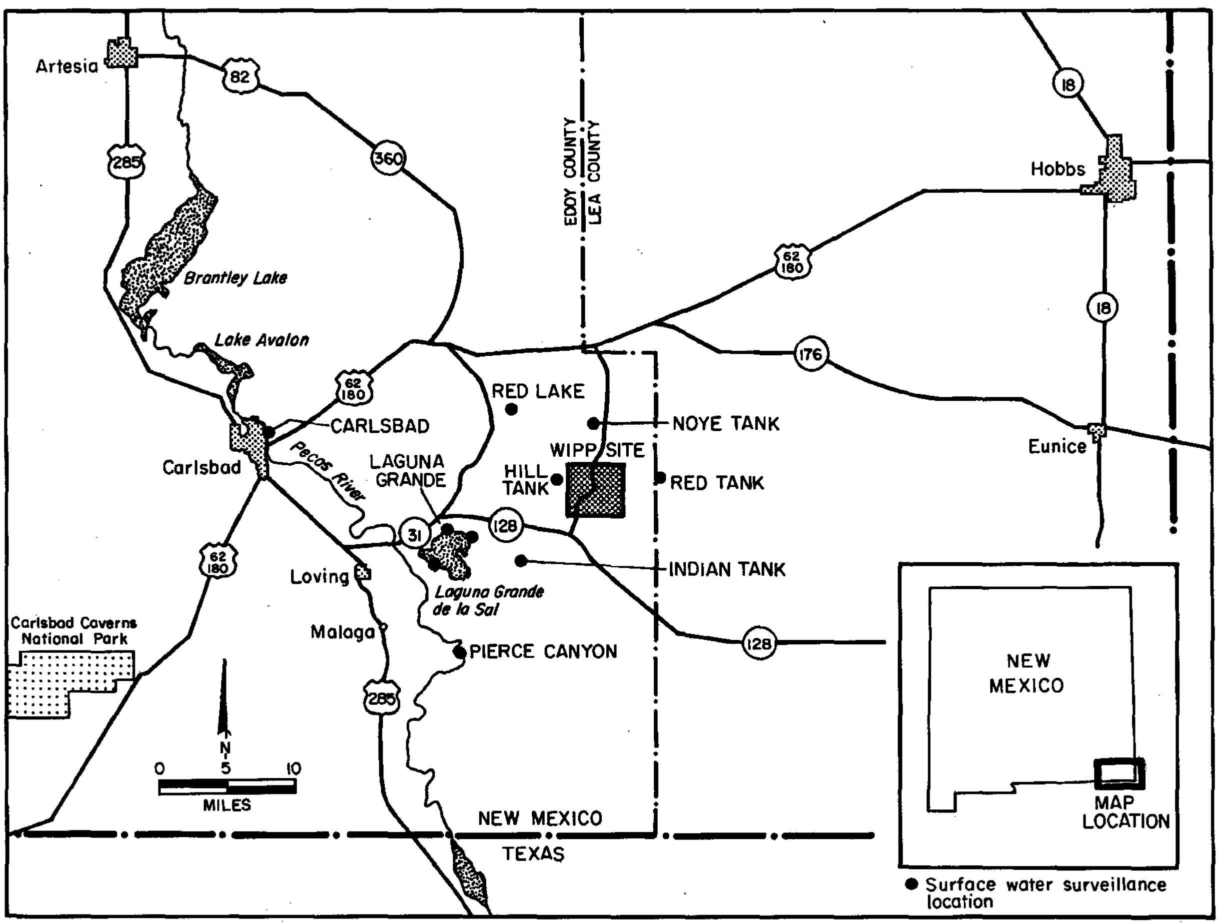

Figure E2. Surface Water Sampling Locations

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LIST OF EEG REPORTS

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