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DOE/WIPP 99-2225

Waste Isolation Pilot Plant
Site Environmental Report for 1998

Editors

Balwan S. Hooda
Vivian L. Allen

October 1999

Westinghouse Government Environmental Services Company, LLC
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PREFACE

The U.S. Department of Energy (DOE) Carlsbad Area Office (CAO) and Westinghouse Waste Isolation Division (WID) are dedicated to maintaining high quality management of WIPP environmental resources. The DOE Order 5400.1, "General Environmental Protection Program," and DOE O 231.1, "Environmental, Safety, and Health Reporting," require WID to implement public and environmental protection programs by monitoring the environment. The annual WIPP Site Environmental Report (SER) summarizes the environmental data that characterize the environmental management performance and demonstrate the compliance with local, state, and federal regulations.

The radiological and nonradiological conditions around the WIPP site were evaluated and reported herein. The United States' first deep geological transuranic (TRU) waste disposal facility, the Waste Isolation Pilot Plant (WIPP), did not receive TRU waste until March 26, 1999. This SER compares the radiological conditions for the previous two years; therefore, this environmental data could be used to add to the baseline/background information about radiological conditions in the environment.

Although this report was written to meet the DOE reporting requirements and guidelines, it is intended for stakeholders. Inquiries may be directed to the U.S. Department of Energy, Carlsbad Area Office, P.O. Box 3090, Carlsbad, New Mexico 88221-3090.

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The authors appreciate the reviews by Cynthia Zvonar and Richard F. Farrell of the U. S. Department of Energy Carlsbad Area Office; and special thanks to Jim W. Kenney and Don Gray of the Environmental Evaluation Group for providing the radiological data for scientific comparisons, and the quality assurance for the environmental data. Thanks to Bob Kehrman of WID for his thorough review of the document.

The Site Environmental Report would not have been complete, and accurate, without the cooperative efforts of various Westinghouse WID groups. Therefore, I would like to extend our sincere thanks to the Environmental Compliance Group: Dan C. Robertson, Linda Frank-Supka, Koreen S. Guillermo, Carl S. Ortiz (Safety Analysis Report team), Rick R. Chavez, Farok Sharif, Jim R. Hollen, Jeff W. Knox, Cindy L. Woodin; and the RCRA (Resource Conservation and Recovery Act) team: Wille A. Most, Miriam Whatley; and, lastly to Steve C. Kouba for all the valuable support provided.

WIPP laboratory personnel provided the gross alpha/beta results for the ambient air filters, and their help is highly appreciated, especially Tony D. Donner, who was always ready to reprocess the samples and provide any information requested from the laboratory. Also, thanks to Peter S. Damm for his review of the Quality Assurance chapter.

Thanks to Dr. Narayani P. Singh for his professional help, peer review, and the scientific evaluation of the Site Environmental Report.

The WIPP library members were very cooperative in locating any documents that were not available in the WIPP library; and without any hesitation or lag time they would not only locate the reference documents but get them to us as soon as possible. Their unrelenting efforts made this report technically viable; so our grateful thanks to Lata S. Desai, Robin Wilson, and Erin Bentley.

This report was compiled and publication assistance provided by Crystal Yeager, Jim Connors, Larry E. Porter and, especially, Vivian L. Allen, who was always willing, enthusiastic, analytical, and extremely conscientious in preparation of this report. Her extra efforts and dedication are highly appreciated.

Finally, thanks to our own Environmental Monitoring Group. These hardworking professionals implement U.S. DOE Order 5400.1, "General Environmental Protection Program," by providing the technical assistance to collect the samples, analyze the data, perform verification and validation, protect the fauna and flora, implement land management, monitor the groundwater, and publish this report.

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ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
AOC	Area of Concern
ASME	American Society of Mechanical Engineers
BLM	Bureau of Land Management
Bq	Becquerel
Bq/L	Becquerel per liter
Bq/m^3	Becquerel per cubic meter
C of C	Certificate of Compliance
CAO	Carlsbad Area Office
CCA	Compliance Certification Application
CDE	committed dose equivalent
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	*Code of Federal Regulations*
CH	contact-handled
Ci	Curie
cm	centimeter
CY	calendar year
DCG	Derived Concentration Guide
DOE	United States Department of Energy
DOI	United States Department of the Interior
DOT	United States Department of Transportation
DP	Discharge Plan
EA	environmental assessment
EC&S	Environmental Compliance and Support (Section)
EDE	effective dose equivalent
EEG	Environmental Evaluation Group
EIS	Environmental Impact Statement
EML	Environmental Measurements Laboratory
EMP	WIPP Environmental Monitoring Plan
EMS	Environmental Management System
EPA	United States Environmental Protection Agency
ERDA	United States Energy Research and Development Administration
FEIS	Final Environmental Impact Statement
FR	*Federal Register*
g	gram
GOCO	government-owned, contractor-operated
HAP	hazardous air pollutant

ISO	International Organization for Standards
kg	kilogram
km	kilometer
L	liter
LMP	Land Management Plan
LUR	Land Use Request
LWA	Land Withdrawal Act
m^3	cubic meters
mBq	millibecquerel
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDL	method detection limit
mg	milligram
mg/L	milligram per liter
ml	milliliter
MOU	memorandum of understanding
mrem	millirem
mrem/yr	millirem per year
mSv	millisievert
mSv/yr	millisievert per year
mt	metric tons
NCRP	National Council of Radiation Protection
NEPA	National Environmental Policy Act
NESHAPs	National Emissions Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NMAC	New Mexico Administrative Codes
NMDG&F	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMIMT	New Mexico Institute of Mining Technology
NPDES	National Pollutant Discharge Elimination System
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
P.L.	Public Law
pCi	picocurie
pCi/L	picocurie per liter
ppbv	parts per billion by volume
PPOA	Pollution Prevention Opportunity Assessment
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
rem	Roentgen equivalent man

RER	relative error ratio
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SARP	Safety Analysis Report for Packaging
SD	soil deep
S.D.	standard deviation
SDWA	Safe Drinking Water Act
SEIS	Supplemental Environmental Impact Statement
SER	Site Environmental Report
SI	soil intermediate
SMA	Special Management Areas
SNL	Sandia National Laboratories
SS	soil surface
S.U.	standard unit
SWMU	solid waste management unit
Sv	Sievert
TDS	total dissolved solid
TOC	total organic carbon
TOH	total organic halogen
TRANSCOM	Transportation Tracking and Communications (system)
TRU	transuranic (waste)
TRUPACT-II	Transuranic Package Transporter Model II
U.S.C.	*United States Code*
USF&WS	United States Department of the Interior, Fish and Wildlife Service
USGS	United States Geological Survey
UTLV	upper tolerance limit value
VOC	volatile organic compound
VRA/CA	Voluntary Release Assessment/Corrective Action
WID	Waste Isolation Division
WIPP	Waste Isolation Pilot Plant
WQSP	WIPP Groundwater Quality Surveillance Program

Symbols

°C	degrees Celsius
°F	degrees Fahrenheit
µCi	microcurie
µg	microgram
µmhos	micromhos
%	percent

Location Codes are provided in Appendix A.

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CHAPTER 1 EXECUTIVE SUMMARY

This 1998 annual Site Environmental Report (SER) was prepared in accordance with U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program"; DOE Order 231.1, "Environmental Safety and Health Reporting"; the "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" (DOE/EH-0173T); and the Environmental Protection Implementation Plan (DOE/WIPP 96-2199). The above orders and guidance documents require that DOE facilities submit an SER to DOE Headquarters, Office of the Assistant Secretary for Environment, Safety, and Health. The purpose of the SER is to provide a comprehensive description of operational environmental monitoring activities, an abstract of environmental activities conducted to characterize site environmental management performance, to confirm compliance with environmental standards and requirements, and to highlight significant programs and efforts of environmental merit at WIPP during calendar year (CY) 1998. The content of this SER is not restricted to a synopsis of the required data. Information pertaining to new and continued monitoring and compliance activities during CY 1998 are also included.

Data contained in chapter 5, "Environmental Radiological Assessment," of this report were derived from the monitoring programs directed by the Waste Isolation Pilot Plant (WIPP) Environmental Monitoring Plan (EMP) (DOE/WIPP 96-2194). The plan provides inclusive guidelines implemented to detect potential impacts to the environment and establish baseline measurements for future environmental evaluations. Surface water, sediment, groundwater, air, soil, and biotic matrices are monitored for an array of radiological factors.

This report also discusses the quality assurance (QA) and quality control (QC) programs that provide the oversight necessary to maintain sample integrity, including:

- Proceduralized (to industry standards) sample collection methodology
- Personnel training
- Verification and validation of environmental data

These criteria ensure that data derived from environmental samples provide an accurate representation of environmental conditions at the WIPP site. The requirements and goals driving these activities are more fully described in the EMP.

The EMP was drafted in accordance with the guidelines in DOE Order 5400.1. The EMP defines the scope and extent of the WIPP environmental monitoring programs and ensures that all appropriate sampling efforts are in place to determine the following: (1) the amount and type of naturally occurring radioactivity in the WIPP area prior to operational status (these quantitative data will support comparisons between preoperational and operational environmental conditions, once WIPP is operating as a waste repository for transuranic [TRU] waste); and (2) a comparison between preoperational and operational radiological observations, once the WIPP site is operating as a waste repository for TRU waste.

The EMP is reviewed annually and updated every three years, as required by DOE Order 5400.1. The revisions/updates address the general changes, improvements, and enhancements to be implemented based on the data generated from the monitoring programs.

1.1 Compliance Summary

A summary of significant compliance-related activities at WIPP during CY 1998 is presented in this chapter. Chapter 3 will address environmental statutes and executive orders comprehensively in terms of compliance status, significant issues, actions, and accomplishments specific to WIPP.

On January 5, 1998, the New Mexico Environment Department (NMED) issued a technical completeness determination on the WIPP's Resource Conservation and Recovery Act (RCRA) Part B Permit Application. On May 15, 1998, the NMED issued a draft RCRA permit for WIPP, entitled *Hazardous Waste Facility Draft Permit, Waste Isolation Pilot Plant, EPA No. NM4890139088 by the New Mexico Environment Department*. On August 14, 1998, the Carlsbad Area Office (CAO) and the Waste Isolation Division (WID) submitted comments on the draft permit. On November 13, 1998, the NMED issued a second draft RCRA permit, which addressed some of the public comments received by the NMED.

Section 8 of the Land Withdrawal Act (LWA) (Public Law [P.L.] 102-579) requires the DOE to submit to the U.S. Environmental Protection Agency (EPA) an application for certification of compliance with the EPA's final disposal regulations. In February 1996, the EPA issued the criteria for the certification of WIPP's compliance with the disposal regulations (Title 40 *Code of Federal Regulations* (CFR) 191, Subparts B and C). In response to the WIPP Compliance Certification Application (CCA) (DOE/CAO 96-2184), which was submitted to the EPA in October 1996, the EPA issued a proposed rule on October 30, 1997 certifying that the DOE complies with the disposal regulations in 40 CFR § 191. On May 18, 1998, the EPA issued a final ruling on the WIPP CCA (*Federal Register* [FR] Vol. 63, No. 95). The EPA certified that WIPP would meet all of the disposal standards.

1.1.1 National Environmental Policy Act Annual Mitigation Report

The 1997 Annual Mitigation Report for the Waste Isolation Pilot Plant (National Environmental Policy Act [NEPA] ID# WP8-0001) was issued June 22, 1998, in accordance with the requirements of DOE Order 451.1A, "National Environmental Policy Act Compliance Program." This order requires DOE facilities to track and annually report progress in implementing a commitment for environmental impact mitigation that is essential to render the impacts of a proposed action nonsignificant or that is made in the Record of Decision (ROD) (*Federal Register*, 1981).

1.1.2 Superfund Amendments and Reauthorization Act Title III Emergency and Hazardous Chemical Inventory

WIPP submitted the Tier II Emergency and Hazardous Chemical Inventory Report for CY 1998 to the CAO for distribution to the New Mexico State Emergency Response Commission, the Eddy County Local Emergency Planning Committee, and the local fire department with jurisdiction over the WIPP site, as required by section 312 of the Superfund Amendments and Reauthorization Act [SARA] Title III (also known as the Emergency Planning and Community Right-to-Know Act). The Tier II report was also distributed to all local fire departments with which WIPP maintains a memorandum of understanding (MOU).

1.1.3 New Mexico Air Quality

WIPP completed all requirements for emissions monitoring and sampling in New Mexico Air Quality Permit 310-M-2. During CY 1998 the backup diesel generators were operated for approximately 41 of the 480 hours allowed by the permit. Operations were within the parameters of the permit.

1.1.4 Environmental Compliance Assessments

During 1998, ten environmental compliance assessments were conducted. Thirty-three improvements were identified and implemented as a result of these assessments. The assessed areas included Material Safety Data Sheet Requirements, Stratospheric Ozone Protection, Hazardous Waste Records/Manifests, New Mexico Department of Game and Fish Permit 1894, Low Volume Air Sampling, Waste Isolation Pilot Plant (WIPP) Environmental Management System (EMS), Hazardous Waste/Material Emergency Response, Construction Landfill, Environmental Vendor Audit Program, and Environmental Compliance and Support Records Validation.

1.1.5 ISO 14001 Environmental Management Systems

The International Organization for Standards (ISO) 14000 standards establish a voluntary management process that goes beyond regulatory compliance. ISO 14000 is the series of international environmental management standards designed to give a common management approach for parties trading products or services having impacts on the environment. The criteria for EMSs are contained in section 14001-1996 of the ISO standard. While these standards are voluntary, many companies and countries are adopting them as a model for their EMSs. WID views ISO 14001 compliance as an important step towards becoming an industry leader at implementing a formal EMS. On August 5, 1997, the WID EMS received third-party registration under the ISO 14001 Standard.

WIPP has developed and implemented the EMS in accordance with the ISO 14001 Standard. The EMS established the necessary organizational structure, planning activities, procedures, and resources to develop, implement, achieve, and maintain WID's environmental management policy, MP 1.14. A description of the EMS can be found in the Environmental Management Implementation Document (WP 02-EC.0).

1.1.6 Voluntary Release Assessment Program at Selected Solid Waste Management Units at WIPP

Activities performed by the CAO and WID in 1998 under the WIPP Voluntary Release Assessment/Corrective Action (VRA/CA) program generally consisted of responses to requests for information from the NMED and responses to the May 15, 1998, and the November 13, 1998, drafts of the RCRA permit issued by the NMED for the WIPP facility. In completing these tasks, the CAO and WID retrieved and reviewed records pertaining to the solid waste management units (SWMUs) for submittal to the NMED, completed a site-specific risk assessment using previously collected data from the VRA/CA program, and prepared comments to the NMED on the draft permits. These efforts focused on compiling documentation and arguments to support ongoing permitting activities.

1.1.7 Federal Acquisition, Recycling, and Waste Prevention

WIPP adopted a systematic and cost-effective affirmative procurement plan for the promotion and procurement of certain products containing recovered materials in July 1995. Affirmative procurement is designed to "close a loop" in the waste minimization recycling process by supporting the market for materials collected through recycling and salvage operations.

Affirmative procurement programs are mandated by RCRA section 6002(I), which requires federal agencies and their procuring agencies to establish material preference programs targeted to purchase recycled materials. Executive Order 13101, "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition," and the EPA guidelines in 40 CFR §§ 248 through 250 and 252 through 253 provide additional guidance for implementing affirmative procurement programs at federal facilities.

1.2 Environmental Monitoring Program Information

Site characterization and environmental baseline measurements at WIPP were initiated during 1975. Many of these elements continue to be maintained on radiological and nonradiological databases. When WIPP becomes operational, baseline measurements will be replaced with "operational measurements" and will continue throughout the operational life of the project.

1.2.1 Environmental Monitoring Plan

WIPP's EMP provides schedules and guidelines for monitoring a comprehensive set of parameters to detect and quantify present or potential environmental impacts, both non-radiologically and radiologically. Radiological surveillance covers an extensive geographic area that includes nearby ranches, villages, and cities. Sampling activities conducted during CY 1998 were performed at locations identified in the EMP.

1.3 Environmental Radiological Program Information

The 1998 SER evaluates environmental radiological data for CY 1998 and compares it to the previous year's data (air, groundwater, surface water, and sediments). The only radiation dose received by the general public living in the vicinity of the WIPP site during CY 1998 was that associated with background radiation.

The radionuclides present in the environment can give both internal and external doses. Internal dose is caused by the intake of radionuclides in humans. The major routes of intake of radionuclides in the general public are ingestion and inhalation. Ingestion includes the intake of the radionuclides from drinking milk and water and consuming agricultural and meat products. Inhalation includes the intake of radionuclides through breathing dust particles. Therefore, environmental radiation monitoring is directed toward these pathways.

1.3.1 Airborne Particulate Sampling

Airborne particulate samples were collected from seven different locations around the WIPP site: South East Control (SEC), Carlsbad (CBD), Mills Ranch (MLR), Smith Ranch (SMR), WIPP East (WEE), WIPP South (WSS), and WIPP Far Field (WFF) (figure 5.1.1). Samples were collected every week (approximate volume of 600 cubic meters [m^3]) on Whatman micro fiberglass filters (4.7 centimeters [cm] in diameter) using low-volume continuous air samplers. The samples were collected at a height of 5 to 6.5 feet to closely match the air inhaled by humans. Filters were counted for gross alpha and beta only after having been stored for five to seven days in the laboratory to make sure that the short-lived radon daughters had decayed.

The mean concentrations of gross alpha activities found in 1998 were as low as 0.046 ± 0.030 mBq/m^3 (millibecquerel per cubic meter) at the SMR location to as high as 0.055 ± 0.034 mBq/m^3 at the SEC. The mean concentrations of gross alpha activities found in 1997 ranged from 0.019 ± 0.050 to 0.029 ± 0.062 mBq/m^3. The standard deviations of the mean activities in 1997 and 1998 were very high compared to the mean concentrations of gross alpha activities found in each year.

The annual mean concentrations of gross beta activities found at these locations for both 1997 and 1998 were quite similar. The WSS location had the lowest gross beta activity of 0.68 ± 0.30 for 1998 and the SMR had the lowest gross beta activity of 0.60 ± 0.40 mBq/m^3 for 1997. The highest beta activity for 1998 was at WFF (0.77 ± 0.29 mBq/m^3).

1.3.2 Groundwater

Representative samples of groundwater were collected from seven wells located around the WIPP site as shown in figure 7.1. Approximately three bore volumes (around 1,000 gallons) of water were pumped out of these wells before approximately 10 gallons of water samples were collected from depths ranging from 600 to 900 feet from six wells (WQSP-1 to WQSP-6), and from a depth of approximately 225 feet from the well WQSP-6A.

Samples were collected twice during CY 1998. Approximately two gallons of water were sent to the contract laboratory for the determination of radionuclides of interest. The rest of the samples were used for to analyze nonradiological parameters and or were put in storage. The samples were acidified to a pH $\leq$ 2 by adding concentrated nitric acid.

Natural precursors such as uranium and potassium were detected in these water samples. The results clearly indicated that there is significant disequilibrium between U-238 and U-234 in these water samples. Disequilibrium between U-238 and U-234 in aqueous systems is a common occurrence, with U-234 activity being higher (~20-30 percent) than the activity of U-238. Among the water samples collected from the wells WQSP-1 through WQSP-6, which are brine water, the activity ratios of U-234 to U-238 ranged from 4.9 (WQSP-3) to 6.7 (WQSP-6), whereas the water sample from well WQSP-6A containing fresh water had the ratio of 1.7 only.

The measurements of K-40 concentrations in samples collected from WQSP-2, WQSP-5, WQSP-6, and WQSP-6A were below their minimum detection concentrations (MDC) (table 5.3.3). The samples from the remaining three wells showed detectable concentrations ranging from 20 ± 24 Bq/L (becquerel per liter) (WQSP-1) to 46 ± 21 Bq/L (WQSP-3).

1.3.3 Surface Water

Eleven different locations around the WIPP site, as shown in figure 5.4.1, were identified for collection of surface water samples. Samples were collected once in CY 1998. One-gallon polyethylene containers were rinsed several times with the water of the sampling location. Finally, sufficient (approximately one gallon) water samples were collected from each of these locations. The samples were labeled and acidified with concentrated nitric acid to a pH $\leq$ 2 immediately after collection. The samples were then shipped to the contract laboratory for analysis.

The concentrations of U-234 ranged from 7.40 ± 3.70 mBq/L (Rainwater Catchment Pond [RCP]) to 274 ± 29.6 mBq/L (Pierce Canyon [PCN]); U-235 ranged from -0.96 ± 1.15 mBq/L (RCP) to 4.44 ± 2.59 mBq/L (Upper Pecos River [UPR]); and U-238 ranged from 6.66 ± 3.37 mBq/L (RCP) to 137 ± 16.6 mBq/L (PCN).

In summary, the concentration of uranium showed a wide variation among the locations; lowest in the sample collected from RCP and highest in the sample from PCN. The large variations in the concentrations of radionuclides among the surface water samples from different locations should normally be expected.

Uranium-238 and U-234 are mostly in equilibrium in soil; however, due to recoil phenomenon, a disequilibrium between the two isotopes is produced in aqueous systems. As a result, the activity of U-234 in most of the water bodies of the world is higher than that of U-238 by approximately 20 to 30 percent. However, larger degrees of disequilibrium are not uncommon. The disequilibrium between U-238 and U-234 was observed in most of the surface water samples also; however, the degree of disequilibrium was much lower than that observed in the ground brine water samples, which ranged from 2 to 7.

1.3.4 Soil Sampling

Soil samples were collected from the same locations around the WIPP site as the air particulate samples: MLR, SEC, SMR, WEE, WFF, and WSS, as shown in figure 5.5.1. Samples were collected from each location in three incremental profiles: 0-2 cm (SS), 2-5 cm (SI), and 5-10 cm (SD), where SS stands for surface soil, SI for intermediate soil, SD for deep soil. Measurements of radionuclides' in-depth profiles provide information about their vertical distribution in the soil systems.

As expected, the concentration of U-238 in soil samples of intermediate depth (2-5 cm) showed a similar pattern as that of U-234. The concentration ranged from 9.25 ±1.63 mBq/g (millibecquerel per gram) at WFF to 24.0 ± 3.63 mBq/g at SEC. Also, as observed for U-234, the means of U-238 concentrations of all SI samples (16.9 ± 4.96 mBq/g) and SS samples (20.7 ± 4.77 mBq/g) were not significantly different from each other.

In summary:

- The mean activities of U-238 (18.4 ± 5.1 mBq/g) and U-234 (18.1± 6.8 mBq/g) were identical, suggesting that both U-238 and U-234 were in equilibrium.

- The mean concentration of U-238 found around the WIPP site (18.4 ± 5.1 mBq/g) was much lower than the mean concentration of 66 mBq/g reported for U-238 in soil samples of the United States (National Council of Radiation Protection [NCRP] Report No. 94).

- Concentrations of U-234 and U-238 in soil samples did not change from 1997 to 1998.

- Concentrations of U-234, U-235, and U-238 in SS (0-2 cm), SI (2-5 cm), and SD (5-10 cm) samples were not significantly different from each other, suggesting that uranium is homogeneously distributed in soil, at least from 0-10 cm deep. The only exception observed was for the location WFF, where the concentrations of U-234 and U-238 in SI and SD samples were significantly lower than their concentrations in SS samples.

Concentrations of K-40 in SI samples (depth of 2-5 cm) ranged from 81 ± 63 mBq/g at WFF to 518 ± 89 mBq/g at WEE, with a mean of 291 ± 158 mBq/g. These results also suggest that there are significant variations among the concentrations of K-40 in the soil samples of different sampling locations. For example, the concentration in WEE sample was higher than the concentrations of all other locations. Also, the concentration found at WFF was significantly lower than the concentration found at every other location. A detailed discussion of these results is in chapter 5, section 5.5.

1.3.5 Sediment Sampling

Sediment samples were collected from 12 locations around the WIPP site, mostly from the same water bodies from which the surface water samples were collected. The samples were generally collected in a knee-deep location of the water body except for CBD. The sample from UPR was taken from the middle section of the river from a bridge. The samples were collected in certified-clean containers from the top six inches of the sediments of the water bodies, brought to the laboratory, dried, and shipped to a commercial laboratory for the determination of individual radionuclides.

Results for uranium concentrations in sediment samples were compared with the uranium concentrations of soil samples. The range of U-234 concentrations in sediment samples (13.3 ± 2.4 mBq/g to 35.5 ± 4.4 mBq/g) was almost identical to the range of U-234 concentrations in surface soil samples (0-2 cm) around the WIPP site (15.2 ± 2.6 mBq/g to 36.3 ± 4.4 mBq/g). Similarly, the range of U-238 concentrations in sediment samples (14.4 ± 2.4 mBq/g to 31.4 ± 4.1 mBq/g) was almost identical to the range of U-238 concentrations in the surface soil samples (15.9 ± 2.6 mBq/g to 28.5 ± 3.7 mBq/g).

In comparison, the concentration of U-234 in 1997 samples was lowest (14.1 ± 2.5 mBq/g) at Noya Tank (NOY) and the highest at CBD (40.7 ± 5.2 mBq/g). For 1998, the U-234 concentration was lowest at UPR (13.3 ± 2.40 mBq/g) and highest at CBD (35.5 ± 4.4 mBq/g). The concentration of U-238 for 1997 ranged from 13.3 ± 2.37 mBq/g (NOY) to 28.9 ± 3.7 mBq/g (CBD). Therefore, U-234 concentrations between the samples of 1997 and 1998 revealed that the concentrations were similar (did not differ significantly) in both years for all locations except UPR and NOY. Concentrations of U-238 also were similar in both years for all locations except UPR and NOY.

1.3.6 Biota Sampling

Uptake of radionuclides by plants and vegetation is an important factor in estimating the intake of individual radionuclides in humans through ingestion. Therefore vegetation samples were collected from the same six locations from which the soil samples were collected. The vegetation samples were chopped into one- to two-inch-long pieces, mixed together well, air dried at room temperature, and sent to the contract laboratory for analysis.

Also, the soft tissues from a deer, a quail, and two rabbits were collected to represent the food chain pathway. Fish is consumed in large quantities; therefore, determination of radionuclides in fish samples is important. Accordingly, fish samples from PCN, PEC, and Brantley Lake (BRA) (three different locations at the Pecos River) were collected. The soft tissues from the deer, quail, rabbits, and the whole fish were sent to the contract laboratory for analysis.

The concentrations of U-234, U-235, and U-238 were determined in vegetation samples; the results are given in table 5.7.1. Concentrations of U-234 ranged from

0.20 ± 0.06 mBq/g (WEE) to 0.75 ± 0.14 mBq/g (MLR). The mean concentration of U-234 in vegetation samples was 0.43 ± 0.20 mBq/g.

Among all the biota samples analyzed, the concentration of U-234 was highest in fish samples. Concentration ranged from 0.22 ± 0.04 mBq/g in the fish collected from BRA to 0.37 ± 0.07 mBq/g in the fish collected from PCN. Concentrations of U-238 in the fish samples ranged from 0.11 ± 0.03 mBq/g to 0.13 ± 0.03 mBq/g. The concentrations of U-234 were higher than the concentrations of U-238 in all the fish samples. This is consistent with the observation that the concentrations of U-234 in water samples from these locations were also higher than the concentrations of U-238.

Potassium-40, a naturally occurring gamma-emitting radionuclide, was also detected in these biota samples. The results are given in table 5.7.7. Concentrations of K-40 in the pooled soft tissues of deer, quail, and rabbit were almost similar and ranged from 107 ± 16 mBq/g in deer to 243 ± 96 mBq/g in rabbit. The concentrations of K-40 in fish were 70 ± 56 mBq/g and 85 ± 56 mBq/g (for PCN and CBD), respectively. The concentration in fish from BRA was below detection level.

1.4 Nonradiological Environmental Monitoring Information

Nonradiological environmental surveillance was also conducted in accordance with the EMP. An extensive baseline of information describing the major ecological components of the Los Medaños region, prior to the initiation of the WIPP site construction activities, was developed. Six universities participated in the initial characterization and baseline surveillance programs. A significant portion of the nonradiological surveillance evaluated the effects of fugitive salt dust generated by the surface stockpiling activities on the surrounding environment. This study is described in the Summary of the Salt Impact Studies at the Waste Isolation Pilot Plant, 1984 to 1990 (DOE/WIPP 92-038).

1.4.1 Land Management

The DOE prepared its Land Management Plan (LMP) as required by section 4 of the LWA, and in collaboration with the U.S. Department of the Interior's (DOI) Bureau of Land Management (BLM) and the state of New Mexico. Changes or amendments to the LMP are made in consultation with the BLM, the state of New Mexico, and affected stakeholders, as appropriate.

The LMP, as required by the LWA, was prepared to identify resource values, promote the concept of multiple-use management, and identify long-term goals for the management of DOE/WIPP lands until the culmination of the decommissioning phase. The plan also provides the opportunity for participation in the land use planning process by the public and local, state, and federal agencies.

1.4.2 Meteorology

The WIPP nonradiological environmental surveillance includes a primary meteorological station that provides support for various programs at WIPP. The primary function of the station is to generate data to model atmospheric conditions for radiological environmental surveillance. The station records meteorological measurements for wind speed, wind direction, and temperature at elevations of 2, 10, and 50 meters (6.6, 33, and 164 feet respectively). Relative humidity, barometric pressure, precipitation, and solar radiation are monitored at ground level. These parameters are measured continuously, and the data are logged at 15-minute intervals in the Central Monitoring System.

Meteorological monitoring is discussed in chapter 6, "Environmental Nonradiological Program Information."

1.4.3 Wildlife Population Monitoring

Observations of various species of wildlife are conducted to assess the effects of WIPP's activities on transient and resident wildlife populations (e.g., raptors, small mammals). Results are published in the Waste Isolation Pilot Plant Raptor Program 1998 Annual Report.

<u>WIPP Raptor Program</u>

During CY 1998, data were collected on resident birds of prey within an area of approximately 870 square miles in the vicinity of WIPP, with the WIPP site as the center of the study area. Most of this sector is managed under the authority of the DOI's BLM Carlsbad Resource Area office, with WIPP lands comprising the nucleus of the research area. This cooperative enterprise between the BLM and the DOE was commissioned through the bilateral development of an interagency agreement. The agreement defines commitments that include specific deliverables and itemized time lines for the completion of each element on behalf of each respective agency.

The CY 1998 field research and public educational activities, collectively referred to as the WIPP Raptor Program, were conducted in relation to raptors (eagles, hawks, falcons, and owls) in the same area. The CY 1998 survey period suggested that raptor populations continue to exhibit predictable downward trends in populations due to drought conditions. Among priority species, 40 Harris hawk (*Parabuteo unicinctus harrisi*) nests and 31 Swainson's hawk (*Buteo swainsoni*) nests were located. Research at each nest included productivity assessments, vegetation measurements, morphological measurements, and nesting behavior.

An educational presentation using live animals, interactive graphics, and upbeat lecture material was developed and implemented to teach children about local wildlife and the WIPP Raptor Program. Presentations were made to over 1,500 students in 67 classrooms throughout Carlsbad, Jal, Santa Fe, Albuquerque, Las Vegas, and Los Alamos, New Mexico, in CY 1998. Talks and presentations were also given to other local groups and organizations.

1.4.4 Reclamation of Disturbed Lands

Reclamation activities during CY 1998 consisted of periodic inspections, supplemental seedings, fence maintenance, and erosion mitigation at several sites. The H-19 hydropad, for example, exhibited severe erosion along a 20- to 30-meter interval on the west elevation. Contour lines were cut perpendicular to the erosion pattern, gullies were filled in, and the area was planted. Eventually, the majority of the pad will be reclaimed in this manner with access points, well heads, and the evaporation pond as the only exclusions.

1.5 Quality Assurance

The purpose of the QA/QC program is to ensure that processes, activities, and products that potentially impact health, safety, and the environment are appropriately planned, implemented, and assessed. The goal of the QA/QC program is twofold: (1) to provide confidence that the data used in demonstrating regulatory compliance are adequate, and (2) to promote continuous improvement in WIPP's operations. The QA program is successful when risks and environmental impacts are identified and minimized, and when safety, reliability, and performance are maximized.

Programs described in this document adhere to policies set forth by QA guidance criteria, including the following:

- ASME [American Society of Mechanical Engineers] NQA-1 [Nuclear Quality Assurance], "Quality Assurance Program Requirements for Nuclear Facilities" (ASME, 1989)
- EPA [Quality Assurance Management Staff] QAMS-005/80, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" (EPA, 1980d)

and the fulfill the requirements of the following:

- "Nuclear Safety Management, Quality Assurance" (10 CFR § 830.120)
- QA plans specified in DOE Orders 5400.1 and 414.1, "Quality Assurance," and DOE/EH-0173T

A comprehensive QA program was implemented to ensure that the data collected reflected selected parameters of the environment. Data have been obtained prior to commencement of operations, providing a sound baseline for comparison with operational phase data. The data will be evaluated to determine future impacts of WIPP on the environment.

The focus of this program includes the following areas:

- Sample collection at specified locations in accordance with approved procedures. These procedures are based on established and accepted practices.

- Procedure review and revision to minimize uncertainties introduced through sampling and analysis, while maintaining comparability and continuity between past and future data.

- Verification and validation of data through performance evaluation by inter-comparison, duplicate analysis, and comparison of radiological data with the Environmental Evaluation Group (EEG).

CHAPTER 2 INTRODUCTION

The WIPP site is located in Eddy County in southeastern New Mexico (figure 2.1). The site is 26 miles east of Carlsbad in a region known as Los Medaños, which represents the initial intergradation between the Llano Estacado and the Chihuahuan desert. This region displays an exceptional diversity of plant and animal inhabitants. Geographically, the region is regarded as a relatively flat, sparsely inhabited plateau with little surface water. The region is popular for recreation, providing opportunities for hunting, camping, hiking, and bird watching.

The majority of the lands outside the WIPP site boundary are managed under the jurisdiction of the DOI's BLM Carlsbad Resource Area office. Land uses in the surrounding area include livestock grazing, potash mining, oil and gas exploration and production (including support services), and recreational activities.

The WIPP site boundary extends at least 1.6 kilometers (one mile) beyond any of the WIPP underground developments and is defined on the surface by the 16-section (4,146 hectares) WIPP Land Withdrawal Area. On October 30, 1992, the LWA was signed into law, transferring the land from the DOI to the DOE. In accordance with edicts contained in the LWA, the WIPP LMP was prepared and submitted to Congress.

Consisting of 16 sections of federal land, the WIPP site is located in Eddy County, New Mexico, in Township 22 South, Range 31 East. With the exception of facilities within the boundaries of the posted 1,454-acre (589 hectares) Off-Limits Area, the surface land uses remain largely unchanged and are managed in accordance with accepted practices for multiple land use. Mining and drilling for purposes other than those which support the WIPP Project are prohibited within the 16-section area.

2.1 Description of the WIPP Project

The WIPP Project is authorized by the DOE National Security, and Military Applications of Nuclear Energy Authorization Act of 1980 (i.e., P.L. 96-164). The legislative mandate is to demonstrate the safe disposal of TRU wastes resulting from national defense activities and programs. To fulfill this mandate, WIPP has been designed to demonstrate safe handling, storage, and disposal of TRU waste in a fully operational disposal facility.

Once TRU wastes have arrived at WIPP, they will be transported into the Waste Handling Building. The waste containers will be removed from the shipping containers, placed on the waste hoist, and lowered to the repository level of 655 m (2,150 feet) below the surface. During the disposal phase, containers of waste will be removed from the hoist and emplaced in excavated storage rooms in the Salado Formation, a thick sequence of salt beds deposited approximately 250 million years ago in the Permian Age. After the disposal areas have been filled, specially designed closures will be placed in the excavated disposal rooms and seals will be placed in the shafts. The nature of salt is such that mine openings will creep closed, causing encapsulation and isolation of the waste within the Salado Formation.

During site operations, the underground area will be ventilated with ambient air that enters the Air Intake Shaft, the Salt Handling Shaft, and the Waste Handling Shaft. The air exits through the Exhaust Shaft. In the event of an underground accident involving radioactivity, exhaust air can be circulated at a reduced flow rate through the Exhaust Filter Building. This building contains banks of high-efficiency particulate air filters that remove contaminated particulate.

2.1.1 WIPP Property Areas

The WIPP site location is shown in figure 2.1. The description of property within the WIPP site is as follows:

Property Protection Area

The interior core area of the facility is approximately 34 surface acres surrounded by a chain link fence. This sector is designated as the "Property Protection Area." All access control features are maintained with uniformed security personnel on duty 24 hours a day.

Exclusive Use Area

The Exclusive Use Area is 277 acres within sections 20, 21, 28, and 29 of Township 22 South, Range 31 East. It is surrounded by a five-strand barbed wire fence and is restricted exclusively for the use of the DOE and its contractors and subcontractors in support of the project. In addition, this area is defined as the point of closest public access for the purposes of analyzing accident consequences to the general public in the WIPP Safety Analysis Report (DOE/WIPP 95-2065). This area is marked by DOE "no trespassing" signs and is patrolled by WIPP security personnel to prevent unauthorized activities or uses.

Off-Limits Area

The Off-Limits Area is 1453.9 acres (approximately 2.2 square miles) within sections 20, 21, 28, and 29 of Township 22 South, Range 31 East. This sector is managed as an area wherein unauthorized entry and introduction of weapons and/or dangerous materials (as provided in 10 CFR §§ 860.3 and 860.4) are prohibited. Pertinent prohibitions and subsequent penalties (10 CFR § 860.5) are posted at consistent intervals along the perimeter as directed in 10 CFR § 860.6. Grazing and public thoroughfare continue until such time that these activities present a threat to the security, safety, and/or environmental quality of WIPP. This sector is patrolled by WIPP security personnel to prevent unauthorized activity or use. While the subject sector is posted, the area is not fenced.

WIPP Land Withdrawal Area

The WIPP site boundary distinguishes the perimeter of the 16-section WIPP Land Withdrawal Area. This tract includes properties outlying the Property Protection Area, the Exclusive Use Area, and the Off-Limits Area. This sector is designated at points of ingress and egress as a Multiple Land Use Area, and is managed accordingly. Certain restrictions, however, do apply. Information regarding land use restrictions is available from the DOE on request.

Special Management Areas

Certain property sectors used in the operation of WIPP (e.g., reclamation sites, well pads, roads) are (and may be) identified as Special Management Areas (SMA). An SMA designation is made due to values, resources, and/or circumstances that meet criteria for protection and management under special management designations. Unique resources of value that are in danger of being lost or damaged, sectors wherein ongoing construction is occurring, fragile plant and/or animal communities, sites of archaeological significance, sectors containing imminent risks (safety hazards), or a sector(s) that may receive an unanticipated elevated security status would be suitable for designation as an SMA. Accordingly, the subject sector would receive special management emphasis under this stipulation. Special Management Areas will be posted against trespass and will be safeguarded commensurate with applicable laws governing property protection. WIPP security personnel will patrol these areas to prevent unauthorized access or use.

2.1.2 Demographics Within the Affected Environment

Approximately 26 residents live in various locations within 10 miles of the WIPP site. The majority of the local population within 50 miles of WIPP are concentrated in and around the communities of Carlsbad, Hobbs, Eunice, Jal, and Artesia. The nearest community is the village of Loving, 18 miles west-southwest of WIPP. The population of Loving increased from an estimated 1,240 in 1990 to a current estimated population of 1,977. The nearest major populated area is Carlsbad, 26 miles west of WIPP. The population of Carlsbad was estimated at 24,952 in 1990, with a current estimated population of 26,974. (Population estimates are calculated by subtracting the number of deaths from the number of births and adding net migration.) The transient population within 10 miles of WIPP is associated with ranching, oil and gas exploration/production, and potash mining.

The two nearby ranch residences (Smith Ranch [SMR] and Mills Ranch [MLR]) are continuously monitored as part of the Environmental Monitoring Program.

Figure 2.1 - Location of the WIPP Site

| 1" = 78 miles |

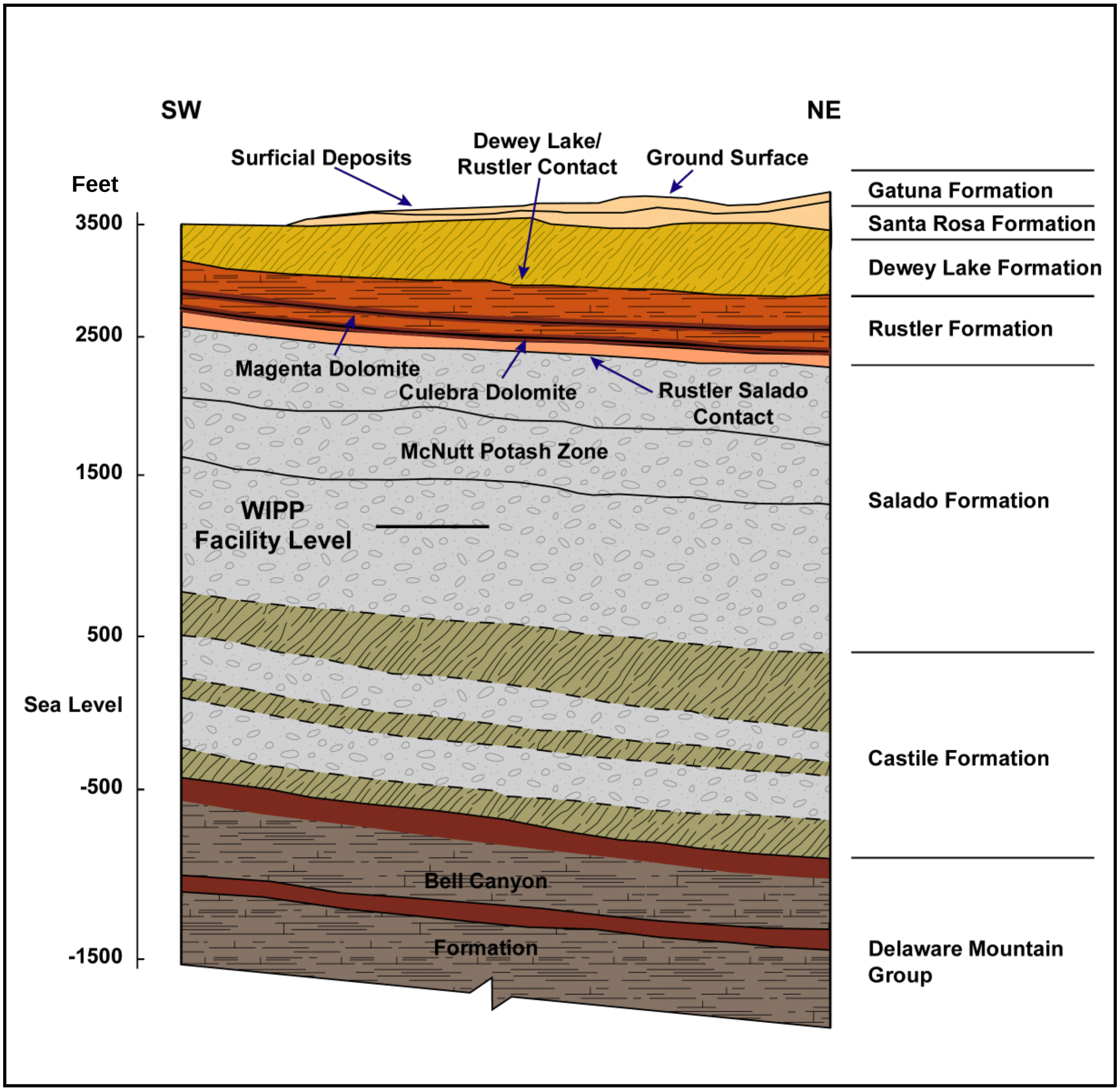

Figure 2.2 - Stratigraph of WIPP

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CHAPTER 3 COMPLIANCE SUMMARY

WIPP is required to comply with all applicable federal and state laws and DOE orders. Documentation of requisite federal and state permits, notifications, and applications for approval is maintained by the WID Environment, Safety, and Health Department. Regulatory requirements are incorporated in facility plans and implementing procedures. The Standards/Requirements Identification Document establishes the environmental, safety, and health requirements that apply to WID and documents the status of WID's compliance with those requirements.

3.1 Compliance Overview

In CY 1998 WIPP maintained compliance with applicable federal and state environmental regulations. Section 3.2 contains a listing of environmental statutes/regulations applicable to WIPP. Section 3.3 describes significant accomplishments and ongoing compliance activities relative to the regulations most pertinent to WIPP's development and eventual opening of the facility. A detailed breakdown of WIPP's compliance with all environmental regulations is available in the WIPP Biennial Environmental Compliance Report (DOE/WIPP 98-2171). Section 3.4 lists other significant accomplishments achieved towards environmental excellence in CY 1998.

3.2 Compliance Status

3.2.1 Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) establishes a comprehensive federal strategy for responding to, and establishing liability for, releases of hazardous substances from a facility to the environment. Hazardous substance cleanup procedures are specified in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR § 300). No release sites have been identified at WIPP that would require cleanup under the provisions of the CERCLA. Any spills of hazardous substances that exceed a reportable quantity must be reported to the National Response Center under the provisions of section 103 of the CERCLA and 40 CFR § 302.

Superfund Amendments and Reauthorization Act of 1986

WIPP is required by sections 311 and 312 of SARA Title III (also known as the Emergency Planning and Community Right-to-Know Act) to submit (1) a list of chemicals for which a material safety data sheet is required, and (2) an Emergency and Hazardous Chemical Inventory Form (Tier II Form) to the State Emergency Response Commission, the Local Emergency Planning Committee, and the fire department with jurisdiction over the facility. The list of chemicals provides external emergency responders with information they may need when responding to a hazardous chemical emergency at WIPP. The Tier II Form, due on March 1 of each year, provides information to the public about hazardous chemicals that a facility has on site above threshold planning quantities at any time during the year. WIPP submits the list of chemicals and the Tier II Form to each fire department with which the CAO maintains an MOU.

Accidental Releases of Reportable Quantities of Hazardous Substances

During 1998, no releases of hazardous substances exceeded the reportable quantity limits.

Pollution Prevention Programs

Pollution prevention activities that took place in 1998 were as follows:

WIPP replaced four-lamp F40 T-12 fluorescent lighting with energy efficient two-lamp F32 T-8 lighting technology in several buildings. Energy savings were the driver for this initiative. A typical 2' x 4' office lighting fixture consumes 196 watts of energy to power two magnetic ballasts and four F40 T-12 lamps. A lighting fixture utilizing a single efficient electronic ballast and two F32 T-8 lamps consumes 85 watts, while providing at least the same light output.

WIPP made its first-time purchase and installation of 100 percent-recycled carpet in the Support Building as part of the renovations on the second floor. In addition, recycled carpet was purchased and installed in the Engineering Building.

Pollution Prevention Opportunity Assessment (PPOA) 98-001, Reduction of Solid Waste, has been initiated. The PPOA recommends the purchase of a sanitary trash compactor to compact sanitary waste at the WIPP site. The compactor will reduce the bulk of sanitary trash by a 4-to-1 ratio.

An additional energy efficient project was the replacement of 1700 watt space heaters with Cozy Legs panels and Cozy Foot Rests. These products use radiant heat, eliminating fire and burn potential to users. The use of these products along with motion sensors on light switches results in energy savings.

Mandatory recycled materials include office and mixed paper (55.52 metric tons [mt]), corrugated cardboard (16.32 mt), aluminum cans (0.12 mt), iron (25.10 mt), batteries (7.80 mt), and engine oils (2.2 mt).

3.2.2 Federal Acquisition, Recycling, and Pollution Prevention

In July 1995 WIPP adopted a systematic and cost-effective affirmative procurement plan for the promotion and procurement of products containing recovered materials. Affirmative procurement is designed to "close a loop" in the waste minimization recycling process by supporting the market for materials collected through recycling and salvage operations.

Affirmative procurement programs are mandated by RCRA section 6002(I), which requires federal agencies and their procuring agencies to establish material preference programs targeted to purchase recycled materials. Executive Order 12873 and the EPA guidelines in 40 CFR §§ 248 through 250 and 252 through 253 provide additional guidance for implementing affirmative procurement programs at federal facilities.

Affirmative procurement programs must include four elements: (1) a preference program; (2) a promotion program; (3) estimation, certification, and verification procedures; and (4) procedures for annual review and monitoring. The purchase and use of recycled products at WIPP will help foster markets for recovered materials and reduce the amount of solid waste requiring disposal.

During 1998 training was provided by the Pollution Prevention Committee to inform employees about the affirmative procurement program. This training provided product identification, requisition preparation, and tools to use during these processes. The committee also developed a catalog that identifies commonly used office supplies that have recycled content.

3.2.3 Resource Conservation and Recovery Act

The RCRA 42 (*United States Code* [U.S.C.] § 3251 et seq.) was enacted in 1976. Implementing regulations were promulgated in May 1980. This body of regulations ensures that hazardous wastes are managed and disposed of in a way that protects human health and the environment. The Hazardous and Solid Waste Amendments of 1984 prohibit land disposal of hazardous wastes unless treatment standards are met. The amendments also place increased emphasis on waste minimization activities and serve as a mechanism to enforce the RCRA cleanup requirements.

The WIPP facility is subject to the permitting requirements under the RCRA and the New Mexico Hazardous Waste Act. Title 40 CFR § 264 outlines the technical standards for treatment, storage, and disposal facilities. Title 40 CFR § 265 outlines interim status standards for owners and operators of hazardous waste treatment, storage, and disposal facilities. Title 40 CFR § 270 outlines the requirements of the RCRA permitting program with respect to general format and content for applications, and the administrative aspects of the permitting and modification processes.

On January 5, 1998, the NMED reissued a completeness determination on the WIPP's RCRA Part B Permit Application. On May 15, 1998, the NMED issued a draft RCRA permit for WIPP, entitled the *Hazardous Waste Facility Draft Permit, Waste Isolation Pilot Plant, EPA No. NM4890139088 by the New Mexico Environment Department*. On August 14, 1998, the CAO and WID submitted comments on the permit. On November 13, 1998, the NMED issued a second draft RCRA permit that addressed some of the public comment received by the NMED.

<u>Hazardous Waste Generator Compliance</u>

Nonradioactive hazardous waste is currently generated through normal facility operations, and is managed in Satellite Accumulation Areas and "less-than-90-day" storage areas. In addition, hazardous waste generated at WIPP is characterized, packaged, labeled, and manifested prior to shipment to an off-site treatment, storage, and disposal facility in accordance with the requirements codified in 40 CFR § 262.

Solid Waste Management Units at WIPP

Activities performed by the CAO and WID in 1998 under the WIPP VRA/CA program generally consisted of responses to requests for information from the NMED and responses to the two drafts of the WIPP facility RCRA permit issued by the NMED in 1998. In completing these tasks, the CAO and WID retrieved and reviewed records pertaining to the SWMUs for submittal to the NMED, completed a site-specific risk assessment using previously collected data from the VRA/CA program, and prepared comments on the draft permits for the NMED. These efforts focused on compiling documentation and arguments to support "no further action" determinations for the WIPP SWMUs and areas of concern (AOCs) in order to remove all SWMUs and AOCs from the final RCRA permit to be issued by the NMED.

3.2.4 National Environmental Policy Act

The NEPA requires the federal government to use all practicable means to consider potential environmental impacts of proposed projects as part of the decision-making process. The NEPA dictates that the public shall be allowed to review and comment on proposed projects that have the potential to significantly affect the environment. The NEPA also directs the federal government to use all practicable means to improve and coordinate federal plans, functions, programs, and resources relating to human health and the environment.

NEPA procedural objectives and public involvement requirements are detailed in the Council on Environmental Quality regulations implementing the NEPA in 40 CFR §§ 1500-1508. The DOE codified its requirements for implementing the council's regulations in 10 CFR § 1021. Further procedural NEPA compliance guidance is provided in DOE Order 451.1A.

Title 10 CFR § 1021.331 requires that, following completion of each environmental impact statement (EIS) and its associated ROD, the DOE shall prepare a mitigation action plan that addresses mitigation commitments expressed in the ROD. Further, DOE Order 451.1A requires DOE facilities to track and annually report progress in implementing a commitment for environmental impact mitigation that is essential to render the impacts of a proposed action not significant or that is made in an ROD. The 1997 Annual Mitigation Report for the Waste Isolation Pilot Plant (NEPA ID# WIP:8:0001) was issued June 22, 1998.

A commitment was made by the DOE in the Supplemental Environmental Impact Statement (SEIS-I) ROD to prepare a second SEIS (SEIS-II) prior to beginning disposal operations at WIPP. In addition, regulatory and statutory changes in the TRU waste inventory and waste acceptance criteria have occurred since the SEIS-I was issued. New hydrologic and geologic information was used in the development of the WIPP performance assessment and the evaluation of the facility's ability to isolate waste. In

September 1997 the DOE published the SEIS-II (DOE/EIS-0026-S-2), taking into account all of the relevant changes since publication of the SEIS-I that might result in potential environmental impacts from WIPP disposal and closures operations. The DOE issued the ROD for the SEIS-II on January 16, 1998.

3.2.5 Clean Air Act

The Clean Air Act (42 U.S.C. § 7401 et seq.) provides for the preservation, protection, and enhancement of air quality, particularly at locations of special interest such as areas of natural, recreational, scenic, or historic value. Under section 109 of the Clean Air Act, the EPA established the National Ambient Air Quality Standards for six "criteria" pollutants: sulfur dioxide, total suspended particulate, carbon monoxide, ozone, nitrogen oxides, and lead. These standards establish primary and secondary standards for ambient air quality that the EPA considers necessary to protect public health and welfare.

The initial WIPP hazardous air pollutant (HAP) emission inventory was developed as a baseline document to calculate maximum potential hourly and annual emissions of both hazardous and criteria pollutants. The HAPs inventory is conducted biannually and compared to the baseline data to identify trends and potential emissions problems. The CY 1999 inventory will be conducted in CY 2000. Emission estimates are used to determine if WIPP is required to obtain an air permit as specified in the following regulations:

- Clean Air Act, § 112, "National Emissions Standards for Hazardous Air Pollutants" (NESHAPs)
- Clean Air Act, Part C (Prevention of Significant Deterioration - Criteria Pollutants)
- New Mexico Administrative Code Title 20, chapter 2, Air Quality

Based on the current HAPs inventory, WIPP operations do not exceed the 10-ton-per-year emission limit for any individual HAP or the 25-ton-per-year limit for any combination of HAPs emissions established in Subpart A of NESHAPs. WIPP does not have NESHAPs Subpart A permitting or reporting requirements at this time. However, 40 CFR § 61, Subpart A, section 61.09(a)(1), requires that the WIPP facility notify the EPA of its anticipated date of initial start-up (i.e., receipt of waste) not more than 60 days and not less than 30 days before actual start-up date. In addition, the EPA required that notification of the actual date of initial start-up must be made within 15 days after start-up.

Based on emission estimates generated in the HAPs inventory, the WIPP site is not required to obtain federal Clean Air Act permits. WIPP, in consultation with the NMED Air Quality Bureau, working in concert with data provided in the first HAPs inventory, was required to obtain a New Mexico Air Quality Control Regulation 702, Operating Permit (recodified in 1997 as Title 20, Chapter 2, Part 72, Construction Permits) for two primary backup diesel generators at the site. The only emission points where the WIPP site exceeds state threshold criteria are the backup diesel generators. WIPP completed all necessary requirements for emissions monitoring and sampling required by New Mexico Air Quality Permit 310-M-2. During CY 1998 the backup diesel generators were operated for approximately 41 of the 480 hours allowed by the permit. There were no malfunctions or abnormal conditions of operation that would cause a violation of the permit.

WIPP's normal operations do not involve or entail any planned or expected releases of airborne radioactive materials to the workplace or the environment. Waste containers accepted for disposal at WIPP are required to meet the 10 CFR § 835 external contamination limits. To ensure compliance, the containers are surveyed both prior to release from the generator sites and as the TRUPACT-II containers are opened at WIPP. Since radioactive material remains in the waste containers unless an accident occurs, there will be no emissions of radionuclides to the ambient air from DOE facilities during normal WIPP waste handling, and the public will not be subjected to radiation. As a result of the above arguments, it may be concluded that WIPP will be operated in compliance with the release standards of 40 CFR § 191, Subpart A, and 40 CFR § 61, Subpart H.

The 1995 Safety Analysis Report establishes the adequacy of the WIPP safety bases regarding plant response to conditions considered to be "extremely unlikely." External doses to workers from the handling of contact-handled (CH) waste containers were estimated to be well within DOE ALARA (as low as reasonably achievable) goals. Moreover, consequences to the public and workers as a result of the release of volatile organic compounds (VOC) during disposal phase normal operations were shown to be many orders of magnitude below health-based limits.

3.2.6 Clean Water Act

Section 402 of the Clean Water Act establishes provisions for the issuance of permits for discharges into waters of the United States. Regulations promulgated to define this permitting process are contained in 40 CFR § 122, subpart A, section (b)(1), and state that "...National Pollutant Discharge Elimination System (NPDES) program requires permits for the discharge of 'pollutants' from any 'point source' into waters of the United States." WIPP has no pollutant discharges from point sources and is currently exempted from obtaining a standard NPDES permit.

In August 1997, WIPP submitted to the EPA a Notice of Intent (NOI) for Storm Water Discharges Associated with Industrial Activity under a NPDES Multi-Sector General Permit. On December 2, 1997, WIPP received a request for additional information necessary to process the NOI. The requested information was submitted in January 1998 and permit NMR05A225 was issued February 23, 1998. This permit replaces the NPDES Storm Water General Permit that was terminated when the national permit program expired on September 9, 1997.

As a condition of the multi-sector general permit, a pollution prevention plan has been developed and implemented. The plan describes how the Best Management Practices and other requirements of the NPDES storm water regulations are being implemented at WIPP.

No sampling is required to demonstrate compliance with the WIPP Storm Water Permit unless a release occurs. Operational permit compliance activities are limited to quarterly inspections of retention basins, spill containment devices, reclamation sites, and site housekeeping practices.

The NPDES sewage sludge regulations promulgated in 40 CFR § 122.21 require all facilities that generate or dispose of sewage sludge to submit an information package describing sewage sludge management and disposal practices. This information is reviewed by the EPA to determine if an NPDES permit will be required for the disposal of sewage sludge at a facility.

On February 14, 1994, the DOE submitted an information package to the EPA Water Management Division and requested a written determination of whether an NPDES permit would be required for sewage sludge generated at WIPP. On March 31, 1994, the EPA Region VI Permits Issuance Section notified the DOE that they had received the information package. The agency determined that the information package was complete and stated they would notify the DOE if a full and complete sewage sludge permit application would be required at a future date.

On January 16, 1992, the NMED issued the Sewage System Discharge Plan (DP-831) for the WIPP sewage facility. In addition to sewage effluent, DP-831 allows for the disposal of a maximum of 1,500 gallons per day of nonhazardous brines generated by seepage into shaft sumps and from pumping of observation wells at the site. Observation well brine waters are collected in portable tanks and transported to the north sewage system evaporation basin. Characterization samples were collected to appropriately disposition brines. On August 28, 1995, WID submitted a request to the NMED requesting a minor amendment to DP-831, increasing the amount of nonhazardous brine for disposal to 2,000 gallons per day. On October 4, 1995, the NMED approved the amendment to DP-831.

In December 1996, an application for renewal of DP-831 was submitted to the NMED. The application consisted of renewal of the existing permit conditions and the addition of the H-19 evaporation pond. This pond was constructed by Sandia National Laboratories (SNL) for use during the Culebra Transport Test Program. The discharge plan renewal and modification was approved by the NMED on July 3, 1997. The permit approves the discharge of up to 8,000 gallons per day of nonhazardous waters generated by mine dewatering activities and pumping of groundwater observation wells, and from miscellaneous nonhazardous sources to the H-19 evaporation pond.

The DOE submits quarterly discharge monitoring reports to the NMED to demonstrate compliance with the inspection, monitoring, and reporting requirements identified in the plan.

Water quality analysis as specified by DP-831 was modified with the issuance of the July 3, 1997, permit. The permit requires quarterly sampling and analysis of the sewage system influent for nitrate; total Kjeldahl nitrogen; total dissolved solids (TDS); Pu-238 and Pu-239+240; americium (Am)-241; U-234, 235, and 238; and Sr-90.

3.2.7 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) (42 U.S.C. § 300f, et seq.) of 1974 provides the regulatory strategy for protecting public water supply systems and underground sources of drinking water. The NMED notified WIPP in a September 9, 1992, letter that the WIPP public water supply was categorized as a nontransient, noncommunity system for reporting and testing requirements.

New Mexico water supply regulations mandate that when a public water supply system supplements other systems, that water system is treated as a single system for compliance sampling purposes. The Carlsbad municipal water supply system is contracted to provide raw water to WIPP from city-owned wells 31 miles north of the site. Because of this contractual agreement, the city of Carlsbad completes the source, or point-of-entry, samples for the various chemical constituents at each well field source.

In a letter dated August 28, 1996, the NMED set the sampling frequency at ten samples every three years. The next required sampling period will be in July 1999.

Bacterial samples were collected and reported monthly throughout 1998. All bacteriological/analytical results were below the SDWA regulatory limits.

3.2.8 National Historic Preservation Act

The National Historic Preservation Act (NHPA) (16 U.S.C. § 470 et seq.) was enacted to protect the nation's cultural resources and establish the National Register of Historic Places. Federal agencies are required to coordinate NEPA compliance with the responsibilities of the NHPA to ensure that historic and cultural properties are given proper consideration in the preparation of environmental assessments (EAs) and EISs. Agency obligations under the NHPA, however, are independent from NEPA and must be complied with even when no EA or EIS is required (i.e., for proposed projects not classified as major federal actions with significant environmental impacts, the DOE must still consider impacts to historic properties and sites). Where both NEPA and the NHPA are applicable, draft EISs must integrate NHPA considerations along with other environmental impact analyses and studies (see 40 CFR § 1502.25).

No new archaeological sites were discovered during 1998, nor were any WIPP-related activities initiated that required archaeological investigation.

3.2.9 Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act (49 App. U.S.C. § 1801 et seq.; 49 CFR §§ 106-179) is one of the major transportation-related statutes that affect the DOE at WIPP. It provides for safe transportation of hazardous materials, including radioactive materials. In the second modification to the Agreement for Consultation and Cooperation, the DOE agreed to comply with all applicable U.S. Department of Transportation (DOT) regulations and corresponding Nuclear Regulatory Commission (NRC) regulations. The DOE issued orders to ensure compliance. The DOE orders establish packaging and transportation safety criteria and require that DOE Field Elements conduct their operations in accordance with all applicable international, federal, state, local, and tribal laws, rules, and regulations governing materials transportation. These DOE orders also require the development of a transportation plan and use of the DOE TRANSCOM (transportation tracking and communications) system to monitor shipments. Additional requirements are included for shipment inspections, notifications, dates, and special instructions.

The following federal regulations are applicable to WIPP:

- Title 10 CFR § 71, NRC requirements for packaging, preparation, and transportation of licensed material.
- Title 49 CFR §§ 171-178, hazardous/radioactive materials regulations.
- Title 49 CFR §§ 173 and 178, packaging specifications
- Title 49 CFR § 174, Subparts A through D and K, shipment of radioactive material by rail regulations.
- Title 49 CFR § 177, routing and training requirements for highway shipments of nuclear material.

The WID Waste Operations Section implements applicable DOT and EPA regulations and DOE orders for the transport of hazardous waste and hazardous materials from WIPP. Shipping sites implement applicable DOT and EPA regulations and DOE orders for the transport of TRU waste to WIPP.

3.2.10 Packaging and Transportation of Radioactive Materials

Regulations for transportation of radioactive materials, under the authority of the DOT, are found in 49 CFR §§ 171 through 178 If the quantity of radioactive material exceeds A_2, as determined by 49 CFR § 173.433, a Type B shipping container (packaging) must be used. The specific requirements for the shipment of radioactive materials and requirements applicable to the Type B packages to be used to transport waste to the WIPP facility are detailed in 49 CFR § 178. Regulations for Type B packaging, under the authority of the NRC, are found in 10 CFR § 71, "Packaging and Transportation of Radioactive Materials." The WIPP LWA requires that TRU waste containers shipped to WIPP shall be transported using packages which have had the design certified by the NRC and which have been determined by the NRC to satisfy its QA requirements.

Additional transportation requirements for the mixed waste shipments (i.e., TRU mixed wastes) are detailed in 40 CFR § 262. The appendix to § 262 provides an example of a hazardous waste manifest and instructions to waste generators and shippers of hazardous wastes.

Contact-handled TRU waste will be shipped in the TRUPACT-II and the HalfPACT. The HalfPACT is a shorter version of the TRUPACT-II; it was designed to transport heavier CH

TRU waste containers. The NRC certified the TRUPACT-II container on August 30, 1989. Since 1989, expansion of the TRUPACT-II payload envelope has been accomplished through applications to the NRC for revisions of the TRUPACT-II Safety Analysis Report for Packaging (SARP) and the Certificate of Compliance (C of C), when applicable. A HalfPACT certification test unit was subjected to hypothetical accident conditions in accordance with the requirements described in 10 CFR § 71, Subpart F. The test results are included in a HalfPACT SARP submitted to the NRC for approval in August 1998. The current revision of the TRUPACT-II C of C, No. 10, expires June 30, 2004.

3.3 Other Significant Accomplishments and Ongoing Compliance Activities

3.3.1 Environmental Compliance Assessment Program

The Environmental Compliance Assessment Program plays a major role in the overall program for environmental protection activities at WIPP. The program was developed to determine if impactive or potentially impactive facility activities protect human health and the environment and if these activities are in compliance with applicable federal, state, and local requirements; with permit conditions/requirements; and with best management practices.

During 1998, ten environmental compliance assessments were conducted. Thirty-three improvements were identified and implemented as a result of these assessments. The assessed areas included Material Safety Data Sheet Requirements, Stratospheric Ozone Protection, Hazardous Waste Records/Manifests, New Mexico Department of Game and Fish Permit 1894, Low Volume Air Sampling, Waste Isolation Pilot Plant (WIPP) Environmental Management System (EMS), Hazardous Waste/Material Emergency Response, Construction Landfill, Environmental Vendor Audit Program, and Environmental Compliance and Support Records Validation.

3.3.2 ISO 14000 – Standards for Environmental Management

The WID EMS received third-party registration on August 5, 1997. Two third-party registration surveillance audits were conducted in CY 1998. No findings or observations were identified during the first surveillance conducted in March. One minor nonconformance was identified during the September 1998 surveillance, and this action was corrected before the audit team left the site.

The Environmental Management System Implementation Document (WP 02-EC.0) was developed to define the roles of WID departments and subcontractors to implement the EMS and update the WID Environmental Management Policy. WP 02-EC.0 applies to all WID operations and designated WID subcontractors at the WIPP site.

The WID Environmental Aspects and Impacts table identifies activities at WIPP that have the potential to have a significant impact on the environment. The Environmental Objectives and Targets table identifies environmental objectives and targets designed to mitigate potential environmental impacts and identifies the date and organization responsible for implementing each of the significant objectives. The goals for this activity are to (1) ensure a system of continuous environmental improvements, (2) more clearly define each organization's roles and responsibilities for implementing the EMS, and (3) promote pollution prevention at WIPP. Additionally, EMS training has been provided to the entire WIPP workforce and EMS training modules have now been integrated into sitewide training programs.

Several actions have been taken to more effectively implement the ISO 14001 Standard at the site. WID formed an ISO 14001 Integration Team that includes members from a majority of WID and subcontractor organizations. Each member is tasked with providing their department's environmental objectives and targets leading to overall improvement under WIPP's EMS.

Integration of WIPP's ISO 14001 program with other Westinghouse government-owned, contractor-operated (GOCO) programs has been initiated. Westinghouse corporate officials and GOCO ISO 14001 coordinators meet regularly to discuss activities to more effectively implement the ISO standard at sites throughout the DOE complex. Information sharing has already occurred, with benefits to all Westinghouse GOCOs. The WID continues to support the ISO 14001 lessons learned programs and shares EMS implementation documentation with both the DOE complex and the private sector.

Articles on ISO 14001 requirements are published periodically in the Westinghouse employee newsletter, *TRU News*. The Environmental Compliance and Support Section (EC&S) of the WID Environment, Safety, and Health Department is responsible for coordinating the annual sitewide review of the EMS Implementation Document, the Environmental Policy, and the Aspects and Impacts and Objectives and Targets tables to ensure that the EMS remains effective.

3.3.3 Pollution Prevention Committee

The Pollution Prevention Committee was formed in 1993 with a representative from each department. The committee prepared a waste minimization charter, which outlines the committee's responsibilities.

During September 1998 the Pollution Prevention Committee participated in the New Mexico State Fair in Albuquerque, New Mexico. Approximately 500 handouts on pollution prevention were distributed to the public. An energy-efficient office display was set up using products made from recycled materials. Additionally a hands-on demonstration was provided using an electric meter to compare the energy requirements of the compact fluorescent light bulb and the incandescent light bulb. Approximately 17,000 fair visitors were informed about energy efficiency in both the home and the workplace.

In October 1998, Energy Awareness Month was celebrated with two displays. One display featured an energy-efficient, low-water-use washer, and an energy-efficient dryer. The second display featured an energy-efficient office. The energy-efficient office demonstrated desk top accessories made of recycled products, computer equipment with the EPA Energy Star Rating, the laser miser used to reduce power "on-time" for printers, a surge protector occupancy sensor, and radiant heat foot rests and Cozy Legs panels. The heaters and surge protector occupancy sensor were the highlights of this display. Interest in the energy-efficient office stems from concerns about 1,700-watt space heaters used at the WIPP site. These space heaters, often left unattended, have an open grill which creates fire and burn hazards due to the high surface temperatures. The radiant heaters eliminate these concerns. During installation of the radiant heaters, each cubicle will also receive a surge protector occupancy sensor, which will result in an overall energy savings of approximately $150 per year (or 3600 kWh/year) per cubicle.

3.3.4 Environmental Training

Environmental training was provided to personnel associated with environmental operations at WIPP. Training courses included technical topics (e.g., RCRA sampling); EMS; basic environmental, safety, and health training; and general sitewide training such as the required General Employee Training module. These courses were conducted both on-site by WIPP personnel and off-site by various contractors.

Table 3.1 - Compliance Status with Major Environmental Regulations Applicable to the WIPP Project

Statute/Regulation	Status
Atomic Energy Act of 1954	No radioactive waste was received during CY 1998.
Clean Air Act	No monitoring/reporting required until after receipt of waste.
Clean Water Act	Quarterly inspections of best management practices to comply with (storm water retention basins) NPDES storm water general permit (NMR00A021).
Comprehensive Environmental Response, Compensation, and Liability Act/SARA	No Land Disposal Units exist at the site. No CERCLA site cleanup required. Reports filed as required under SARA for hazardous substances are maintained on site.
Endangered Species Act of 1973	In November 1996, WIPP completed the draft 1996 Threatened and Endangered Species Survey. The survey is part of the analysis required for the SEIS-II. There were no threatened or endangered species located on WIPP land. Individual permits to collect biological samples and to band nonendangered species of raptors are maintained. No threatened and endangered species have been identified. Consultation with federal and state agencies is not required.
Federal Land Policy and Management Act	An MOU between the DOE and the BLM was issued in July 1994. This MOU outlines the responsibilities the BLM and the DOE have with regard to land use management for the withdrawal area.
Federal Insecticide, Fungicide, and Rodenticide Act	All use of pesticides is approved by Industrial Safety and is performed by subcontractors.
Hazardous Materials Transportation Act	Appropriate shipping papers accompany hazardous materials and hazardous wastes shipped off-site to ensure compliance with the act.
National Environmental Policy Act (as supplemented by DOE Order 451.1A, and 10 CFR § 1021)	The 1997 Annual Mitigation Report for the Waste Isolation Pilot Plant (NEPA ID# WIP:97:0001) was issued June 22, 1998, in accordance with the requirement of DOE Order 451.1E, "National Environmental Policy Act Compliance Program." This order requires DOE facilities to track and annually report progress in implementing a commitment for environmental impact mitigation that is essential to render the impacts of a proposed action nonsignificant or that is made in the ROD.
National Historic Preservation Act	Activities requiring excavation in previously undisturbed areas are surveyed by licensed, permitted archaeologists. Required reports are submitted to the New Mexico State Historic Preservation Officer.
New Mexico Air Quality Control Act	During CY 1998 the backup diesel generators were operated for approximately 41 of the 480 hours allowed by the permit. There were no malfunctions or abnormal conditions of operation that would cause a violation of the permit.
New Mexico Radioactive Materials Act	No radioactive wastes had been received at WIPP in CY 1998.

Table 3.1 - Compliance Status with Major Environmental Regulations Applicable to the WIPP Project

Statute/Regulation	Status
New Mexico Water Quality Act	The DOE submits quarterly discharge monitoring reports to the NMED Groundwater Quality Bureau to comply with the requirements of DP-831.
New Mexico Wildlife Conservation Act	See "Endangered Species Act."
Resource Conservation and Recovery Act	*Hazardous-waste generator compliance:* All site-generated hazardous wastes were transported off site within the 90-day accumulation period. The NMED issued a declaration of technical completeness for Revision 6.5 of the RCRA Part B Permit Application on January 5, 1998, and is currently drafting the RCRA permit. *Underground Storage Tanks:* Annual registration fee paid.
Toxic Substances Control Act	Procurement of asbestos-/PCB-containing materials not allowed. Other portions of the Toxic Substances Control Act are not applicable.

Table 3.2 - DOE Orders Affecting the WIPP Environmental Program

Order No.	Date	Title	Annotation
DOE 5400.1 Paragraphs 2B, 4B, and 4C of Chapter II, and 2D and 3B of Chapter III are canceled by DOE O 231.1	11/09/88 Change 1 6/29/90	General Environmental Protection Program	Establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for ensuring compliance with federal and state environmental protection laws and regulations, federal executive orders, and internal department policies.
DOE 5400.5 Paragraph 1A(3)(A) of Chapter II is canceled by DOE O 231.1	2/8/90 Change 2 1/7/93	Radiation Protection of the Public and the Environment	Establishes standards and requirements for operations of the DOE and DOE contractors with respect to protection of the public and the environment against undue risk from radiation.
DOE O 231.1, Change 2	11/7/97	Environmental, Safety, and Health Reporting	Ensures collection and reporting of information on environment, safety, and health.
DOE 0 225.1A, cancels DOE O 225.1	11/26/97	Accident Investigation	Prescribes requirements for conducting investigations of accidents and preventing recurrence of such accidents.
DOE O 414.1	11/24/98	Quality Assurance	Promotes effective management through performance requirements and technical standards.
DOE O 435.1	7/9/99	Radioactive Waste Management	Promotes radioactive waste management in a manner that is protective of workers, public health and safety, and the environment.
DOE O 451.1A	9/11/95 Change 1 10/26/95	National Environmental Policy Act Compliance Program	Establishes DOE policy for implementation of the National Environmental Policy Act of 1969 (P.L. 91-190).
DOE O 460.1A	10/2/96	Packaging and Transportation Safety	Establishes safety requirements for the proper packaging and transportation of DOE off-site shipments and on-site transfers of hazardous materials and for model transportation.
DOE 5484.1 Paragraphs 1-5, 6a(1)-(10), 6f(1)-(8), and the second misnumbered 6f, and Chapter I and Chapter II are canceled and replaced by DOE O 231.1	2/24/87	Environmental Protection, Safety, and Health Protection Information Reporting Requirements	Establishes the requirements and procedures for the investigation of occurrences that have environment, safety, or health protection significance, and for efficient and environmental monitoring of DOE operations.

Table 3.2 - DOE Orders Affecting the WIPP Environmental Program

Order No.	Date	Title	Annotation
DOE 5480.23	04/10/92 Change 1 03/10/94	Nuclear Safety Analysis Reports	To establish uniform requirements for the preparation and review of safety analyses of DOE operations that include the following: identification of hazards, their elimination or control, assessment of the risk, and documented management authorization of their operation
DOE O 151.1	9/25/95 Change 1 10/26/95	Comprehensive Emergency Management System	Establishes requirements for comprehensive planning, preparedness, response, and recovery activities of emergency management programs for the DOE or for programs requiring DOE assistance.
DOE O 430.1	8/24/95 Change 1 10/26/95	Life-Cycle Assessment Management	To plan, acquire, operate, maintain, and dispose of physical assets as valuable national resources.

Table 3.3 - Active Environmental Permits for the Waste Isolation Pilot Plant
(Does Not Include RCRA Permits)

Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration	Current Permit Status	WID Owner	Signed By Title/Date	Signed For
Department of the Interior, Bureau of Land Management	Right-of-Way for Water Pipeline	NM53809	08/17/1983	None	Active (in perpetuity)	Engineering	Issued by BLM - WIPP signature not required 08/17/83	DOE-CAO
Department of the Interior, Bureau of Land Management	Right-of-Way for the North Access Road	NM55676	08/24/1983	None	Active (in perpetuity)	Facility Operations	Issued by BLM - WIPP signature not required 08/24/83	DOE-CAO
Department of the Interior, Bureau of Land Management	Right-of-Way for Railroad	NM55699	09/27/1983	None	Active (in perpetuity)	Facility Operations	Issued by BLM - WIPP signature not required 09/27/83	DOE-CAO
Department of the Interior, Bureau of Land Management	Right-of-Way for Dosimetry and Aerosol Sampling Sites	NM63136	07/31/1986	07/31/2111	Active	Environmental Monitoring	Issued by BLM - WIPP signature not required 07/31/86	DOE-CAO
Department of the Interior, Bureau of Land Management	Right-of-Way for Seven Subsidence Monuments	NM65801	11/07/1986	None	Active	Mine Engineering	Issued by BLM - WIPP signature not required 11/07/86	DOE-CAO
Department of the Interior, Bureau of Land Management	Right-of-Way for Aerosol Sampling Site	NM77921	08/18/1989	08/18/2019	Active	Environmental Monitoring	Issued by BLM - WIPP signature not required 09/18/89	DOE-CAO
Department of the Interior, Bureau of Land Management	Right-of-Way for Ten Raptor Nesting Platforms	NM82212	09/12/1989	12/13/2019	Active	Environmental Monitoring	N/A - Raptor platforms are inside WIPP 16 sections, therefore Right- of-Way does not apply	DOE-CAO
Department of the Interior, Bureau of Land Management	Right-of-Way for Survey Monument Installation	NM82245	12/13/1989	12/13/2019	Active	Mine Engineering	Issued by BLM - WIPP signature not required 12/13/89	DOE-CAO
New Mexico State Engineer Office	H-14 and H-15 test wells	NM1469 & NM1470	10/18/1986	None	Active	Environmental Monitoring (SNL/DOE)	J. W. Mercer, SNL Engineering Products Div. 7133 10/12/86 (Permit application not dated. Application received at State Eng. Office 10/12/86)	DOE-CAO
Department of the Interior, Bureau of Land Management	Free Use Permit for Caliche	NM96943	01/09/1997	01/09/2000	Active	Environmental Monitoring	D. C. Lynn, WIPP Land Use Coordinator 06/06/1995	DOE-CAO

Table 3.3 - Active Environmental Permits for the Waste Isolation Pilot Plant
(Does Not Include RCRA Permits)

Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration	Current Permit Status	WID Owner	Signed By Title/Date	Signed For
New Mexico Environment Department Groundwater Bureau	Discharge Permit	DP-831	07/03/1997	07/03/2002	Active	EC&S and Facility Operations	G. E. Dials, Manager 12/16/1996	DOE-CAO
New Mexico Environment Department	Operating Permit for two backup diesel generators	310-M-2	12/07/1993	None	Active	EC&S and Facility Operations	A. E. Hunt Project Manager 06/18/1993	DOE-CAO
New Mexico Department of Game and Fish	Individual Banding	#1961	04/01/1997	12/31/1999	Active	Environmental Monitoring	Permit - for use by WIPP	DOE
New Mexico Department of Game and Fish	Master Collecting	#1894	01/01/1999	12/31/1999	Active	Environmental Monitoring	Permit - for use by WIPP	DOE
New Mexico Department of Game and Fish	Concurrence that WIPP construction activities will have no significant impact on state-listed threatened or endangered species	None 07/25/1983 None Active	05/26/1989	None	Active	Environmental Monitoring	N/A	N/A
Department of the Interior, Fish and Wildlife Service	Master Personal Banding	#22478	05/19/1993	Auto. renewed every 3 years	Active	Environmental Monitoring	Permit - for use by WIPP	DOE
Department of the Interior, Fish and Wildlife Service	Concurrence that WIPP construction activities will have no significant impact on federally listed threatened or endangered species	None	05/29/1980	None	Active	Environmental Monitoring	N/A	N/A
New Mexico State Engineer Office	Appropriation: Exhaust Shaft Exploratory Borehole	C-2505 C-2506 C-2507	12/06/1996	12/31/2000	Active	EC&S and Geotechnical Engineering	E. K. Hunter, Asst. Manager ONTWO 09/10/1997	DOE-CAO
New Mexico State Engineer Office	Appropriation: WQSP-1 through 6a	C-2413 through C-2419	10/21/1996	None	Active	EC&S and Environmental Monitoring	E. K. Hunter, Asst. Manager ONTWO 07/03/1996	DOE-CAO
New Mexico State Engineer Office	Declaration of Owner of Underground Water Rights	C-2636 through C-2639	1/12/1999	None (Permits are to obtain SEO well numbers, and will be terminated upon completion of P&A.	Active	EC&S and Environmental Monitoring	G. T. Basabilvaso	DOE-CAO

Table 3.3 - Active Environmental Permits for the Waste Isolation Pilot Plant
(Does Not Include RCRA Permits)

Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration	Current Permit Status	WID Owner	Signed By Title/Date	Signed For
New Mexico Environment Department-UST Bureau	Registration of two Underground Storage Tanks	NM 06233 (Number changes annually)	07/01/1998	06/30/1999	Active	EC&S and Facility Operations	V. Daub, Deputy Project Site Manager 06/18/1992	DOE-CAO
Environmental Protection Agency	NPDES Storm Water Multi-Sector General Permit for use in the state of New Mexico	NMR05A225	02/23/1998	09/09/2002	Active	EC&S	G. E. Dials, Manager, DOE-CAO	DOE-CAO
New Mexico Commissioner of Public Lands	Right-of-Way for High Volume Air Sampler	RW-22789	10/03/1985	10/03/2020	Active	Environmental Monitoring	Permit - for use by WIPP	DOE

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CHAPTER 4 ENVIRONMENTAL PROGRAM INFORMATION

WIPP's policy is to conduct its operations in a manner commensurate with all applicable environmental laws and regulations.

4.1 Environmental Monitoring Plan

WIPP's EMP outlines programs that monitor a comprehensive set of parameters to detect and quantify present and future environmental impacts. Nonradiological portions of the plan focus on the immediate area surrounding the site.

The purpose of the EMP is to prescribe programs that evaluate WIPP's effect on the local ecosystem. Evaluation of the severity, geographic extent, and environmental significance are important to the mission of the facility. The EMP sampling schedule is provided in table 4.1.

The EMP describes the monitoring of naturally occurring and specific anthropogenic radionuclides. This surveillance has included the monitoring of worldwide fallout. The geographic scope of radiological sampling is based on projections of potential release pathways from the stored waste at WIPP. Surrounding population centers are also monitored.

Results and discussions pertaining to respective monitoring programs prescribed by the EMP are provided in chapter 5, "Environmental Radiological Program Information," and chapter 6, "Environmental Nonradiological Program Information."

DOE Order 5400.1 requires the EMP to be reviewed internally every year and updated every three years. The most recent EMP update was in September 1996. In compliance with DOE Orders 5400.1 and 5400.5, WID monitors the environment annually as a part of the ongoing mission to protect the public and the environment.

4.2 Baseline Data

Four programs are currently in place within the WIPP Environmental Monitoring Section: (1) Land Management Programs (includes the WIPP Raptor Program) (section 4.3), (2) Environmental Radiological Assessment (chapter 5), (3) Nonradiological Program Information (chapter 6), and (4) WIPP Groundwater Surveillance Programs (chapter 7). The purpose of these programs is to collect the data needed to detect and quantify possible impacts that construction and operational activities at WIPP may have on the surrounding ecosystem and, when necessary, provide technical support for issues that require technical expertise in the disciplines of environmental science or land management. The data are used to assess impacts of WIPP operations on the environment and to demonstrate compliance with applicable standards for radiological and nonradiological programs.

Preoperational studies must be considered during environmental evaluations. These assessments have contributed to baseline data gathered during the construction phase and provided much of the foundation for long-term monitoring programs. Examples of such investigations include the following:

- WIPP Site Characterization Program - instituted in 1976 by SNL to monitor air quality, background radiation levels, and groundwater quality.

- WIPP Biology Program - began in 1975 with site characterization studies of climate, soils, vegetation, arthropods, and vertebrates.

- Investigations of the Site Geohydrology - conducted by the U.S. Geological Survey (USGS) at the request of the DOE. In addition, the NRC issued a contract to Columbia University to perform a study of radionuclide mobility in the highly saline groundwaters of the Delaware Basin.

- Radiological Monitoring of Air, Water, and Biological Media - conducted by the U.S. Atomic Energy Commission before and after the Project Gnome nuclear detonation.

4.3 Land Management Programs

On October 30, 1992, the LWA became law. This act transferred the responsibility for the management of the WIPP Land Withdrawal Area from the Secretary of the Interior to the Secretary of Energy. In accordance with sections 3(a)(1) and (3) of the act, these lands:

> . . . are withdrawn from all forms of entry, appropriation, and disposal under the public land laws . . . and are reserved for the use of the Secretary of Energy . . . for the construction, experimentation, operation, repair and maintenance, disposal, shutdown, monitoring, decommissioning, and other activities associated with the purposes of WIPP as set forth in section 213 of the DOE National Security and Military Application of the Nuclear Energy Act of 1980 (P.L. 96-164; 93 Stat. 1259, 1265) and this Act.

The DOE developed the LMP as required by section 4 of the WIPP LWA. The development of this plan was in consultation and cooperation with the DOI's BLM and the state of New Mexico. Changes or amendments to the plan require the involvement of the BLM, the state of New Mexico, and affected stakeholders, as appropriate.

The LMP, as required by the LWA, was developed to identify resource values, promote the concept of multiple-use management, and identify long-term goals for the management of WIPP lands until the culmination of the decommissioning phase. The plan also provides the opportunity for participation in the land use planning process by the public and local, state, and federal agencies.

The LMP was prepared through the integration of the LWA, BLM planning regulations (43 CFR § 1600) issued under the authority of the Federal Land Policy and Management Act of 1976; the NEPA, as amended; and existing MOUs among the DOE and local, state, and/or federal agencies. The LMP is designed to provide a comprehensive framework for the management and coordination of WIPP land uses during the life of the project. The LMP, and any subsequent amendments, will continue through the decommissioning phase.

Guidelines in the LMP provide for the management and oversight of WIPP lands under the jurisdiction of the DOE in addition to lands outside the WIPP boundary used in the operation of WIPP (e.g., groundwater surveillance well pads outside the withdrawn area). Furthermore, the plan provides for multiagency involvement in the administration of DOE land management actions. The LMP, as well as any documents referenced therein, is available to person(s) and/or organization(s) desiring to conduct activities on lands under the jurisdiction of WIPP in addition to those involved in development and/or amending existing land management actions.

The LMP envisions and encourages direct communication among stakeholders, including federal and state agencies involved in managing the resources within, or activities impacting the areas adjacent to, the WIPP Land Withdrawal Area. It sets forth cooperative arrangements and protocols for addressing WIPP-related land management actions. The DOE recognizes the guidelines for contemporary land management practices that pertain to rational adherence with edicts in the WIPP Land Withdrawal Area and all applicable regulatory requirements contained therein. Commitments contained in current permits, agreements, or concurrent MOUs with other agencies (e.g., state of New Mexico, DOI), will be adhered to when addressing/evaluating land use management activities and future amendments that affect the management of WIPP lands.

The LMP is reviewed on a biennial basis to assess the adequacy and effectiveness of the document, or as may be necessary to address emerging issues potentially affecting WIPP lands. Affected agencies, groups, and/or individuals may be involved in the review process. Components of the LMP emphasize management protocols for the following issues: administration of the plan, environmental compliance, wildlife, cultural resources, grazing, recreation, energy and mineral resources, lands/realty, reclamation, security, industrial safety, emergency management, maintenance, and work control. Each issue and its complementary planning/management criteria are described in respective chapters of the document.

4.3.1 Land Management and Environmental Compliance

Parties who desire to conduct activities that impact lands under the jurisdiction of WIPP, outside the inner core of the facility designated as the Property Protection Area, are required to prepare a Land Use Request (LUR). An LUR consists of a narrative description of the project, a completed environmental review, and a map depicting the location of the proposed activity. The LUR is used to determine if applicable regulatory requirements have been met prior to the approval of a proposed project. An LUR is submitted to the land use coordinator by any WIPP organization or outside entity wishing to complete any construction, rights-of-way, pipeline easements, or similar actions within the WIPP site boundary and on lands used in the operation of WIPP, under the jurisdiction of the DOE.

During CY 1998, 19 LURs were submitted for review and approval. All 19 met applicable criteria and were approved.

4.3.2 Wildlife Population Monitoring

WIPP is involved in the planning of wildlife investigation and management projects. Recommendations for approaches, potential prospectuses, and proposed investigational plans are evaluated. Tools, techniques, and personnel available for conducting investigations and achieving management objectives are examined. These criteria are essential to wildlife objectives for effective planning related to choices between alternatives, establishment of realistic constraints (e.g., time, funding, manpower), practicality, or expediency in the development of efficient research methodology.

The LUR process provides consideration to wildlife within the WIPP Land Withdrawal Area during planning stages of projects involving the disturbance or encroachment of wildlife habitat inside DOE lands. Monitoring and research of specific wildlife populations occur in accordance with applicable laws, agreements, and regulations subject to funding and personnel constraints.

WIPP conducts a number of general wildlife management activities. Each activity is mandated and/or supported by state and federal guidelines or by way of commitments created through interagency agreements (e.g., Raptor Research and Monitoring Interagency Agreement) and/or MOUs.

Wildlife species in the area are significantly diverse and complex. Management of indigenous wildlife incorporates the development of a logical sequence when programming activities. Solutions for problems (e.g., home-range, territoriality) serve the implementation of conservation and resource management objectives as they pertain to the management and operation of the WIPP site.

<u>Affected Biological and Wildlife Environment</u>

The wildlife habitat around WIPP is categorized in accordance with the BLM's standardized habitat sites subsequent to a detailed integrated habitat inventory classification system. WIPP lands comprise a small part of those lands grouped into major habitat types as described in Appendix L-2 of the East Roswell Grazing EIS. Moreover, habitat types and species inventories were conducted for the DOE during initial site characterization studies as described in the WIPP Biology Program, the FEIS, the site and preliminary design validation studies, and the EMP (DOE/WIPP 92-040). Wildlife in the vicinity of WIPP is characterized by a wide variety of insects, amphibians, reptiles, birds, and mammals.

The Chihuahuan desert has long been regarded for its extraordinary diversity of plant and animal communities. The location of WIPP, the Los Medaños region of the Chihuahuan desert, exemplifies this unusual array of biotic factors. Los Medaños is in an area of intergradation between the northern region of the Chihuahuan desert and the Llano Estacado (Staked Plains). The region is characterized by aeolian and alluvial sedimentation on upland plains that form hummocks, dunes, sand ridges, and swales, with the presence of Havard shinnery oak as a prominent foliar factor. Although the abundance of shinnery oak has aided in the stabilization of the dunes, a number of them remain unstable and exhibit distinct signs of shifting. An additional predominant shrub is honey mesquite, which has invaded what at one time was a short-grass, shinnery oak-dominated landscape.

As with many areas, the shinnery oak community has shifted from a dominant bluestem/grama grassland with varying amounts of shinnery oak, sand sage, and yucca to a composition dominated by dropseeds, three-awns, and gramas, with high densities of plains yucca, annual forbs, and mesquite.

According to the BLM's Resource Management Plan, 15 percent of the wildlife species identified in the resource area use the shinnery oak habitat, with 30 percent occupying areas consisting primarily of grass compositions with greater than 75 percent grasses in the description of the potential plant community.

The subtle blend of plant communities with shinnery oak/dune habitat that somewhat dominates grassland affords a composition of factors that results in the diverse wildlife population of the Los Medaños region.

Wildlife populations are characterized by numerous species of arthropods, amphibians, reptiles, birds, and mammals. Now and then, aquatic mollusks, inhabitants of local stock ponds and livestock drinking units, are observed. Jerusalem crickets (*Stenopelmatus fuscus*) are an example of one order of insects that occupy the locality of WIPP.

Red-spotted toads (*Bufo punctatus*) and New Mexico spadefoot toads (*Spea hammondi*) are two examples of no fewer than ten different species of indigenous amphibians. Their significance is seldom recognized until spring or summer rains, at which time they appear in extraordinary numbers.

Reptiles are more conspicuous inhabitants due to their diurnal nature. Ornate box turtles (*Terrapene ornata*), desert side-blotched lizards (*Uta stansburiana*), and Texas horned lizards (*Phrynosoma cornutum*), a federal notice-of-review species listed under the Endangered Species Act, are three of approximately 35 distinct species of indigenous reptiles. Moreover, three species of rattlesnake can be encountered in the area.

Bird densities vary according to preferred food and habitat availability. The habitat heterogeneity of the Los Medaños region accounts for a wide assortment of bird species that inhabit the area either as seasonal transients or permanent residents. Large numbers of mourning doves (*Zenaida macroura*), pyrrhuloxias (*Cardinalis sinuata*), and black-throated sparrows (*Amphispiza bilineata*) are frequently observed. A unique desert subspecies of the northern bobwhite (*Colinus virginianus*), scaled quail (*Callipepla squamata*), and an occasional lesser prairie chicken (*Typanuchus pallidicinctus*) represent the gallinaceous inhabitants. Due to a scarcity of surface waters in the immediate vicinity of WIPP, migrating or breeding waterfowl are not common.

The area supports a particularly abundant and diverse population of raptors, or birds of prey. Harris hawks (*Parabuteo unicinctus*), Swainson's hawks (*Buteo swainsoni*), and great horned owls (*Bubo virginianus*) are species commonly found nesting in the area. The density of large avian-predator nests is generally regarded as a predominant raptor breeding population.

As is common in desert biomes, black-tailed jackrabbits (*Lepus californicus*) and desert cottontails (*Sylvilagus audoboni*) are the most conspicuous mammals. Three species of ground squirrel (*Spermophilus spp.*), and numerous other rodents such as kangaroo rats (*Dipodomys spp.*) and cactus mice (*Peromyscus eremicus*), also occupy the area. Large piles of debris, which may consist of aluminum cans, cow dung, and other rubbish (sometimes to a height of nearly five feet), clustered at the base of cactus or large mesquites characterize the houses (or "middens") of the southern plains woodrat (*Neotoma micropus*). Although specimens rarely exceed weights of 300 grams, several wood rats that weighed nearly 500 grams have been captured by WIPP biologists near WIPP. Big-game species, such as desert mule deer (*Odocoileus hemionus*), and carnivores, such as coyotes (*Canis latrans*) and badgers (*Taxidea taxis*), also frequent the area.

The DOE consulted with the United States Fish and Wildlife Service (USF&WS) in 1979 to determine the presence of threatened or endangered species at or near the WIPP site. At that time, the USF&WS listed the Lee pincushion cactus (*Coryphantha sneedi* var. *leei*), the black-footed ferret (*Mustela nigripes*), the American peregrine falcon (*Falco peregrinus anatum*), and the bald eagle (*Haliaeetus leucocephalus*) as threatened or endangered species that could occur on lands within or outlying the WIPP site. However, no critical habitat for endangered species was identified at WIPP.

In 1989, the DOE again consulted with the USF&WS to update the list of threatened and endangered species. The agency advised the DOE that the list of species provided in 1979 was still valid.

During 1989, the DOE consulted with the New Mexico Department of Game and Fish (NMDG&F) regarding the state-listed endangered species in the vicinity of WIPP. NMDG&F Regulation 657, dated January 9, 1988, listed seven birds and one reptile in one of two endangerment categories that occur or are likely to occur at the site.

During 1995, the USF&WS transmitted the April 24, 1995, updated list of threatened and endangered species (including a Notice of Review) for Eddy and Lea Counties, New Mexico. Included were approximately 18 species that occur or are likely to occur on WIPP lands. Accordingly, the list was disseminated to pertinent WID departments for consideration and incorporation into applicable documents. A comprehensive evaluation in support of the SEIS-II was conducted during CY 1996 to determine the presence/ absence of threatened and/or endangered species in the vicinity of WIPP. Results indicated that activities associated with the operation of WIPP have no impact on any threatened or endangered species. Considerations pertaining to protected species are implemented in accordance with pertinent management plan(s) during the deliberation and administration of projects conducted on WIPP lands.

Population density measurements of birds and small nocturnal mammals, begun in 1985, were performed annually to assess the effects of WIPP surface activities (e.g., construction, salt piles) on wildlife populations. Customary protocol involved comparative data analyses between two outlying or "control" plots and two experimental plots near WIPP operations. A Hantavirus investigation during CY 1994 prompted the temporary postponement of small nocturnal mammal surveys. Previous years' investigations revealed no detectable detrimental impacts from salt encroachment on the peripheral environment; therefore, annual appraisals of small mammal populations have been discontinued indefinitely.

WIPP Raptor Program

During CY 1998, the WIPP Raptor Program enhanced both the field research and the wildlife education components of the program. Data were collected on resident raptors (eagles, hawks, falcons, and owls) within an area of approximately 870 square miles in the vicinity of WIPP, with WIPP as the center of the area. Most of the area is managed by the DOI's BLM Carlsbad Resource Area office. The program is a cooperative effort between the BLM and the DOE that was commissioned through the bilateral development of an interagency agreement. The agreement defines commitments on behalf of each respective agency, including deliverables and itemized time lines for the completion of each element.

In CY 1998, research was continued on long-term studies of productivity and population demographics of the raptor community in and around WIPP. Other studies that specifically targeted the behavioral ecology of the Harris hawk were started. The WIPP Raptor Program was invited to join in an international effort to study the Swainson's hawk and initiate more detailed studies on the species.

The CY 1998 survey period indicated that raptor populations are starting to recover from drought conditions that characterized the past several years. A total of 40 Harris hawk nesting territories, 31 Swainson's hawk nests, and 18 great horned owl nest sites were monitored. Although four groups of Harris hawks attempted autumnal nests, none were successful.

An evaluation of reoccupancy in known territories was conducted during 1998. Reoccupancy percentages were relatively low for Harris hawks. Approximately one-half of the groups studied in 1997 were not present on territories in 1998. In most cases territorial abandonment did not seem to be related to loss of the nest site used previously. The failure to reoccupy previous nest sites was most likely related to prey densities and, predominantly in Harris hawks, influenced by water availability. Therefore, occupancy trends are considered dynamic and contingent on extrinsic environmental factors. Unfavorable conditions in 1998 may have made some historic territories uninhabitable.

Mortality factors were evaluated and found to be predominated by electrocution and illegal shooting. Mortality incidents were reported to the USF&WS.

The education program, designed to promote a deeper understanding of natural history, raptors, and the WIPP Raptor Program among local school children, was greatly enhanced in CY 1998. A presentation format using live animals was developed and implemented for use in the intimate environment of the classroom. Although this format is more time-intensive than presenting to large groups, it was decided that the benefits of affording children a close look at native wildlife outweighed any disadvantages. Classroom presentations were made to over 1,500 students in classrooms throughout Carlsbad, Jal, Santa Fe, Albuquerque, Las Vegas, and Los Alamos, New Mexico. Other presentations were given to senior citizen groups and special interest groups in the Carlsbad area. Personnel from the WIPP Raptor Program also participated in presentations held at the WIPP site and were active in the Shadowing Program, which offers an opportunity for WIPP DOE and contractor employees to share with local students their diverse knowledge, self-determination, academic achievement, and commitment to community service.

4.3.3 Reclamation of Disturbed Lands

The DOE recognizes responsibilities pursuant to applicable federal, state, and local environmental regulations to enhance and restore areas affected by WIPP activities, including areas disturbed prior to WIPP activities that were accepted as part of the land transfer from the BLM to the DOE. These obligations include protocols designed to be revised as needed and are in no way limited, except by law, to revisions based on new techniques for reclamation and new plans that WIPP may incorporate in the future. WIPP reclamation activities are conducted in accordance with the Environmental Protection Implementation Plan (DOE/WIPP 90-050); DOE Order 5400.1; the DOE Organization Act (42 U.S.C. § 7112); the Federal Land Policy and Management Act of 1976 (P.L. 94-579); the SEIS-I; the FEIS; and all applicable reclamation requirements by federal laws and regulations, executive orders, MOUs, DOE orders, and state and local laws. These commitments encompass any unforeseeable future mandates or amendments to existing regulations.

In accordance with the LMP, WIPP implements a contemporary reclamation program and corresponding long-range reclamation plans. As locations are identified for reclamation, WIPP personnel reclaim these areas by using the best acceptable reclamation practices. Seed mixes used reflect those species indigenous to the vicinity with priority given to those plant species which are conducive to soil stabilization, wildlife, and livestock needs.

Without an active reclamation program, the establishment of stable ecological conditions in arid environments may require decades or centuries to achieve, depending on natural and unnatural disturbances and environmental conditions present during the entirety of the reclamation process. Reclamation activities are intended to reduce soil erosion, increase the rate of plant colonization and succession, and provide habitat for wildlife in disturbed areas. In addition to maintaining the compliance posture of WIPP with respective external entities, reclamation ultimately serves to mitigate the effects of WIPP-related activities on affected plant and animal communities. The objective of the DOE reclamation program is to return lands used in the operation of WIPP that are no longer commissioned for WIPP operations to a stable ecological condition. Plant species and topography of the reclaimed area are indicative of the vicinity. It is the intent of the DOE to establish reclamation guidelines for land use requestors.

Reclamation activities during CY 1998 consisted of working in problem areas (e.g., drainages, eroded slopes, etc.) on existing reclamation sites where additional stabilization measures were employed. Existing fences left in place were repaired as necessary.

4.3.4 Oil and Gas Surveillance

Surveillance of oil and gas activities within one mile of the WIPP boundary were conducted throughout CY 1998 in accordance with the BLM/DOE MOU. Oil and gas activities within the defined land sectors are monitored twice monthly to identify new activities associated with oil and gas exploration/production, including:

- Drilling
- Survey staking
- Geophysical exploration
- Pipeline construction
- Work-overs
- Changes in well status
- Anomalous occurrences (e.g., leaks, spills, accidents, etc.)

The oil and gas industry is well established in the Los Medaños region of New Mexico (the vicinity of WIPP), with producing oil and gas fields, support services, and compressor stations. Nearly all phases of oil and gas activities have occurred in the locality. These phases include seismic exploration, exploratory drilling, field development (comprised of production and injection wells), and sundry other activities associated with hydrocarbon extraction.

As identified in the BLM's Oil and Gas Potential Occurrence Zones, the Los Medaños region is located in a region designated as having a "high potential for oil and gas occurrence." This region, part of the Delaware Basin, is bordered by the Capitan Reef. Most hydrocarbon extraction has occurred outside the basin, within the reef. Although the Delaware Basin accounts for approximately 32 percent of lands in Eddy County, only 17 percent of the oil and gas wells are located within its boundaries.

During 1995, oil and gas reserves in the immediate vicinity of the WIPP Land Withdrawal Area were evaluated by the New Mexico Bureau of Mines and Mineral Resources. Results from this evaluation were compiled in a report, Evaluation of Mineral Resources at the Waste Isolation Pilot Plant Site, March 31, 1996.

During CY 1998, WIPP surveillance teams conducted 24 routine surveillances and 137 cursory inspections and additional surveillances as required.

To date, no wells drilled in the vicinity have exceeded the interval between bottom hole location and the WIPP site boundary. Routine oil and gas surveillance activities continue on a bimonthly basis with supplementary oversight conducted as conditions warrant.

Table 4.1 - Environmental Monitoring Sampling Schedule		
Type of Sample	**Sampling Locations**	**Sampling Frequency**
Liquid effluent	1	Semiannual (oversight)
Liquid effluent	1	Quarterly (DP 831 permit)
Airborne effluent	3	Continuous
Meteorology	2	Continuous
Atmospheric particulate @ CBD (Carlsbad) MLR (Mills Ranch) SMR (Smith Ranch) WEE (WIPP East) WFF (WIPP Far Field) SEC (South East Control) WSS (WIPP South)	7	Weekly
Vegetation	6	Annual
Beef/deer/game birds/rabbits	As available	Annual
Soil	6	Annual
Surface water	14	Annual
Groundwater	7	Semiannual
Fish	3	Annual
Sediment	12	Annual
Aerial photography	Sitewide	Annual
VOCs	2	Semiweekly

CHAPTER 5 ENVIRONMENTAL RADIOLOGICAL ASSESSMENT

5.1 Airborne Gross Alpha/Beta

Radionuclides present in the environment, whether naturally occurring or from aboveground nuclear tests, contribute to radiation doses to humans. Therefore, environmental monitoring around a nuclear facility is imperative for characterizing radiation conditions. Gross alpha and beta measurements in airborne particulate, which are quick and easy, provide information about the approximate amount of radioactivity present in the vicinity of a nuclear facility. Therefore, gross alpha and beta measurements were performed on the air particulate samples collected around the WIPP site.

Airborne particulate samples were collected from seven different locations around the WIPP site: SEC, CBD, MLR, SMR, WEE, WSS, and WFF (figure 5.1.1). Samples were collected every week (approximately 600 m^3 in volume) on Whatman micro fiberglass filters (4.7 cm in diameter) using low-volume continuous air samplers. The samples were collected at a height of 5 to 6.5 feet to closely match the air inhaled by humans. Filters were counted for gross alpha and beta only after being stored for five to seven days in the laboratory to make sure that the short-lived radon daughters had decayed.

Blank fiberglass filter papers were also counted for gross alpha and beta activities so that background corrections (activities present in the blank filter papers) could be made in the gross alpha and beta measurements of the air samples. Gross alpha and beta counts were measured in blank filter paper weekly along with the samples. Counts obtained for blank filter paper were then subtracted from the counts observed for the samples to get the net gross alpha and beta counts for the sample. The net gross alpha and beta activities per cubic meter of air were then determined by dividing the net total activity of gross alpha and beta found in each weekly sample by the amount of air pulled through each sample. The results are given in Appendix B.

Mean concentrations of all the 52 weekly gross alpha activities measured at each of the seven locations are summarized in table 5.1.1. The weekly gross alpha activities for 1998 varied significantly at each location ranging from a minimum of -0.022 ± 0.037 mBq/m^3 to a maximum of 0.20 ± 0.061 mBq/m^3. However, the annual mean concentrations of gross alpha activities found at all locations were similar, ranging from 0.046 ± 0.030 mBq/m^3 to 0.055 ± 0.034 mBq/m^3. The weight of air particulate collected over a period of one year (tables 5.1.3 through 5.1.6) varied by a factor of two among these locations (479.8 mg [milligram] at WSS and 1065.1 mg at CBD). The mean gross alpha activities were quite similar at all locations despite the fact that amount of air particulate varied significantly.

Table 5.1.1 - Annual Mean Gross Alpha Activities Found in Air Particulate Samples Collected Weekly at Various Locations

Location	1997 Gross Alpha Activity (mBq/m^3)			1998 Gross Alpha Activity (mBq/m^3)		
	Min. ± TPU (2σ)	Max. ± TPU (2σ)	Mean ± 2 SD	Min. ± TPU (2σ)	Max. ± TPU (2σ)	Mean ± 2 SD
CBD	-0.034 ± 0.025	0.113 ± 0.049	0.027 ± 0.061	-0.0054 ± 0.040	0.14 ± 0.042	0.049 ± 0.032
SMR	-0.064 ± 0.042	0.118 ± 0.050	0.029 ± 0.062	-0.022 ± 0.037	0.12 ± 0.040	0.046 ± 0.03
WFF	-0.046 ± 0.041	0.081 ± 0.046	0.019 ± 0.050	-0.0033 ± 0.043	0.2 ± 0.061	0.053 ± 0.035
WSS	-0.052 ± 0.044	0.084 ± 0.039	0.023 ± 0.060	-0.0098 ± 0.040	0.13 ± 0.064	0.05 ± 0.030
MLR	-0.043 ± 0.043	0.090 ± 0.039	0.023 ± 0.047	-0.022 ± 0.037	0.13 ± 0.040	0.05 ± 0.031
SEC	-0.035 ± 0.043	0.096 ± 0.040	0.026 ± 0.051	-0.01 ± 0.037	0.17 ± 0.062	0.055 ± 0.034
WEE	-0.041 ± 0.045	0.080 ± 0.040	0.022 ± 0.055	-0.012 ± 0.041	0.14 ± 0.058	0.054 ± 0.032

The annual mean gross alpha activities found at each location in 1997 and 1998 were compared (table 5.1.1) for trend analysis. As can be seen, the mean concentrations of gross alpha activities found in 1998 ranged from 0.046 ± 0.030 to 0.055 ± 0.034 mBq/m^3 and the mean concentrations of gross alpha activities found in 1997 ranged from 0.019 ± 0.050 to 0.029 ± 0.062 mBq/m^3 for each of the seven locations. The standard deviations of the mean activities in 1997 and 1998 were high compared to the mean concentrations of gross alpha activities found in each year. The relative error ratio (RER), in accordance with WIPP procedure WP 02-EM 3004, "Radiological Data Verification and Validation," was calculated for the annual mean gross alpha activities found at each location in 1997 and 1998 to check whether the concentrations found in 1998 were statistically different from the concentrations found in 1997 at each location, using the following equation:

$$RER = \frac{(Mean\ \ Activity)_{98} - (Mean\ \ Activity)_{97}}{\sqrt{(S.D.)^2_{98} + (S.D.)^2_{97}}}$$

where S.D. is the standard deviation of the mean. The RERs found for all locations were less than one, suggesting that the mean gross alpha activities found in 1998 were not different from the mean gross alpha activities found in 1997 at these locations.

The mean of all 52 weekly gross beta activities measured at these seven locations are summarized in table 5.1.2. The results clearly indicate that the weekly gross beta activities varied at each location, ranging from a minimum of -0.021 ± 0.060 to a maximum of 1.6 ± 0.14 mBq/m^3. However, the annual mean concentrations of gross beta activities found at these locations were quite similar and ranged from 0.68 ± 0.30 to 0.77 ± 0.29 mBq/m^3.

Table 5.1.2 - Annual Mean Gross Beta Activities Found in Air Particulate Samples Collected Weekly at Various Locations

Location	1997 Gross Beta Activity (mBq/m^3)			1998 Gross Beta Activity (mBq/m^3)		
	Min. ± TPU (2σ)	Max. ± TPU (2σ)	Mean ± 2 SD	Min. ± TPU (2σ)	Max. ± TPU (2σ)	Mean ± 2 SD
CBD	-0.222 ± 0.056	1.05 ± 0.126	0.640 ± 0.456	0.33± 0.086	1.3 ± 0.11	0.74 ± 0.26
SMR	-0.047 ± 0.111	1.10 ± 0.136	0.604 ± 0.406	0.17 ± 0.11	1.4 ± 0.11	0.73 ± 0.29
WFF	-0.143 ± 0.106	1.38 ± 0.149	0.639 ± 0.469	0.29 ± 0.098	1.4 ± 0.11	0.77 ± 0.29
WSS	-0.140 ± 0.107	1.14 ± 0.125	0.606 ± 0.426	0.23 ± 0.092	1.5 ± 0.11	0.68 ± 0.30
MLR	-0.165 ± 0.108	1.19 ± 0.141	0.641 ± 0.457	0.066 ± 0.082	1.3 ± 0.11	0.70 ± 0.30
SEC	-0.139 ± 0.110	1.25 ± 0.138	0.631 ± 0.476	-0.021 ± 0.060	1.5 ± 0.12	0.77 ± 0.31
WEE	-0.106 ± 0.109	1.13 ± 0.138	0.621 ± 0.443	0.063 ± 0.10	1.6 ± 0.14	0.72 ± 0.31

The annual mean gross beta activities found at each location in 1997 and 1998 were compared (table 5.1.2) to check the trend. The RER calculations showed that the mean activities found in 1998 were not different from the mean activities found in 1997 at any of these seven locations.

The weekly volumes of air pulled through each sampler installed at various locations are given in tables 5.1.3 through 5.1.6. Also, the weights of air particulate collected on the filter paper every week at these locations are given in the same table. As can be seen, the volumes of air pulled through all the samplers were quite similar but the weight of the particulate collected on these filter papers differed from location to location, and also from week to week at each location.

One duplicate sample was collected every quarter by rotating the portable sampler from one location to another every quarter: SMR in the first quarter, CBD in the second quarter, SEC in the third quarter, and MLR in the fourth quarter. The samples were collected by both samplers in identical conditions at all four locations. Duplicate samples were collected and analyzed for the quality control of (a) air sampling technique, (b) determination of gross alpha and beta activities, and (c) analysis of the individual radionuclides in airborne particulate. The duplicate data are provided in Appendix B, and were found to be quite comparable from location to location.

Table 5.1.3 - Weight of Air Particulates and Volume of Air - 1st Quarter 1998

	Carlsbad (CBD)		Mills Ranch (MLR)		Far Field (WFF)		WIPP East (WEE)	
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Week	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)
1	16.9	645.08	4.4	594.76	N/A	N/A	4.5	540.04
2	19.3	591.58	7.1	584.44	5.3	537.22	7.4	601.55
3	22.6	617.27	8.5	601.55	8.4	597.62	8.7	592.60
4	23.6	580.12	8.2	549.57	8.2	566.02	7.8	548.09
5	12.6	613.68	8.3	613.01	6.9	598.92	8.1	559.56
6	13.1	593.35	4.8	567.67	3.9	555.29	4.6	539.47
7	22.4	591.90	7.2	571.54	8.2	585.83	8.8	565.64
8	22.4	576.92	11.9	569.36	7.7	552.52	10.7	563.98
9	20.0	611.40	9.6	601.04	9.2	644.22	11.7	621.01
10	12.6	592.95	7.7	572.25	6.3	538.89	6.8	541.57
11	15.3	561.56	9.1	553.18	5.0	545.31	5.7	545.64
12	30.4	587.34	15.4	561.79	16.6	565.31	18.6	566.45
Total	231.2	7163.13	102.2	6940.17	85.7	6287.14	103.4	6785.58
	WIPP South (WSS)		Smith Ranch (SMR) #1		Smith Ranch (SMR) #2		South East (SEC)	
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Week	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)
1	4.5	561.30	8.5	618.37	7.8	584.36	4.4	575.89
2	7.2	584.44	14.7	585.54	14.2	597.27	7.6	630.81
3	8.4	578.63	20.3	632.31	19.8	615.51	7.4	598.34
4	8.3	534.86	16.8	569.17	16.7	541.03	8.1	587.57
5	8.6	610.91	13.1	613.01	24.0	607.28	8.9	640.31
6	4.1	541.55	12.8	581.59	17.9	587.29	4.3	581.50
7	8.4	579.43	17.6	588.34	18.4	588.69	8.4	624.72
8	8.1	566.84	24.4	534.49	30.6	564.95	8.1	565.49
9	8.0	591.99	19.2	605.28	20.1	622.17	11.1	632.31
10	6.7	523.48	9.3	578.50	18.8	570.20	7.0	566.79
11	6.0	556.95	12.4	552.85	11.7	590.79	6.3	601.55
12	14.3	575.98	26.1	584.14	28.8	566.79	17.1	541.93
Total	92.6	6806.34	195.2	7043.57	228.8	7036.32	98.7	7147.20

Table 5.1.4 - Weight of Air Particulates and Volume of Air - 2nd Quarter 1998								
	Carlsbad (CBD) #1		Carlsbad (CBD) #2		Far Field (WFF)		WIPP` East (WEE)	
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Week	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)
13	19.7	580.26	13.7	499.76	11.0	566.49	13.7	571.77
14	30.8	556.38	23.5	581.84	16.1	537.89	17.9	557.03
15	20.2	578.05	N/A	N/A	11.0	561.49	8.3	595.84
16	24.8	618.37	27.1	598.68	11.2	590.44	11.2	567.85
17	33.7	566.66	32.7	558.12	12.4	525.12	10.9	492.68
18	28.7	530.90	27.2	548.03	11.3	525.31	14.4	539.21
19	44.1	553.41	34.6	540.80	25.2	530.90	25.6	514.79
20	37.3	556.92	37.1	579.77	19.4	526.13	N/A	N/A
21	35.4	488.67	34.6	514.08	16.6	520.48	16.8	515.71
22	38.3	561.30	39.0	569.85	17.7	536.93	20.4	545.18
23	19.4	554.40	23.0	551.21	13.8	559.45	14.5	514.39
24	27.1	539.47	27.6	553.74	12.0	549.24	12.0	544.20
25	30.4	561.97	29.0	579.08	12.8	562.97	12.8	571.54
Total	389.9	7246.74	349.1	6674.95	190.5	7092.83	178.5	5958.42
	Smith Ranch (SMR)		WIPP South (WSS)		Mills Ranch (MLR)		South East (SEC)	
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Week	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)
13	21.1	594.41	10.1	539.25	12.0	583.09	14.0	565.31
14	23.2	571.05	15.4	554.16	16.2	591.49	16.2	573.04
15	13.6	570.99	8.6	574.62	13.1	562.46	8.1	570.18
16	N/A	N/A	11.4	602.26	10.0	600.10	11.4	564.31
17	18.9	514.79	N/A	N/A	12.1	540.06	13.5	563.47
18	32.6	565.49	11.6	482.97	13.3	574.06	14.8	507.32
19	N/A	N/A	N/A	N/A	26.2	526.13	29.1	534.06
20	32.4	605.48	18.6	487.80	23.1	613.37	19.8	485.81
21	26.3	488.38	17.5	510.01	23.1	516.02	18.1	483.53
22	33.1	543.23	15.7	490.65	N/A	N/A	62.3	483.73
23	26.4	540.75	14.9	538.69	14.5	563.31	15.3	498.43
24	19.3	539.47	12.3	538.82	N/A	N/A	15.2	530.88
25	17.6	548.36	20.7	602.98	N/A	N/A	14.4	595.49
Total	264.5	6082.39	156.8	5922.21	163.6	5670.09	252.2	6955.55

N/A = Sample not collected

Table 5.1.5 - Weight of Air Particulates and Volume of Air - 3rd Quarter 1998

	Carlsbad (CBD)		Smith Ranch (SMR)		Far Field (WFF)		WIPP East (WEE)	
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Week	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)
26	19.3	545.82	13.7	539.79	10.2	562.97	10.6	540.11
27	23.2	538.50	22.9	549.57	10.3	448.95	14.0	556.26
28	24.3	542.00	21.2	555.93	N/A	N/A	16.3	543.88
29	15.5	505.22	13.8	539.47	N/A	N/A	9.7	520.11
30	21.0	591.55	18.3	568.01	12.9	596.20	14.0	587.99
31	17.2	554.07	11.0	559.78	7.8	563.98	7.7	542.55
32	13.8	552.09	9.8	556.45	7.4	574.94	7.7	566.45
33	12.7	558.35	12.8	561.78	7.4	543.46	8.0	552.86
34	16.3	559.78	11.6	542.97	9.6	534.39	8.5	542.97
35	24.3	557.59	18.7	550.56	12.1	553.41	11.9	544.85
36	20.1	557.62	15.3	560.96	10.1	572.35	10.8	557.45
37	16.3	563.44	16.5	536.93	8.7	585.83	8.6	562.97
38	16.1	555.93	14.4	551.87	7.8	526.35	7.6	523.28
39	18.7	576.57	25.6	570.86	9.7	585.40	10.4	553.94
Total	258.8	7758.53	225.6	7744.92	114.0	6648.24	145.8	7695.65
	Mills Ranch (MLR)		WIPP South (WSS)		South East (SEC) #1		South East (SEC) #2	
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Week	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)
26	13.6	577.26	10.3	542.64	11.5	514.48	10.8	540.38
27	14.5	511.33	25.0	587.64	16.2	555.93	15.4	545.18
28	19.3	554.73	19.5	583.74	16.0	576.57	15.9	562.30
29	12.9	528.36	5.6	514.39	10.0	543.88	9.8	555.27
30	N/A	N/A	N/A	N/A	14.5	621.60	15.1	609.78
31	8.0	543.29	9.9	589.39	7.1	559.78	8.3	556.92
32	7.0	552.95	9.9	572.45	8.0	554.40	8.3	568.35
33	8.6	582.53	6.6	551.78	9.5	556.59	10.7	590.49
34	9.0	537.25	10.6	574.40	9.9	550.88	9.4	579.08
35	14.2	553.74	9.9	550.88	13.2	560.78	13.5	577.60
36	10.8	561.30	11.4	552.75	12.8	584.44	12.4	590.49
37	9.4	554.40	8.1	531.54	8.0	540.11	8.4	548.03
38	10.9	558.25	N/A	N/A	9.3	547.05	8.7	564.48
39	10.2	564.00	9.2	559.29	12.4	599.76	12.8	614.04
Total	148.4	7179.38	136.0	6710.90	158.4	7866.25	159.5	8002.41

N/A = Sample not collected

Table 5.1.6 - Weight of Air Particulates and Volume of Air - 4th Quarter 1998

	Carlsbad (CBD)		Smith Ranch (SMR)		Far Field (WFF)		WIPP East (WEE)	
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Week	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)
40	23.0	575.98	19.9	546.40	7.6	534.01	8.2	542.32
41	18.2	607.61	16.3	573.38	10.1	622.24	11.1	561.23
42	9.6	542.36	6.6	590.79	6.9	589.74	6.3	566.84
43	12.4	616.28	5.7	435.33	4.2	515.31	5.3	486.68
44	14.6	614.78	13.9	601.55	8.4	504.86	8.9	581.15
45	17.4	544.98	15.1	546.29	7.7	589.45	7.1	548.59
46	25.0	610.10	16.1	592.99	9.5	619.02	11.3	573.04
47	N/A	N/A	12.0	601.55	5.9	593.66	6.8	579.32
48	10.1	627.95	10.6	610.82	4.9	616.53	4.6	593.70
49	11.7	612.22	7.1	594.78	5.5	624.96	5.2	573.27
50	10.2	589.04	7.9	626.21	6.8	606.83	5.7	449.87
51	15.0	618.37	12.8	600.83	5.7	586.88	6.3	621.23
52	18.0	613.40	18.6	625.33	7.2	597.62	7.8	606.54
Total	185.2	7173.00	162.6	7546.30	90.4	7601.10	94.6	7283.80
	WIPP South (WSS)		Mills Ranch (MLR) #1		Mills Ranch (MLR) #2		South East (SEC)	
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Week	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)	(mg)	(m^3)
40	11.3	559.11	10.3	549.01	11.3	568.07	8.3	535.29
41	8.6	559.78	12.0	529.64	12.6	563.81	9.5	580.01
42	5.1	592.95	4.8	595.82	6.4	578.63	6.5	536.29
43	6.3	564.31	8.1	618.74	4.1	595.47	N/A	N/A
44	7.8	569.02	9.3	603.34	12.3	600.48	7.1	549.36
45	8.3	562.13	9.6	573.83	10.4	616.44	N/A	N/A
46	11.9	549.90	11.8	587.29	11.1	584.09	13.9	601.55
47	7.9	590.79	8.2	564.64	19.9	573.24	8.6	616.53
48	7.8	581.94	4.6	596.55	4.4	582.28	6.1	602.98
49	6.1	619.65	5.6	591.93	8.1	611.49	6.6	603.32
50	7.4	603.27	7.3	634.04	7.6	625.47	7.8	638.00
51	5.9	621.60	6.6	604.41	6.3	581.50	6.7	603.04
52	N/A	N/A	9.1	599.39	9.5	613.23	7.5	586.39
Total	94.4	6974.40	107.3	7648.60	124.0	7694.20	88.6	6452.70

N/A = Sample not collected

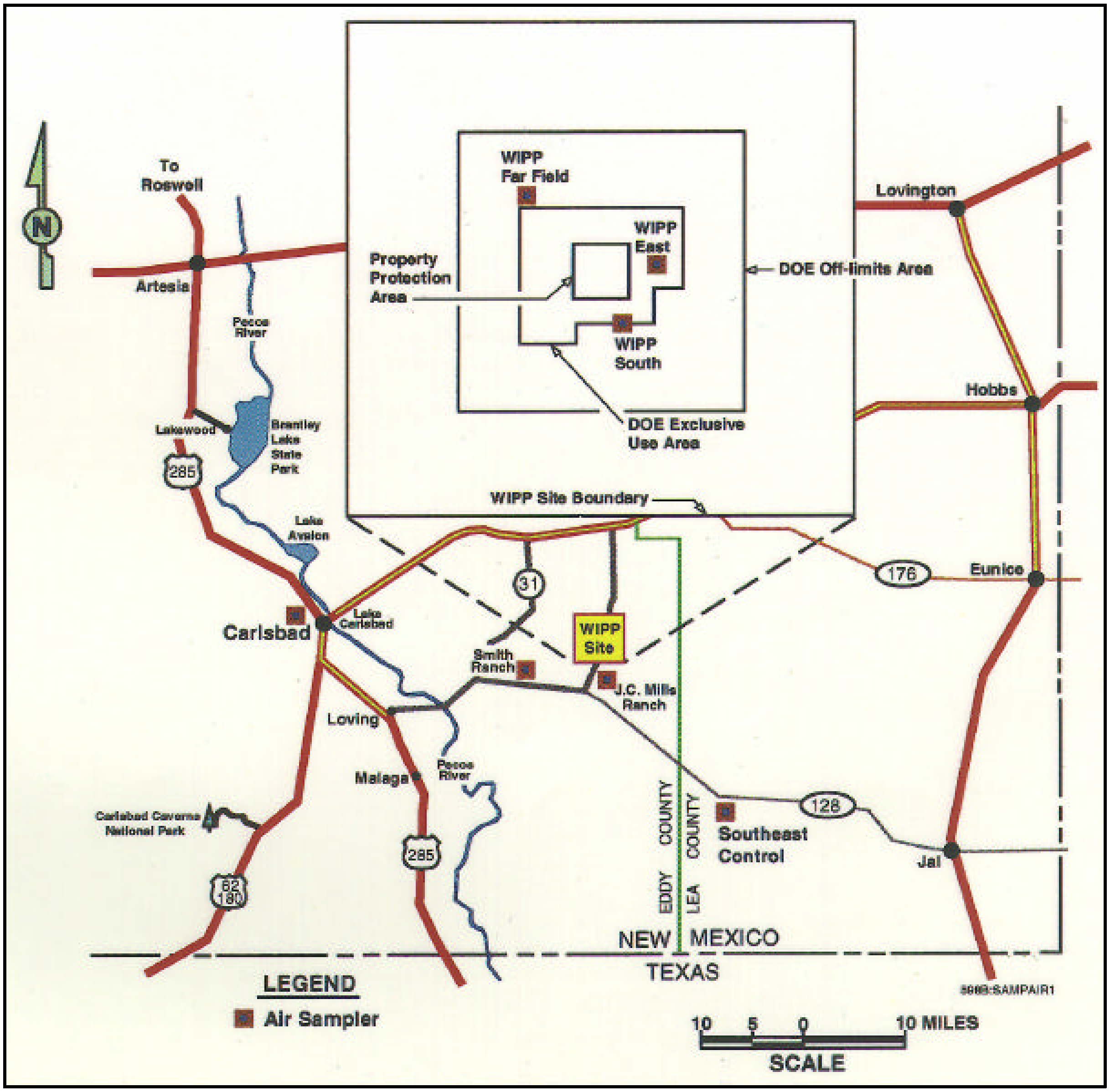


Figure 5.1.1 - Air Sampling Locations

5.2 Airborne Particulate

The major pathways for the intake of radioactive materials in the human body are from the inhalation of dust particles and ingestion of food and drinking water. The uptake of insoluble materials (classified as class Y compound in earlier metabolic models or “S” type materials in recent models) through ingestion is very poor; therefore, inhalation becomes the major pathway for the intake of such radioactive materials. Plutonium, the major constituent of the TRU wastes to be disposed of at the WIPP site, is mostly in insoluble form (class Y or S); therefore, the inhalation pathway would contribute most of the radiation doses. Accordingly, plutonium and other radionuclides of interest were determined in air particulate samples around the WIPP site.

Sample Preparation: The weekly air particulate samples were collected on fiberglass filter papers and composited for each quarter. They were transferred into a Pyrex beaker. The samples were spiked with appropriate tracers and heated in a Muffle oven at 250°C for two hours, followed by two hours at 375°C and six hours at 525°C. The ash was cooled, transferred quantitatively into a Teflon beaker by rinsing with concentrated nitric acid, and heated with concentrated hydrofluoric acid. The residue was heated with a mixture of nitric and hydrofluoric acids until completely dissolved. Hydrofluoric acid was removed quantitatively by evaporating to dryness. Approximately 25 ml (milliliters) of concentrated nitric acid and one gram of boric acid were added, heated, and finally evaporated to dryness. The residue was dissolved in 8 M (molar) HNO_3 (nitric acid) for gamma spectrometry and determinations of Sr-90 and alpha-emitting radionuclides.

Determination of Individual Radionuclides: Beryllium-7, K-40, Co-60, and Cs-137 were determined by gamma spectrometry. Strontium-90 and alpha-emitting radionuclides were determined by sequential separation and counting. Determination of actinides involved co-precipitation, ion exchange separation, source preparation, and alpha spectrometry.

Results and Discussions: Isotopes of plutonium and americium were measured because they are the most significant alpha-emitting radionuclides among the constituents of TRU wastes to be received at the WIPP site. Uranium isotopes were measured because they are prominent alpha-emitting radionuclides in a natural environment.

The minimum and the maximum concentrations of naturally occurring isotopes of uranium (U-234, U-235, and U-238) found among the four quarters of the composited air particulate samples are given in tables 5.2.1, 5.2.2, and 5.2.3, respectively. The minimum concentrations of U-234 ranged from 1.66E-06 ± 1.18E-06 Bq/m^3 (SMR) to 2.74E-06 ± 1.41E-06 Bq/m^3 (SEC), whereas the maximum concentrations of U-234 ranged from 3.22E-06 ± 1.44E-06 Bq/m^3 (CBD) to 4.70E-06 ± 1.78E-06 Bq/m^3 (WSS). The variations among the minimum and maximum concentrations found at each location were not significant, suggesting that there were no significant variations in the concentrations of U-234 in different quarters.

The concentration of U-235 in the natural environment is very low compared to the concentrations of U-234 and U-238 (1 µg [microgram] of natural uranium contains 12.4 mBq [0.33 pCi (picocurie)] of U-238, 0.37 mBq [0.01 pCi] of U-235, and 12.4 mBq [0.33 pCi] of U-234); therefore, the amount of U-235 in air particulate samples is expected to be very low. The mean concentrations of U-235 (mean of all four quarters) found at all locations except at SEC were lower than their minimum detectable activities (MDA). The mean concentration of U-235 at SEC (9.11E-07 ± 1.77 E-06 Bq/m^3) was very close to its MDA (8.05E-07 Bq/m^3). These results suggest that the concentrations of U-235 in air particulate samples collected at these locations were nondetectable.

The significant differences in the minimum and the maximum concentrations of U-238 found at each of these locations suggest that there was significant variation in the concentrations of U-238 in air particulate samples collected in different quarters. Because the concentrations of U-234 did not vary significantly from quarter to quarter, and U-234 is in equilibrium with the parent U-238, there should not be any significant variation among the concentrations of U-238 found in four different quarters.

The reported concentration ranges of Pu-238 found in quarterly composited air filters collected at each of these seven locations are given in table 5.2.4. The concentrations found at these locations were below their respective MDAs. The reported minimum and maximum concentrations of Pu-239+240 found among four quarterly composited samples at each location are given in table 5.2.5. The concentrations found were below their respective MDAs.

The ranges of Am-241 concentrations in these air particulate samples are given in table 5.2.6. All these results were associated with very large analytical uncertainties. The concentration at WFF was slightly greater than the MDA for this sample (about 7 percent greater), but was less than the average MDA for these analyses. The reported Am-241 concentration for WEE was actually less than the reported MDA for this sample and is therefore not considered a positive indication.

Among all the non-alpha-emitting radionuclides, Sr-90 and Cs-137 are important constituents of the TRU waste to be disposed of at WIPP. Therefore, it is important to study the background levels of these two radionuclides before receiving the waste. Beryllium-7 and K-40, the naturally available gamma-emitting radionuclides, were also determined in these samples. Cobalt-60, though not a major constituent of the waste, was also determined.

The results obtained for the concentrations of beryllium (Be-7) in air particulate samples were positive and similar at all locations (table 5.2.7). The mean concentrations of all four quarters ranged from 1.31E-02 ± 2.98E-03 Bq/m^3 found at CBD to 1.68E-02 ± 5.44E-03 Bq/m^3 found at MLR. The minimum and the maximum concentrations of Be-7 found at each location did not differ significantly from each other, suggesting that there was not significant variation among the concentrations of Be-7 from one quarter to other at all the sampling locations.

Concentrations of K-40, a naturally available gamma-emitting radionuclide in the environment, were below their MDAs in all the quarterly samples collected at all seven locations (table 5.2.8). Also, the analytical errors associated with these measurements were much higher than the concentrations found. These results suggest that the concentrations of K-40 in air particulate samples were nondetectable.

As can be seen from the results given in table 5.2.9, Co-60 was not detected in most samples. The maximum concentrations of Co-60 found at WEE and WSS were slightly higher than the MDAs. These results, therefore, suggest that the concentrations of Co-60 in air particulate samples were either below the detectable level or near the detection limit.

The results for Sr-90 are given in table 5.2.10. The mean concentration of Sr-90 found at each location was below its MDA, suggesting that the annual mean concentration of Sr-90 was below detection limit. However, the maximum concentrations found at four of the seven locations were positive, ranging from 3.42E-05 ± 1.92E-05 Bq/m^3 to 4.85E-05 ± 2.52E-05 Bq/m^3.

The range and mean concentrations of Cs-137 in air particulate samples of different sampling locations are given in table 5.2.11. The mean concentration for each location was below its MDA, suggesting that the concentration of Cs-137 was low and could not be detected. The maximum concentrations found at MLR, WFF, and WSS were slightly above the average MDAs. They ranged from 3.65E-05 ± 1.59E-05 Bq/m^3 at MLR to 5.55E-05 ± 2.85E-05 Bq/m^3 at WSS.

Duplicate air particulate samples were collected at SMR, CBD, SEC, and MLR by rotating the portable sampler from one location to another every quarter: SMR in the first quarter, CBD in the second quarter, SEC in the third quarter and MLR in the fourth quarter. The samples were collected by both samplers in identical conditions at all four locations. The duplicate samples were analyzed to check the reproducibility of the data. The results are given in table 5.2.12.

The results for U-234 and U-238, Be-7, and Sr-90 were compared in original and duplicate samples for four locations. The results for all other radionuclides were excluded because their concentrations were mostly nondetectable. The RER tests were performed to check whether or not the concentrations of these radionuclides in original and duplicate samples differed. The tests showed that the concentrations of U-234 in original and duplicate samples did not differ from each other, nor did concentrations of U-238 in original and duplicate samples collected at SMR, CBD, and SEC. However, the original sample collected at MLR gave negative results, whereas, the duplicate sample gave a concentration of 1.33E-06 ± 7.40E-07 Bq/m^3. This suggests that there were analytical problems associated with the determinations of U-238 in this sample.

Applying the same test, no differences were found between the concentrations of Be-7 in original and duplicate samples. Concentration of Sr-90 in original and duplicate samples collected at CBD were not different from each other, whereas the concentrations of Sr-90 in original and duplicate samples collected at SMR, SEC, and MLR were below detection levels. In general it can be concluded that the data from the duplicates were reproducible.

The results obtained for the concentrations of Pu-238, Pu-239+240, and Am-241 in air particulate samples were compared with the results found by the Environmental Evaluation Group (EEG). The WID results were quite similar to the EEG results in that the concentrations of these radionuclides were very low and could not be detected either by the EEG or by WID. The mean concentrations of Pu-238 (-9.0E-09 ± 2.6E-08 Bq/m^3), Pu-239+240 (1.7E-08 ± 1.6E-08 Bq/m^3), and Am-241 (2.3E-08 ± 3.6E-08 Bq/m^3) reported by the EEG were below their MDCs. The MDCs for Pu-238, Pu-239+240, and Am-241, as reported by EEG, were 5.3E-07 Bq/m^3, 1.4E-07 Bq/m^3, and 4.4E-07 Bq/m^3, respectively. For comparison sake, the best estimates of the true means found by WID were -3.00E-08 ± 8.08E-08 Bq/m^3 for Pu-238, 1.36E-07 ± 8.08E-08 Bq/m^3 for Pu-239+240, and 2.23E-07 ± 1.19E-07 Bq/m^3 for Am-241. However, the mean concentrations of Pu-238, Pu-239+240, and Am-241 found by WID also were below their detection limits, which were 1.44E-06, 9.28E-07, and 1.20E-06 Bq/m^3, respectively. The lower MDCs reported by the EEG are calculated based on the high-volume sampling method employed by the EEG.

Table 5.2.1 - Measurement of Radionuclides in Air Particulate - Uranium-234

	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	2.20E-06	1.11E-06	3.22E-06	1.44E-06	2.63E-06	4.28E-07	1.29E-06
Mills Ranch (MLR)	2.22E-06	1.11E-06	4.22E-06	1.48E-06	2.93E-06	8.83E-07	1.28E-06
South East Control (SEC)	2.74E-06	1.41E-06	3.85E-06	1.29E-06	3.10E-06	5.24E-07	1.15E-06
Smith Ranch (SMR)	1.66E-06	1.18E-06	3.77E-06	1.44E-06	2.55E-06	9.18E-07	1.79E-06
WIPP East (WEE)	1.75E-06	1.26E-06	3.33E-06	1.33E-06	2.62E-06	6.93E-07	1.70E-06
WIPP Far Field (WFF)	2.66E-06	1.15E-06	3.85E-06	1.52E-06	3.18E-06	5.40E-07	1.29E-06
WIPP South (WSS)	2.14E-06	1.26E-06	4.70E-06	1.78E-06	3.10E-06	1.11E-06	1.62E-06

Table 5.2.2 - Measurement of Radionuclides in Air Particulate - Uranium-235

	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	2.22E-07	5.18E-07	4.85E-07	6.29E-07	3.92E-07	1.17E-07	6.35E-07
Mills Ranch (MLR)	1.11E-07	1.85E-07	5.22E-07	1.48E-06	3.58E-07	1.99E-07	1.23E-06
South East Control (SEC)	-1.75E-07	4.44E-07	3.55E-06	1.33E-06	9.11E-07	1.77E-06	8.05E-07
Smith Ranch (SMR)	-2.59E-07	4.44E-07	3.11E-06	1.22E-06	9.63E-07	1.51E-06	1.07E-06
WIPP East (WEE)	-2.96E-07	7.03E-07	1.44E-06	8.88E-07	2.65E-07	8.07E-07	1.15E-06
WIPP Far Field (WFF)	0.00E+00	3.70E-07	3.41E-07	5.92E-07	1.76E-07	1.53E-07	7.82E-07
WIPP South (WSS)	-3.06E-07	7.40E-07	2.23E-07	6.29E-07	2.53E-08	2.30E-07	1.25E-06

Table 5.2.3 - Measurement of Radionuclides in Air Particulate - Uranium-238

	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	3.33E-07	4.81E-07	3.00E-06	1.04E-06	2.12E-06	1.23E-06	8.69E-07
Mills Ranch (MLR)	-1.11E-07	4.44E-07	3.26E-06	1.26E-06	2.24E-06	1.58E-06	1.48E-06
South East Control (SEC)	-1.11E-07	4.44E-07	3.14E-06	1.07E-06	1.87E-06	1.48E-06	5.57E-07
Smith Ranch (SMR)	2.22E-07	4.07E-07	3.33E-06	1.15E-06	2.15E-06	1.48E-06	7.95E-07
WIPP East (WEE)	4.07E-07	5.92E-07	2.93E-06	1.48E-06	1.87E-06	1.12E-06	1.02E-06
WIPP Far Field (WFF)	2.18E-06	1.11E-06	3.24E-06	1.22E-06	2.65E-06	4.44E-07	9.80E-07
WIPP South (WSS)	9.03E-07	8.51E-07	4.18E-06	1.22E-06	2.37E-06	1.41E-06	1.34E-06

Table 5.2.4 - Measurement of Radionuclides in Air Particulate - Plutonium-238							
	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	1.38E-07	1.15E-06	2.22E-07	4.81E-07	6.83E-07	1.03E-06	1.14E-06
Mills Ranch (MLR)	-4.25E-07	1.04E-06	3.20E-07	7.03E-07	-7.95E-09	3.58E-07	1.58E-06
South East Control (SEC)	-3.70E-07	6.66E-07	-1.35E-07	4.81E-07	-2.18E-07	1.32E-07	1.54E-06
Smith Ranch (SMR)	-6.99E-07	2.00E-06	3.33E-07	5.18E-07	-4.94E-08	4.49E-07	1.72E-06
WIPP East (WEE)	1.11E-07	6.66E-07	2.96E-07	4.81E-07	2.03E-07	1.31E-07	1.15E-06
WIPP Far Field (WFF)	-3.77E-07	1.18E-06	7.40E-08	5.55E-07	-1.58E-07	2.28E-07	1.62E-06
WIPP South (WSS)	-6.47E-07	1.04E-06	2.59E-07	5.92E-07	-2.90E-07	4.82E-07	1.35E-06
Best estimate of true mean					-3.00E-08	8.08E-08	
Inhaled Air Derived Concentration Guide (DCG) Class W					1.11E-03		

Table 5.2.5 - Measurement of Radionuclides in Air Particulate - Plutonium-239+240							
	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	-2.76E-07	5.55E-07	6.66E-07	4.81E-07	9.76E-08	4.05E-07	8.14E-07
Mills Ranch (MLR)	-1.11E-07	5.18E-07	3.20E-07	4.81E-07	7.03E-09	2.09E-07	1.05E-06
South East Control (SEC)	0.00E+00	4.07E-07	7.58E-07	8.88E-07	4.13E-07	3.84E-07	8.23E-07
Smith Ranch (SMR)	7.40E-08	4.44E-07	1.76E-07	3.48E-07	1.33E-07	5.29E-08	6.75E-07
WIPP East (WEE)	-2.59E-07	5.18E-07	1.49E-07	7.77E-07	-4.65E-08	1.70E-07	9.43E-07
WIPP Far Field (WFF)	-5.62E-07	1.33E-06	5.18E-07	5.18E-07	-9.65E-08	4.55E-07	1.33E-06
WIPP South (WSS)	-2.59E-07	5.18E-07	4.81E-07	4.44E-07	2.05E-07	4.04E-07	8.60E-07
Best estimate of true mean					1.36E-07	8.08E-08	
Inhaled Air Concentration Guide (DCG) Class W					7.40E-03		

Table 5.2.6 - Measurement of Radionuclides in Air Particulate - Americium-241							
	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	-7.66E-08	5.18E-07	2.59E-07	5.18E-07	1.02E-07	1.66E-07	1.09E-06
Mills Ranch (MLR)	-2.77E-07	1.07E-06	4.62E-07	4.81E-07	1.02E-07	3.04E-07	1.81E-06
South East Control (SEC)	1.71E-07	8.88E-07	9.99E-07	6.66E-07	5.42E-07	3.45E-07	1.09E-06
Smith Ranch (SMR)	1.85E-07	9.25E-07	1.67E-06	1.07E-06	6.54E-07	6.90E-07	1.35E-06
WIPP East (WEE)	2.22E-07	5.18E-07	1.32E-06*	1.04E-06	7.84E-07	4.67E-07	1.05E-06
WIPP Far Field (WFF)	-1.11E-07	4.81E-07	9.36E-07*	7.06E-07	3.39E-07	4.36E-07	7.08E-07
WIPP South (WSS)	-2.96E-07	5.18E-07	7.40E-07	8.88E-07	1.09E-07	4.69E-07	1.32E-06
Best estimate of true mean					2.23E-07	1.19E-07	
Inhaled Air Derived Concentration Guide (DCG) Class W					7.40E-03		

*Notes: 1. For WEE, the individual MDA was reported as 1.43E-06 Bq/m^3

2. For WFF, the individual MDA was reported as 8.71E-07 Bq/m^3. The reported value is less than the average MDA.

Table 5.2.7 - Measurement of Radionuclides in Air Particulate - Beryllium-7							
	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	1.10E-02	3.11E-03	1.52E-02	6.66E-03	1.31E-02	2.98E-03	6.44E-03
Mills Ranch (MLR)	1.07E-02	2.81E-03	2.11E-02	9.25E-03	1.68E-02	5.44E-03	1.11E-02
South East Control (SEC)	1.15E-02	7.40E-03	1.59E-02	9.62E-03	1.33E-02	2.29E-03	9.10E-03
Smith Ranch (SMR)	1.32E-02	3.11E-03	1.70E-02	8.88E-03	1.48E-02	1.96E-03	8.97E-03
WIPP East (WEE)	1.03E-02	2.63E-03	1.74E-02	8.88E-03	1.35E-02	3.57E-03	9.04E-03
WIPP Far Field (WFF)	1.33E-02	7.77E-03	1.41E-02	3.14E-03	1.37E-02	5.23E-04	7.27E-03
WIPP South (WSS)	9.47E-03	3.14E-03	1.59E-02	1.07E-02	1.33E-02	3.36E-03	9.25E-03

Table 5.2.8 - Measurement of Radionuclides in Air Particulate - Potassium-40							
	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	-1.34E-04	3.55E-04	4.99E-04	6.66E-04	1.83E-04	2.66E-04	5.55E-04
Mills Ranch (MLR)	-2.84E-04	4.44E-04	3.56E-04	6.66E-04	5.80E-05	3.16E-04	6.75E-04
South East Control (SEC)	-2.28E-04	3.63E-04	1.85E-04	6.66E-04	-3.25E-05	2.11E-04	6.10E-04
Smith Ranch (SMR)	-6.29E-04	4.07E-04	2.96E-04	3.70E-04	-1.27E-04	4.57E-04	6.38E-04
WIPP East (WEE)	-2.21E-04	4.07E-04	3.33E-04	4.07E-04	3.60E-05	2.64E-04	6.29E-04
WIPP Far Field (WFF)	-3.06E-04	6.29E-04	6.99E-05	6.29E-04	-1.17E-04	1.67E-04	6.66E-04
WIPP South (WSS)	-3.53E-04	4.07E-04	2.59E-04	3.70E-04	-8.20E-05	2.77E-04	6.94E-04

Table 5.2.9 - Measurement of Radionuclides in Air Particulate - Cobalt-60							
	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	-2.49E-05	3.66E-05	2.59E-05	2.11E-05	3.34E-06	2.31E-05	3.88E-05
Mills Ranch (MLR)	1.49E-06	1.74E-05	1.34E-05	2.63E-05	9.03E-06	6.56E-06	3.64E-05
South East Control (SEC)	-2.60E-05	1.70E-05	1.93E-05	2.96E-05	-7.24E-06	2.02E-05	3.50E-05
Smith Ranch (SMR)	-5.66E-06	1.92E-05	3.18E-05	1.59E-05	9.41E-06	1.73E-05	3.70E-05
WIPP East (WEE)	-6.96E-06	2.22E-05	3.77E-05	2.29E-05	1.05E-05	1.91E-05	3.65E-05
WIPP Far Field (WFF)	-1.27E-05	3.55E-05	2.49E-05	3.00E-05	1.16E-06	1.65E-05	3.69E-05
WIPP South (WSS)	-7.51E-05	4.07E-05	4.92E-05	3.29E-05	-1.02E-05	5.41E-05	3.77E-05

Table 5.2.10 - Measurement of Radionuclides in Air Particulate - Strontium-90							
	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	-3.17E-06	1.92E-05	3.42E-05	1.92E-05	1.43E-05	1.71E-05	2.89E-05
Mills Ranch (MLR)	7.33E-06	2.00E-05	2.56E-05	1.96E-05	1.88E-05	8.18E-06	3.18E-05
South East Control (SEC)	1.35E-05	1.85E-05	1.68E-05	1.85E-05	1.44E-05	1.59E-06	3.00E-05
Smith Ranch (SMR)	-1.21E-06	1.92E-05	3.60E-05	1.89E-05	1.82E-05	1.66E-05	3.00E-05
WIPP East (WEE)	8.18E-06	1.66E-05	3.09E-05	1.92E-05	1.81E-05	1.03E-05	3.14E-05
WIPP Far Field (WFF)	9.25E-06	2.15E-05	3.67E-05	2.03E-05	2.11E-05	1.14E-05	3.06E-05
WIPP South (WSS)	1.19E-05	2.07E-05	4.85E-05	2.52E-05	2.65E-05	1.56E-05	3.25E-05

Table 5.2.11 - Measurement of Radionuclides in Air Particulate - Cesium-137

	Minimum	TPU	Maximum	TPU	Mean Conc. (Bq/m^3)	SD (95%)	MDA
Carlsbad (CBD)	0.00E+00	0.00E+00	2.51E-05	2.59E-05	9.34E-06	1.20E-05	3.79E-05
Mills Ranch (MLR)	4.25E-06	3.03E-05	3.65E-05	1.59E-05	1.56E-05	1.81E-05	3.61E-05
South East Control (SEC)	-2.45E-05	4.07E-05	3.70E-05	3.70E-05	7.54E-06	2.52E-05	3.45E-05
Smith Ranch (SMR)	-2.09E-05	3.11E-05	3.70E-05	3.33E-05	8.44E-06	2.90E-05	3.69E-05
WIPP East (WEE)	1.66E-05	2.48E-05	2.17E-05	2.59E-05	1.91E-05	3.64E-06	3.08E-05
WIPP Far Field (WFF)	5.55E-06	1.96E-05	4.62E-05	2.96E-05	2.52E-05	2.04E-05	4.56E-05
WIPP South (WSS)	-3.20E-05	3.44E-05	5.55E-05	2.85E-05	1.61E-05	4.44E-05	3.46E-05

Table 5.2.12 - Measurement of Radionuclides in Duplicate Air Particulate Samples

Location		U-234			U-238		
		Conc. Bq/m^3	TPU	MDA	Conc. Bq/m^3	TPU	MDA
Smith Ranch (SMR)		2.08E-06	1.15E-06	1.37E-06	1.76E-06	1.11E-06	1.37E-06
Smith Ranch (SMR)	Dup	3.88E-06	1.41E-06	1.11E-06	2.25E-06	1.18E-06	1.33E-06
Carlsbad (CBD)		2.61E-06	1.22E-06	1.26E-06	2.32E-06	1.07E-06	1.04E-06
Carlsbad (CBD)	Dup	2.80E-06	1.15E-06	8.88E-07	2.22E-06	1.48E-06	2.18E-06
South East Control (SEC)		2.74E-06	1.11E-06	9.99E-07	2.85E-06	1.07E-06	6.66E-07
South East Control (SEC)	Dup	3.03E-06	1.26E-06	1.26E-06	2.55E-06	1.04E-06	7.03E-07
Mills Ranch (MLR)		2.22E-06	1.11E-06	1.15E-06	-1.11E-07	4.44E-07	1.04E-06
Mills Ranch (MLR)	Dup	3.48E-06	1.33E-06	1.11E-06	1.33E-06	7.40E-07	2.59E-07

Location		Be-7			Sr-90		
		Conc. Bq/m^3	TPU	MDA	Conc. Bq/m^3	TPU	MDA
Smith Ranch (SMR)		N/A	N/A	N/A	-1.21E-06	1.92E-05	3.37E-05
Smith Ranch (SMR)	Dup	0.00E+00	0.00E+00	0.00E+00	1.81E-05	2.22E-05	3.63E-05
Carlsbad (CBD)		1.52E-02	6.66E-03	9.62E-03	3.42E-05	1.92E-05	2.81E-05
Carlsbad (CBD)	Dup	1.85E-02	9.99E-03	1.48E-02	3.51E-05	1.81E-05	2.63E-05
South East Control (SEC)		1.59E-02	9.62E-03	1.29E-02	1.35E-05	1.85E-05	3.07E-05
South East Control (SEC)	Dup	2.56E-02	9.62E-03	1.07E-02	1.12E-05	1.52E-05	2.52E-05
Mills Ranch (MLR)		1.07E-02	2.81E-03	3.03E-03	2.36E-05	1.78E-05	2.70E-05
Mills Ranch (MLR)	Dup	1.17E-02	3.22E-03	3.63E-03	1.99E-05	1.55E-05	2.40E-05

5.3 Groundwater

Sample Collection: Groundwater samples were collected from seven different wells around the WIPP site as shown in figure 7.1. Extreme precautions were taken to collect the most representative samples. Approximately three bore volumes (approximately 1,000 gallons) of water were pumped out of these wells before collecting approximately 10 gallons of water samples. The water samples were collected from depths ranging from 600- 900 feet from six wells (WQSP-1 to WQSP-6), and from a depth of 225 feet from WQSP-6A. Samples were collected twice in CY 1998. Approximately two gallons of water were sent to the contract laboratory for the determination of radionuclides of interest. The rest of the samples were used to analyze for nonradiological parameters or were put in storage. The samples were acidified to a pH $\leq$ 2 by adding concentrated nitric acid drop by drop.

Determination of Individual Radionuclides: The acidified water samples were used for the determination of gamma-emitting radionuclides, such as Be-7, K-40, Co-60, and Cs-137, by gamma-spectrometry. An aliquot of approximately 500 ml was used for the determination of Sr-90. Another aliquot was used for the sequential determinations of uranium, plutonium, and americium by alpha-spectrometry, which involved the co-precipitation of actinides with iron carrier, ion exchange chromatographic separation of individual radionuclides, source preparation by electrodeposition or micro-precipitating, and alpha-spectrometry.

Results and Discussions: Isotopes of naturally occurring uranium were measured in three to four water samples collected from each of the wells. The mean concentrations of U-234, U-235, and U-238 are reported in table 5.3.1 for CY 1998. The concentrations of U-234 ranged from 2.21E-01 ± 4.27E-03 Bq/L (WQSP-6A) to 1.20E+00 ± 1.85E-01 Bq/L (WQSP-2); and U-238 ranged from 5.30E-02 ± 2.17E-02 Bq/L (WQSP-3) to 1.99E-01 ± 3.78E-02 Bq/L (WQSP-1). The concentrations of U-235 were very low as expected and were associated with large analytical uncertainties. These are therefore excluded from further discussions.

The results clearly indicate that there is significant disequilibrium between U-238 and U-234 in these water samples. Disequilibrium between U-238 and U-234 is common, with U-234 activity being higher (~20 percent) than U-238 activity. However, greater degrees of disequilibrium have been reported in other water bodies of the world. Among the water samples collected from WQSP-1 through WQSP-6, which are brine water, the activity ratios of U-234 to U-238 ranged from 4.9 (WQSP-3) to 6.7 (WQSP-6), whereas the water sample from well WQSP-6A, which contains fresh water, had a ratio of 1.7.

The results for the concentrations of uranium isotopes in water samples collected from these wells in 1998 were compared with their results in water samples collected in 1997. The results are included in table 5.3.1. The concentrations of U-234 ranged from 2.78E-03 ± 1.70E-03 Bq/L (WQSP-5) to 3.47E-01 ± 5.98E-01 Bq/L (WQSP-2) and the concentrations of U-238 ranged from 1.18E-03 ± 1.18E-03 Bq/L (WQSP-5) to 1.01E-01 ± 1.40E-01 Bq/L (WQSP-1). A careful review of the results for both years clearly indicates that the concentrations of U-234 and U-238 in water samples collected from each well in 1997 were significantly lower than their concentrations in water samples collected in 1998. It is unlikely that the concentrations of uranium isotopes in groundwater will increase so drastically within a year. To evaluate this discrepancy, the data for 1996 were examined. When the concentrations of U-234 and U-238 in groundwater samples collected from each well in 1996 were compared with their concentrations in the water samples collected from corresponding wells in 1998, there were no significant differences. It is believed that the long storage of the samples collected in 1997 prior to the analysis may have resulted in adsorption onto the storage container walls. Sample acidification minimizes this effect, but in this instance, the long storage period of several hundred days may have contributed to the variation in concentrations noted.

Plutonium-238, Pu-239+240, and Am-241 were also analyzed in these groundwater samples; the results are given in table 5.3.2. Positive values for Pu-238 were indicated in two wells, WQSP-1 and WQSP-4. Review of the laboratory data did not reveal any anomalies with these analyses; however, these values are believed to be the result of the laboratory process, and to reflect false-positive values. The concentrations of Pu-239+240 in water samples of all the wells for both years were below their MDAs.

The results for the concentrations of Am-241 in water samples collected in 1997 and 1998 are also included in table 5.3.2. As can be seen, the concentration of Am-241 in WQSP-3 during 1998 was reported as 2.92E-03 ± 1.62E-03 Bq/L, which was slightly higher than its MDA of 2.01E-03 Bq/L. A review of the laboratory data showed that the tracer recovery for this sample was lower than acceptable. The positive result therefore reflects the low tracer yield and is believed to be a false-positive result.

The results of the measurements of K-40 are given in table 5.3.3. Concentrations were below the MDA in samples collected from wells WQSP-2, WQSP-5, WQSP-6, and WQSP-6A. The samples from the remaining three wells showed detectable concentrations. Concentrations of Co-60, Sr-90, and Cs-137 were also measured in these samples; the results are included in table 5.3.3. As can be seen, the concentrations found were below their MDA.

Table 5.3.1 - Uranium Concentrations in Groundwater

	U-234			**U-235**			**U-238**		
Location	**Activity**	**2 SD**	**MDA**	**Activity**	**2 SD**	**MDA**	**Activity**	**2 SD**	**MDA**
1997	**Bq/L**			**Bq/L**			**Bq/L**		
WQSP-1	4.74e-03	8.18E-01	3.50E-03	4.74E-03	6.91E-03	1.89E-03	1.01E-01	1.40E-01	2.53e-03
WQSP-2	3.46E-01	5.98E-01	2.76E-03	2.07E-03	3.03E-03	1.44E-03	5.69E-02	9.81E-02	1.71E-03
WQSP-3	8.32E-03	4.45E-03	1.20E-03	-1.30E-04	1.83E-04	1.02E-03	2.83E-03	2.28E-03	1.61E-03
WQSP-4	1.70E-01	1.93E-01	4.26E-03	9.25E-04	1.21E-03	2.45E-03	4.12E-02	4.88E-02	3.46E-03
WQSP-5	2.78E-03	1.70E-03*	2.18E-03	-2.96E-04	4.07E-04*	1.37E-03	1.18E-03	1.18E-03*	1.74E-03
WQSP-6	2.60E-01	3.65E-01	3.07E-03	7.21E-04	8.11E-04	2.44E-03	3.75E-02	5.16E-02	2.61E-03
WQSP-6A	1.63E-02	3.70E-03	2.37E-03	2.81E-03	1.41E-03	1.15E-03	4.44E-03	1.89E-03	1.70E-03
	U-234			**U-235**			**U-238**		
Location	Activity	2 SD	MDA	Activity	2 SD	MDA	Activity	2 SD	MDA
1998	**Bq/L**			**Bq/L**			**Bq/L**		
WQSP-1	1.48e-02	2.27E-01	2.45E-03	7.95E-03	8.81E-04	1.78E-03	1.99E-01	3.78E-02	1.54E-03
WQSP-2	1.20E+00	1.85E-01	1.71E-02	5.36E-03	3.94E-03	1.48E-02	1.97E-01	4.14E-02	1.58E-02
WQSP-3	2.60E-01	2.26E-02	4.35E-03	2.94E-03	1.08E-03	1.54E-03	5.30E-02	2.17E-02	1.65E-03
WQSP-4	3.64E-01	3.96E-02	1.14E-02	4.28E-02	6.87E-02	7.71E-03	7.28E-02	1.30E-02	8.34E-03
WQSP-5	5.92E-01	3.70E-02	2.74E-03	3.58E-03	1.20E-03	1.01E-03	9.00E-02	7.70E-03	1.01E-03
WQSP-6	4.93E-01	2.14E-02	4.08E-03	4.07E-03	3.70E-04	2.31E-03	7.40E-02	3.70E-03	2.79E-03
WQSP-6A	2.21E-01	4.27E-03	4.85E-03	1.38E-02	1.05E-02	1.30E-03	1.30E-01	9.79E-03	1.91E-03

*Total Propagated Error (only one result available).

Table 5.3.2 - Plutonium and Americium Concentrations in Groundwater									
	Am-241			Pu-238			Pu-239+240		
Location	Activity	2 SD	MDA	Activity	2 SD	MDA	Activity	2 SD	MDA
1997	Bq/L			Bq/L			Bq/L		
WQSP-1	9.25E-04	3.66E-04	1.91E-03	2.53E-03	3.22E-03	2.28E-03	4.81E-04	1.57E-04	9.99E-04
WQSP-2	1.26E-03	6.45E-04	2.02E-03	1.20E-03	1.88E-03	1.64E-03	-1.23E-04	1.30E-04	1.22E-03
WQSP-3	4.44E-04	4.19E-04	4.44E-04	0.00E+00	0.00E+00	1.37E-03	2.41E-04	4.97E-04	1.02E-03
WQSP-4	8.69E-04	5.01E-04	1.79E-03	2.28E-03	2.77E-03	1.78E-03	-1.20E-04	1.75E-04	1.27E-03
WQSP-5	2.00E-03	1.05E-03	3.92E-03	1.65E-03	2.64E-03	4.11E-03	9.25E-04	1.15E-03	3.55E-03
WQSP-6	1.30E-04	1.83E-04	3.40E-03	5.18E-04	1.20E-03	1.61E-03	-1.85E-04	1.05E-04	1.41E-03
WQSP-6A	4.81E-04	1.04E-03	1.81E-03	-4.07E-04	4.44E-04	1.44E-03	2.59E-04	5.18E-04	9.99E-04
1998									
WQSP-1	5.83E-04	5.52E-04	2.40E-03	2.30E-03	1.25E-03	1.91E-03	-1.11E-04	1.57E-04	1.66E-03
WQSP-2	1.31E-03	9.05E-04	2.81E-03	5.18E-04	3.97E-04	2.03E-03	-9.25E-05	3.48E-04	1.59E-03
WQSP-3	2.92E-03	1.62E-03	2.01E-03	2.50E-03	2.87E-04	2.53E-03	3.21E-04	1.40E-04	2.15E-03
WQSP-4	9.62E-04	1.22E-03	2.87E-03	2.02E-03	1.69E-03	1.43E-03	3.33E-04	7.43E-04	1.74E-03
WQSP-5	3.49E-03	6.60E-03	1.41E-02	4.56E-04	6.96E-04	1.63E-03	3.70E-05	2.06E-04	1.27E-03
WQSP-6	-3.82E-04	6.32E-03	1.48E-02	-6.66E-04	1.03E-03	1.53E-03	2.22E-04	6.22E-04	1.57E-03
WQSP-6A	-1.70E-03	4.65E-03	1.40E-02	1.73E-04	1.54E-04	2.49E-03	1.36E-04	2.35E-04	1.30E-03

Table 5.3.3 - Gamma Emitters and Strontium-90 in Groundwater						
	K-40			Co-60		
Location	Activity	2 SD	MDA	Activity	2 SD	MDA
1997	Bq/L			Bq/L		
WQSP-1	1.98E+01	2.43E+00	1.09E+01	4.01E-02	2.65E-01	4.67E-01
WQSP-2	1.10E+01	6.99E+00	1.46E+01	1.73E-01	3.53E-01	4.78E-01
WQSP-3	4.56E+01	2.14E+00	8.21E+00	-3.73E-01	9.97E-02	3.93E-01
WQSP-4	2.31E+01	3.36E+00	1.02E+01	4.11E-02	8.01E-02	4.17E-01
WQSP-5	6.20E+00	6.65E+00	1.09E+01	-7.58E-01	1.04E+00	3.96E-01
WQSP-6	3.69E+00	3.87E+00	9.88E+00	-2.57E-01	7.65E-01	3.45E-01
WQSP-6A	-1.73E-01	4.35E+00	1.05E+01	-5.18E-02	1.54E-01	3.76e-01
	Sr-90			Cs-137		
Location	Activity	2 SD	MDA	Activity	2 SD	MDA
1998	Bq/L			Bq/L		
WQSP-1	5.97e-02	2.66E-02	6.10E-02	3.66E-01	3.83E-01	5.64E-01
WQSP-2	3.82E-02	2.24E-02	5.83E-02	1.21E-01	5.66E-01	4.62E-01
WQSP-3	5.30E-02	1.13E-02	5.80E-02	1.11E-01	7.37E-01	3.42E-01
WQSP-4	4.41E-02	5.72E-02	6.17E-02	1.80E-01	4.07E-01	3.40E-01
WQSP-5	3.82E-02	4.88E-02	5.80E-02	6.23E-02	3.47E-01	3.52E-01
WQSP-6	3.63E-02	4.13E-02	5.43E-02	7.28E-02	3.55E-01	3.31E-01
WQSP-6A	2.63E-02	2.52E-02	5.67E-02	4.44E-02	2.87E-01	3.87E-01

5.4 Surface Water

Sample Collection: Eleven different locations around the WIPP site, as shown in figure 5.4.1, were identified for collecting the surface water samples. Samples were collected once in CY 1998. One-gallon polyethylene containers were rinsed several times with the water of the sampling location. Finally, sufficient (approximately one gallon) water samples were collected from each of these locations. The samples were labeled properly and acidified immediately after collection with concentrated nitric acid to a pH $\leq$ 2. Later, the samples were shipped to the contract laboratory for analysis. Chain of custody was maintained throughout the process.

Determination of Individual Radionuclides: Gamma-spectrometry was used for the determination of K-40, Co-60, and Cs-137. Strontium-90, a beta-emitting radionuclide, was determined by separating it from the sample and beta counting. Uranium, plutonium, and americium were determined by alpha-spectrometry. These alpha-emitting radionuclides were separated from the bulk of water samples by co-precipitation with iron carrier. Ion-exchange chromatography was used for the separation of individual radionuclides. Finally, the samples were counted by alpha-spectrometry.

Results and Discussions: Concentrations of U-234, U-235, and U-238 in water samples are given in table 5.4.1. Concentrations of U-234 ranged from 7.40 ± 3.70 mBq/L (RCP) to 274 ± 29.6 mBq/L (PCN), U-235 ranged from -0.96 ± 1.15 mBq/L (RCP) to 4.44 ± 2.59 mBq/L (UPR), and U-238 ranged from 6.66 ± 3.37 mBq/L (RCP) to 137 ± 16.6 mBq/L (PCN). In summary, the concentration of uranium varied among the locations; it was lowest in the sample collected from RCP and highest in the sample from PCN. The water sample from RCP was mostly rain water and therefore contained little uranium in the soil. On the other hand, PCN gets runoff water from a very large area of land, and the runoff water leaches uranium from the soil. In conclusion, large variations in the concentrations of radionuclides among the water samples from different locations should normally be expected.

Data for uranium concentrations in water samples from the Pecos River collected at four different sampling locations were evaluated to see whether there is any correlation with the flow of the river. The sampling locations included UPR, which is upstream; BRA, which is downstream from UPR with controlled water flow due to the construction of a dam; CBD, the next downstream location with no restricted water flow; and PCN, the furthermost downstream location. Concentrations of U-234 and U-238 at the UPR were 155 ± 19.6 mBq/Land 81.4 ± 12.2 mBq/L, respectively, whereas the sample from BRA showed reduced concentrations of U-234 and U-238 (81.4 ± 12.6 mBq/L and 48.1 ± 8.51 mBq/L, respectively).

The substantial decrease in the activities of uranium at this sampling location may be due to the fact that the water from this location may contain much smaller amounts of suspended particles compared to the samples from UPR. This is because water is quite stationary at this location due to the dam, which causes the suspended particles to settle on the bottom. Naturally, a water sample containing larger amounts of suspended particles will have higher amounts of uranium. This conclusion is substantiated by the fact that the sample collected from CBD contained almost the same concentrations of U-234 (155 ± 19.6 mBq/L) and U-238 (74.0 ± 11.5 mBq/L) as the sample from UPR. This is because suspended particles were not allowed to settle due to the unrestricted flow of the river. The last downstream sampling location of the river (PCN) contained the largest concentrations of U-234 (274 ± 29.6 mBq/L) and U-238 (137 ± 16.6 mBq/L) because it accumulates the runoff water from a much larger land area; the water flow is not restricted, causing the suspended particles to float in the water. In conclusion, a sample from a water body might show a lower concentration of uranium if the water flow is restricted, which allows large fractions of suspended particles to settle.

Uranium-238 and U-234 are mostly in equilibrium in soil; however, due to recoil phenomenon disequilibrium between the two isotopes is produced in aqueous systems. As a result, the activity of U-234 in most of the water bodies of the world is higher than that of U-238 by approximately 20 to 30 percent. However, larger degrees of disequilibrium are not uncommon. The disequilibrium between U-238 and U-234 was observed in most of the surface water samples also. However, the degree of disequilibrium was much lower than observed in the ground brine water samples, which ranged from 2 to 7.

Results for uranium concentrations in 1998 samples were compared with the uranium concentrations in 1997 samples (table 5.4.2). The results clearly indicate that the concentrations of U-234 and U-238 in water samples collected from PCN, CBD, TUT Tank (TUT), SEW, Hill Tank (HIL), and Indian Tank (IDN) in 1998 were significantly higher than their concentrations in water samples of the corresponding locations in 1997, whereas the concentrations of U-234 and U-238 in samples of remaining locations were similar in both years. The higher concentrations of uranium found in the samples of these locations may be due to the differences in meteorological conditions and area of runoff water being accumulated at that particular location. The activity ratios of U-234/U-238 were also compared for both years. The and ratios were similar for both years

Plutonium-238, Pu-239+240, and Am-241 were also measured in these water samples; the results are given in table 5.4.3. Concentrations of Pu-238 were below the MDAs in all samples except the one collected from IDN. The activity of Pu-238 in this sample was 1.07 ± 0.70 mBq/L, which was slightly above its MDA of 0.70 mBq/L. Measurements of Pu-239+240 showed that none of these samples had detectable levels. The concentration of Am-241 also was below its MDA in all the samples except the one collected from IDN. The activity of Am-241 in this sample (1.66 ± 1.33 mBq/L) was slightly above its MDA (1.52 mBq/L) and was associated with very large analytical uncertainty. In both cases, the values reported were less than the average MDAs for these analyses.

The radionuclides present in the soil or on the soil surface are leached with rain and flood water and are accumulated in the water bodies. Potassium-40, a naturally occurring gamma-emitting radionuclide present in large amounts in the soil, was not detected in any of these water samples (table 5.4.4). At the same time, Co-60 and Cs-137, which are present in very small quantities in the soil, were detected in a few samples (table 5.4.4). Among the four water samples containing detectable concentrations of Co-60, the concentration ranged from 2.59E-01 ± 1.81E-01 Bq/L (IDN) to 8.14E-01 ± 5.92E-01 Bq/L (PCN). However, these concentrations were only slightly above their MDA and were associated with large analytical uncertainties. Cesium-137 was detected in only two samples. The sample from SEW contained 6.66E-01 ± 5.92E-01 Bq/L, and the sample from BRA contained 7.40E-01 ± 5.92E-01 Bq/L. These concentrations were slightly above their MDA of 5.92E-01 and 6.29E-01 Bq/L, respectively, and were associated with very large analytical uncertainties. Therefore, it can be concluded that the concentrations of K-40, Co-60, and Cs-137 in these water samples were essentially nondetectable.

Strontium-90 was also analyzed in these water samples; the results are given in table 5.4.4. Concentrations of Sr-90 above the MDA occurred in four out of eleven samples. Among these four samples, the concentration ranged from 19 ± 12 mBq/L (SEW) to 52 ± 31 mBq/L (IDN). These concentrations were slightly above the MDAs. A review of the laboratory data indicated that the chemical recoveries were very low and that the method blank resulted in a relatively high MDA greater than three of the reported results. The uncertainties associated with these measurements are therefore quite high.

Duplicate samples were collected from locations PCN and HIL to check the reproducibility of the sampling and the measurement techniques. Since the activities of all the radionuclides except uranium were nondetectable in the water samples, only the results for the uranium isotopes were compared between original and duplicate samples (table 5.4.5). The concentrations of U-234 and U-238 in original and duplicate samples of both locations were almost the same. Concentrations of U-235 in water samples were

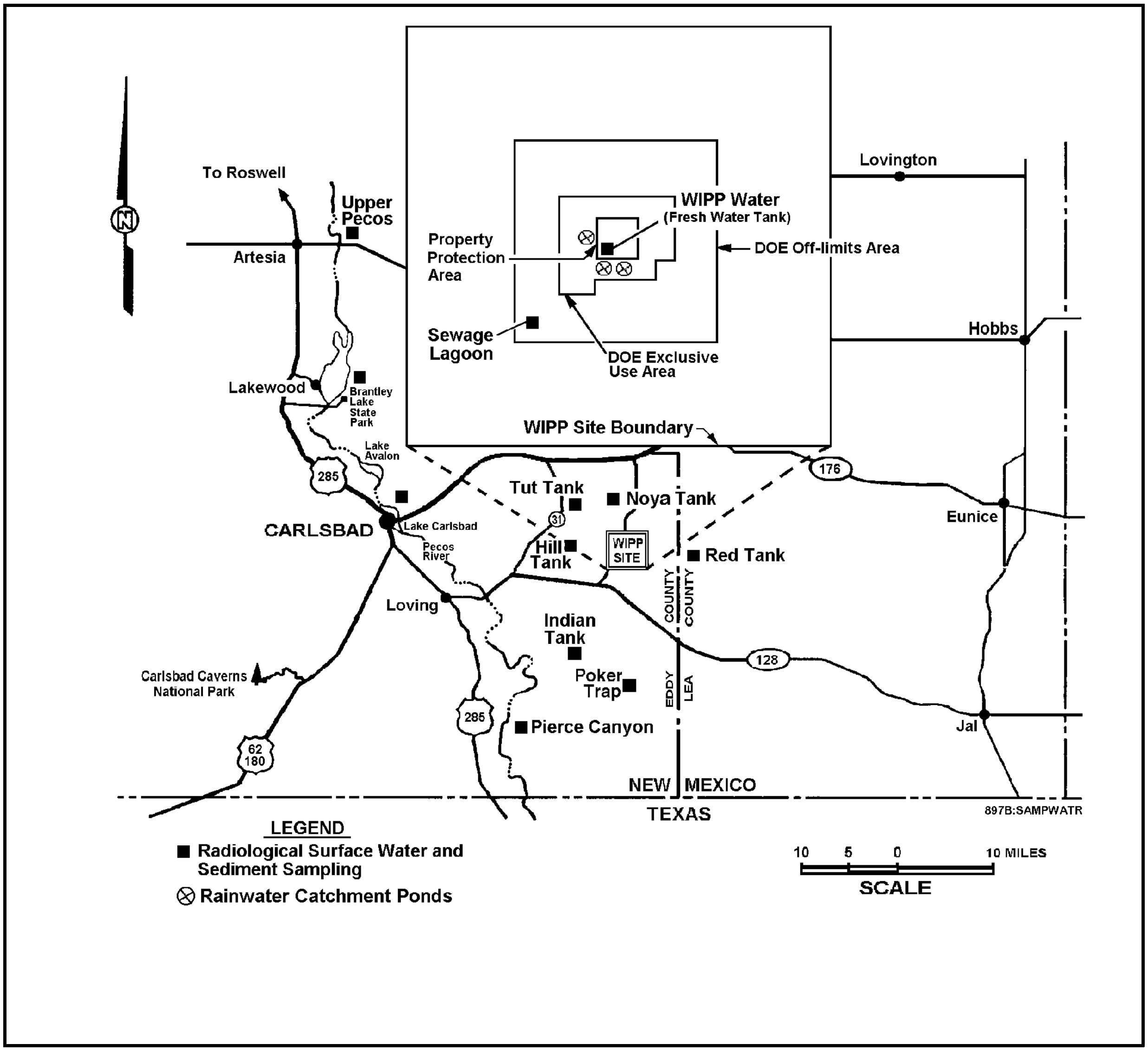


Figure 5.4.1 - Environmental Sampling Locations

very low and were associated with large analytical uncertainties. Also, its concentrations in original and duplicate samples did not differ significantly from each other.

The EEG, an independent technical evaluation group, also measured the concentrations of Pu-238, Pu-239+240, and Am-241 in surface water samples collected from around the WIPP site. The results were compared with those of the EEG to confirm the validity of the data. Concentrations of these radionuclides reported by the EEG (table 5.4.6) were comparable to the WID results. The results of both groups suggest that the concentrations of Pu-238, Pu-239+240, and Am-241 in surface water samples were below the detection limits.

Table 5.4.1 - Surface Water Data

	U-234			U-235			U-238			
Location	**Conc. (Bq/L)**	**TPU**	**MDA**	**Conc. (Bq/L)**	**TPU**	**MDA**	**Conc. (Bq/L)**	**TPU**	**MDA**	**U-234/U-238 Ratio**
TUT	1.63E-02	4.81E-03	2.92E-03	0.00E+00	7.77E-04	2.00E-03	1.92E-02	5.18E-03	2.92E-03	0.8
CBD	1.55E-01	1.96E-02	4.07E-03	4.07E-03	2.22E-03	1.96E-03	7.40E-02	1.15E-02	2.48E-03	2.1
UPR	1.55E-01	1.96E-02	4.07E-03	4.44E-03	2.59E-03	2.92E-03	8.14E-02	1.22E-02	2.52E-03	1.9
BRA	8.14E-02	1.26E-02	4.07E-03	2.18E-03	1.74E-03	2.03E-03	4.81E-02	8.51E-03	2.03E-03	1.7
PCN	2.74E-01	2.96E-02	4.07E-03	2.59E-03	2.03E-03	2.81E-03	1.37E-01	1.66E-02	2.81E-03	2.0
SEW	4.44E-02	8.88E-03	3.37E-03	6.29E-04	8.88E-04	8.51E-04	1.48E-02	4.44E-03	2.29E-03	3.0
FWT	5.18E-02	9.62E-03	4.07E-03	1.59E-03	1.70E-03	2.37E-03	2.22E-02	5.92E-03	3.44E-03	2.3
RCP	7.40E-03	3.70E-03	4.07E-03	-9.62E-04	1.15E-03	3.51E-03	6.66E-03	3.37E-03	3.51E-03	1.1
HIL	1.22E-02	4.81E-03	5.18E-03	3.33E-04	1.74E-03	3.51E-03	9.25E-03	3.55E-03	8.88E-04	1.3
NOY	9.25E-03	4.07E-03	4.81E-03	0.00E+00	1.44E-03	3.14E-03	8.51E-03	3.55E-03	3.14E-03	1.1
IDN	4.07E-02	8.14E-03	5.55E-03	2.44E-03	4.07E-03	6.66E-03	3.51E-02	7.77E-03	6.29E-03	1.2

Table 5.4.2 - Comparison of U-234 and U-238 Concentrations Between Surface Water of 1997 and 1998

	1998			1997		
Location	U-234 ± 2σ (mBq/L)	U-238 ± 2σ (mBq/L)	U-234/U-238 (Activity Ratio)	U-234 ± 2σ (mBq/L)	U-238 ± 2σ (mBq/L)	U-234/U-238 (Activity Ratio)
UPR	155 ± 19.6	81.4 ± 12.2	1.9 ± 0.37	152 ± 15.3	134 ± 13.8	1.1± 0.16
BRA	81.4 ± 12.6	48.1 ± 8.51	1.7 ± 0.73	76.3 ± 7.07	41.1 ± 4.75	1.9 ± 0.28
CBD	155 ± 19.6	74.0 ± 11.5	2.1 ± 0.42	97.5 ± 8.30	49.6 ± 5.23	2.0 ± 0.27
PCN	274 ± 29.6	137 ± 16.6	2.0 ± 0.33	127 ± 10.9	71.1 ± 7.18	1.8 ± 0.24
TUT	16.3 ± 4.81	19.2 ± 5.18	0.8 ± 0.32	5.62 ± 1.83	4.21 ± 1.59	1.3 ± 0.64
SEW	44.4 ± 8.88	14.8 ± 4.44	3.0 ± 1.08	9.37 ± 2.62	3.24 ± 1.48	2.9 ± 1.55
FWT	51.8 ± 9.62	22.2 ± 5.92	2.3 ± 0.75	43.8 ± 4.93	14.1 ± 2.60	3.1± 0.67
HIL	12.2 ± 4.81	9.25 ± 3.55	1.3 ± 0.72	2.07 ± 1.03	1.19 ± 0.85	1.7 ± 1.48
NOY	9.25 ± 4.07	8.51 ± 3.55	1.1 ± 0.67	5.97 ± 1.81	2.75 ± 1.26	2.2 ± 1.21
IDN	40.7 ± 8.14	35.1 ± 7.77	1.2 ± 0.36	5.34 ± 1.55	5.56 ± 1.71	1.0 ± 0.42

Table 5.4.3 - Surface Water Data									
	Am-241			Pu-238			Pu-239/240		
Location	Conc. (Bq/L)	TPU	MDA	Conc. (Bq/L)	TPU	MDA	Conc. (Bq/L)	TPU	MDA
TUT	0.00E+00	1.52E-03	3.14E-03	6.66E-04	7.03E-04	9.62E-04	1.48E-04	7.77E-04	1.59E-03
CBD	1.85E-04	1.33E-03	2.63E-03	1.11E-04	7.03E-04	1.41E-03	5.18E-04	5.55E-04	7.77E-04
UPR	4.44E-03	4.81E-03	7.77E-03	6.29E-04	1.81E-03	3.44E-03	6.29E-04	1.55E-03	2.96E-03
BRA	8.14E-04	1.33E-03	2.26E-03	-1.11E-03	1.15E-03	2.48E-03	2.96E-04	4.44E-04	7.40E-04
PCN	5.55E-04	1.26E-03	2.29E-03	4.81E-04	7.40E-04	1.29E-03	0.00E+00	4.81E-04	1.11E-03
SEW	4.07E-04	9.62E-04	1.81E-03	-3.70E-04	9.99E-04	2.11E-03	1.11E-04	6.66E-04	1.37E-03
FWT	1.07E-03	2.55E-03	4.81E-03	0.00E+00	7.03E-04	1.52E-03	-1.11E-04	2.59E-04	9.25E-04
RCP	1.48E-04	1.66E-03	3.03E-03	0.00E+00	5.18E-04	1.18E-03	-1.11E-04	5.55E-04	1.37E-03
HIL	-8.14E-04	1.41E-03	3.07E-03	1.85E-04	5.92E-04	1.26E-03	7.03E-04	9.62E-04	1.59E-03
NOY	8.51E-04	1.04E-03	1.59E-03	-2.96E-04	3.70E-04	1.11E-03	1.11E-04	4.44E-04	9.62E-04
IDN	1.66E-03	1.33E-03	1.52E-03	1.07E-03	7.03E-04	7.03E-04	1.85E-04	5.55E-04	1.04E-03

Table 5.4.4 - Surface Water Data

	K-40			Co-60		
Location	**Conc. (Bq/L)**	**TPU**	**MDA**	**Conc. (Bq/L)**	**TPU**	**MDA**
TUT	8.14E+00	1.55E+01	2.29E+01	1.81E-01	6.29E-01	6.66E-01
CBD	1.74E+01	1.52E+01	1.92E+01	7.03E-01	6.29E-01	6.66E-01
UPR	3.48E+00	1.44E+01	2.22E+01	-5.55E-02	6.29E-01	7.03E-01
BRA	-1.04E+01	1.33E+01	1.92E+01	-4.44E-01	6.29E-01	6.29E-01
PCN	8.14E+00	1.63E+01	2.48E+01	8.14E-01	5.92E-01	7.03E-01
SEW	5.18E+00	1.52E+01	2.37E+01	-1.37E-01	5.92E-01	6.66E-01
FWT	-1.74E+00	2.70E+00	3.26E+00	3.59E-01	2.03E-01	2.59E-01
RCP	1.44E+00	2.70E+00	3.26E+00	-6.66E-02	2.29E-01	2.63E-01
HIL	2.40E+00	1.74E+00	2.33E+00	0.00E+00	2.11E-01	2.63E-01
NOY	-1.59E+00	2.70E+00	3.14E+00	-1.74E-01	2.52E-01	2.74E-01
IDN	3.48E+00	4.44E+00	6.29E+00	2.59E-01	1.81E-01	2.26E-01

	Sr-90			Cs-137		
Location	**Conc. (Bq/L)**	**TPU**	**MDA**	**Conc. (Bq/L)**	**TPU**	**MDA**
TUT	1.41E-02	1.11E-02	1.74E-02	3.59E-01	5.92E-01	5.92E-01
CBD	1.07E-02	2.44E-02	4.07E-02	-6.66E-01	6.29E-01	5.92E-01
UPR	-1.18E-02	2.59E-02	4.81E-02	5.18E-02	7.03E-01	1.18E+00
BRA	2.44E-02	3.18E-02	5.18E-02	7.40E-01	5.92E-01	6.29E-01
PCN	1.37E-02	2.92E-02	4.81E-02	-2.26E-01	5.92E-01	5.92E-01
SEW	1.89E-02	1.18E-02	1.81E-02	6.66E-01	5.92E-01	5.92E-01
FWT	2.03E-02	1.29E-02	1.89E-02	1.66E-01	2.66E-01	4.07E-01
RCP	2.22E-02	1.37E-02	2.00E-02	8.14E-02	2.03E-01	1.78E-01
HIL	1.11E-02	1.22E-02	1.96E-02	-6.29E-02	2.18E-01	2.03E-01
NOY	7.77E-03	1.37E-02	2.29E-02	-5.92E-02	2.18E-01	2.03E-01
IDN	5.18E-02	3.11E-02	4.81E-02	-6.66E-02	2.26E-01	2.07E-01

Table 5.4.5 - Duplicate Analysis

	U-234			U-235			U-238			U-234/U-238 Ratio
Location	Conc. (Bq/L)	TPU	MDA	Conc. (Bq/L)	TPU	MDA	Conc. (Bq/L)	TPU	MDA	
COY (ORI)	2.74E-01	2.96E-02	4.07E-03	2.59E-03	2.03E-03	2.81E-03	1.37E-01	1.66E-02	2.81E-03	2.0
COY(DUP)	2.74E-01	3.18E-02	3.63E-03	4.44E-03	3.03E-03	4.07E-03	1.37E-01	1.81E-02	4.07E-03	2.0
HIL (ORI)	1.22E-02	4.81E-03	5.18E-03	3.33E-04	1.74E-03	3.51E-03	9.25E-03	3.55E-03	8.88E-04	1.3
HIL (DUP)	1.44E-02	4.44E-03	2.96E-03	1.66E-03	1.55E-03	2.03E-03	1.07E-02	3.70E-03	2.96E-03	1.3

Table 5.4.6 - EEG Data on Surface Water							
		Am-241		Pu-238		Pu-239	
Date	Location	Conc. Bq/L	TPU (2 Sig)	Conc. Bq/L	TPU (2 Sig)	Conc. Bq/L	TPU (2 Sig)
6/23/98	PECOS @ CBD	-2.0E-03	1.4E-03	5.22E-04	9.03E-04	3.4E-05	4.9E-04
6/23/98	PECOS @ P.C.	5.7E-05	1.1E-03	-2.58E-04	7.47E-04	9.0E-05	5.0E-04
7/22/98	WIPP EFFLUENT	-1.4E-03	7.3E-04	-4.45E-04	6.82E-04	-1.2E-04	4.3E-04
7/29/98	HILL TANK	N/A	N/A	2.58E-05	5.87E-04	-3.5E-05	4.5E-04
7/29/98	NOYA TANK	-5.1E-04	7.8E-04	-1.90E-04	4.91E-04	2.4E-05	5.2E-04
7/29/98	INDIAN TANK	-9.0E-04	6.4E-04	-4.45E-04	6.33E-04	3.7E-06	4.7E-04

N/A = Not analyzed

5.5 Soil Samples

Sampling: Soil samples were collected from six different locations around the WIPP site. These were collected at the same locations as the air particulate samples. These locations are identified as MLR, SEC, SMR, WEE, WFF, and WSS in figure 5.5.1. Samples were collected from each location in three incremental profiles: 0-2 cm (SS), 2-5 cm (SI), and 5-10 cm (SD), where SS stands for surface soil, SI for intermediate soil, SD for deep soil. Measurements of radionuclides in depth profiles provide information about their vertical movements in the soil systems. Measurements of radionuclides in soil samples are quite helpful in assessing the radiation doses to the public.

Sample Preparation: Soil samples were dried at 110°C for several hours and homogenized by grinding to small particle sizes. An aliquot (one gram) of soil was dissolved by heating it with a mixture of nitric, hydrochloric, and hydrofluoric acids. Finally, it was heated with nitric and boric acids to remove hydrofluoric acid, and the residue was dissolved in hydrochloric acid for the determination of individual radionuclides.

Determination of Individual Radionuclides: Gamma-emitting radionuclides (K-40, CO-60, and Cs-137) were determined by counting an aliquot of well-homogenized ground soil samples by gamma-spectrometry. Strontium-90 was determined from an aliquot of the sample solution by separating it from other stable and radioactive elements using radiochemical techniques and beta-counting. Another aliquot of the sample solution was used for the sequential determinations of alpha-emitting radionuclides, such as U-234, U-235, and U-238; Pu-238 and Pu-239+240; and Am-241. These radionuclides were separated from the bulk of the inorganic materials present in the soil samples and from one another by radiochemical separations including co-precipitation and ion-exchange chromatography. Finally, they were micro-precipitated, filtered onto micro-filter papers, and counted alpha-spectrometrically.

Results and Discussions: Concentrations of U-234, U-235, and U-238 in three depth profiles of soil samples collected from all six sampling locations (WSQP-1 through WQSP-6) are given in table 5.5.1. Concentrations of U-234 in SS (0-2 cm) ranged from a minimum of 15.2 ± 2.55 mBq/g at SMR to a maximum of 36.3 ± 4.44 mBq/g at SEC.

Concentrations in samples of WEE, WSS, MLR, and SMR were similar and were in a very narrow range of 15.2 ± 2.55 mBq/g to 18.9 ± 3.03 mBq/g. The concentrations in samples of SEC (36.3 ± 4.44 mBq/g) and WFF (28.5 ± 3.70 mBq/g) were significantly higher than all other locations.

Concentrations of U-238 in the same SS samples ranged from 15.9 ± 2.55 mBq/g at WSS to 28.5 ± 3.70 mBq/g at WFF, with a mean of 20.7 ± 4.77 mBq/g. Since U-238 and U-234 are mostly in equilibrium in a soil matrix, and the concentration of U-234 was significantly higher in soil samples of SEC and WFF compared to the other locations; a similar trend should be expected for U-238. As expected, U-238 was found to be significantly higher in soil samples of SEC (24.4 ± 3.29 mBq/g) and WFF (28.5 ± 3.70 mBq/g) compared to the other locations.

Concentration of U-235 was much lower than the concentrations of U-234 and U-238, and ranged from 0.33 ± 0.37 mBq/g at SMR to 1.55 ± 0.63 mBq/g at SEC. Because of the very low activity of U-235 in soil, most of the results were associated with large analytical uncertainties.

The results for uranium in the soil samples of intermediate depth (2-5 cm) are also given in table 5.5.1. The concentration of U-234 ranged from 7.40 ± 1.48 mBq/g at WFF to 23.7 ± 3.66 mBq/g at SEC and the mean concentration was 17.2 ± 6.5 mBq/g. These results were compared with the concentration of uranium in surface soils to see the effect of depth profile. Except for locations SEC and WFF, concentrations of U-234 in surface and intermediate soils were not different from each other. Also, the mean of U-234 concentrations in all soil samples of intermediate depths (17.2 ± 6.5 mBq/g) was not significantly different from the mean of U-234 concentrations in SS (22.0 ± 8.56 mBq/g).

As expected, concentration of U-238 in SI (2-5 cm) sampled showed a similar pattern as U-234. The concentration ranged from 9.25 ±1.63 mBq/g at WFF to 24.0 ± 3.63 mBq/g at SEC. Again, except for the locations SEC and WFF, U-238 concentrations in surface and intermediate soils were the same (not significantly different from each other). Also, as observed for U-234, the means of U-238 concentrations of all SI samples (16.9 ± 4.96 mBq/g) and SS samples (20.7 ± 4.77 mBq/g) were not significantly different from each other.

Concentrations of U-235 in SI samples were very low and ranged from 0.04 ± 0.26 mBq/g at WFF to 0.89 ± 0.52 mBq/g at SMR. These concentrations were similar to the concentrations of U-235 in SS.

Concentrations of U-234, U-235, and U-238 were measured in 5-10 cm (SD) samples also; the results are included in table 5.5.1. Concentrations of U-234 varied from 9.25 ±1.78 mBq/g at WFF to 21.5 ± 2.89 mBq/g at SMR. The mean concentration for all the locations was 15.7 ± 4.8 mBq/g, which was not significantly different from the mean concentrations of U-234 in SI samples (17.2 ± 6.5 mBq/g) and SS samples (22.0 ± 8.56 mBq/g).

Similarly, the concentration of U-238 in these samples ranged from 9.99 ± 1.85 mBq/g at WFF to 25.2 ± 3.22 mBq/g at SMR. The mean concentration for all the locations was 17.4

± 5.49 mBq/g, which was not significantly different from the mean concentrations of U-238 in SI samples (16.9 ± 4.96 mBq/g) and SS samples (20.7 ± 4.77 mBq/g).

Concentrations of U-235 in SD samples, as expected, were quite low, and ranged from 0.26 ± 0.26 mBq/g at WFF to 1.04 ± 0.48 mBq/g at SMR, with a mean of 0.69 ± 0.30 mBq/g. These concentrations were similar to the concentrations of U-235 found in SI and SS samples.

Concentrations of U-234 in SS samples at these locations for 1997 and 1998 were compared to examine the annual trend. In 1997, the concentrations ranged from 13.3 ± 1.55 mBq/g (WSS) to 17.8 ± 0.96 mBq/g (MLR), and the mean concentration was 15.7 ± 1.80 mBq/g. This mean concentration of U-234 for 1997 (15.7 ± 1.8 mBq/g) was not significantly different from the mean concentration of U-234 for 1998 (22.0 ± 8.56 mBq/g).

Concentrations of U-238 in SS samples of these locations for 1997 and 1998 were also compared to see the annual trend. Again, the mean concentrations of U-238 in 1998 (20.7 ± 4.77 mBq/g) and in 1997 (16.0 ± 3.09 mBq/g) did not differ significantly from each other.

The results can be summarized as follows:

- The mean activities of U-238 (18.4 ± 5.1 mBq/g) and U-234 (18.1± 6.8 mBq/g) were identical, suggesting that both U-238 and U-234 were in equilibrium as expected for soil matrix.

- The mean concentration of U-238 found around the WIPP site (18.4± 5.1 mBq/g) was much lower than the mean concentration of 66 mBq/g reported for U-238 in soil samples of the United States (NCRP Report No 94).

- The concentrations of U-234 and U-238 in soil samples did not change from 1997 to 1998. This is what should be expected because the source term of uranium around the WIPP site remained the same (the naturally occurring uranium only).

- Concentrations of U-234, U-235, and U-238 in SS (0-2 cm), SI (2-5 cm), and SD (5-10 cm) samples were not significantly different from each other, suggesting that uranium is homogeneously distributed in soil, at least from 0-10 cm deep. The only exception observed was for the location WFF, where the concentrations of U-234 and U-238 in SI and SD samples were significantly lower than their concentrations in SS samples.

Besides uranium, other alpha-emitting actinides, such as Pu-238, Pu-239+240, and Am-241, were measured in these soil samples; the results are given in table 5.5.2. Concentrations of Pu-238 in all eighteen samples analyzed were below the detection limit of the technique used.

Concentrations of Pu-239+240 were also below their detection limits in 16 out of 18 samples (table 5.5.2). Of the two samples that had detectable concentrations of Pu-239+240, the SS sample from SEC had the higher activity (0.74 ± 0.41 mBq/g). The

SD sample from WSS showed a concentration of 0.37 ± 0.30 mBq/g. The analytical errors associated with these two results were quite high, giving poor confidence in the reported value.

Concentrations of Am-241 were also determined in these samples; the results are included in table 5.5.2. Three of the 18 samples indicated concentrations of Am-241. These were the SD sample at WEE, the SI sample at WSS, and the SI sample at MLR. Based on a review of the laboratory data, no discernable reason for these values could be determined; however, the values are believed to be false-positives due to laboratory cross-contamination.

Concentrations of K-40, a naturally occurring gamma-emitting radionuclide, were determined in these samples; the results are given in table 5.5.3. Concentrations in SS (0-2 cm) ranged from 148 ± 63 mBq/g at WFF to 444 ± 85 mBq/g at SEC with a mean of 328 ± 111 mBq/g. Among all the sampling locations, the concentration in SS at WFF was significantly lower than the concentration in SS at all other locations. Also, the concentrations in SS at SEC and MLR were significantly higher than the concentrations found in SS at WEE, WSS, and WFF. These results clearly show the significant variations among the concentrations of K-40 in SS at different locations.

Concentrations of K-40 in SI samples (2-5 cm) ranged from 81 ± 63 mBq/g at WFF to 518 ± 89 mBq/g at WEE, with a mean of 291 ± 158 mBq/g. These results also suggest that there are significant variations among the concentrations of K-40 in soil samples of different sampling locations (e.g., the concentration in the WEE sample was higher than the concentrations of all other locations). Also, the concentration found at WFF was lower than the concentration found at every other location.

Similarly, the concentration of K-40 in SD samples (5-10 cm) at various locations varied significantly and ranged from 31 ± 67 mBq/g at WSS to 481 ± 93 mBq/g at WEE. The mean concentration was 278 ± 164 mBq/g. Again, the concentration found at the location WEE was higher than the concentrations found at all other locations. Also, the concentration found at WSS was lower than the concentration found at every other location.

The results for K-40 were further reviewed to see whether there is any significant variation between its concentrations in three incremental depths of soil. Concentrations in SS, SI, and SD samples did not differ substantially from each other for the locations SEC, MLR, WFF, and SMR. Among the samples from WEE, the concentration in SI was higher than the concentration found in SS, but did not differ from the concentration in SD. Also, the concentration in SD was higher than the concentration in SS. Among the samples from WSS, the concentrations in SS and SI did not differ significantly from each other, but were higher than the concentration found in SD. In general (except a few anomalies), these results suggest that K-40 is homogeneously distributed in soil at least up to a depth of 10 cm. This conclusion is further supported by the fact that the mean concentration of K-40 in SS samples of all locations (328 ± 111 mBq/g) did not differ significantly from the mean concentrations found in the SI samples (291 ± 158 mBq/g) and also in the SD samples (278 ± 164 mBq/g).

Cobalt-60 was also analyzed in these samples; the results are included in table 5.5.3. Concentrations were below their MDA in samples collected from WEE, WSS, and SMR, and slightly above their MDA in the SS sample from SEC, the SI sample from MLR, and the SS and SD samples from WFF. These results were associated with large analytical uncertainties.

Strontium-90, present in the environment from the global fallout of aboveground nuclear testings, was not detected in any of the 18 samples analyzed (table 5.5.3). Concentrations were at or below their MDA in all the samples.

Concentrations of Cs-137 were also determined; the results are included in table 5.5.3. As can be seen, Cs-137 was present in detectable amounts in a few samples. Among the samples showing the detectable activities of Cs-137, the concentration ranged from 4.07 ± 2.96 mBq/g in the SI sample of WFF to 15.9 ± 4.81 mBq/g in the SS sample of MLR. It was, however, observed that the concentration of Cs-137 was higher in SS samples compared to the SI and SD samples collected from SEC, WEE, and MLR. This trend was not, however, observed in the samples for other locations.

The results for Co-60, Sr-90, and Cs-137 in 1998 samples were compared with the results of these radionuclides in 1997 samples. Their concentrations in soil samples of both years were either nondetectable or close to their detection limits. Also, the results for both years were associated with large analytical uncertainties, which are inherent problems associated with low-level measurements. Based on these observations, it can be concluded that the concentrations of these radionuclides in both years were essentially identical.

Soil samples collected from two locations, SEC and SMR, were divided into two parts and analyzed separately. The results are included in table 5.5.4. Concentrations of Am-241 in both aliquots of the SEC sample were below their MDA. Similarly, the concentrations of Pu-238 in both aliquots of the samples were nondetectable. On the other hand, the concentrations of Pu-239+240 in both aliquots of the SEC sample and both aliquots of the SMR sample differed from each other. The data for Pu-239+240 suggest that the results are not highly reproducible due to the nonhomogeneity of the samples or because of the analytical uncertainties associated with the laboratory measurements of low-level radionuclides in environmental samples.

Neither Co-60 nor Cs-137 was detected in either of the two aliquots of both samples. Potassium-40 measurements in both aliquots of the SMR sample (333 ± 81 mBq/g and 329 ± 89 mBq/g) were identical. However, in the aliquots of the SEC sample, the concentrations were observed to vary from 444 ± 85 mBq/g to 27 ± 69 mBq/g.

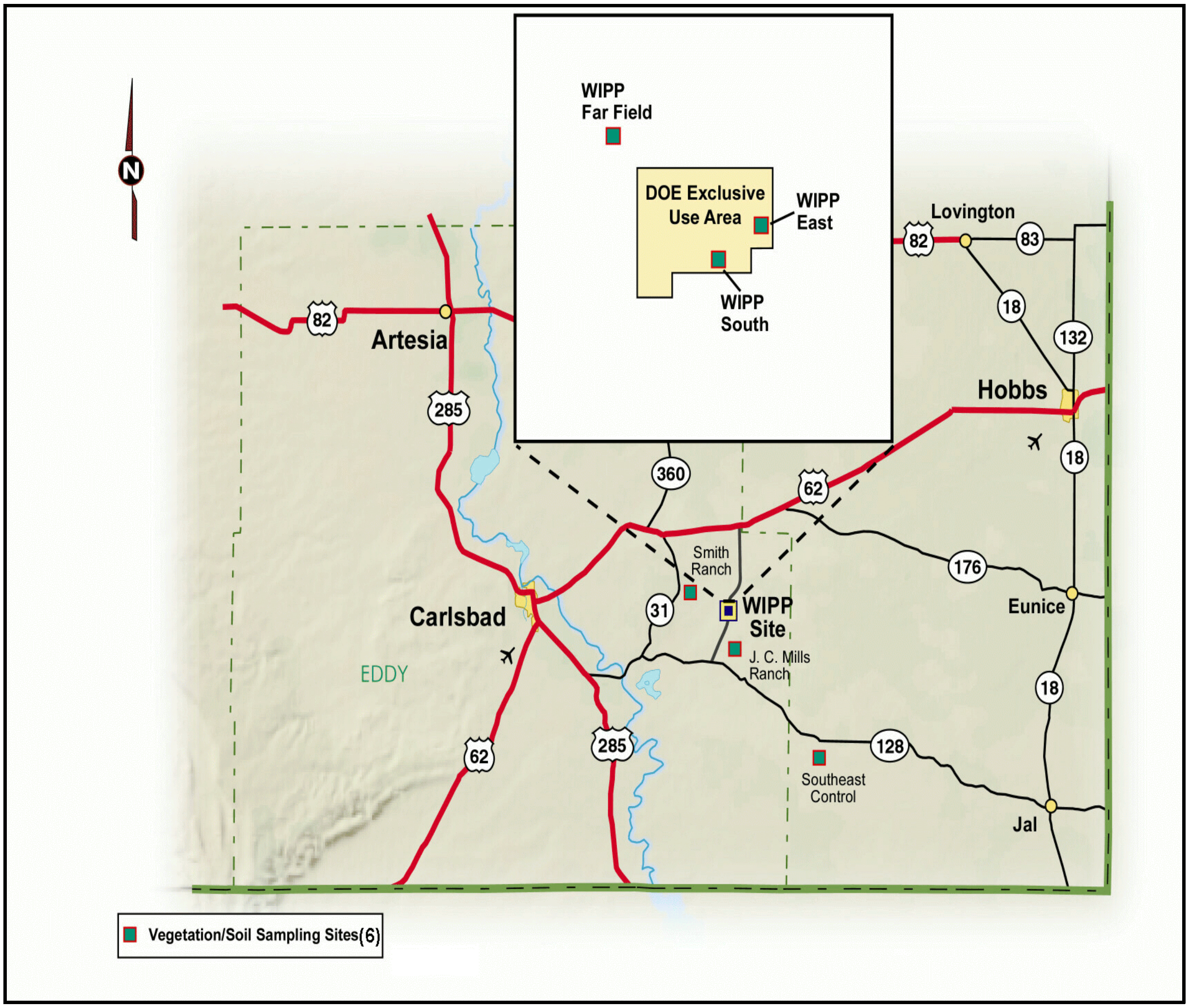


Figure 5.5.1 - Soil Sampling Locations

Table 5.5.1 - Uranium Concentration in Soil											
			U-234			U-235			U-238		
Location			Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
South East Control (SEC)	SS	0-2 cm	3.63E-02	4.44E-03	9.62E-04	1.55E-03	6.29E-04	4.44E-04	2.44E-02	3.29E-03	5.55E-04
	SI	2-5 cm	2.37E-02	3.66E-03	1.41E-03	7.40E-04	6.29E-04	8.88E-04	2.40E-02	3.63E-03	8.88E-04
	SD	5-10 cm	1.81E-02	2.74E-03	8.14E-04	8.51E-04	5.18E-04	4.44E-04	1.96E-02	2.89E-03	6.66E-04
WIPP East (WEE)	SS	0-2 cm	1.74E-02	2.52E-03	8.88E-04	8.51E-04	4.81E-04	5.55E-04	1.89E-02	2.63E-03	5.55E-04
	SI	2-5 cm	2.15E-02	3.14E-03	9.25E-04	7.03E-04	4.81E-04	4.81E-04	1.92E-02	2.89E-03	7.03E-04
	SD	5-10 cm	1.96E-02	3.26E-03	1.33E-03	9.25E-04	6.29E-04	6.29E-04	2.00E-02	3.22E-03	7.77E-04
WIPP South (WSS)	SS	0-2 cm	1.55E-02	2.59E-03	1.11E-03	3.33E-04	5.18E-04	8.88E-04	1.59E-02	2.55E-03	8.88E-04
	SI	2-5 cm	1.41E-02	2.44E-03	8.51E-04	2.96E-04	4.44E-04	7.77E-04	1.66E-02	2.70E-03	1.85E-04
	SD	5-10 cm	1.37E-02	2.81E-03	2.52E-03	4.81E-04	5.55E-04	8.51E-04	1.70E-02	2.85E-03	5.92E-04
Mills Ranch (MLR)	SS	0-2 cm	1.89E-02	3.03E-03	9.99E-04	5.92E-04	4.44E-04	1.85E-04	1.92E-02	3.03E-03	5.55E-04
	SI	2-5 cm	1.92E-02	3.07E-03	1.22E-03	4.44E-04	4.81E-04	7.03E-04	1.85E-02	2.96E-03	8.88E-04
	SD	5-10 cm	1.18E-02	2.07E-03	5.92E-04	5.92E-04	4.07E-04	1.85E-04	1.26E-02	2.15E-03	4.81E-04
WIPP Far Field (WFF)	SS	0-2 cm	2.85E-02	3.70E-03	7.77E-04	7.77E-04	5.92E-04	8.51E-04	2.85E-02	3.70E-03	8.51E-04
	SI	2-5 cm	7.40E-03	1.48E-03	7.03E-04	3.70E-05	2.59E-04	5.18E-04	9.25E-03	1.63E-03	4.07E-04
	SD	5-10 cm	9.25E-03	1.78E-03	7.40E-04	2.59E-04	2.59E-04	1.48E-04	9.99E-03	1.85E-03	6.66E-04
Smith Ranch (SMR)	SS	0-2 cm	1.52E-02	2.55E-03	1.04E-03	3.33E-04	3.70E-04	5.18E-04	1.74E-02	2.70E-03	5.18E-04
	SI	2-5 cm	1.48E-02	2.44E-03	9.62E-04	8.88E-04	5.18E-04	4.81E-04	1.44E-02	2.37E-03	7.03E-04
	SD	5-10 cm	2.15E-02	2.89E-03	8.51E-04	1.04E-03	4.81E-04	3.70E-04	2.52E-02	3.22E-03	5.92E-04

Table 5.5.2 - Americium and Plutonium Concentration in Soil											
			Am-241			Pu-238			Pu-239+240		
Location			Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
South East Control (SEC)	SS	0-2 cm	2.22E-04	5.18E-04	8.88E-04	1.85E-04	2.96E-04	4.81E-04	7.40E-04	4.07E-04	1.48E-04
	SI	2-5 cm	4.81E-04	6.29E-04	1.04E-03	0.00E+00	4.07E-04	7.77E-04	3.33E-04	3.70E-04	5.18E-04
	SD	5-10 cm	1.11E-04	7.40E-04	1.48E-03	-7.40E-05	4.44E-04	9.25E-04	0.00E+00	5.18E-04	9.99E-04
WIPP East (WEE)	SS	0-2 cm	1.11E-04	4.07E-04	7.40E-04	2.59E-04	4.07E-04	7.03E-04	1.48E-04	2.22E-04	3.70E-04
	SI	2-5 cm	4.81E-04	4.81E-04	7.40E-04	1.11E-04	3.70E-04	7.03E-04	3.70E-05	3.70E-04	7.03E-04
	SD	5-10 cm	4.81E-04	3.70E-04	4.07E-04	0.00E+00	4.44E-04	8.88E-04	2.22E-04	3.33E-04	5.18E-04
WIPP South (WSS)	SS	0-2 cm	1.04E-03	1.11E-03	1.52E-03	-1.11E-04	4.81E-04	9.99E-04	1.48E-04	2.59E-04	4.81E-04
	SI	2-5 cm	8.88E-04	5.18E-04	5.55E-04	2.22E-04	2.96E-04	4.44E-04	5.92E-04	4.81E-04	6.29E-04
	SD	5-10 cm	5.92E-04	4.81E-04	6.66E-04	0.00E+00	2.22E-04	4.81E-04	3.70E-04	2.96E-04	1.48E-04
Mills Ranch (MLR)	SS	0-2 cm	0.00E+00	5.18E-04	1.04E-03	-1.48E-04	4.81E-04	1.26E-03	6.66E-04	8.14E-04	1.26E-03
	SI	2-5 cm	4.81E-04	3.70E-04	1.85E-04	0.00E+00	6.66E-04	1.52E-03	9.62E-04	8.51E-04	1.04E-03
	SD	5-10 cm	0.00E+00	4.81E-04	9.99E-04	1.48E-04	2.96E-04	5.55E-04	1.48E-04	3.70E-04	7.03E-04
WIPP Far Field (WFF)	SS	0-2 cm	-1.11E-04	4.07E-04	8.88E-04	4.07E-04	5.18E-04	7.77E-04	5.18E-04	5.55E-04	7.77E-04
	SI	2-5 cm	2.96E-04	5.18E-04	8.88E-04	3.70E-05	2.96E-04	5.92E-04	-7.40E-05	1.85E-04	5.18E-04
	SD	5-10 cm	5.55E-04	4.81E-04	6.66E-04	9.25E-04	1.04E-03	1.59E-03	-4.07E-04	5.92E-04	1.59E-03
Smith Ranch (SMR)	SS	0-2 cm	7.40E-05	4.44E-04	8.88E-04	0.00E+00	8.14E-04	1.81E-03	5.18E-04	5.92E-04	4.44E-04
	SI	2-5 cm	0.00E+00	4.07E-04	8.14E-04	1.48E-04	5.18E-04	9.99E-04	1.48E-04	2.96E-04	5.18E-04
	SD	5-10 cm	-5.92E-04	7.03E-04	1.52E-03	8.14E-04	1.18E-03	1.96E-03	-1.48E-04	6.29E-04	1.48E-03

Table 5.5.3 - Beta and Gamma Emitters Concentration in Soil								
			K-40			Co-60		
Location			Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
South East Control (SEC)	SS	0-2 cm	4.44E-01	8.51E-02	4.07E-02	5.55E-03	3.70E-03	3.70E-03
	SI	2-5 cm	N/A			3.48E-03	3.70E-03	3.33E-03
	SD	5-10 cm	3.33E-01	9.25E-02	7.40E-02	1.33E-03	4.44E-03	4.07E-03
WIPP East (WEE)	SS	0-2 cm	3.07E-01	8.51E-02	6.66E-02	-1.96E-03	3.70E-03	3.37E-03
	SI	2-5 cm	5.18E-01	8.88E-02	4.07E-02	-6.29E-03	4.44E-03	3.55E-03
	SD	5-10 cm	4.81E-01	9.25E-02	5.55E-02	-3.29E-03	4.44E-03	3.70E-03
WIPP South (WSS)	SS	0-2 cm	2.89E-01	7.77E-02	5.55E-02	-1.96E-03	3.70E-03	3.26E-03
	SI	2-5 cm	2.33E-01	6.66E-02	4.81E-02	7.77E-04	3.37E-03	3.03E-03
	SD	5-10 cm	3.07E-02	6.66E-02	9.62E-02	-1.85E-04	3.51E-03	3.37E-03
Mills Ranch (MLR)	SS	0-2 cm	4.44E-01	8.88E-02	4.07E-02	-2.33E-03	4.07E-03	3.44E-03
	SI	2-5 cm	3.26E-01	9.62E-02	8.51E-02	1.04E-02	3.07E-03	4.07E-03
	SD	5-10 cm	3.29E-01	8.14E-02	4.81E-02	-3.26E-03	4.07E-03	4.07E-03
WIPP Far Field (WFF)	SS	0-2 cm	1.48E-01	6.29E-02	5.55E-02	3.18E-03	3.07E-03	2.85E-03
	SI	2-5 cm	8.14E-02	6.29E-02	7.40E-02	-5.55E-03	3.63E-03	2.92E-03
	SD	5-10 cm	1.37E-01	7.03E-02	7.77E-02	4.07E-03	2.70E-03	2.40E-03
Smith Ranch (SMR)	SS	0-2 cm	3.33E-01	8.14E-02	5.92E-02	-6.66E-03	3.70E-03	3.00E-03
	SI	2-5 cm	2.96E-01	8.14E-02	5.55E-02	-2.89E-03	3.70E-03	3.33E-03
	SD	5-10 cm	3.55E-01	8.14E-02	4.81E-02	-7.03E-04	3.70E-03	3.14E-03

Table 5.5.3 - Beta and Gamma Emitters Concentration in Soil (continued)

			Sr-90			Cs-137		
Location			**Conc. (Bq/g)**	**TPU**	**MDA**	**Conc. (Bq/g)**	**TPU**	**MDA**
South East Control (SEC)	SS	0-2 cm	-2.92E-01	7.03E-02	1.26E-01	7.77E-03	4.81E-03	7.40E-03
	SI	2-5 cm	3.33E-02	2.59E-02	4.07E-02	7.40E-03	5.55E-03	7.77E-03
	SD	5-10 cm	7.03E-03	7.40E-03	1.18E-02	2.59E-03	4.07E-03	4.44E-03
WIPP East (WEE)	SS	0-2 cm	1.15E-02	1.81E-02	3.00E-02	8.51E-03	3.37E-03	3.70E-03
	SI	2-5 cm	3.48E-02	2.48E-02	3.70E-02	2.59E-04	2.48E-03	4.07E-03
	SD	5-10 cm	6.29E-03	2.44E-02	4.07E-02	-3.07E-03	4.07E-03	3.51E-03
WIPP South (WSS)	SS	0-2 cm	7.77E-03	1.81E-02	3.07E-02	4.81E-03	3.70E-03	5.55E-03
	SI	2-5 cm	1.22E-02	2.00E-02	3.33E-02	6.29E-03	4.07E-03	5.55E-03
	SD	5-10 cm	-1.29E-01	4.44E-02	8.14E-02	2.59E-03	3.00E-03	4.44E-03
Mills Ranch (MLR)	SS	0-2 cm	3.70E-02	2.11E-02	3.11E-02	1.59E-02	4.81E-03	5.92E-03
	SI	2-5 cm	1.85E-02	1.92E-02	3.11E-02	4.44E-03	6.29E-03	9.62E-03
	SD	5-10 cm	6.29E-02	4.07E-02	6.29E-02	3.70E-03	4.07E-03	5.92E-03
WIPP Far Field (WFF)	SS	0-2 cm	-6.66E-03	1.18E-02	2.18E-02	8.51E-04	3.26E-03	2.96E-03
	SI	2-5 cm	4.44E-03	1.26E-02	2.11E-02	4.07E-03	2.96E-03	3.40E-03
	SD	5-10 cm	2.29E-03	1.11E-02	1.92E-02	2.18E-03	2.77E-03	4.07E-03
Smith Ranch (SMR)	SS	0-2 cm	2.96E-02	2.07E-02	3.14E-02	-5.55E-04	3.70E-03	3.70E-03
	SI	2-5 cm	1.26E-02	1.48E-02	2.44E-02	5.18E-03	3.48E-03	4.07E-03
	SD	5-10 cm	1.44E-02	1.29E-02	2.07E-02	4.44E-03	3.63E-03	4.07E-03

N/A = Results Not Available

Table 5.5.4 - Duplicate Measurements

			Am-241			Pu-238			Pu-239+240		
Location			**Conc. (Bq/g)**	**TPU**	**MDA**	**Conc. (Bq/g)**	**TPU**	**MDA**	**Conc. (Bq/g)**	**TPU**	**MDA**
SEC	SS	0-2 cm	2.22E-04	5.18E-04	8.88E-04	1.85E-04	2.96E-04	4.81E-04	7.40E-04	4.07E-04	1.48E-04
SEC Duplicate	SS	0-2 cm	4.07E-04	6.66E-04	1.11E-03	1.11E-04	2.59E-04	5.18E-04	0.00E+00	2.59E-04	5.92E-04
SMR	SD	5-10 cm	N/A			0.00E+00	8.14E-04	1.81E-03	5.18E-04	5.92E-04	4.44E-04
SMR Duplicate	SD	5-10 cm	N/A			3.33E-04	7.40E-04	1.33E-03	2.37E-03	9.62E-04	8.51E-04
			K-40			**Co-60**			**Cs-137**		
SEC	SS	0-2 cm	4.44E-01	8.51E-02	4.07E-02	5.55E-03	3.70E-03	3.70E-03	7.77E-03	4.81E-03	7.40E-03
SEC Duplicate	SS	0-2 cm	2.70E-02	6.29E-02	8.51E-02	-5.55E-03	3.70E-03	3.26E-03	2.59E-03	4.44E-03	7.03E-03
SMR	SD	5-10 cm	3.33E-01	8.14E-02	5.92E-02	-6.66E-03	3.70E-03	3.00E-03	-5.55E-04	3.70E-03	3.70E-03
SMR Duplicate	SD	5-10 cm	3.29E-01	8.88E-02	7.40E-02	7.03E-03	3.40E-03	3.70E-03	-5.18E-04	3.70E-03	3.51E-03
			U-234			**U-235**			**U-238**		
SEC	SS	0-2 cm	3.63E-02	4.44E-03	9.62E-04	1.55E-03	6.29E-04	4.44E-04	2.44E-02	3.29E-03	5.55E-04
SEC Duplicate	SS	0-2 cm	2.63E-02	3.70E-03	1.74E-03	8.51E-04	7.03E-04	9.99E-04	2.89E-02	4.07E-03	1.33E-03
SMR	SD	5-10 cm	1.52E-02	2.55E-03	1.04E-03	3.33E-04	3.70E-04	5.18E-04	1.74E-02	2.70E-03	5.18E-04
SMR Duplicate	SD	5-10 cm	2.26E-02	3.26E-03	6.29E-04	1.15E-03	5.55E-04	1.85E-04	2.03E-02	3.03E-03	6.29E-04

N/A= Results Not Available

5.6 Sediments

Sample Collection: Sediment samples were collected from eleven locations around the WIPP site, mostly from the same water bodies from which the surface water samples were collected. The samples were generally collected in a knee-deep location of the water body, except for at UPR. The sample from UPR was taken from the middle section of the river from a bridge on the river. The samples were collected in polyethylene bags from the top six inches of the sediments of the water bodies, brought to the laboratory, dried, and shipped to a commercial laboratory for the determination of individual radionuclides.

Sample Preparation: Sediment samples were dried at 110°C for several hours and homogenized by grinding to smaller particle sizes. An aliquot (one gram) was dissolved by heating it with a mixture of nitric, hydrochloric, and hydrofluoric acids. The residue was heated with nitric and boric acids to remove hydrofluoric acid quantitatively. Finally, the residue was dissolved in hydrochloric acid for the determination of individual radionuclides.

Determination of Individual Radionuclides: About 100 grams of dried and homogenized sediment samples were counted by gamma-spectrometry for the determinations of K-40, Co-60, and Cs-137. Strontium-90 was determined from an aliquot of dissolved sediment samples by chemical separation and beta counting. Uranium, plutonium, and americium were determined by alpha-spectrometry after chemical separations and micro-precipitating and filtering onto micro filter papers.

Results and Discussions: The results for uranium concentrations in these sediment samples are given in table 5.6.1. The concentration of U-234 ranged from 13.3 ± 2.4 mBq/g (UPR) to 35.5 ± 4.4 mBq/g (CBD), with a mean of 24.0 ± 5.8 mBq/g. Similarly, the concentration of U-238 ranged from 14.4 ± 2.4 mBq/g (UPR) to 31.4 ± 4.1 mBq/g (CBD), with a mean of 24.1 ± 4.9 mBq/g. The concentration of U-235, as expected, was much lower than the concentrations of U-234 and U-238 and ranged from 0.44 ± 0.41 mBq/g (UPR) to 1.3 ± 0.70 mBq/g (TUT), with a mean of 0.97 ± 0.24 mBq/g.

Table 5.6.1 - Uranium Concentration in Sediment

	U-234			U-235			U-238		
Location	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
HIL	2.22E-02	3.18E-03	9.62E-04	6.66E-04	5.55E-04	7.40E-04	2.29E-02	3.22E-03	6.66E-04
UPR	1.33E-02	2.37E-03	1.11E-03	4.44E-04	4.07E-04	5.18E-04	1.44E-02	2.44E-03	6.66E-04
BRA	2.03E-02	3.22E-03	1.33E-03	1.07E-03	7.03E-04	8.14E-04	2.33E-02	3.51E-03	8.14E-04
TUT	2.52E-02	4.07E-03	1.15E-03	1.26E-03	7.03E-04	6.66E-04	2.96E-02	4.44E-03	8.14E-04
CBD	3.55E-02	4.44E-03	1.04E-03	1.07E-03	5.55E-04	5.92E-04	3.14E-02	4.07E-03	5.92E-04
PCN	2.92E-02	4.07E-03	1.11E-03	1.11E-03	6.29E-04	5.92E-04	2.29E-02	3.48E-03	8.51E-04
NOY	2.03E-02	3.29E-03	1.37E-03	1.07E-03	6.66E-04	7.40E-04	2.07E-02	3.29E-03	7.40E-04
RED	1.92E-02	3.03E-03	1.15E-03	1.07E-03	7.77E-04	1.07E-03	1.89E-02	2.96E-03	9.25E-04
LST	2.40E-02	3.70E-03	9.99E-04	9.99E-04	6.29E-04	6.29E-04	2.22E-02	3.48E-03	6.29E-04
IDN	2.22E-02	3.70E-03	2.59E-03	6.66E-04	6.29E-04	8.88E-04	2.89E-02	4.07E-03	5.92E-04
PKT	2.85E-02	4.07E-03	1.92E-03	9.99E-04	7.77E-04	1.07E-03	2.85E-02	4.07E-03	1.37E-03

Ratios of U-234 to U-238 concentrations in these samples ranged from 0.77 ± 0.17 mBq/g (IDN) to 1.28 ± 0.23 mBq/g (PCN), which are quite close to unity. Also, the ratio of the mean concentration of U-234 to the mean concentration of U-238 was 1.0 ± 0.32 mBq/g. These results, therefore, suggest that U-238 and U-234 are in equilibrium as found in soil samples also.

Results for uranium concentrations in sediment samples were compared with the uranium concentrations of soil samples. The range of U-234 concentrations in sediment samples (13.3 ± 2.4 mBq/g to 35.5 ± 4.4 mBq/g) was almost identical to the range of U-234 concentrations in SS samples (0-2 cm) around the WIPP site (15.2 ± 2.6 mBq/g to 36.3 ± 4.4 mBq/g). Similarly, the range of U-238 concentrations in sediment samples (14.4 ± 2.4 mBq/g to 31.4 ± 4.1 mBq/g) was almost identical to the range of U-238 concentrations in the SS samples (15.9 ± 2.6 mBq/g to 28.5 ± 3.7 mBq/g). These results indicate that the concentrations of uranium in sediment samples are the reflection of uranium in the soil samples. The results for uranium concentrations in sediment samples for 1998 were compared with the results of 1997 samples to examine the annual trend (table 5.6.2).

Table 5.6.2 - Comparison of U-234 and U-238 Concentrations Between Sediment Samples of 1997 and 1998

	1998			1997		
Location	**U-234± 2σ (mBq/g)**	**U-238± 2σ (mBq/g)**	**U-234/U-238 (Activity Ratio)**	**U-234± 2σ (mBq/g)**	**U-238± 2σ (mBq/g)**	**U-234/U-238 (Activity Ratio)**
HIL	22.2 ± 3.2	22.9 ± 3.2	0.97 ± 0.20	18.9 ± 3.1	17.8 ± 2.9	1.06±0.25
UPR	13.3 ± 2.4	14.4 ± 2.4	0.92 ± 0.23	20.7 ± 2.9	19.6 ± 2.8	1.06±0.21
BRA	20.3 ± 3.2	23.3 ± 3.5	0.87 ± 0.19	23.3 ± 3.4	19.2 ± 2.9	1.21±0.25
TUT	25.2 ± 4.1	29.6 ± 4.4	0.85 ± 0.19	22.6 ± 3.5	24.1 ± 3.6	0.94±0.20
CBD	35.5 ± 4.4	31.4 ± 4.1	1.13 ± 0.20	40.7 ± 5.2	28.9 ± 3.7	1.41±0.26
PCN	29.2 ± 4.1	22.9 ± 3.5	1.28 ± 0.27	25.9 ± 3.7	28.9 ± 4.1	0.90±0.18
NOY	20.3 ± 3.3	20.7 ± 3.3	0.98 ± 0.22	14.1 ± 2.5	13.3 ± 2.4	1.06±0.27
RED	19.2 ± 3.0	18.9 ± 3.0	1.02 ± 0.23	17.0 ± 2.7	17.4 ± 2.7	0.98±0.22
IDN	22.2 ± 3.7	28.9 ± 4.1	0.77 ± 0.17	21.8 ± 3.3	22.2 ± 3.3	0.98±0.21
Mean±SD	24.0 ± 5.8	24.1 ± 4.9	0.98 ± 0.15	22.8 ± 7.6	21.3 ± 5.3	1.07±0.16

As can be seen from the above table, the concentration of U-234 in samples for 1997 ranged from 14.1 ± 2.5 mBq/g (NOY) to 40.7 ± 5.2 mBq/g (CBD), and the concentration of U-238 ranged from 13.3 ± 2.37 mBq/g (NOY) to 28.9 ± 3.7 mBq/g (CBD). A comparison of U-234 concentrations between the samples for 1997 and 1998 revealed that the concentrations were similar(did not differ significantly) in both years for all the locations except UPR and NOY. Concentrations of U-238 also were similar in both years for all the locations except UPR and NOY. No apparent reason could be found for the significant differences in 1998 as compared to 1997 for the concentrations of U-234 and U-238 in samples of UPR and NOY. This might, however, have been due to the analytical variables. Since the samples from seven out of the nine locations showed no significant differences in uranium concentrations in both years, it can be concluded that there is no change in uranium concentrations in sediments, at least in the time frame of the last two years.

Ratios of U-234 to U-238 concentrations for each location were also compared for both years. In 1997, ratios ranged from 0.90 ± 0.18 mBq/g (PCN) to 1.41 ± 0.26 mBq/g (CBD) and in 1998, it ranged from 0.85 ± 0.19 mBq/g (TUT) to 1.28 ± 0.27 mBq/g (PCN). Ratios for each location in both years were essentially the same. Also, the ratio of the mean concentration of U-234 to U-238 concentration was approximately 1.0, suggesting that both parent (U-238) and daughter (U-234) were in equilibrium in the sediment samples.

Plutonium-238, Pu-239+240, and Am-241 were also determined in these samples; the results are given in table 5.6.3. The concentrations of Pu-238 in the CBD sample (0.96 ± 0.67 mBq/g) and in the Red Tank (RED) sample (1.0 ± 0.59 mBq/g) were slightly above their MDAs of 0.70 mBq/g and 0.52 mBq/g, respectively. The analytical errors associated with these measurements were large. These values are believed to be false-positive values, though a review of the laboratory data revealed no discernable reason for these results. The sample from RED also indicated a concentration of Pu-239+240 of 0.81±0.48 mBq/g, which was above the MDA of 0.44 mBq/g. The concentration of Am-241 also was below its MDA in all but one sample Poker Trap (PKT). The concentration in the sample from PKT (1.0 ± 0.52 mBq/g) was above its MDA of 0.52 mBq/g.

Potassium-40, a naturally occurring gamma-emitting radionuclide, was also measured; the results are included in table 5.6.4. Concentrations ranged from 181 ± 59 mBq/g (PCN) to 1110 ± 166 mBq/g (TUT), with a mean of 573 ± 303 mBq/g. Concentration of K-40 in the sediment sample from TUT was significantly higher than its concentrations in samples at all other locations. The samples from UPR, BRA, and PCN (all from the Pecos River) had the lowest concentrations of K-40. The sample from CBD, another sampling location from the Pecos River, had a significantly higher concentration of K-40 compared to the samples from the other three Pecos River sampling locations (UPR, BRA, and PCN). These results suggest that the concentrations of K-40 varied significantly among various locations.

The results for K-40 concentrations in sediment samples were compared with the concentration of K-40 in SS samples of the WIPP vicinity. The concentrations in soil samples ranged from 148 ± 63 mBq/g to 444 ± 85 mBq/g, with a mean of 328 ± 111 mBq/g. The results suggest that the concentration of K-40 in sediment samples may be slightly higher than the soil samples.

The results for K-40 concentrations in sediment samples for 1998 were compared with the results of 1997 samples to examine the annual trend. The mean concentration of K-40 in 1998 samples (573 ± 303 mBq/g) was almost similar to its mean concentration of 1997 samples (680 ± 239 mBq/g). Concentrations of K-40 in 1997 and 1998 were similar (did not differ significantly) in the samples of all but three locations. The 1997 samples from UPR, PCN, and Lost Tank (LST) contained significantly higher concentrations of K-40 than 1998 samples of the corresponding locations. In conclusion, the sediment samples from the majority (≈ 75 percent) of the locations did not show significant differences in 1998 from 1997.

Strontium-90, which is present in the environment from the fallout of aboveground nuclear tests, was also determined in these samples; the results are given in table 5.6.4. The results clearly indicate that the concentrations of Sr-90 in these samples were nondetectable (lower than their MDA).

Cesium-137 was also determined in five sediment samples; the results are included in table 5.6.4. Concentrations in four out of five samples were above their MDA and the analytical errors associated with these measurements were reasonably low and acceptable. Concentrations of Cs-137 in these four samples did not differ from each other significantly and ranged from 17 ± 5.6 mBq/g (PKT) to 22 ± 10 mBq/g (IDN). The mean concentration of Cs-137 in sediment was 19 ± 2.4 mBq/g.

The results for Cs-137 concentrations in 1998 sediment samples were compared with the results of 1997 samples to study the annual trend. Among the 1997 samples, only the results for the locations TUT, HIL, NOY, IDN, and PKT were included because the results for 1998 contained the samples from these locations only. Concentration in sediment samples from NOY were nondetectable in both years. Among the remaining four locations, the concentration in 1997 samples ranged from 6.7 ± 3.7 mBq/g (HIL) to 28 ± 12 mBq/g (PKT), with a mean concentration of 17 ± 8.8 mBq/g.

The mean concentration of Cs-137 in 1998 samples (19 ± 2.4 mBq/g) was not significantly different from the mean concentration of 1997 samples (17 ± 8.8 mBq/g). Also, when the comparisons were made for the individual sampling location, it was found that the concentrations of Cs-137 in 1998 and 1997 samples were not different from each other for each location. In conclusion, the concentrations of Cs-137 in 1998 samples were almost the same as in 1997 samples.

Duplicate analyses were performed for all the radionuclides in a sediment sample collected from HIL. The sample was dried, homogenized, and divided into two parts for the duplicate analyses. Both parts were analyzed separately; the results are given in table 5.6.5. Results for U-234 in the original (33 ± 7.4 mBq/g) and duplicate analyses (31 ± 4.4 mBq/g) were almost identical. Similarly, the concentrations of U-238 in the original (30 ± 7.0 mBq/g) and duplicate analyses (31± 4.8 mBq/g) were also identical.

Plutonium-238, Pu-239+240, and Am-241 were below detection levels in both sets of analyses. Cobalt-60 and Cs-137 were also not detected in the original and duplicate samples. The results for K-40 in the original (85 ± 59 mBq/g) and duplicate (629 ± 137 mBq/g) analyses were significantly different from each other. Potassium-40 found in the original analysis (85 ± 59 mBq/g) seems to be an outlier because another sample analyzed from HIL (table 5.6.4) gave a concentration of 629 ± 126 mBq/g, which was identical to the result (629 ± 137 mBq/g) of duplicate analysis. Based on these results, it can be concluded that the sampling and the measurement techniques were quite reproducible.

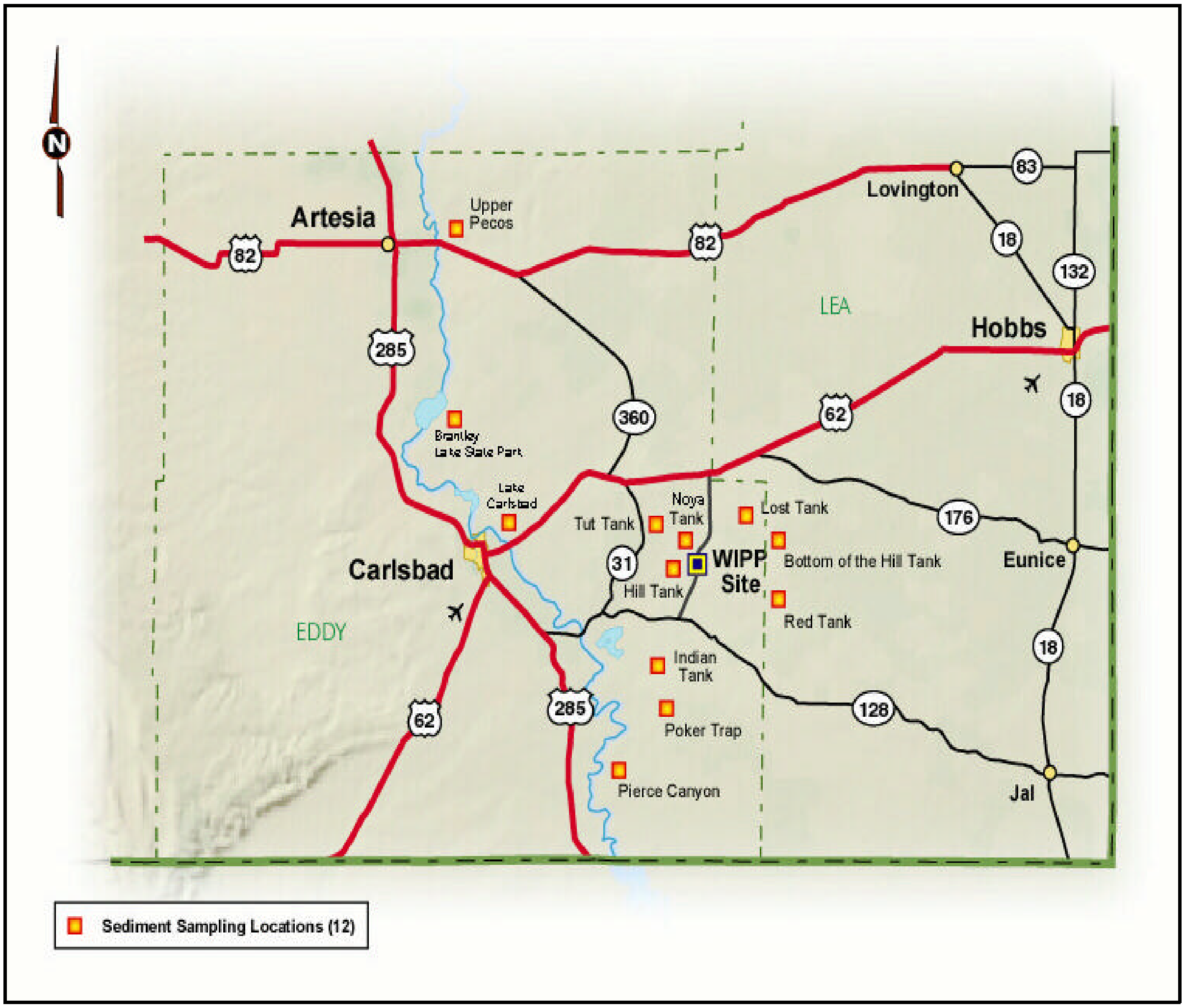


Figure 5.6.1 - Sediment Sampling Sites

Table 5.6.3 - Americium and Plutonium Concentration in Sediments

	Am-241			Pu-238			Pu-239/240		
Location	**Conc. (Bq/g)**	**TPU**	**MDA**	**Conc. (Bq/g)**	**TPU**	**MDA**	**Conc. (Bq/g)**	**TPU**	**MDA**
HIL	3.70E-04	3.70E-04	4.81E-04	2.59E-04	4.44E-04	7.40E-04	3.70E-04	4.07E-04	5.92E-04
UPR	4.81E-04	5.18E-04	7.40E-04	0.00E+00	1.48E-04	4.44E-04	7.40E-05	1.85E-04	4.44E-04
BRA	1.11E-04	3.70E-04	7.40E-04	1.48E-04	1.85E-04	1.85E-04	7.40E-05	1.48E-04	1.85E-04
TUT	1.85E-04	3.33E-04	6.29E-04	7.40E-05	2.59E-04	5.18E-04	1.48E-04	2.96E-04	5.18E-04
CBD	2.59E-04	8.14E-04	1.52E-03	9.62E-04	6.66E-04	7.03E-04	2.96E-04	3.33E-04	2.59E-04
PCN	1.11E-04	4.44E-04	8.14E-04	3.70E-04	5.55E-04	8.88E-04	-1.11E-04	5.18E-04	1.15E-03
NOY	4.44E-04	9.99E-04	1.81E-03	7.40E-05	2.59E-04	5.55E-04	-1.11E-04	2.96E-04	7.03E-04
RED	7.03E-04	7.03E-04	1.07E-03	9.99E-04	5.18E-04	4.44E-04	8.14E-04	4.81E-04	4.44E-04
LST	5.18E-04	5.55E-04	7.77E-04	-1.11E-04	3.33E-04	7.40E-04	2.22E-04	2.96E-04	4.81E-04
IDN	1.85E-04	4.81E-04	8.88E-04	2.96E-04	5.18E-04	9.25E-04	5.92E-04	6.29E-04	9.25E-04
PKT	9.99E-04	5.92E-04	5.18E-04	1.07E-03	1.18E-03	1.89E-03	5.18E-04	5.18E-04	6.66E-04

Table 5.6.4 - Beta and Gamma Emitters in Sediments

	K-40					
Location	**Conc. (Bq/g)**	**TPU**	**MDA**			
HIL	6.29E-01	1.26E-01	7.03E-02			
UPR	2.15E-01	6.66E-02	5.92E-02			
BRA	2.15E-01	6.29E-02	5.18E-02			
TUT	1.11E+00	1.66E-01	8.88E-02			
CBD	4.07E-01	1.22E-01	9.99E-02			
PCN	1.81E-01	5.92E-02	*			
NOY	8.51E-01	1.22E-01	5.18E-02			
RED	5.18E-01	1.07E-01	4.44E-02			
LST	6.29E-01	1.26E-01	9.62E-02			
IDN	6.66E-01	1.48E-01	1.07E-01			
PKT	8.88E-01	1.33E-01	4.07E-02			
	Sr-90			**Cs-137**		
	Conc. (Bq/g)	**TPU**	**MDA**	**Conc. (Bq/g)**	**TPU**	**MDA**
HIL	-5.92E-03	2.07E-02	3.66E-02	*		
UPR	-8.14E-04	2.18E-02	3.70E-02			
BRA	9.25E-03	2.15E-02	3.59E-02			
TUT	-1.44E-02	5.55E-02	9.99E-02	1.92E-02	7.77E-03	9.25E-03
CBD	1.55E-02	2.59E-02	4.44E-02	*		
PCN	1.96E-02	1.70E-02	2.74E-02			
NOY	-1.66E-02	4.44E-02	8.14E-02	7.77E-03	7.03E-03	1.04E-02
RED	-5.92E-04	4.44E-02	8.14E-02	*		
LST	-1.22E-02	2.07E-02	3.70E-02			
IDN	-1.89E-02	5.55E-02	9.99E-02	2.22E-02	9.99E-03	1.29E-02
PKT	1.15E-02	2.07E-02	3.48E-02	1.70E-02	5.55E-03	6.29E-03

* Data not available from laboratory.

Table 5.6.5 - Duplicate Analysis in Sediment Matrix

	U-234			U-235			U-238		
Location	**Conc. (Bq/g)**	**TPU**	**MDA**	**Conc. (Bq/g)**	**TPU**	**MDA**	**Conc. (Bq/g)**	**TPU**	**MDA**
Hill Tank (HIL)	3.26E-02	7.40E-03	4.07E-03	1.59E-03	2.37E-03	4.07E-03	2.96E-02	7.03E-03	3.48E-03
Duplicate	3.07E-02	4.44E-03	1.55E-03	1.48E-03	8.51E-04	8.51E-04	3.14E-02	4.81E-03	8.51E-04
	Am-241			Pu-238			Pu-239+240		
Hill Tank (HIL)	4.07E-04	4.07E-04	5.92E-04	-2.96E-04	5.55E-04	1.22E-03	2.96E-04	3.70E-04	5.55E-04
Duplicate	6.66E-04	5.92E-04	8.88E-04	2.22E-04	3.33E-04	5.55E-04	2.96E-04	3.70E-04	5.55E-04
	K-40			**Co-60**			**Cs-137**		
Hill Tank (HIL)	8.51E-02	5.92E-02	5.18E-02	0.00E+00	0.00E+00	2.96E-03	0.00E+00	0.00E+00	3.18E-03
Duplicate	6.29E-01	1.37E-01	9.25E-02	0.00E+00	0.00E+00	4.81E-03	1.44E-02	8.88E-03	1.26E-02

5.7 Biota

Sample Collection: Uptake of radionuclides by plants and vegetation is an important factor in estimating the intake of individual radionuclides in humans through ingestion. Therefore, vegetation samples were collected from the same six locations from where the soil samples were collected. The vegetation samples were chopped into one to two-inch-long pieces, mixed together well, air dried at room temperature, and sent to the contract laboratory for analysis. Also collected were the soft tissues from a deer, a quail, and two rabbits to estimate the intake of the radionuclides in humans through this part of food chain. Fish is consumed in large amounts; therefore, determination of radionuclides in fish samples is important. Accordingly, fish samples from PCN, PEC, and BRA (three different locations at Pecos River) were collected. The soft tissues from the deer, quail, rabbits, and whole fish were sent to the contract laboratory for analysis.

Sample Preparation: Weighed amounts of aliquots were taken from the bulk of the chopped vegetation samples from each location. The aliquots were transferred into separate containers and dried at 100°C. The samples were dry-ashed followed by wet-ashing and dissolution in 8M nitric acid. The aliquots from the dissolved samples were taken for the determinations of Sr-90, U-234, U-235, U-238, Pu-238, Pu-239+240, and Am-241. Gamma spectrometric determinations of K-40, Co-60, and Cs-137 were performed directly from the large aliquots of air-dried chopped vegetation samples.

Results and Discussions: Concentrations of U-234, U-235, and U-238 were determined in vegetation samples; the results are given in table 5.7.1. Concentrations of U-234 ranged from 0.20 ± 0.06 mBq/g (WEE) to 0.75 ± 0.14 mBq/g (MLR). The mean concentration of U-234 in the vegetation sample was 0.43 ± 0.20 mBq/g.

Table 5.7.1 - Uranium Concentration in Vegetation

	U-234			U-235			U-238		
Location	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
SEC	5.03E-04	9.99E-05	1.04E-05	1.44E-05	1.44E-05	1.04E-05	4.96E-04	9.99E-05	2.66E-05
WFF	2.81E-04	7.03E-05	4.81E-05	-3.37E-06	1.70E-05	3.70E-05	2.14E-04	5.92E-05	3.37E-05
WEE	2.02E-04	5.92E-05	4.81E-05	1.35E-05	2.03E-05	3.18E-05	2.32E-04	6.29E-05	2.52E-05
WSS	3.56E-04	8.14E-05	5.18E-05	1.61E-05	1.44E-05	8.14E-06	3.08E-04	7.03E-05	1.63E-05
SMR	5.03E-04	1.11E-04	5.55E-05	3.56E-05	3.00E-05	5.92E-05	5.36E-04	1.18E-04	5.92E-05
MLR	7.51E-04	1.41E-04	6.66E-05	2.86E-05	2.33E-05	1.29E-05	7.81E-04	1.41E-04	4.07E-05

The results clearly indicate that the concentrations of U-234 varied significantly among the vegetation samples of various locations. The concentration found in the MLR sample was significantly higher than the concentration in each of the remaining samples. Concentrations in samples from WFF, WEE, and WSS were not different from each other but were significantly lower than the concentrations found in SEC and SMR samples.

The results for U-238 were similar to U-234 as can be seen from table 5.7.1. The concentration of U-238 ranged from 0.21 ± 0.06 mBq/g in the sample from WFF to 0.78 ±

0.14 mBq/g in the sample from MLR. The mean concentration of U-238 was 0.43 ± 0.22 mBq/g, exactly the same as found for U-234.

The results for U-238 also suggest that concentrations of uranium varied significantly among the samples of various locations. Again, the concentration in the MLR sample was significantly higher than the concentrations found in all other samples. As observed for U-234, the concentrations of U-238 in samples from WFF, WEE, and WSS were not different from each other but were significantly lower than the concentrations found in the SEC and SMR samples.

Concentration ratios of U-234 to U-238 in all six samples were close to one suggesting that U-238 and daughter U-234 were in equilibrium. This is what should have been expected because U-238 and U-234 were in equilibrium in soil samples also.

Concentrations of U-235 in these samples were very low, almost close to detection levels. It was therefore difficult to derive meaningful conclusions from these results.

Plutonium-238 and Pu-239+240 were also analyzed in these samples; the results are given in table 5.7.2. Concentrations of Pu-238 and Pu-239+240 were nondetectable.

Table 5.7.2 - Alpha Emitters in Vegetation

	Am-241			Pu-238			Pu-239/240		
Location	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
SEC	-2.67E-05	4.07E-05	9.62E-05	-1.46E-05	1.89E-05	1.89E-05	6.25E-06	1.44E-05	6.66E-05
WFF	5.73E-06	1.81E-05	3.44E-05	-1.51E-05	5.55E-05	1.44E-04	-6.36E-05	6.29E-05	1.89E-04
WEE	-2.99E-06	2.33E-05	4.81E-05	5.11E-06	1.11E-05	4.44E-05	5.11E-06	2.55E-05	5.18E-05
WSS	5.14E-05	3.22E-05	4.44E-05	0.00E+00	8.51E-05	1.78E-04	2.76E-05	5.55E-05	9.99E-05
SMR	0.00E+00	5.18E-05	1.11E-04	1.01E-04	1.22E-04	1.92E-04	3.01E-05	5.92E-05	1.07E-04
MLR	7.81E-06	2.07E-05	4.07E-05	3.81E-05	3.55E-04	3.55E-05	2.54E-05	4.44E-05	3.55E-05

Americium-241 was also determined in these samples; the results are included in table 5.7.2. Concentrations of Am-241 were less than their MDA for all but one sample. The WSS sample contained 0.051 ± 0.032 mBq/g of vegetation, which was slightly higher than the MDA of 0.044 mBq/g. Based on a review of the laboratory data, no discernable reason for this result could be determined based on laboratory error; however, this value is believed to be a false-positive.

Concentrations of K-40 were also determined in these samples; the results are given in table 5.7.3. The concentration in the SEC sample was below its MDA. The concentrations among the samples of the remaining four locations ranged from 169 ± 93 mBq/g in the WFF sample to 470 ± 67 mBq/g in the sample from SMR. The results clearly indicated that the concentration of K-40 in the SMR sample was significantly higher than its concentrations in all other samples.

Table 5.7.3 - Beta and Gamma Emitters in Vegetation						
	K-40			Co-60		
Location	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
SEC	1.30E-01	1.18E-01	1.33E-01	-9.06E-03	7.03E-03	6.29E-03
WFF	1.69E-01	9.25E-02	9.62E-02	-5.66E-03	4.44E-03	3.55E-03
WEE	2.46E-01	9.62E-02	8.51E-02	3.67E-03	4.07E-03	3.70E-03
WSS	2.11E-01	4.07E-02	1.78E-02	-5.18E-04	2.11E-03	2.11E-03
SMR	4.70E-01	6.66E-02	1.89E-02	5.62E-03	2.07E-03	2.48E-03
MLR	2.46E-01	5.92E-02	3.70E-02	-4.62E-03	2.89E-03	2.22E-03
	Sr-90			Cs-137		
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
SEC	4.51E-03	4.81E-03	8.14E-03	2.38E-03	6.29E-03	5.92E-03
WFF	1.71E-02	1.04E-02	1.63E-02	2.86E-03	4.07E-03	4.07E-03
WEE	2.06E-02	1.15E-02	1.74E-02	-4.33E-03	5.18E-03	4.44E-03
WSS	3.68E-03	3.37E-03	5.18E-03	-6.10E-04	1.78E-03	1.52E-03
SMR	-4.07E-03	3.44E-03	6.29E-03	1.32E-03	2.15E-03	1.96E-03
MLR	-3.30E-03	3.33E-03	5.92E-03	5.33E-04	2.48E-03	4.07E-03

Cobalt-60, another gamma-emitting radionuclide, was also analyzed in these samples; the results are included in table 5.7.3. Concentrations were below their MDA in all the samples except the SMR sample.

Concentrations of Sr-90 in four of the six samples were below their MDA (table 5.7.3). Among the two samples showing detectable activities of Sr-90, WFF and WEE samples had the concentrations of 17 ± 10 mBq/g and 21 ± 12 mBq/g, respectively.

Cesium-137 was also determined in these samples; the results are given in table 5.7.3. Concentrations of Cs-137 in all the samples were below their MDA.

A duplicate analysis of the vegetation sample collected from SEC was performed for all the radionuclides. The results are given in table 5.7.4. Concentrations of U-234 in the original (0.50 ± 0.10 mBq/g) and the duplicate (0.54 ± 0.12 mBq/g) were almost identical. Also, the concentrations of U-238 in both analyses were the same (0.50 ± 0.10 mBq/g and 0.51± 0.11 mBq/g). The results for K-40 were also similar in both analyses. The original analysis gave the concentration of 130 ± 118 mBq/g, whereas the duplicate analysis gave the concentration of 147 ± 104 mBq/g. The other radionuclides, including Pu-238, Pu-239+240, Am-241, Co-60, Sr-90, and Cs-137, were below their MDA in both the original and duplicate analyses. These results, therefore, suggest that the sampling and measurement techniques were quite reproducible.

Table 5.7.4 - Duplicate Vegetation Analyses									
Location	U-234			U-235			U-238		
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
SEC	5.40E-04	1.15E-04	4.44E-05	2.28E-05	2.74E-05	4.07E-05	5.07E-04	1.11E-04	4.07E-05
	AM-241			Pu-238			Pu-239/240		
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
SEC	1.59E-05	2.52E-05	4.44E-05	2.99E-05	7.03E-05	1.37E-04	0.00E+00	5.55E-05	1.37E-04
	K-40			Co-60					
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA			
SEC	1.47E-01	1.04E-01	1.07E-01	-7.62E-03	5.55E-03	4.44E-03			
	Sr-90			Cs-137					
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA			
SEC	-5.40E-03	5.18E-03	9.62E-03	-5.59E-03	4.81E-03	4.44E-03			

Measurements of U-234, U-235, and U-238 in biota samples were also performed. The biota samples included the soft tissues of a deer, a quail, two rabbits, and three fish samples (the whole fish collected from three different locations of Pecos River: PCN, PEC, and BRA). The results for the concentrations of uranium in these samples are given in table 5.7.5.

Among all the biota samples analyzed, the concentration of U-234 was highest in the fish samples. Concentration ranged from 0.22 ± 0.04 mBq/g in the fish collected from BRA to 0.37 ± 0.07 mBq/g in the fish collected from PCN. Concentrations of U-238 in the fish samples ranged from 0.11 ± 0.03 mBq/g to 0.13 ± 0.03 mBq/g. As can be seen, the concentrations of U-234 were higher than the concentrations of U-238 in all the fish samples. This might simply have been due to the fact that the concentrations of U-234 in water samples of these locations were also higher than the concentrations of U-238 by a factor of almost two.

Concentrations of U-234 in pooled soft tissues of deer (0.26 ± 0.16 mBq/g) and quail (0.11 ± 0.03 mBq/g) were almost similar. Concentrations of U-238 in soft tissues of deer (0.13 ± 0.09 mBq/g) and quail (0.04 ± 0.02 mBq/g) were also not significantly different from each other. However, the concentrations of U-234 and U-238 in soft tissue of both rabbits were significantly lower than their concentrations in deer and quail. For example, the mean concentrations of U-234 and U-238 in rabbits were 0.016 ± 0.009 mBq/g and 0.017 ± 0.014 mBq/g, respectively.

Concentrations of Pu-238, and Pu-239+240 were also determined in these biota samples; the results are given in table 5.7.6. Concentrations of Pu-238 and Pu-239+240 were below their MDA in all the samples. Americium-241 was also determined in these samples; the results are included in table 5.7.5. Concentrations of Am-241 in all but one sample (PEC fish) were below their MDA. However, the result for Am-241 in the fish sample from PEC (0.012 ± 0.009 mBq/g) had a large analytical error associated with the measurement. The reported value was also less than the reported MDA for this suite of samples.

Potassium-40, a naturally occurring gamma-emitting radionuclide, was also determined in these biota samples; the results are given in table 5.7.7. Concentration of K-40 in fish was lowest compared to the deer, quail, and rabbit. Concentrations of K-40 in the pooled soft tissues of deer, quail, and rabbit were almost similar and ranged from 107 ± 16 mBq/g in deer to 243 ± 96 mBq/g in the rabbit. Concentration of K-40 in fish was much lower. In samples from PCN and PEC its concentrations were 70 ± 56 mBq/g and 85 ± 56 mBq/g, respectively. The concentration in fish from BRA was below the detection level.

Cobalt-60 was also determined in these biota samples and results are included in table 5.7.7. Concentrations of Co-60 in all but one sample (fish from BRA) were below their MDA. The concentration in the fish sample from BRA (2.7 ± 1.7 mBq/g) was slightly above the MDA.

Cesium-137 was determined in these biota samples; the results are given in table 5.7.7. Except for the fish sample collected from PEC, no other fish, deer, rabbit, and quail had detectable activities of Cs-137. The concentration in the fish sample from PEC was 4.1 ± 1.9 mBq/g.

Duplicate analyses were performed on the pooled soft tissues of a deer; the results are given in table 5.7.8. Concentrations of Pu-238, Pu-239+240, and Am-241 in the original and duplicate samples were below their MDAs. Concentrations of K-40 in both analyses (107 ± 16 mBq/g and 104 ± 16 mBq/g) were essentially identical. Concentrations of Co-60, Sr-90, and Cs-137 in the original and duplicate analyses were also found to be below their MDA.

A duplicate analysis was also performed for the fish sample; the results are included in table 5.7.8. Concentrations of U-234 in the original (0.23 ± 0.044 mBq/g) and duplicate (0.23 ± 0.041 mBq/g) were identical. Concentrations of U-238 in the original (0.13 ± 0.032 mBq/g) and duplicate (0.093 ± 0.026 mBq/g) analyses were similar to each other. Plutonium-238, Pu-239+240, and Am-241 in the original and duplicate samples were below their MDA as can be seen from the table 5.7.8. Concentrations of K-40, Co-60, and Sr-90 were below their MDA in the original and duplicate analyses. Concentration of Cs-137 in the original analysis (2.2 ± 1.9 mBq/g) was quite different from the concentration found in the duplicate analysis (0.26 ± 1.9 mBq/g). Based on these duplicate analyses, the analytical results were found to be generally reproducible.

Table 5.7.5 - Uranium Concentration in Biota									
	U-234			U-235			U-238		
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
Deer	2.63E-04	1.63E-04	1.96E-04	3.31E-05	8.14E-05	1.52E-04	1.32E-04	9.25E-05	4.44E-05
Quail	1.05E-04	3.00E-05	2.00E-05	1.59E-06	1.11E-05	2.18E-05	4.00E-05	1.81E-05	1.55E-05
Rabbit (Tissue)	2.20E-05	1.15E-05	1.41E-05	-1.71E-06	3.40E-06	8.51E-06	7.07E-06	6.66E-06	9.62E-06
Rabbit (Tissue)	8.95E-06	1.78E-05	3.11E-05	3.44E-06	5.18E-06	4.81E-06	2.65E-05	1.48E-05	1.29E-05
Fish (PCN)	3.67E-04	6.66E-05	3.55E-05	9.40E-06	8.51E-06	4.81E-06	1.12E-04	3.11E-05	4.81E-06
Fish (PEC)	2.73E-04	5.18E-05	2.40E-05	3.54E-06	7.03E-06	1.26E-05	1.28E-04	3.18E-05	1.26E-05
Fish (BRA)	2.22E-04	4.44E-05	1.92E-05	8.29E-05	2.48E-05	1.18E-05	1.24E-04	3.14E-05	1.48E-05

Table 5.7.6 - Alpha Emitters Concentration in Biota									
	Am-241			Pu-238			Pu-239/240		
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
Deer	3.36E-06	5.92E-06	9.99E-06	1.22E-06	5.18E-06	9.62E-06	-1.79E-06	2.70E-06	7.40E-06
Quail	7.40E-06	6.29E-06	8.51E-06	3.44E-06	7.03E-06	1.26E-05	7.95E-07	7.40E-06	1.41E-05
Rabbit (Tissue)	9.77E-07	7.03E-06	1.41E-05	-1.47E-06	8.14E-06	1.63E-05	0.00E+00	3.66E-06	8.14E-06
Rabbit (Tissue)	-1.14E-05	1.26E-05	2.92E-05	-5.18E-06	8.14E-06	1.92E-05	-2.75E-06	5.18E-06	1.37E-05
Fish (PCN)	-5.55E-06	1.15E-05	2.52E-05	9.40E-07	8.51E-06	1.78E-05	5.62E-06	6.66E-06	9.25E-06
Fish (PEC)	1.22E-05	9.25E-06	4.81E-06	8.84E-07	7.03E-06	1.52E-05	-8.84E-07	4.44E-06	1.15E-05
Fish (BRA)	0.00E+00	1.55E-05	3.18E-05	-1.01E-05	1.74E-05	3.51E-05	1.84E-06	4.44E-06	9.99E-06

Table 5.7.7 - Beta and Gamma Emitters Concentration in Biota									
	K-40			Co-60			Cs-137		
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
Deer	1.07E-01	1.59E-02	1.22E-02	1.35E-04	5.92E-04	6.29E-04	-1.15E-04	4.81E-04	5.18E-04
Quail	1.22E-01	8.51E-02	9.62E-02	1.85E-03	2.92E-03	3.29E-03	1.22E-03	2.77E-03	3.11E-03
Rabbit (Tissue)	2.43E-01	9.62E-02	1.07E-01	-3.21E-03	4.44E-03	4.44E-03	3.07E-03	3.70E-03	4.07E-03
Rabbit (Tissue)	1.35E-01	6.29E-02	6.66E-02	-1.55E-03	3.07E-03	3.33E-03	2.64E-03	2.70E-03	2.92E-03
Fish (PCN)	7.03E-02	5.55E-02	6.66E-02	7.77E-04	1.85E-03	2.00E-03	-1.22E-03	1.85E-03	2.03E-03
Fish (PEC)	8.51E-02	5.55E-02	6.29E-02	-8.51E-04	1.96E-03	1.96E-03	4.07E-03	1.85E-03	2.07E-03
Fish (BRA)	1.41E-02	5.18E-02	8.51E-02	2.70E-03	1.74E-03	2.03E-03	7.03E-04	1.85E-03	1.89E-03

Table 5.7.8 - Duplicate Analyses

	U-234			U-235			U-238		
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
Deer	2.03E-04	1.52E-04	2.03E-04	-1.68E-05	3.37E-05	1.26E-04	3.38E-04	1.70E-04	1.55E-04
Fish (PEC)	2.30E-04	4.44E-05	2.22E-05	7.07E-06	7.03E-06	1.26E-05	1.28E-04	3.18E-05	1.52E-05
Fish (PEC)	2.28E-04	4.07E-05	1.52E-05	2.64E-06	7.03E-06	1.33E-05	9.32E-05	2.55E-05	1.33E-05
	Am-241			Pu-238			Pu-239/240		
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
Deer	1.92E-06	6.29E-06	1.18E-05	1.28E-06	5.18E-06	9.62E-06	1.28E-06	1.81E-06	1.74E-06
Fish (PEC)	1.63E-05	1.29E-05	1.78E-05	-1.50E-05	1.52E-05	3.18E-05	2.64E-06	5.18E-06	8.88E-06
Fish (PEC)	2.26E-05	1.74E-05	2.44E-05	7.92E-06	8.88E-06	1.33E-05	-8.81E-07	4.44E-06	1.15E-43
	K-40			Co-60			Cs-137		
	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA	Conc. (Bq/g)	TPU	MDA
Deer	1.04E-01	1.59E-02	1.22E-02	-7.29E-04	6.29E-04	5.92E-04	4.07E-04	4.44E-04	4.81E-04
Fish (PEC)	4.44E-02	5.55E-02	7.03E-02	4.81E-04	2.00E-03	2.11E-03	2.22E-03	1.85E-03	2.03E-03
Fish (PEC)	4.07E-02	5.92E-02	8.14E-02	-3.70E-04	2.00E-03	1.89E-03	2.59E-04	1.85E-03	2.07E-03
	Sr-90								
	Conc. (Bq/g)	TPU	MDA						
Deer	6.07E-02	1.70E-02	1.96E-02						
Fish (PEC)	2.40E-04	4.44E-04	7.40E-04						
Fish (PEC)	-2.89E-04	3.00E-04	5.55E-04						

CHAPTER 6 ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

This chapter discusses nonradiological environmental surveillance data collected between January 1 and December 31, 1998. Nonradiological programs at WIPP include the following subprograms: land management, including reclamation and restoration of disturbed lands; oil and gas surveillance; wildlife population monitoring (chapter 4, "Environmental Program Information"); and meteorological monitoring. In addition to the nonradiological environmental surveillance programs, VOCs were monitored to comply with the provisions of WIPP's hazardous waste permit, and liquid effluent monitoring was conducted in accordance with DP-831 criteria. The results of the environmental monitoring activities and discussions are presented in chapters 5, 6, and 7 of this report.

6.1 Principal Functions of Nonradiological Sampling

The principal functions of the nonradiological environmental surveillance are to:

- Assess the impacts of construction and operational activities from WIPP on the surrounding ecosystem.
- Monitor ecological conditions in the Los Medaños region.
- Investigate unusual or unexpected elements in the ecological databases.
- Provide environmental data which are important to the mission of the WIPP Project, but which have not or will not be acquired by other programs.
- Comply with applicable commitments identified with existing agreements (e.g., BLM/DOE MOU, Interagency Agreements, Agreements in Principal, etc.).

6.2 Meteorology

A principle component of the nonradiological environmental surveillance is a primary meteorological station located 600 meters northeast of the Waste Handling Building. The main function of the station is to generate data for modeling atmospheric conditions. The station provides measurements of wind speed, wind direction, and temperature at 2, 10, and 50 meters. The station also provides ground-level measurements of barometric pressure, relative humidity, precipitation, and solar radiation. These parameters are measured continuously and the data are stored in the Central Monitoring System.

In addition to the primary meteorological station, the WIPP Far Field Station is located 1,000 meters northwest of the Waste Handling Building. At the WIPP Far Field Station a secondary meteorological station measures and records temperature and barometric pressure at ground level and wind speed and wind direction at 10 meters (32.8 feet).

6.2.1 Climatic Data

The annual rate of precipitation at the WIPP site for 1998 was 160.2 mm (6.25 inches), which is 379.3 mm (14.79 inches) below last year's rate. The annual precipitation for 1998 was 70 percent less than that recorded for 1997. Figure 6.1 displays the monthly precipitation at WIPP.

The mean annual temperature for the WIPP area in 1998 was 18°C (64°F). The mean monthly temperatures for the WIPP area ranged from 6°C (43°F) during December to 29°C (84°F) in June. Generally, maximum temperatures occur in June through September, while minimum temperatures occur in December through February, as illustrated in figures 6.2, 6.3, and 6.4.

The lowest recorded temperature was -11°C (12°F) on December 23. The maximum recorded temperature was 43°C (100°F) on June 26.

6.2.2 Wind Direction and Wind Speed

The predominate wind direction in the WIPP area was from the southeast sector (135°). Seasonal weather systems move through this area, briefly altering the predominant southeasterly winds and sometimes resulting in violent convectional storms at the 2-meter level. Wind speed measured at the 2-meter level were calm (less than 0.5 meters per second [m/s]) 2.06 percent of the time. Winds of 1.4 through 2.8 m/s were the most prevalent over 1998, accounting for 33.36 percent of the time. Figures 6.5, 6.6, and 6.7 display the annual wind data at WIPP for CY 1998.

6.3 Volatile Organic Compounds Monitoring

The Confirmatory Volatile Organic Compound (VOC) Monitoring Program was implemented on April 21, 1997, in accordance with WP12-VC.01, Confirmatory VOC Monitoring Program. The program is designed to determine VOC concentrations attributed to open and closed panels. Nine compounds were chosen to represent the VOCs responsible for approximately 99 percent of the calculated RCRA constituents that posed human health risks. These target compounds are 1,1-dichloroethylene, methylene chloride, chloroform, 1,1,1-trichloroethane, carbon tetrachloride, 1,2-dichloroethane, toluene, chlorobenzene, and 1,1,2,2-tetrachloroethane.

Sampling for target compounds is done at two locations designated as air monitoring stations. The stations are defined as VOC-A, located downstream from Panel 1 in E300, and VOC-B, upstream from Panel 1, currently in S1950. As waste is placed in new panels, the location of VOC-B will be relocated to always represent the background ambient air. Location of VOC-A will not change.

Target compounds found in VOC-B represent the ambient air found in the mine before passing through the panels containing waste. The VOC concentrations measured at this location will consist of background concentrations entering the facility through the air intake shaft, concentrations attributed to upstream facility operations, and concentrations from waste disposal activities. Compounds found in VOC-A would represent both the background mine air and any potential releases from Panel 1.

For each quantified target VOC, the concentration measured at VOC-B will be subtracted from the concentration measures at VOC-A to assess the magnitude of VOC releases from the panel. Since no hazardous waste is currently in the underground, target compounds found are attributed to background sources.

The VOC sampling reported in this section is performed using guidance included in Compendium Method TO-14A, Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Specially Prepared Canisters with Subsequent Analysis by Gas Chromatography (EPA, 1997) as a basis. The samples are analyzed using gas chromatography/mass spectrometry (GC/MS) under an established QA/QC program. Laboratory analytical procedures have been developed based on the concepts contained in both TO-14A and the draft EPA Contract Laboratory Program (CLP) Volatile Organics Analysis of Ambient Air in Canisters (EPA, 1994).

The routine laboratory reporting limit is 5.0 parts per billion by volume (ppbv) for 1,1,1-trichloroethane, 1,1-dichloroethene, methylene chloride, and toluene and 2.0 ppbv for 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, carbon tetrachloride, chlorobenzene, and chloroform. For dilution factors greater than one, the 5.0 ppbv and 2.0 ppbv values are multiplied by the dilution to calculate the laboratory reporting limit for the diluted sample. Samples designated with an "*" are canisters that have been pressurized (diluted) by the laboratory to bring them up to 5 pounds per square inch (psi). Reporting limits have been adjusted by the dilution factor.

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with a 99 percent confidence that the analyte concentration is greater than zero. Values for constituents detected at concentrations less than the laboratory reporting limits but above the 0.5 ppbv method detection limit are estimated and designated with the "J" (estimated) flag. Compounds not detected are designated with the "U," Undetected, flag.

Other qualifiers were used by the validator of the data to indicate out of the ordinary situations. All qualifiers and abbreviations used are listed at the end of the tables.

Methylene chloride was found in the samples ranging from the 0.5 ppbv detection limit to 24 ppbv. Most of the hits are due to laboratory contamination and are qualified with a "B." Methylene chloride is also found in paint remover, aerosol propellant, degreasing and metal cleaning agents, and adhesives.

On August 18, 1998, 1,1,1-trichloroethane was found. Typically, 1,1,1-TCA can be found as a solvent and carrier in many aerosols and as a cleaning solvent for electrical equipment.

Toluene had the most frequent hits of the nine compounds. The concentrations ranged from the 0.5 ppbv detection limit to a high of 143 ppbv on May 20, 1998. Approximately 12 percent of the toluene detected is above the reporting limit of 5.0 ppbv. The remaining toluene hits are below the reporting limit, but above the detection limit, and are qualified with a "J." Possible sources could be products of incomplete combustion of diesel fuel, cleaning solvents, or paint.

The following tables represent data with reportable concentrations of target analytes collected during January 1998 through December 1998. Until acceptance of TRU mixed waste, all VOC monitoring data represents background sources of VOCs.

Table 6.1 - VOC Monitoring Program Data - Station VOC-A										
SAMPLE	SAMPLE	CONCENTRATION (ppbv)								
DATE	NUMBER	111TA	1122T	11DCE	12DCA	CCL4	CHBNZ	CHFRM	DCM	C7H8
1/6/98	152	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	3.5 J
1/7/98	154	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
1/12/98	156	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.2 J
1/13/98	158	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 U
1/19/98	160	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 JU
1/21/98	162	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.3 J
1/26/98	164	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
1/28/98	168	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.9 J
2/2/98	170	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.9 J
2/4/98	172	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
2/9/98	174	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 J
2/11/98	176	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.8 J
2/16/98	178	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	2.0 J
2/19/98	180	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.8 J
2/23/98	182	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
2/25/98	184	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
3/5/98	186	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	2.2 J
3/6/98	188	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/9/98	190	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/11/98	192	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/16/98	194	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.0 J	5.0 U
3/17/98	196	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/24/98	198	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
3/25/98	200	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/30/98	202	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
4/1/98	204	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/6/98	207	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U

Table 6.1 - VOC Monitoring Program Data - Station VOC-A										
SAMPLE DATE	SAMPLE NUMBER	CONCENTRATION (ppbv)								
		111TA	1122T	11DCE	12DCA	CCL4	CHBNZ	CHFRM	DCM	C7H8
4/7/98	210	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/13/98	212	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/15/98	214	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/20/98	216	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	11.0
4/22/98	218	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	15.1
4/27/98	220	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	2.2 J
4/29/98	222	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
5/4/98	224	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	4.5 J
5/6/98	226	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	2.4 J
5/11/98	228	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
5/13/98	230	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
5/18/98	232	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	10.3
5/20/98	234	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	132
5/26/98	236	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
5/27/98	238	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 J
6/1/98	240	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	4.4 J
6/3/98	242	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
6/5/98	244	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.1 J
6/10/98	246	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
6/15/98	249	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	10.2
6/17/98	252	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
6/22/98	254	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
6/23/98	256	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.9 J
6/26/98	258	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.4 J
6/30/98	260	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
7/6/98	262	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 J
7/9/98	266	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J

Table 6.1 - VOC Monitoring Program Data - Station VOC-A

SAMPLE DATE	SAMPLE NUMBER	CONCENTRATION (ppbv)								
		111TA	1122T	11DCE	12DCA	CCL4	CHBNZ	CHFRM	DCM	C7H8
7/13/98	268	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.0 J
7/15/98	270	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.7 J
7/20/98	272	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
7/22/98	274	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
7/27/98	276	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	16	1.4 J
7/29/98	278	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	24	1.5 J
8/3/98	280	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
8/5/98	282	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
8/10/98	284	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.6 J	1.7 J
8/12/98	286	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.9 J
8/17/98	288	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
8/18/98	290	11	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
8/24/98	293	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.9 J
8/26/98	296*	5.9 U	2.4 U	5.9 U	2.4 U	2.4 U	2.4 U	2.4 U	5.9 U	5.9 U
8/31/98	298	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/2/98	300	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/8/98	302	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/9/98	305	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.8 J
9/14/98	307	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	3.1 J
9/16/98	309	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/21/98	311	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/23/98	313	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	7.6	6.6
9/28/98	315	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/30/98	317	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
10/5/98	319	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.7 J	1.1 J
10/7/98	321*	5.3 U	2.1 U	5.3 U	2.1 U	2.1 U	2.1 U	2.1 U	5.3 U	5.3 U
10/14/98	323	5.0 U	2.0 UJ	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	4.5 J	0.6 J

Table 6.1 - VOC Monitoring Program Data - Station VOC-A

SAMPLE DATE	SAMPLE NUMBER	CONCENTRATION (ppbv)								
		111TA	1122T	11DCE	12DCA	CCL4	CHBNZ	CHFRM	DCM	C7H8
10/15/98	325	5.0 U	2.0 UJ	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
10/19/98	327	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
10/21/98	329	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
10/26/98	331	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
10/27/98	333	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
11/2/98	336	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
11/4/98	339	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
11/9/98	341	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.1 JB	5.0 U
11/10/98	343	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.2 JB	0.7 J
11/18/98	345	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.2 JB	5.0 U
11/19/98	347	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.2 JB	5.0 U
11/23/98	349	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.3 JB	5.0 U
11/24/98	351	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.1 JB	5.0 U
12/1/98	353	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/2/98	355	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/7/98	357	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/9/98	359	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/14/98	361	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
12/16/98	363	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.8 J
12/21/98	365	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.5 JB	0.5 J
12/22/98	367	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.6 JB	5.0 U
12/28/98	369	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
12/29/98	371	5.0 UXP	2.0 UXP	5.0 UXP	2.0 UXP	2.0 UXP	2.0 UXP	2.0 UXP	5.0 UXP	0.7 JXP
COUNT (n)		104	104	104	104	104	104	104	104	104
AVERAGE		5.1 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	4.9 J	4.4 J
MINIMUM		5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.5 U	0.5 U

Table 6.1 - VOC Monitoring Program Data - Station VOC-A

SAMPLE DATE	SAMPLE NUMBER	CONCENTRATION (ppbv)								
		111TA	1122T	11DCE	12DCA	CCL4	CHBNZ	CHFRM	DCM	C7H8
MAXIMUM		11.0	2.4 U	5.9 U	2.4 U	2.4 U	2.4 U	2.4 U	24.0	132

LEGEND

111TA = 1,1,1-Trichloroethane
1122T = 1,1,2,2-Tetrachloroethane
11DCE = 1,1-Dichloroethylene
12DCA = 1,2-Dichloroethane
CCL4 = Carbon tetrachloride
CHBNZ = Chlorobenzene
CHFRM = Chloroform
DCM = Methylene chloride
C7H8 = Toluene

FLAGS

B = Compound present in the laboratory blank, background subtraction not performed.

J = Estimated value: Below Reporting Limits but above Method Detection Limit (MDL)

U = Compound analyzed for, but not detected above the method detection limits

X = Custody seal broken on metal carrier, but carrier still locked.

P = Valve was open upon arrival at laboratory, but was sealed with brass cap. No apparent loss of pressure, still 8.8 psi

* = Diluted by laboratory

Table 6.2 - VOC Monitoring Program Data - Station VOC-B

SAMPLE DATE	SAMPLE NUMBER	CONCENTRATION (ppbv)								
		111TA	1122T	11DCE	12DCA	CCL4	CHBNZ	CHFRM	DCM	C7H8
1/6/98	151	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	2.8 J
1/7/98	153	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
1/12/98	155	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
1/13/98	157	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.8 J
1/19/98	159	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
1/21/98	161	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
1/26/98	163	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
1/28/98	167	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
2/2/98	169	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.9 J
2/4/98	171	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
2/9/98	173	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
2/11/98	175	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
2/16/98	177	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.4 J
2/19/98	179	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
2/23/98	181	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
2/25/98	183	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
3/5/98	185	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.5 J
3/6/98	187	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/9/98	189	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/11/98	191	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/16/98	193	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/17/98	195	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
3/24/98	197**	5.0 UJ	2.0 UJ	5.0 UJ	2.0 UJ	2.0 UJ	2.0 UJ	2.0 UJ	1.2 J	5.0 UJ
3/25/98	199	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
3/20/98	201	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U

Table 6.2 - VOC Monitoring Program Data - Station VOC-B

SAMPLE DATE	SAMPLE NUMBER	CONCENTRATION (ppbv)								
		111TA	1122T	11DCE	12DCA	CCL4	CHBNZ	CHFRM	DCM	C7H8
4/1/98	203	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/6/98	205	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/7/98	209	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/13/98	211	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/15/98	213	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/20/98	215	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	10.4
4/22/98	217	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	3.5 J
4/27/98	219	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
4/29/98	221	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
5/4/98	223	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	4.0 J
5/6/98	225	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	2.3 J
5/11/98	227	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
5/13/98	229	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
5/18/98	231	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	10.2
5/20/98	233	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	143
5/26/98	235	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
5/27/98	237	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.9 J
6/1/98	239	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
6/3/98	241	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
6/5/98	243	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.4 J
6/10/98	245	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
6/15/98	247	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.7 J
6/17/98	251	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
6/22/98	253	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
6/23/98	255	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U

Table 6.2 - VOC Monitoring Program Data - Station VOC-B

SAMPLE DATE	SAMPLE NUMBER	CONCENTRATION (ppbv)								
		111TA	1122T	11DCE	12DCA	CCL4	CHBNZ	CHFRM	DCM	C7H8
6/26/98	257	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
6/30/98	259	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
7/6/98	261	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
7/9/98	265	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
7/13/98	267	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.9 J
7/15/98	269	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	1.7 J
7/20/98	271	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
7/22/98	273	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
7/27/98	275	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
7/29/98	277	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	13	1.3 J
8/3/98	279	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
8/5/98	281	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
8/10/98	283	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
8/12/98	285*	5.7 U	2.3 U	5.7 U	2.3 U	2.3 U	2.3 U	2.3 U	5.7 U	0.7 J
8/17/98	287	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
8/18/98	289	6.4	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
8/24/98	291	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
8/26/98	295	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
8/31/98	297	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/2/98	299	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/8/98	301	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/9/98	304	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/14/98	306	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/16/98	308	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/21/98	310	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/23/98	312*	5.9 U	2.4 U	5.9 U	2.4 U	2.4 U	2.4 U	2.4 U	1.9 J	18
9/28/98	314	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
9/30/98	316	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U

Table 6.2 - VOC Monitoring Program Data - Station VOC-B										
SAMPLE DATE	SAMPLE NUMBER	CONCENTRATION (ppbv)								
		111TA	1122T	11DCE	12DCA	CCL4	CHBNZ	CHFRM	DCM	C7H8
10/5/98	318	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
10/7/98	320	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
10/14/98	322**	5.0 U	2.0 UJ	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
10/15/98	324**	5.0 U	2.0 UJ	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 J
10/19/98	326	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
10/21/98	328	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
10/26/98	330	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
10/27/98	332	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	9.0
11/2/98	334	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.6 J
11/4/98	338	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
11/9/98	340	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.1 JB	5.0 U
11/10/98	342	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.3 JB	5.0 U
11/18/98	344	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.6 JB	5.0 U
11/19/98	346	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.3 JB	5.0 U
11/23/98	348	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.2 JB	5.0 U
11/24/98	350	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.2 JB	5.0 U
12/1/98	352	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/2/98	354	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/7/98	356	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/9/98	358	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/14/98	360	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 J
12/16/98	362	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/21/98	364	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.6 JB	5.0 U
12/22/98	366	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.6 JB	5.0 U
12/28/98	368	5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U
12/29/98	370	5.0 UX	2.0 UX	5.0 UX	2.0 UX	2.0 UX	2.0 UX	2.0 UX	5.0 UX	5.0 UX
COUNT (n)		104	104	104	104	104	104	104	104	104

Table 6.2 - VOC Monitoring Program Data - Station VOC-B

SAMPLE DATE	SAMPLE NUMBER	CONCENTRATION (ppbv)								
		111TA	**1122T**	**11DCE**	**12DCA**	**CCL4**	**CHBNZ**	**CHFRM**	**DCM**	**C7H8**
AVERAGE		5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	4.7 J	5.7
MINIMUM		5.0 U	2.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.6 J	0.5 J
MAXIMUM		6.4	2.4 U	5.9 U	2.4 U	2.4 U	2.4 U	2.4 U	13	143

LEGEND
- 111TA = 1,1,1-Trichloroethane
- 1122T = 1,1,2,2-Tetrachloroethane
- 11DCE = 1,1-Dichloroethylene
- 12DCA = 1,2-Dichloroethane
- CCL4 = Carbon tetrachloride
- CHBNZ = Chlorobenzene
- CHFRM = Chloroform
- DCM = Methylene chloride
- C7H8 = Toulene

FLAGS
- B = Compound present in the laboratory blank, background subtraction not performed.
- J = Estimated value: Below Reporting Limits, but above Method Detection Limit (MDL)
- U = Compound analyzed for, but not detected above the method detection limits
- X= Custody seal broken on metal carrier, but carrier still locked.
- * = Diluted by laboratory
- ** = Data qualified during validation.

6.4 Seismic Activity

WIPP is located about 60 miles east of the western margin of the Permian Basin. Geologic structure and tectonic pattern of the Permian Basin are chiefly the result of large-scale subsidence and uplift during the Paleozoic era. The broad basin is divided into a series of subbasins that passed through their last stage of significant subsidence during the Late Permian. The Delaware subbasin occupies the southwestern portion of the Permian Basin and hosts the WIPP site. It is bordered by the Roosevelt Uplift to the north, the Marathon Thrust Belt to the south, the Central (Permian) Basin Platform to the east, and the Sierra Diablo Platform and Guadalupe and Sacramento Mountains to the west. The Delaware Basin contains a thick sequence of evaporite layers.

All major tectonic elements of the Delaware Basin were essentially formed before deposition of the Permian evaporites, and the region has been relatively stable since then. Deep-seated faults are rare, except along the western and eastern basin margins, and there is no evidence of young, deep-seated faults inside the basin.

Researchers suspect that some low-magnitude quakes may result from secondary oil recovery (water flooding). Their foci are about as deep as the bottom of relatively shallow wells, most of which are concentrated on the Central Basin Platform.

Significant recent seismic events near WIPP on January 2, 1992, and April 14, 1995, had magnitudes of 5.0 and 5.3 respectively. The January 2, 1992, Rattlesnake Canyon earthquake had an epicenter 60 kilometers (km) east-southeast of the WIPP site, while the April 14, 1995, event's epicenter was located about 240 km southwest of WIPP, near Alpine, Texas. *Neither quake had any effect on WIPP structures, as documented by post-event inspections by WIPP staff and the New Mexico Environment Department.* The magnitudes of both events were within the parameters used to develop the seismic risk assessment of the WIPP structures.

Seismic information for the WIPP region before 1962 was derived from chronicles of the effects of those tremors on people, structures, and surface features. Seismicity in New Mexico reported prior to 1962 was mostly limited to the corridor between Albuquerque and Socorro, part of a structure known as the Rio Grande Rift. Since 1962, most seismic information has been based on instrumental data recorded at various seismograph stations. Currently, seismicity within 300 km of the WIPP site is being monitored by the New Mexico Institute of Mining and Technology (NMIMT), in Socorro, New Mexico, using data from a seven-station network approximately centered on the site (figure 6.8). Station signals are transmitted to the NMIMT Seismological Observatory in Socorro. When appropriate, readings from the WIPP network stations are combined with readings from an additional NMIMT network in the central Rio Grande Rift. Occasionally, data are also exchanged with the University of Texas at El Paso and Texas Tech University in Lubbock, both of which operate stations in West Texas.

The mean operational efficiency of the WIPP seismic monitoring stations during CY 1998 was approximately 97.3 percent.

From January 1 through December 31, 1998, locations for 114 seismic events were recorded within 300 km of WIPP. These data include origin times, epicenter coordinates, and magnitudes. The strongest recorded event (magnitude 3.7) was located near Alpine, Texas, 235 km south of the site. Another noteworthy shock of magnitude 2.8 in December 1998 resulted from a second collapse in the Nash Draw Mine, about 15 km west of WIPP. The first collapse there (magnitude 3.5) had been recorded in October 1997. None of these events had any effect on WIPP structures.

6.5 Liquid Effluent Monitoring

The WIPP sewage lagoon system is a zero-discharge facility consisting of two primary settling lagoons, two polishing lagoons, a chlorination system, and three evaporation basins. The entire facility is lined with 30 mil synthetic liners, and is designed to dispose of domestic sewage as well as site-generated brine waters from observation well pumping and underground dewatering activities at the site.

The WIPP sewage facility is operated under DP-831 and managed in accordance with EPA sewage sludge regulations (40 CFR § 503), New Mexico Solid Waste Management Regulations (Part 700), New Mexico Water Quality Control Regulations (3-100), and applicable WIPP controlled procedures. These requirements provide guidance for disposal of domestic sewage, site-generated brine waters, and nonhazardous waste waters.

DP-831 allows for the disposal of 2,000 gallons per day of nonhazardous brines. The DOE submits quarterly discharge monitoring reports to the NMED to demonstrate compliance with the inspection, monitoring, and reporting requirements identified in the plan. No effluent limits were established in DP-831. The NMED Groundwater Protection and Remediation Bureau established a list of analytes to be sampled on a quarterly basis as indicators of sewage system performance.

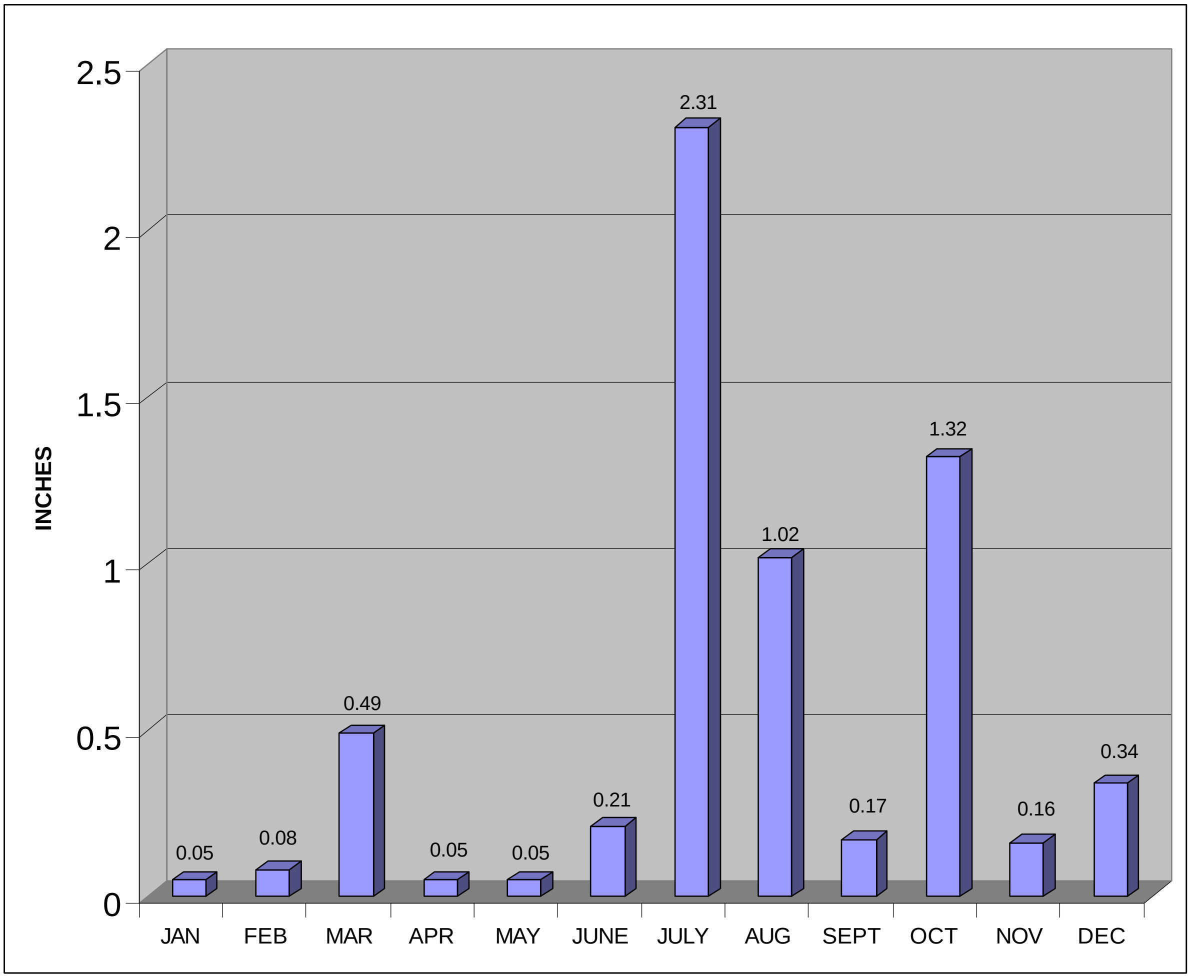
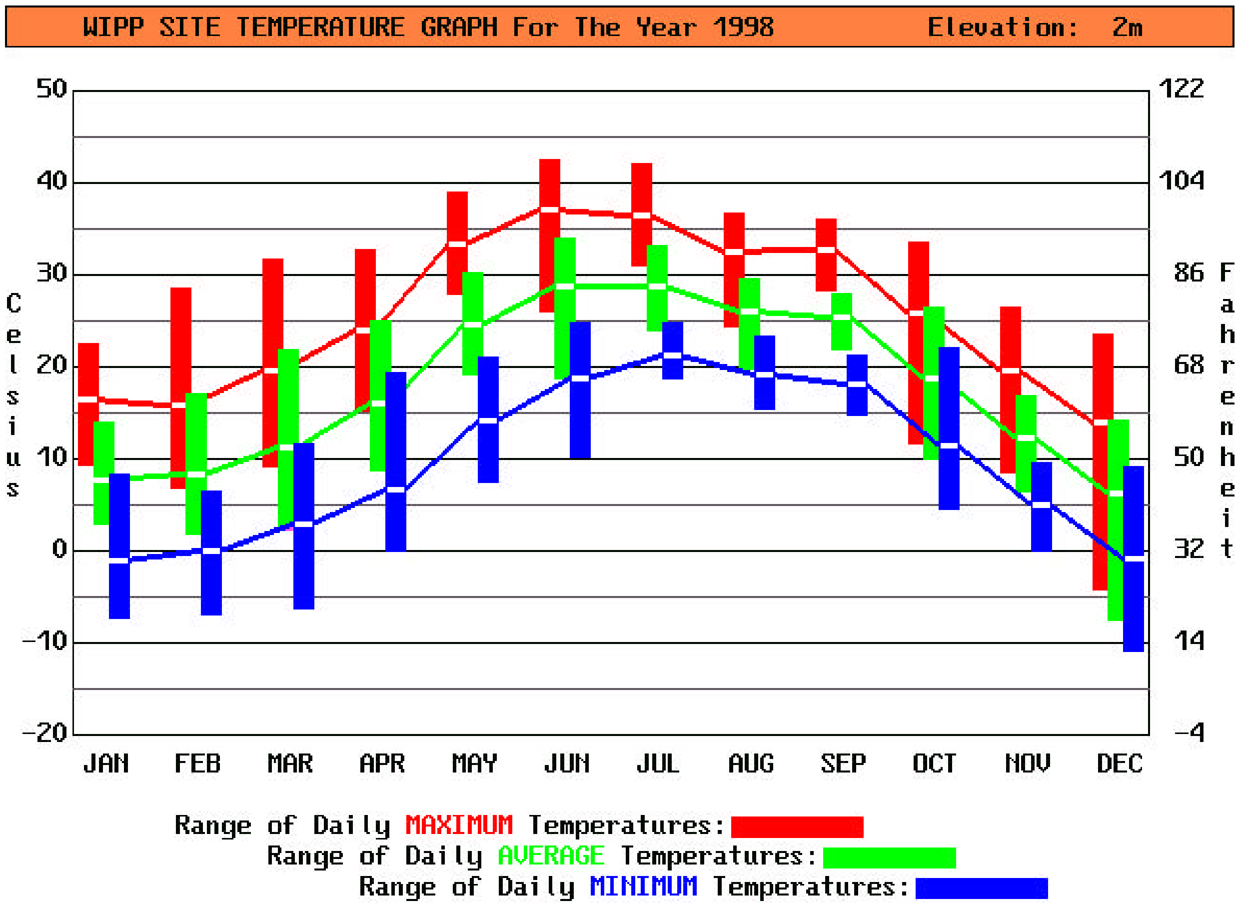


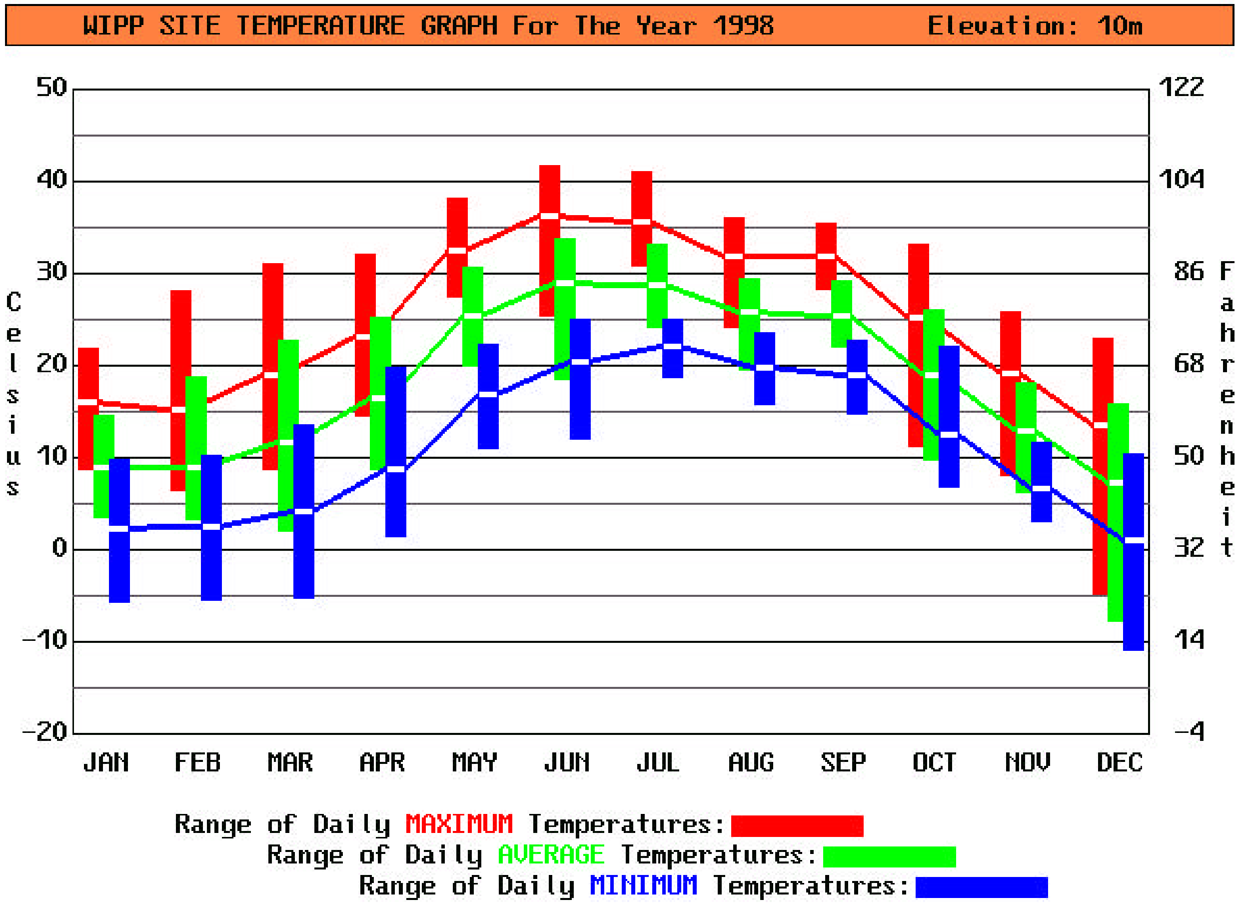
Figure 6.1 - 1998 Precipitation



Year Location: WIPP SITE Elevation: 2m

1998	Max HI	Avg HI	Min HI	Max AV	Avg AV	Min AV	Max LO	Avg LO	Min LO
Jan:	22.43	16.50	9.31	13.95	7.64	2.86	8.39	-1.09	-7.34
Feb:	28.53	15.83	6.85	17.10	8.23	1.96	6.42	0.06	-6.84
Mar:	31.71	19.60	9.09	21.85	11.29	2.19	11.70	2.85	-6.22
Apr:	32.80	23.87	15.18	25.05	16.13	8.81	19.41	6.61	-0.04
May:	38.95	33.25	27.99	30.22	24.61	19.25	21.12	14.15	7.58
Jun:	42.53	37.11	26.00	33.98	28.73	18.84	24.71	18.70	10.29
Jul:	42.13	36.44	31.09	33.18	28.72	23.97	24.77	21.21	18.68
Aug:	36.69	32.54	24.36	29.50	25.96	19.70	23.36	19.21	15.32
Sep:	36.11	32.74	28.34	27.89	25.35	21.85	21.32	18.18	14.88
Oct:	33.56	25.81	11.59	26.40	18.70	10.01	22.08	11.46	4.67
Nov:	26.43	19.67	8.53	16.87	12.20	6.54	9.51	5.00	-0.01
Dec:	23.45	13.96	-4.09	14.25	6.21	-7.59	9.16	-0.76	-10.76
Ann:	42.53	25.61	-4.09	33.98	17.81	-7.59	24.77	9.63	-10.76

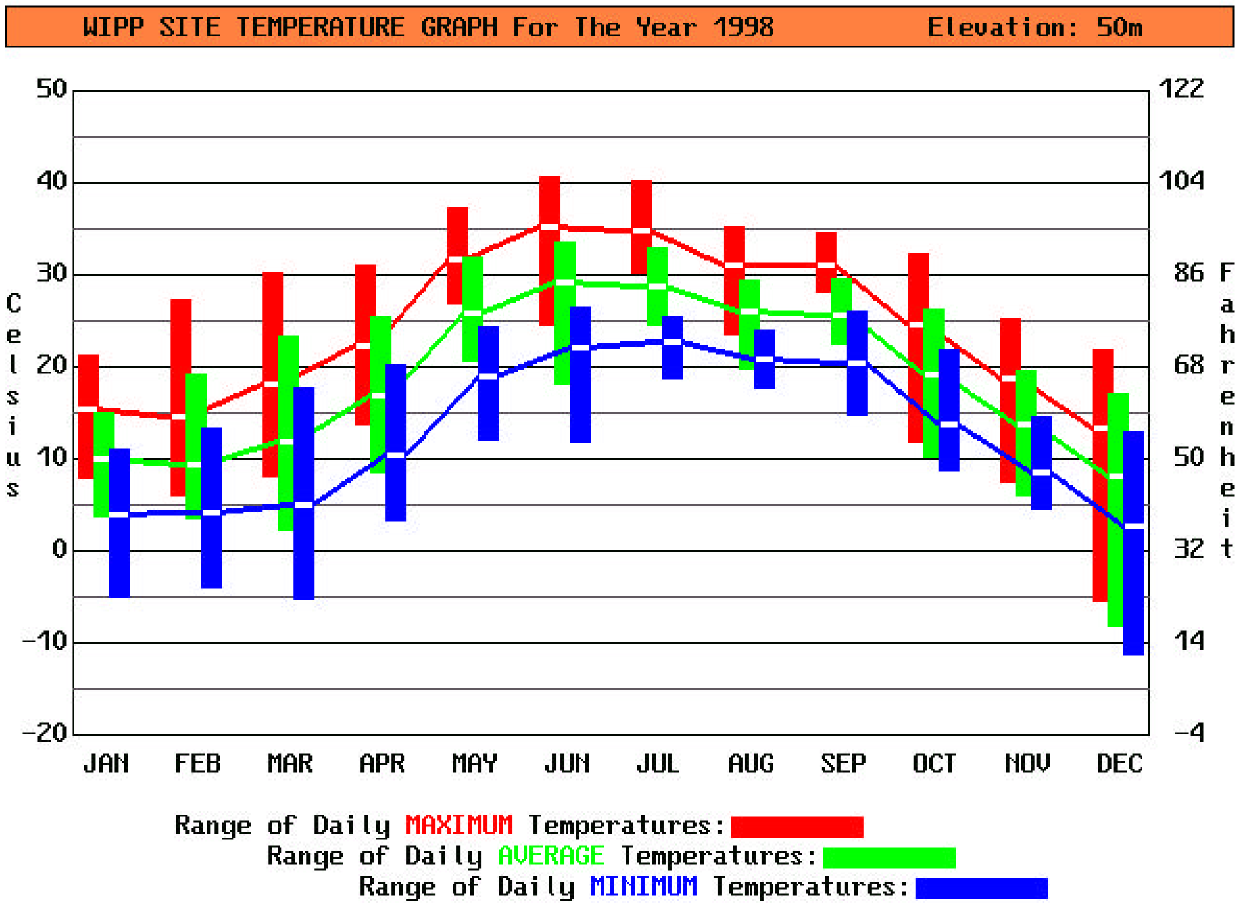
Figure 6.2 - WIPP Site Temperature Graph for the Year 1998 - Elevation: 2m



Year Location: WIPP SITE Elevation: 10m

1998	Max HI	Avg HI	Min HI	Max AV	Avg AV	Min AV	Max LO	Avg LO	Min LO
Jan:	21.95	16.03	8.80	14.48	9.04	3.47	9.77	2.24	-5.54
Feb:	28.13	15.27	6.51	18.82	8.91	3.27	10.26	2.52	-5.51
Mar:	31.06	18.95	8.79	22.71	11.58	2.18	13.63	4.09	-5.31
Apr:	32.11	23.15	14.48	25.20	16.54	8.66	19.76	8.80	1.56
May:	38.21	32.56	27.53	30.65	25.40	20.06	22.32	16.93	10.99
Jun:	41.60	36.31	25.37	33.68	29.05	18.54	24.92	20.39	11.99
Jul:	41.11	35.66	30.90	33.06	28.72	24.13	25.07	21.98	18.79
Aug:	36.11	31.87	24.14	29.35	25.93	19.67	23.61	19.83	15.84
Sep:	35.43	31.93	28.30	29.14	25.44	22.01	22.63	18.97	14.84
Oct:	33.08	25.21	11.30	26.14	18.86	9.81	22.16	12.46	6.95
Nov:	25.90	19.22	8.11	18.18	12.84	6.34	11.69	6.69	3.13
Dec:	22.89	13.61	-4.72	15.90	7.19	-7.76	10.39	1.05	-10.80
Ann:	41.60	24.98	-4.72	33.68	18.29	-7.76	25.07	11.33	-10.80

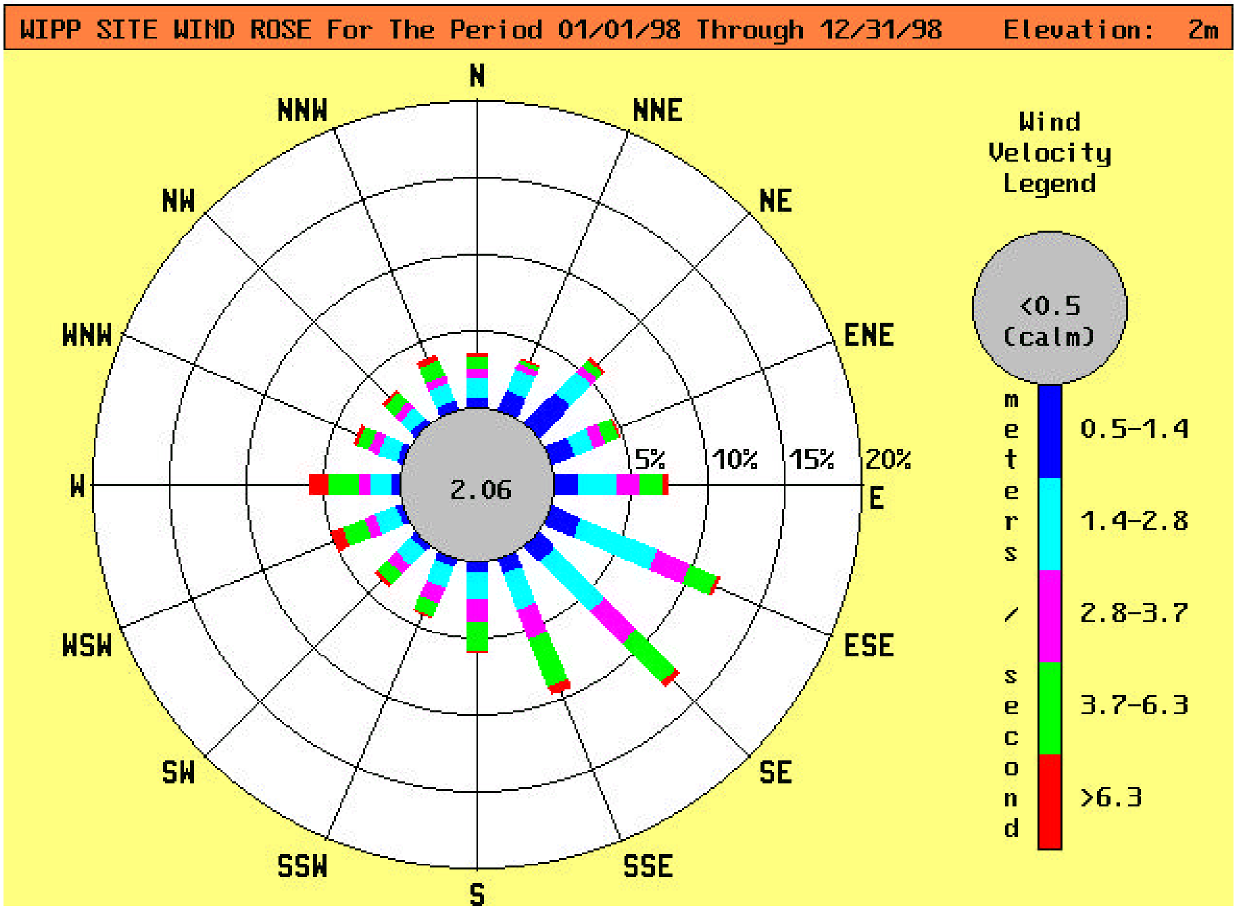
Figure 6.3 - WIPP Site Temperature Graph for the Year 1998 - Elevation: 10m



Year Location: WIPP SITE Elevation: 50m

1998	Max HI	Avg HI	Min HI	Max AV	Avg AV	Min AV	Max LO	Avg LO	Min LO
Jan:	21.35	15.38	7.94	15.06	10.03	3.67	10.94	4.06	-5.01
Feb:	27.37	14.56	5.96	19.23	9.30	3.64	13.43	4.16	-3.96
Mar:	30.30	18.14	8.10	23.33	11.85	2.34	17.66	5.08	-5.20
Apr:	31.10	22.30	13.70	25.44	16.86	8.47	20.15	10.52	3.34
May:	37.39	31.72	26.92	31.83	25.91	20.60	24.29	18.92	12.05
Jun:	40.62	35.31	24.56	33.63	29.21	18.06	26.56	22.07	11.87
Jul:	40.13	34.71	30.24	32.82	28.76	24.67	25.43	22.64	18.68
Aug:	35.25	31.01	23.63	29.32	26.06	19.72	24.06	20.92	17.78
Sep:	34.51	31.02	28.08	29.62	25.68	22.45	25.99	20.44	14.70
Oct:	32.30	24.49	11.95	26.20	19.07	10.25	21.91	13.67	8.65
Nov:	25.18	18.68	7.53	19.66	13.80	6.06	14.63	8.62	4.67
Dec:	21.94	13.31	-5.37	17.15	8.09	-8.22	12.99	2.79	-11.32
Ann:	40.62	24.22	-5.37	33.63	18.72	-8.22	26.56	12.82	-11.32

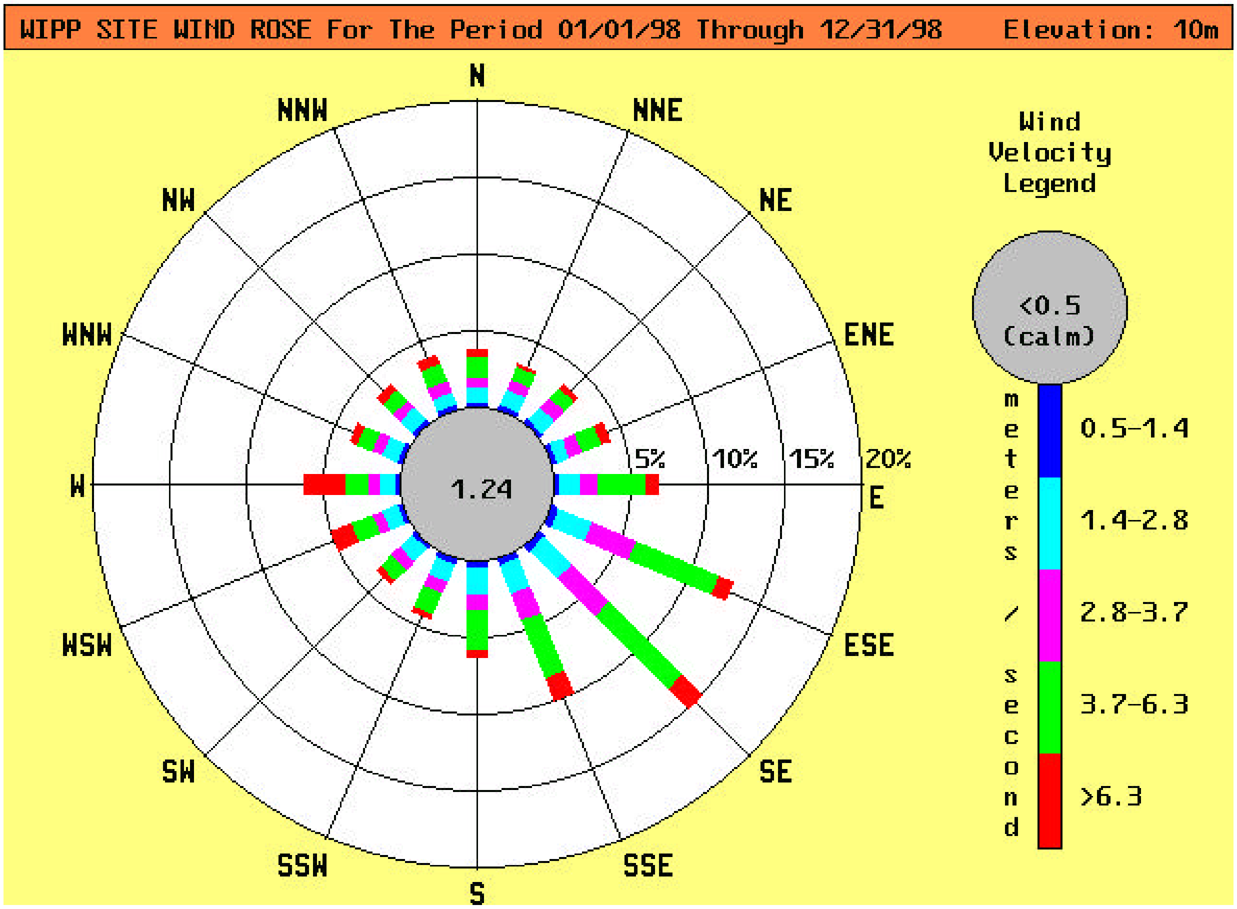
Figure 6.4 - WIPP Site Temperature Graph for the Year 1998 - Elevation: 50m



Location: WIPP SITE Elevation: 2m
Beginning Date: 01/01/98 End Date: 12/31/98

m/s:	<0.5	0.5-1.4	1.4-2.8	2.8-3.7	3.7-6.3	>6.3	Totals
N :	0.091	0.654	1.353	0.631	0.845	0.168	3.741
NNE:	0.146	1.490	1.578	0.482	0.448	0.071	4.215
NE :	0.205	2.765	2.100	0.562	0.539	0.134	6.307
ENE:	0.260	1.535	1.473	0.853	1.002	0.106	5.228
E :	0.228	1.575	2.623	1.584	1.615	0.311	7.937
ESE:	0.146	2.026	5.497	2.354	2.080	0.186	12.289
SE :	0.106	1.436	4.640	2.988	3.664	0.485	13.319
SSE:	0.280	1.042	2.560	2.058	3.447	0.562	9.949
S :	0.063	0.742	1.846	1.513	1.895	0.100	6.159
SSW:	0.040	0.579	1.481	1.147	1.016	0.108	4.372
SW :	0.049	0.408	1.475	0.819	0.947	0.254	3.953
WSW:	0.034	0.479	1.530	0.848	1.618	0.853	5.362
W :	0.046	0.514	1.455	0.819	2.095	1.142	6.070
WNW:	0.060	0.431	1.284	0.753	0.753	0.225	3.507
NW :	0.057	0.488	1.113	0.602	0.910	0.223	3.393
NNW:	0.251	0.539	1.347	0.622	1.182	0.257	4.198
Tot:	2.061	16.704	33.356	18.636	24.058	5.186	100.000

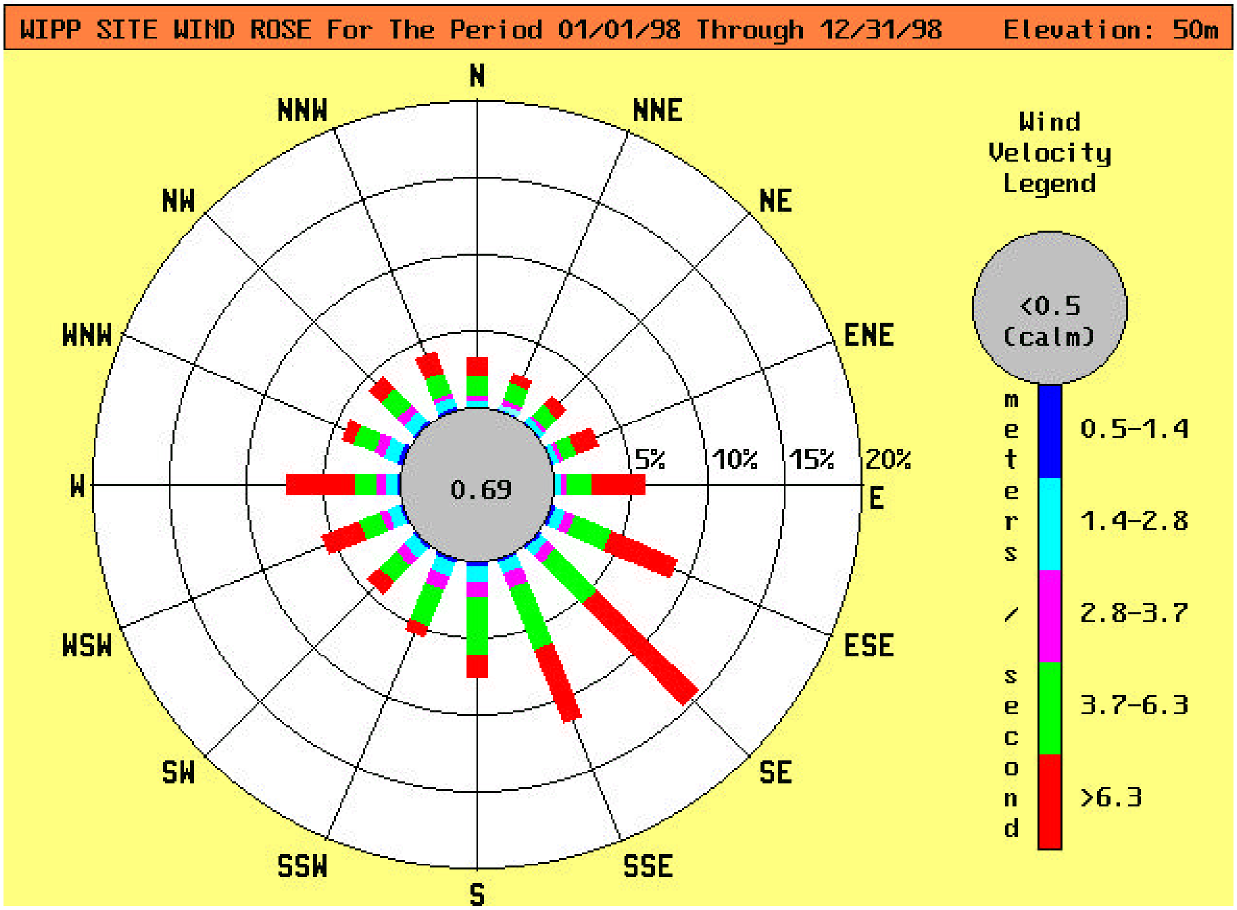
Figure 6.5 - WIPP Site Wind Rose for the Period January 1, 1998, through December 31, 1998 - Elevation: 2m



Location: WIPP SITE Elevation: 10m
Beginning Date: 01/01/98 End Date: 12/31/98

m/s:	<0.5	0.5-1.4	1.4-2.8	2.8-3.7	3.7-6.3	>6.3	Totals
N :	0.026	0.314	1.050	0.739	1.396	0.468	3.993
NNE:	0.043	0.331	1.193	0.802	0.899	0.220	3.487
NE :	0.049	0.345	1.159	0.919	0.990	0.348	3.810
ENE:	0.034	0.300	0.925	0.990	1.450	0.588	4.287
E :	0.066	0.354	1.378	1.247	3.213	0.873	7.132
ESE:	0.088	0.408	2.480	3.185	5.987	0.942	13.091
SE :	0.094	0.471	2.680	3.473	6.789	1.915	15.422
SSE:	0.151	0.385	2.118	1.886	4.135	1.592	10.268
S :	0.271	0.439	1.752	1.082	2.677	0.408	6.630
SSW:	0.040	0.354	1.310	0.950	1.530	0.260	4.443
SW :	0.034	0.337	1.164	0.759	1.022	0.482	3.799
WSW:	0.009	0.280	1.182	0.713	1.564	1.438	5.186
W :	0.029	0.322	1.110	0.779	1.572	2.711	6.524
WNW:	0.046	0.311	1.150	0.839	1.113	0.542	4.001
NW :	0.043	0.342	1.179	0.676	1.045	0.400	3.684
NNW:	0.214	0.320	0.973	0.793	1.364	0.579	4.244
Tot:	1.236	5.614	22.803	19.834	36.747	13.767	100.000

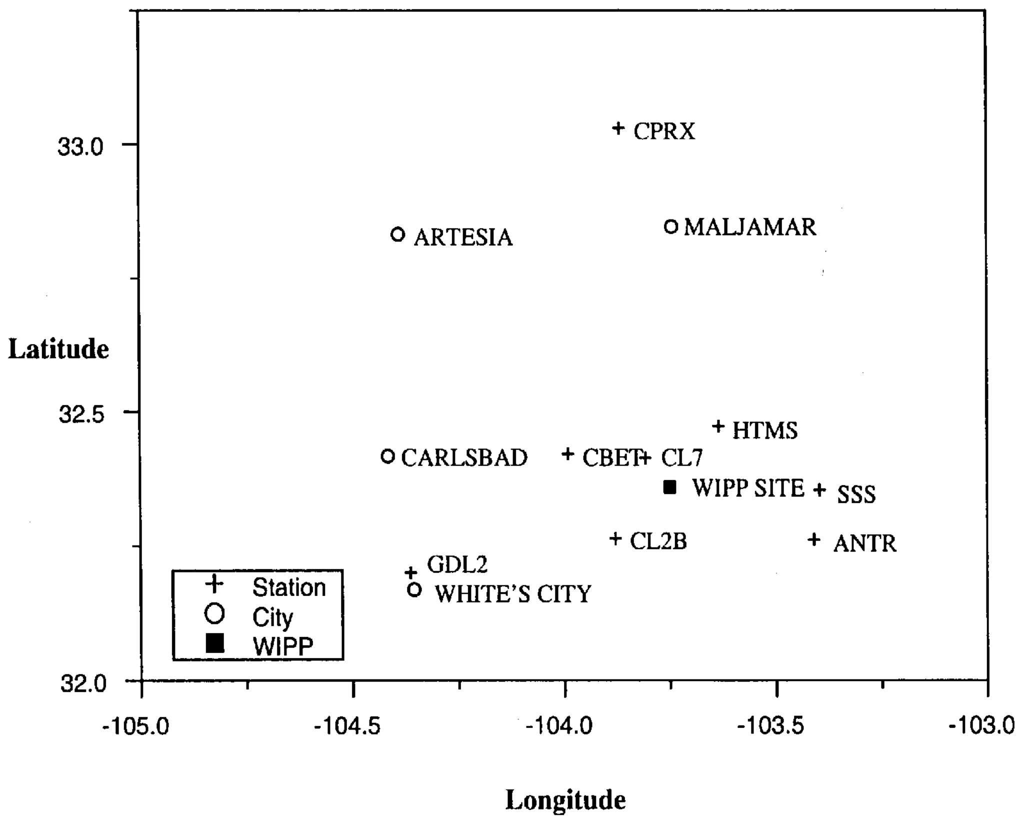
Figure 6.6 - WIPP Site Wind Rose for the Period January 1, 1998, through December 31, 1998 - Elevation: 10m



Location: WIPP SITE Elevation: 50m
Beginning Date: 01/01/98 End Date: 12/31/98

m/s:	<0.5	0.5-1.4	1.4-2.8	2.8-3.7	3.7-6.3	>6.3	Totals
N :	0.020	0.123	0.494	0.414	1.338	1.236	3.624
NNE:	0.017	0.120	0.482	0.388	1.196	0.674	2.877
NE :	0.020	0.117	0.377	0.348	1.116	0.848	2.825
ENE:	0.020	0.103	0.422	0.274	1.110	1.570	3.499
E :	0.014	0.106	0.457	0.468	1.630	3.393	6.067
ESE:	0.009	0.163	0.819	0.739	2.683	4.703	9.115
SE :	0.023	0.128	0.739	0.850	3.861	9.364	14.966
SSE:	0.411	0.177	0.965	1.002	4.435	5.009	11.998
S :	0.009	0.260	1.053	1.110	3.773	1.490	7.694
SSW:	0.014	0.214	1.059	1.096	2.543	0.850	5.776
SW :	0.017	0.177	0.956	0.799	1.504	1.096	4.549
WSW:	0.017	0.240	0.967	0.605	1.533	2.620	5.982
W :	0.017	0.248	0.833	0.736	1.430	4.486	7.751
WNW:	0.046	0.354	1.116	0.822	1.495	0.819	4.652
NW :	0.009	0.205	0.965	0.691	1.607	1.013	4.489
NNW:	0.023	0.163	0.639	0.451	1.441	1.418	4.135
Tot:	0.685	2.897	12.343	10.793	32.694	40.588	100.000

Figure 6.7 - WIPP Site Wind Rose for the Period January 1, 1998, through December 31, 1998 - Elevation: 50m



Definitions of Abbreviations

SSS - San Simon Swale
CBET - Carlsbad East Tower
CL2B - Carlsbad Station
CL7 - Carlsbad Station 7
CPRX - Caprock
GDL2 - Guadalupe Mountains
HTMS - Hat Mesa

Figure 6.8 - WIPP Seismograph Station Locations

CHAPTER 7 GROUNDWATER PROTECTION

Current groundwater monitoring activities at WIPP are outlined in the Groundwater Surveillance Program Plan (WP 02-1, Revision 3). The plan is a QA document that contains program plans for each of the activities performed by groundwater monitoring personnel. In addition, WIPP has detailed procedures for performing specific activities, such as pumping system installations, field parameter analyses and documentation, and QA records management. Groundwater monitoring activities are also defined in the EMP.

The objective of the groundwater monitoring program is to determine the physical and chemical characteristics of groundwater; maintain surveillance of groundwater levels surrounding the WIPP facility, both before and throughout the operational lifetime of the facility; and fulfill the requirements of the RCRA Part B Permit Application and DOE Order 5400.1.

Background data were collected from 1995 through 1997 and reported in DOE/WIPP 98-2285, Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Report. This background data will be compared to water quality data collected throughout the operational life of the facility. The data obtained by the WQSP in 1998 supported two major programs at WIPP: (1) the RCRA Detection Monitoring Program supporting the RCRA Part B Permit Application in compliance with 40 CFR § 264 and 20 New Mexico Administrative Codes (NMAC) 4.1, and (2) performance assessment supporting the Compliance Certification Application in compliance with 40 CFR § 191 and 40 CFR § 194. Each of these programs requires a unique set of analyses and data. Particular sample needs are defined by each program.

Groundwater quality data were gathered from six wells completed in the Culebra member of the Rustler Formation and one well completed in the Dewey Lake Formation (figure 7.1).

Groundwater surface elevation data is gathered from 77 well bores, five of which are equipped with production-inflated packers to allow groundwater level surveillance of more than one producing zone through the same well bore (figure 7.2).

Groundwater monitoring activities during CY 1998 included groundwater quality sampling and groundwater level surveillance.

Groundwater Quality Sampling

Sampling for groundwater quality was performed semiannually at seven well sites during CY 1998 (figure 7.1). The wells were serially sampled as soon as possible after the pump was turned on to better observe early chemical reactions to pumping. Field analysis for Eh (an indicator of oxidation or reduction of chemical species), specific gravity, specific conductance, acidity or alkalinity, chloride, divalent cations, and total iron were performed on a periodic basis during the serial sampling.

The total gallons of water removed throughout the year from the Culebra as a result of groundwater surveillance activity was approximately 21,892 gallons. During the same period, 4,494 gallons of water were removed from the Dewey Lake Formation. Water quality of the Culebra sampled near WIPP is naturally poor and is not suitable for human consumption or for agricultural purposes. The groundwater of the Culebra is considered to be class III waters by EPA guidelines.

Water quality measurements performed in the Dewey Lake Formation indicate that the waters are considerably fresher. Samples collected from the Dewey Lake Formation are suitable for livestock consumption having TDS values below 10,000 mg per liter (mg/L). These waters are classified as Class II waters according to EPA guidance. Saturation of the Dewey Lake Formation in the area of WIPP is discontinuous and no hydrologic connection has been established that would indicate that WIPP activities would have an Impact on the Dewey Lake.

Sampling during CY 1997 marked the end of data collection for baseline purposes for the RCRA permitting process; thus 1998 sampling was treated as detection monitoring. table 7.1 summarizes the parameter or constituent each well is monitored. Tables 7.2 through 7.8 contain the summary of analysis results for each parameter or constituent for sampling rounds six and seven. Background groundwater quality was defined for each individual well because Culebra groundwater chemistry is extremely variable across the WIPP site. A 95th upper tolerance limit value (95th UTLV) or 95th percentile confidence interval based on the distribution type, was computed for background data sets with concentrations that are well above the method detection limit. This 95th UTLV or 95th percentile implies that 5 percent, or one in twenty of the values, would be expected to be above the 95th UTLV or 95th percentile and would not necessarily represent contamination. Organic parameter tolerance limits are based on the method detection limit reported by the laboratory due to the large number of nondetects. Maximum concentration is defined for groundwater protection in 40 CFR § 264.94 for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The EPA guidance manual "Statistical Analysis of Groundwater Data at RCRA Facilities" states that four data points are needed to establish baseline. Gross alpha and beta analyses were performed on two sampling rounds (six and seven). According to the Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, a minimum of four data points are needed to establish baseline. Since we have only received analysis for two rounds, we can not establish baseline until year 2000.

Total dissolved solids, filterable residue, of Culebra in the WIPP area range from less than 10,000 to over 280,000 mg/L. High TDS samples require dilution prior to analysis, and the dilution factors varied from sampling rounds and wells. The variable dilution factors resulted in method detection limits that were not consistent and concentrations reported as "nondetect" which exceeded the maximum contamination level. For gross alpha and beta analysis the total aliquot size ranged from 1 ml to 15 ml; subsequently, the reported detection limits are very high.

Three different contract laboratories performed the groundwater chemistry analysis based on the recommended EPA methods. Due to the variability in dilution factors and instrument sensitivity, the concentrations and method detection limits are reported at different levels. The analytical results for detectable constituents are plotted in comparison to the baseline in Time Trend Plots (figures 7.5 through 7.67). Environmental

Protection Agency contract laboratory program (CLP) guidelines were used to validate and qualify the reported data.

WQSP-1 Analytical Summary: The chloride result, 37,600 mg/L, for WQSP-1 round six is above the maximum baseline concentration, but below the 95th UTLV of 39,105 mg/L (see table 7.2). The pH value for round seven is below the acceptable values of 6.89 - 7.65 S.U. (standard unit) at 5.80 S.U. The erroneous result was an analytical mistake confirmed by the laboratory. The pH was measured at WIPP prior to sample shipment and the result was within the acceptable range at 7.09 S.U.

Specific conductance measurement is above the 95th UTLV of 90,030 µmhos/cm at 110,000 µmhos/cm. The laboratory performed the measurement at 19.6°C. The method for specific conductance measurement states that the more the temperature of measurement deviates from the recommended 25°C, the greater the uncertainty in applying the temperature correction. Specific Conductance is also measured prior to sample shipment and the result obtained on-site was 81,600 µmhos/cm.

The laboratory reported potassium values, round seven, 710 mg/L above the 95th UTLV value of 525 mg/L. The laboratory noted matrix interference while performing this analysis. Further investigation and research is being performed at the contract laboratory to fine-tune the calibration curve.

To perform the total organic halogen (TOH) method, the sample is loaded in two columns and a reading is obtained for both sample aliquots. The second column should not exceed 10 percent of the two-column total measurement. The method suggests that if the 10 percent figure is exceeded, one of three events could have happened: (1) the first column was overloaded and a legitimate measure of breakthrough was obtained, in which case taking a smaller sample may be necessary; (2) channeling or some other failure occurred, in which case the sample may need to be rerun; or (3) a high random bias occurred, and the result should be rejected and the sample rerun.

The TOH analysis on round seven consistently yielded high results and the second column reading exceeded 10 percent of the two-column total measurement. The sample was not rerun. In addition, the dilution factor applied to the reading appears to be incorrect. The laboratory used 50 ml aliquot and notes that the dilution factor is 100. Most likely the dilution factor used should have been 2. The incorrect dilution factor inflates the final concentration calculated. The method also states that preferred volume of 50 ml sample aliquot will result in a range of 0.501 to 1 mg/L. However, the laboratory reported a concentration of 8.8 mg/L for 50 ml aliquot. This exceeds the instrument optimum range.

Total organic carbon (TOC) reported value for round seven is <5 mg/L (below detection limit). Historically the concentrations ranged between 0.65 to 1.5 mg/L. The laboratory for round seven performed the analysis by combustion-infrared method, which is suitable for samples with TOC greater or equal to 1 mg/L; however, the historical data was analyzed by the persulfate-ultraviolet oxidation method which is more sensitive.

The silver matrix spike duplicate recovery for round seven was 45 percent, below the acceptable recovery criteria. As a result, the silver concentration is qualified as UJ (the analyte was not detected above the reported sample quantitation limit). However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample).

Semi-volatile organic compounds for round seven, 2-methylphenol and 4-methylphenol, failed to meet the response factor (RF) percent difference of less than 25 percent. The two compounds were qualified as "UJ." The VOC methyl ethyl ketone was qualified with an "R" (rejected/unusable) because the RF was less than 0.05 for the continuing calibration. All other QC samples analyzed with each analytical set met method specific criteria.

WQSP-2 Analytical Summary: The specific conductance measurement is above the 95th UTLV of 85,420 µmhos/cm at 110,000 µmhos/cm (see table 7.3). The laboratory performed the measurement at 21.1°C. The deviation of the temperature from the recommended 25°C is the cause of the higher value as discussed for WQSP-1. The specific conductance measurement prior to sample shipment was 78,700 µmhos/cm. The potassium value, 580 mg/L, for round seven exceeded the UTLV value of 529 mg/L. The laboratory experienced matrix interference problems during analysis. The RF for methyl ethyl ketone, round six was 0.05 for the continuing calibration and therefore qualified the result with an "R" (rejected/unusable). The laboratory control sample for semi-volatile analysis failed to meet the minimum acceptance limit recoveries for 1,2-dichlorobenzene and hexachloroethane. The reported results are qualified with an R (rejected/unusable). All other QC samples met all methods specified criteria for this batch.

WQSP-3 Analytical Summary: The magnesium result (see table 7.4) of 2,340 mg/L for round six exceeds the maximum baseline value; however, the concentration is below the 95th UTLV (2,363 mg/L). Specific conductance measurements are above the 95th UTLV of 206,500 µmhos/cm at 342,000 µmhos/cm and 370,000 µmhos/cm for rounds six and seven, respectively. The laboratory did not record the temperature on the raw data for round six. The laboratory performed the measurement at 18.1°C for round seven. The deviation of the temperature from the recommended 25°C is the cause of the higher value as discussed for WQSP-1. The specific conductance measurements prior to sample shipment were 191,300 µmhos/cm for round six and 190,400 µmhos/cm for round seven.

The TOC reported value for round seven is <5 mg/L (below detection limit). Historically the concentrations ranged between 0.71 to 1.95 mg/L. The laboratory for round seven performed the analysis with a less sensitive method, as discussed in WQSP-1. Round 6 semi-volatile results are qualified with an R (rejected/unusable) because the sample extraction time was exceeded by six days. Methly ethyl ketone was also rejected on the volatile analysis due the RF of less than 0.05 during continuing calibration. The QC samples met all methods specified criteria for this batch.

WQSP-4 Analytical Summary: The magnesium concentration of 1,280 mg/L (see table 7.5) is above the maximum baseline limit for round six, but below the 95th UTLV of 1,370 mg/L. The pH measurement for round six is 7.10 S.U. and the 95th UTLV is 7.13 to 7.61 S.U. The error associated with a pH measurement is 0.1 S.U. The difference in the second decimal place is accounted for by the method error. Specific conductance measurement for round seven is above the 95th UTLV of 127,000 µmhos/cm at 180,000 µmhos/cm. The laboratory performed the measurement at 23°C. The deviation of the temperature from the recommended 25°C is the cause of the higher value as discussed for WQSP-1. The specific conductance measurement prior to sample shipment was 117,100 µmhos/cm.

The TOC reported value for round seven is <5 mg/L (below detection limit). Historically the concentrations ranged between 0.68 to 2.09 mg/L. The laboratory for round seven performed the analysis with a less sensitive method, as discussed in the summary for WQSP-1. The potassium result, 1,370 mg/L, for round seven exceeded the 95th UTLV value of 841 mg/L. The laboratory experienced matrix interference during the metals analysis.

The round seven TOH value, 3.0 mg/L, was above the 95th UTLV value of 0.275. WQSP-1 entails a detailed discussion of the method constraints and laboratory analysis procedure. Round 6 silver and chromium results are qualified as "J" (estimated) due to the matrix spike recoveries outside the specified criteria. Post-digestion spike samples were analyzed for the above mentioned metals with similar results. Methyl ethyl ketone result was qualified with an "R" (rejected/unusable) because the relative response factor in the initial calibration was less than 0.05. Methyl ethyl ketone on round seven was qualified with "UJ" (estimated) because the analysis was performed four days past holding time. All other volatile compounds were analyzed within holding time. All other QC samples met all method specified criteria for this batch.

<u>WQSP-5 Analytical Summary</u>: The specific conductance measurement (see table 7.6) for round seven is above the 95th UTLV of 47,900 µmhos/cm at 58,000 µmhos/cm. The laboratory performed the measurement at 20°C. The deviation of the temperature from the recommended 25°C is the cause of the higher value as discussed for WQSP-1. The specific conductance measurement prior to sample shipment was 42,500 µmhos/cm. The TOC reported value for round seven is <5 mg/L (below detection limit). Historically the concentrations ranged between 0.85 to 2.02 mg/L. The laboratory for round seven performed the analysis with a less sensitive method, as discussed in the analytical summary for WQSP-1.

The magnesium, potassium, and calcium results, round seven, reported were above the 95th UTLV. The laboratory performed the metals analysis 3 times because of matrix interference problems. The reported analysis dilution was 1:180. The chloride result for round seven, 19,000 mg/L, exceeded the 95th UTLV of 16,200 mg/L. The duplicate result was 16,000 mg/L and the calculated relative percent difference is 17 percent. All QC samples associated with this analysis passed required criteria. The RF during initial calibration for methyl ethyl ketone (round six) was less than 0.05. The result was qualified with an "R" (rejected/unusable). Potassium for round seven was qualified with a J (estimated concentration above the detection limit) due to the matrix spike value outside of acceptable range. The laboratory narrated that there was a matrix interference when analyzing for potassium. The RF percent difference during continuing calibration exceeded 25 percent criteria for pyridine and qualified as "UJ" (estimated limit of detection). The TOH value reported for round seven, 0.80 mg/L, exceeds the 95th UTLV value of 0.094. WQSP-1 discusses the method and laboratory limitations for this analysis.

WQSP-6 Analytical Summary: The TOH concentration (see table 7.7) reported for round seven, 0.47 mg/L, exceeds the 95th UTLV of 0.065 mg/L. The analytical summary for WQSP-1 discusses the method and laboratory analysis constraints related to this analysis. Methyl ethyl ketone result for round six was qualified with an "R" (rejected/unusable) because the relative response factor during initial calibration was less than 0.05. Percent difference exceeded 25 percent for methylene chloride during continuing calibration and qualified the result with a "UJ" (estimated limit of detection). Matrix spike percent recovery failed to meet minimum criteria for thallium results (round seven) and was qualified as "J" (estimated quantity).

WQSP-6A Analytical Summary: Potassium concentration (see table 7.8), 7.50 mg/L, for round seven exceeded the 95th UTLV of 5.96 mg/L. Methyl ethyl ketone (round six) result was qualified with an "R" (rejected/unusable) due to the relative response factor value less than 0.05 during initial calibration. Toluene was reported for the sample and method blank during the tentatively identified compound search. Vinyl chloride and methyl ethyl ketone exceeded 25 percent difference for the continuing calibration response factor compared to the initial calibration response factor. These compounds were qualified with "UJ" (estimated limits of detection). Toluene concentration is qualified as "U" (nondetect) because similar concentration was quantified in the trip blank and duplicate sample.

The analytical results for rounds six and seven fall within the established baseline values with the exceptions noted above. The groundwater group has instructed the contract laboratory to analyze specific conductance closer to the recommended 25°C. The laboratory agreed to change from the current TOC method to the more sensitive persulfate-ultraviolet oxidation method. The potassium and total organic halide procedures are being researched and modified to handle the difficult matrix of WIPP groundwaters. The laboratory has been provided with the 95th UTLV and maximum contamination levels, which allows the laboratory to assess the results prior to reporting to WIPP. If the sample results fail to meet any stated criteria, the laboratory is provided with extra samples to perform the necessary reruns.

Groundwater Level Surveillance

In October 1988, WIPP was tasked with conducting a groundwater level surveillance program. Seventy-six well bores are used to perform surveillance of eight water-bearing zones in the WIPP area. The two zones of primary interest are the Culebra and Magenta members of the Rustler Formation. Sixty measurements are taken in the Culebra, and nine in the Magenta. Three measurements each are taken in the Dewey Lake and Santa Rosa Formations. Two measurements are taken in the Rustler/Salado contact. One measurement each is taken in Bell Canyon, Forty-niner, and an unnamed lower member. Locations of groundwater level surveillance sites are pictured in figure 7.2.

Four well bores are configured to allow monitoring of more than one formation. These are H-01 Culebra/Magenta, H-03d Dewey Lake/Forty-niner, H-16 Dewey Lake/unnamed lower member, and WIPP-25 Culebra/Magenta.

Groundwater surface elevations in the vicinity of WIPP may be influenced by site activities, such as pumping tests for site characterization, water quality sampling, or shaft sealing. Other influences on groundwater surface elevations may be caused by natural groundwater level fluctuations and industrial influences from agriculture, mining, and resource exploration.

Groundwater elevation measurements in the Culebra indicate that the generalized directional flow of groundwater is north to south in the vicinity of WIPP (figure 7.3). Regional groundwater levels taken in Culebra observation wells with four or more data points for the year show increasing trends in water levels in 45 wells and decreasing trends in 14 wells. Forty-three wells had fluctuations in water levels of less than two feet.

Total fluctuations of more than two feet in groundwater levels occurred in seventeen wells completed to the Culebra. Seven wells with fluctuations of more than two feet (WQSP-1, WQSP-2, WQSP-3, WQSP-6, H-18, WIPP-12, and WIPP-13) may have been influenced by groundwater sampling activities. Five wells (ERDA [U.S. Energy Research and Development Administration]-9, H-3b2, WIPP-19, WIPP-21, and WIPP-22) may have been influenced by site activities performed in earlier years, such as shaft grouting. H-1 was influenced by well-maintenance activities; DOE-2 experienced a packer failure; and WIPP-27 may have been influenced by potash mining activities in the area. WIPP-30 was influenced by as-yet-undetermined causes. P-18 continued a rising trend of unknown origin dating back to its completion in 1977.

Water level increases originating to the south of the site in the H-9 area extending up the gradient toward the site continue to be studies as new variables are introduced.

Groundwater flow directions in the Magenta appear to be generally from east to west across the WIPP site (figure 7.4). Regional groundwater level measurements taken in the Magenta indicate that water levels near or outside the WIPP boundary appear to be relatively stable. Water levels increased in the three Magenta wells near the center of the site (H-1, H-2b1, and H-3b1) because of a casing leak in H-1.

Groundwater level measurements are taken monthly in at least one accessible well bore at each well site for each available formation. Redundant well bores at each well site are measured on a quarterly basis (table 7.9). Data are transmitted on a monthly basis to the EEG, SNL, CTAC (CAO Technical Assistance Contractors), and technical subcontractors as requested by the CAO. A copy of the data is placed in the operating record for inspection by authorized agencies.

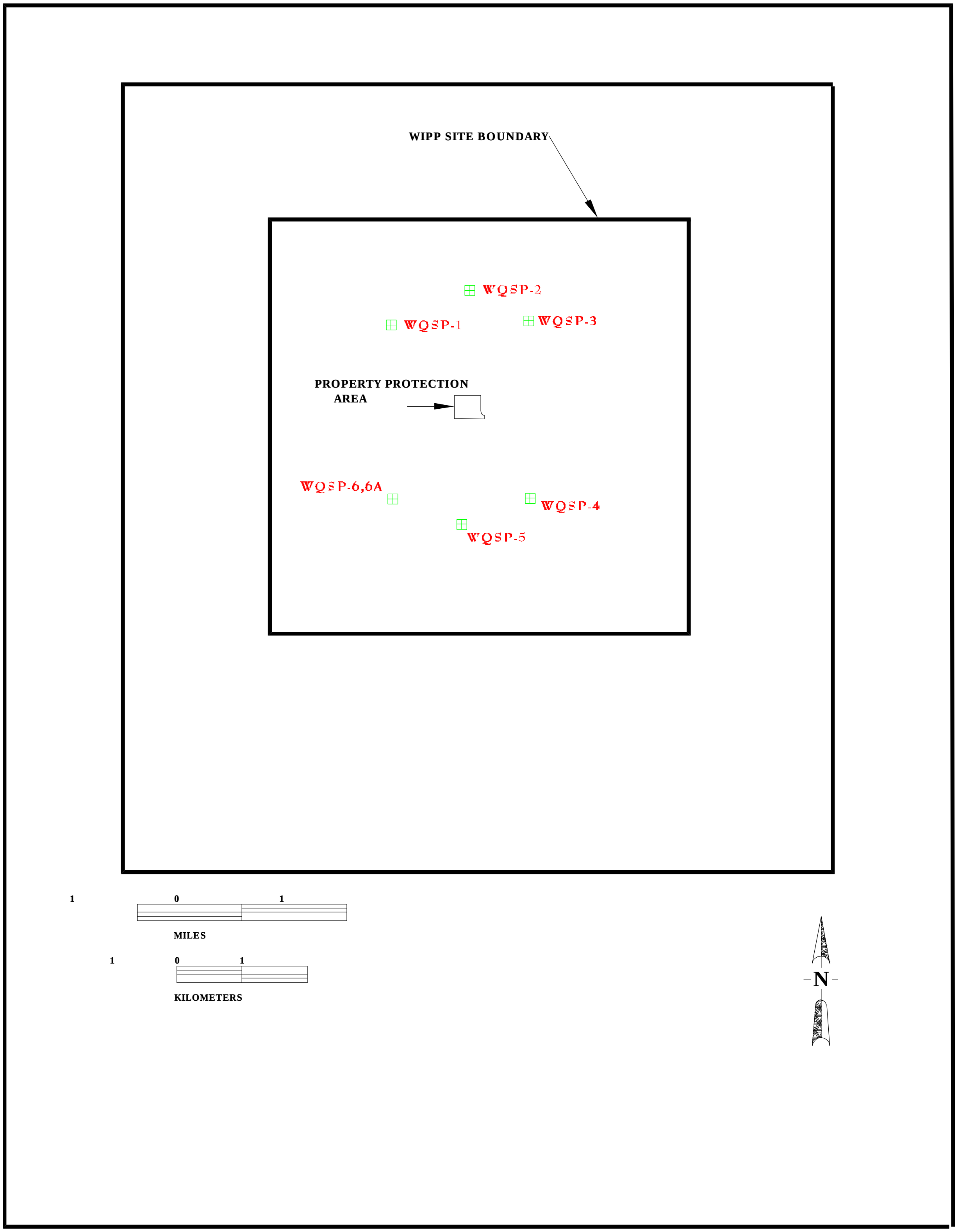


Figure 7.1 - Water Quality Sampling Program Sample Wells - 1998

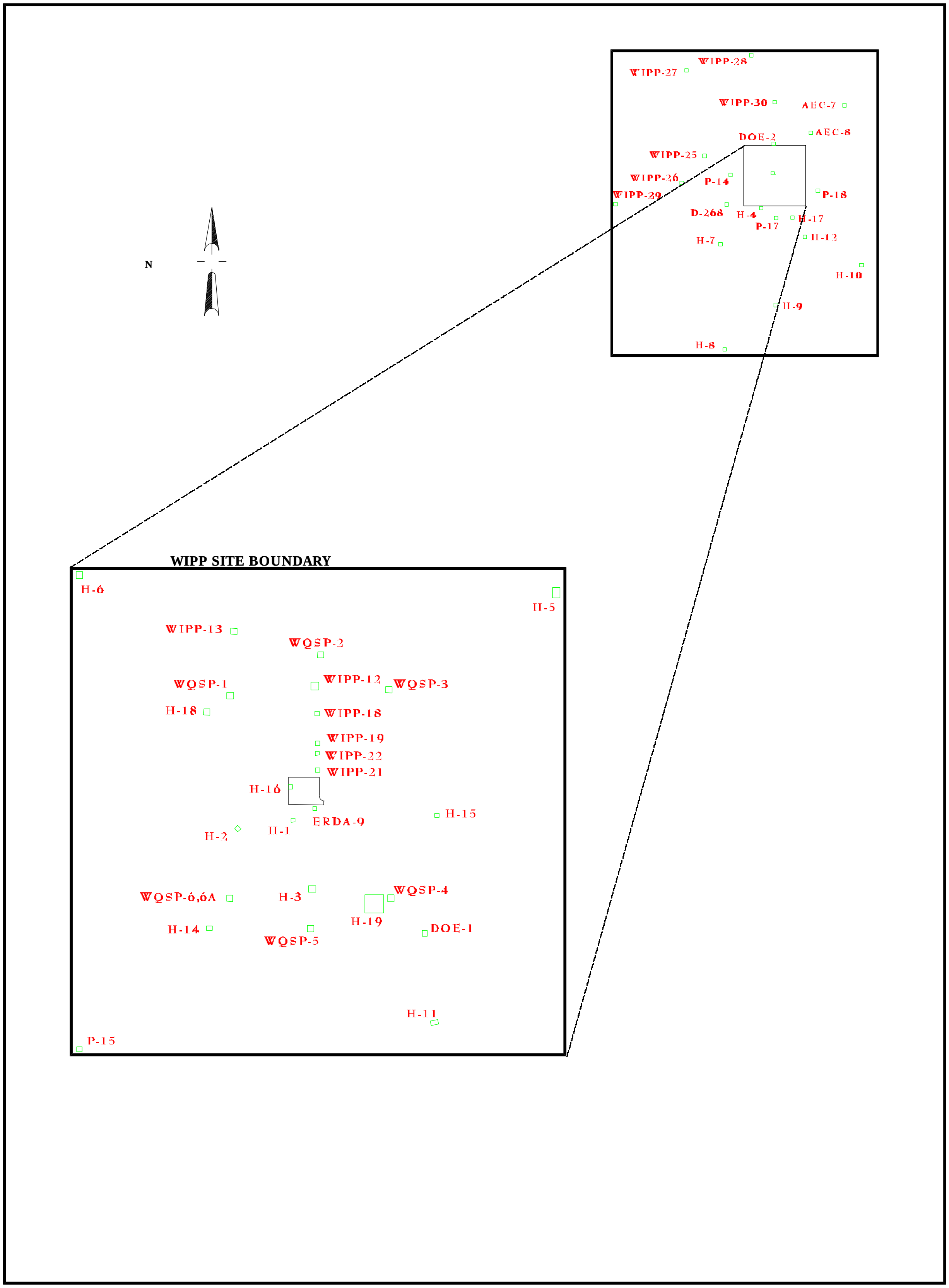
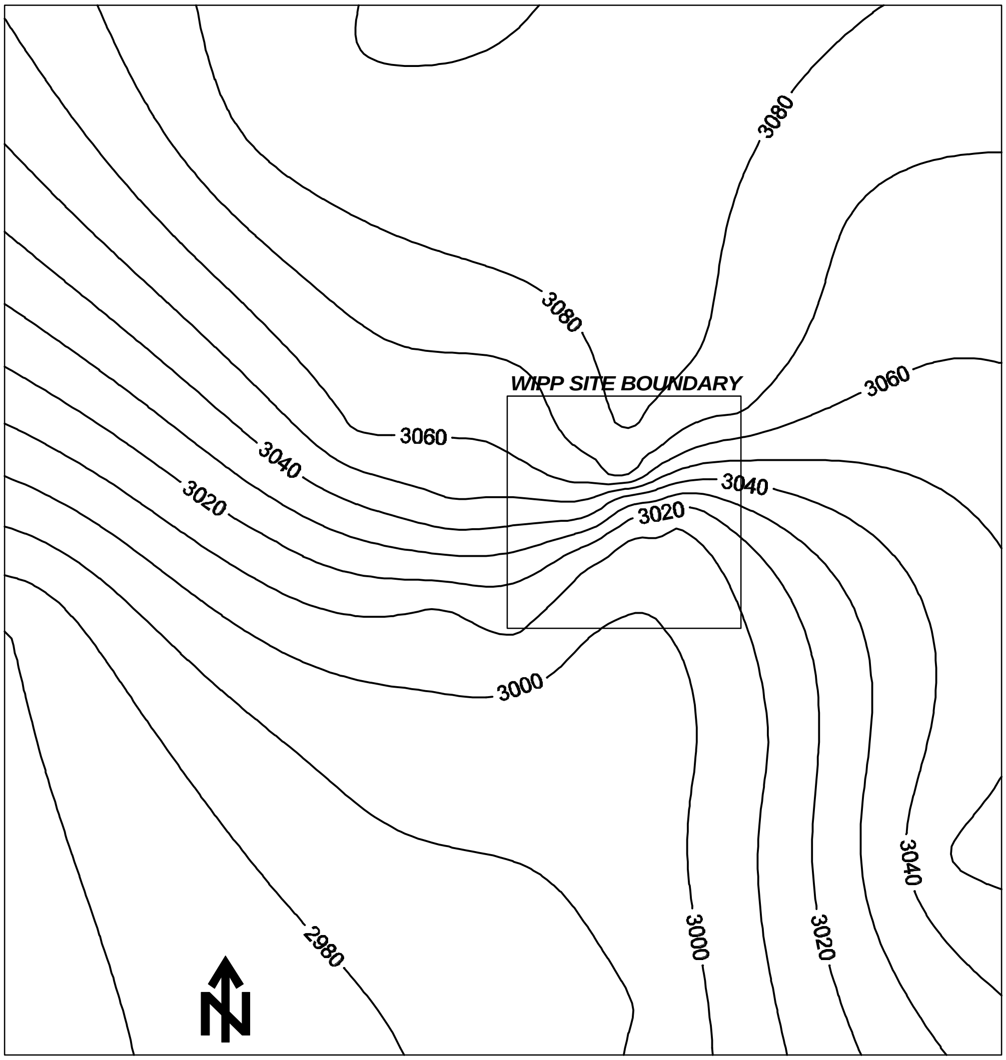


Figure 7.2 - Groundwater Level Surveillance Wells



Note: Contour elevations are in feet above mean sea level

0FT. 10000FT. 20000FT.

Figure 7.3 - Potentiometric Surface of the Culebra Dolomite Member of the Rustler Formation Near the WIPP Site as of December 1998 (adjusted to equivalent fresh water head)

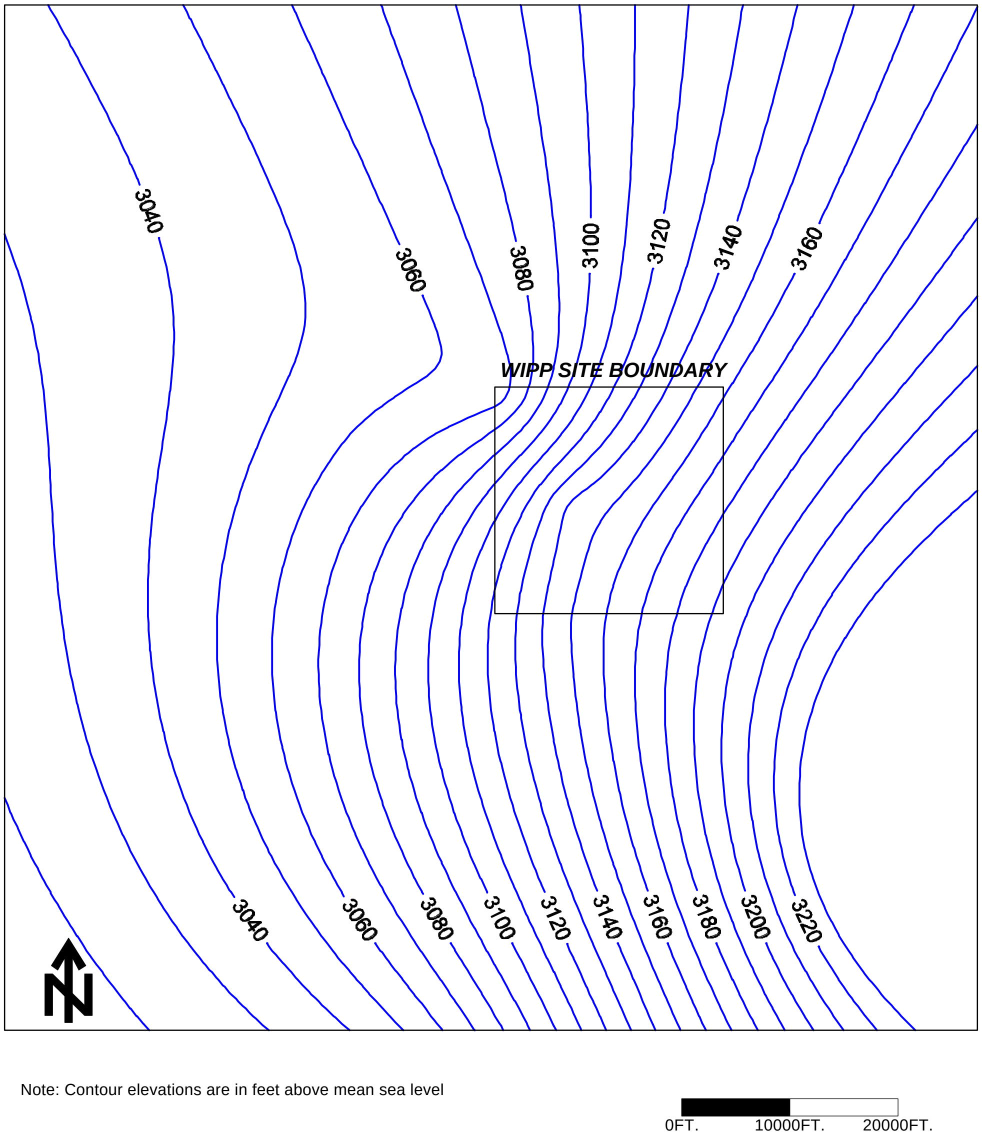


Figure 7.4 - Potentiometric Surface of the Magenta Dolomite Member of the Rustler Formation Near the WIPP Site as of December 1998 (adjusted to equivalent fresh water head)

Table 7.1 - Parameter or Constituent Required by 20 NMAC 4.1.500			
Constituent or	**Method**	**Constituent**	**Method**
pH	EPA 150.1	Specific conductance	EPA 120.1
Total organic carbon (TOC)	EPA 415.1	Total organic halogen (TOH)	EPA 9020B
Total dissolved solids (TDS)	EPA 160.1	Total suspended solids (TSS)	EPA 160.2
Density	ASTM D854-92	Calcium	EPA 6010B
Magnesium	EPA 6010B	Potassium	EPA 6010B
Chloride	EPA 9253	Iron	EPA 6010B
Chloroform	EPA 8260B	1,2-Dichloroethane	EPA 8260B
Carbon tetrachloride	EPA 8260B	Chlorobenzene	EPA 8260B
1,1-Dichloroethylene	EPA 8260B	1,1-Dichloroethane	EPA 8260B
Methylene chloride	EPA 8260B	1,1,2,2-Tetrachloroethane	EPA 8260B
Toluene	EPA 8260B	1,1,1-Trichloroethane	EPA 8260B
Cresols	EPA 8270C	1,4-Dichlorobenzene	EPA 8260B
1,2-Dichlorobenzene	EPA 8270C	*cis*-1,2-Dichloroethylene	EPA 8260B
2,4-Dinitrophenol	EPA 8270C	2,4-Dinitrotoluene	EPA 8270C
Hexachloroethane	EPA 8270C	Hexachlorobenzene	EPA 8270C
Isobutanol	EPA 8015B	Methyl Ethyl Ketone	EPA 8260B
Pyridine	EPA 8270C	Pentachlorophenol	EPA 8270C
1,1,2-Trichloroethane	EPA 8260B	Tetrachloroethylene	EPA 8260B
Trichlorofluoromethane	EPA 8260B	Trichloroethylene	EPA 8260B
Nitrobenzene	EPA 8270B	Xylenes	EPA 8260B
Arsenic	EPA 6010B	Vinyl chloride	EPA 8260B
Cadmium	EPA 6010B	Barium	EPA 6010B
Lead	EPA 6010B	Chromium	EPA 6010B
Selenium	EPA 6010B	Mercury	EPA 7470A
Antimony	EPA 6010B	Silver	EPA 6010B
Nickel	EPA 6010B	Beryllium	EPA 6010B
Gross alpha	EPA 900.0	Thallium	EPA 6010B
		Gross beta	EPA 900.0

Table 7.2 - WQSP-1

Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
pH	7.28	5.80	S.U.	N/A	N/A	6.89-7.65	N/A
Total organic carbon (TOC)	0.50	5.00	mg/L	0.50	5.00	2.37	N/A
Total dissolved solids (TDS)	69000.00	60000.00	mg/L	400.00	10.00	77600.00	N/A
Density	1.043	1.051	g/mL	N/A	N/A	1.072	N/A
Magnesium	1080.00	1140.00	mg/L	1.00	0.50	1310.00	N/A
Chloride	37600.00	34000.00	mg/L	2500.00	0.500	39105.00	N/A
Chloroform	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Carbon tetrachloride	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,1-Dichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Methylene chloride	5.00	5.00	ug/L	5.00	5.00	< MDL†	N/A
Toluene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Cresols	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,2-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
2,4-Dinitrophenol	10.00	25.00	ug/L	10.00	25.00	< MDL†	N/A
Hexachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Isobutanol	N.R.	N.R.	ug/L	N.R	N.R	< MDL†	N/A
Pyridine	10.00	1.00	ug/L	10.00	1.00	< MDL††	N/A
1,1,2-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichlorofluoromethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Nitrobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Arsenic	0.050	0.050	mg/L	0.050	0.050	N/A	0.05
Cadmium	0.010	0.050	mg/L	0.010	0.005	N/A	0.01
Lead	0.050	0.050	mg/L	0.050	0.005	N/A	0.05
Selenium	0.050	0.010	mg/L	0.050	0.01	N/A	0.01
Antimony	0.050	0.290	mg/L	0.050	0.050	0.05	N/A
Nickel	0.100	0.100	mg/L	0.100	0.100	0.10	N/A
Gross alpha	270 ± 320	600 ± 370	pCi/L	500	420	*	N/A
Specific conductance	38700.00	110000.00	umhos/cm	3.00	N/A	90030.00	N/A
Total organic halogen (TOH)	0.0361	8.80	mg/L	0.01	0.01	0.045	N/A
Total suspended solids (TSS)	25.00	1.00	mg/L	10.00	1.00	33.5	N/A
Calcium	1610.00	1710.00	mg/L	2.00	0.50	1740.00	N/A
Potassium	467.00	710.00	mg/L	2.00	0.50	525.00	N/A
Iron	0.50	0.30	mg/L	0.50	0.30	1.32	N/A
1,2-Dichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Chlorobenzene	5.00	1.00	ug/L	5.00	1.00	< MDL[†]	N/A
1,1-Dichloroethane	5.00	N.R.	ug/L	5.00	N.R.	< MDL[†]	N/A
1,1,2,2-Tetrachloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL[†]	N/A
1,1,1-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL[†]	N/A
1,4-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL[†]	N/A
cis-1,2-Dichloroethylene	5.00	N.R.	ug/L	5.00	N.R.	< MDL[†]	N/A
2,4-Dinitrotoluene	10.00	1.00	ug/L	10.00	1.00	< MDL[†]	N/A
Hexachlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL[†]	N/A
Methyl ethyl ketone	N.R.	50.00	ug/L	N.R.	50.00	< MDL[†]	N/A
Pentachlorophenol	10.00	5.00	ug/L	10.00	5.00	< MDL[†]	N/A
Tetrachloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL[†]	N/A
Trichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL[†]	N/A
Xylenes	10.00	1.00	ug/L	10.00	1.00	< MDL[†]	N/A
Vinyl chloride	10.00	2.00	ug/L	10.00	2.00	< MDL[†]	N/A
Barium	0.025	1.00	mg/L	0.020	1.00	N/A	1.0
Chromium	0.100	0.500	mg/L	0.100	0.050	N/A	0.05
Mercury	0.002	0.001	mg/L	0.002	0.001	N/A	0.002
Silver	0.050	0.500	mg/L	0.050	0.050	N/A	0.05
Beryllium	0.010	0.010	mg/L	0.010	0.001	0.02	N/A
Thallium	0.050	0.980	mg/L	0.050	0.005	0.05	N/A
Gross beta	420 ± 360	470 ± 360	pCi/L	570	550	*	N/A

* Not enough data points to establish 95^{th} upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.3 - WQSP-2							
Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
pH	7.30	7.30	S.U.	N/A	N/A	6.91-7.66	N/A
Total organic carbon (TOC)	1.40	5.00	mg/L	0.50	5.00	8.15	N/A
Total dissolved solids (TDS)	60400.00	59000.00	mg/L	20.00	200.00	74660.00	N/A
Density	1.050	1.052	g/mL	N/A	N/A	1.06	N/A
Magnesium	1060.00	950.00	mg/L	0.072	0.50	1173.00	N/A
Chloride	35500.00	37000.00	mg/L	0.016	0.500	42167.00	N/A
Chloroform	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Carbon tetrachloride	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,1-Dichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Methylene chloride	10.00	5.00	ug/L	10.00	5.00	< MDL†	N/A
Toluene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Cresols	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,2-Dichlorobenzene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
2,4-Dinitrophenol	27.00	25.00	ug/L	25.00	25.00	< MDL†	N/A
Hexachloroethane	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Isobutanol	N.R.	N.R	ug/L	N.R	N.R	< MDL†	N/A
Pyridine	11.00	1.00	ug/L	11.00	1.00	< MDL†	N/A
1,1,2-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichlorofluoromethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Nitrobenzene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Arsenic	0.020	5.000	mg/L	0.001	0.050	N/A	0.05
Cadmium	0.010	0.500	mg/L	0.001	0.005	N/A	0.01
Lead	0.010	0.500	mg/L	0.001	0.005	N/A	0.05
Selenium	0.020	1.00	mg/L	0.001	0.010	N/A	0.01
Antimony	0.014	0.500	mg/L	0.001	0.005	0.05	N/A
Nickel	0.080	1.00	mg/L	0.008	0.010	0.05	N/A
Gross alpha	200 ± 300	430 ± 380	pCi/L	510	540	*	N/A
Specific conductance	77600.00	110000.00	umhos/cm	3.00	N/A	85420.00	N/A
Total organic halogen (TOH)	1.50	1.80	mg/L	0.01	0.01	63.80	N/A
Total suspended solids (TSS)	10.00	1.00	mg/L	10.00	1.00	44.00	N/A
Calcium	1540.00	1380.00	mg/L	0.012	2.00	1640.00	N/A
Potassium	481.00	580.00	mg/L	0.074	2.00	529.00	N/A
Iron	0.275	0.500	mg/L	0.011	0.005	1.0	N/A
1,2-Dichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Chlorobenzene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.3 - WQSP-2							
Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
1,1-Dichloroethane	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
1,1,2,2-Tetrachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,1-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,4-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
cis-1,2-Dichloroethylene	5.00	N.R	ug/L	5.00	N.R.	< MDL†	N/A
2,4-Dinitrotoluene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Hexachlorobenzene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Methyl ethyl ketone	10.00	50.00	ug/L	10.00	50.00	< MDL†	N/A
Pentachlorophenol	11.00	5.00	ug/L	10.00	5.00	< MDL†	N/A
Tetrachloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Xylenes	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Vinyl chloride	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Barium	0.070	1.00	mg/L	0.004	0.02	N/A	1.0
Chromium	0.041	5.00	mg/L	0.001	0.05	N/A	0.05
Mercury	0.001	0.001	mg/L	0.0001	0.001	N/A	0.002
Silver	0.0310	5.00	mg/L	0.001	0.050	N/A	0.05
Beryllium	0.010	1.00	mg/L	0.001	0.01	0.02	N/A
Thallium	0.010	2.10	mg/L	0.001	0.005	0.05	N/A
Gross beta	120 ± 330	310 ± 350	pCi/L	560	570	*	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.4 - WQSP-3

Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
pH	6.90	6.80	S.U.	N/A	N/A	6.7-7.1	N/A
Total organic carbon (TOC)	1.30	5.00	mg/L	0.10	5.00	2.49	N/A
Total dissolved solids (TDS)	193000.0	200000.00	mg/L	20.00	10.00	230400.00	N/A
Density	1.100	1.151	g/mL	N/A	N/A	1.16	N/A
Magnesium	2340.00	2100.00	mg/L	0.07	0.10	2363.00	N/A
Chloride	125000.00	120000.00	mg/L	0.016	0.500	156600.00	N/A
Chloroform	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Carbon tetrachloride	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,1-Dichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Methylene chloride	10.00	5.00	ug/L	10.00	5.00	< MDL†	N/A
Toluene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Cresols	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,2-Dichlorobenzene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
2,4-Dinitrophenol	26.00	1.00	ug/L	25.00	1.00	< MDL†	N/A
Hexachloroethane	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Isobutanol	N.R.	500.00	ug/L	N.R.	500.00	< MDL†	N/A
Pyridine	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,2-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichlorofluoromethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Nitrobenzene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Arsenic	0.020	5.00	mg/L	0.001	5.00	N/A	0.05
Cadmium	0.010	0.50	mg/L	0.001	0.50	N/A	0.01
Lead	0.012	0.80	mg/L	0.001	0.50	N/A	0.05
Selenium	0.020	2.00	mg/L	0.001	2.00	N/A	0.01
Antimony	0.053	0.50	mg/L	0.001	0.50	0.13	N/A
Nickel	0.080	5.00	mg/L	0.008	5.00	0.25	N/A
Gross alpha	1700 ± 880	-450 ± 1000	pCi/L	970	2100	*	N/A
Specific conductance	342000.0	370000.00	umhos/cm	N/A	N/A	206500.00	N/A
Total organic halogen (TOH)	6.00	33.00	mg/L	0.01	0.01	56.40	N/A
Total suspended solids (TSS)	10.00	9.00	mg/L	10.00	1.00	113.00	N/A
Calcium	1380.00	1200.00	mg/L	0.012	0.10	1680	N/A
Potassium	1460.00	1300.00	mg/L	0.074	0.10	1914.00	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.4 - WQSP-3

Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
Iron	0.2770	37.00	Mg/L	0.011	3.00	4.0	N/A
1,2-Dichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Chlorobenzene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,1-Dichloroethane	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
1,1,2,2-Tetrachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,1-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,4-Dichlorobenzene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
cis-1,2-Dichloroethylene	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
2,4-Dinitrotoluene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Hexachlorobenzene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Methyl ethyl ketone	10.00	50.00	ug/L	10.00	50.00	< MDL†	N/A
Pentachlorophenol	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Tetrachloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Xylenes	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Vinyl chloride	10.00	2.00	ug/L	10.00	2.00	< MDL†	N/A
Barium	0.082	1.00	mg/L	0.004	1.00	N/A	1.0
Chromium	0.114	2.00	mg/L	0.001	2.00	N/A	0.05
Mercury	0.001	0.001	mg/L	0.0001	0.001	N/A	0.002
Silver	0.010	0.50	mg/L	0.001	0.50	N/A	0.05
Beryllium	0.010	0.10	mg/L	0.001	0.10	0.08	N/A
Thallium	0.01	5.00	mg/L	0.001	5.00	0.13	N/A
Gross beta	1100 ± 460	770 ± 720	pCi/L	640	1100	*	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.5 - WQSP-4

Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
pH	7.10	7.20	S.U.	N/A	N/A	7.13-7.61	N/A
Total organic carbon (TOC)	1.00	5.00	mg/L	0.10	5.00	3.80	N/A
Total dissolved solids (TDS)	99300.00	100000.00	mg/L	20.00	10.00	125000.00	N/A
Density	1.10	1.08	g/mL	N/A	N/A	1.09	N/A
Magnesium	1280.00	1230.00	mg/L	0.072	0.50	1370.00	N/A
Chloride	57100.00	53000.00	mg/L	0.016	0.500	63900.00	N/A
Chloroform	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Carbon tetrachloride	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,1-Dichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Methylene chloride	10.00	5.00	ug/L	10.00	5.00	< MDL†	N/A
Toluene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Cresols	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,2-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
2,4-Dinitrophenol	27.00	25.00	ug/L	25.00	25.00	< MDL†	N/A
Hexachloroethane	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Isobutanol	N.R.	500.00	ug/L	N.R.	500.00	< MDL†	N/A
Pyridine	11.00	5.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,2-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichlorofluoromethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Nitrobenzene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Arsenic	0.020	0.50	mg/L	0.001	0.05	N/A	0.05
Cadmium	0.010	0.500	mg/L	0.001	0.005	N/A	0.01
Lead	0.010	0.500	mg/L	0.001	0.005	N/A	0.05
Selenium	0.020	2.00	mg/L	0.001	0.01	N/A	0.01
Antimony	0.014	0.50	mg/L	0.001	0.05	<0.05	N/A
Nickel	0.080	5.00	mg/L	0.008	0.10	<0.1	N/A
Gross alpha	650 ± 640	790 ± 690	pCi/L	940	1000	*	N/A
Specific conductance	113000.00	180000.00	umhos/cm	N/A	N/A	127000.00	N/A
Total organic halogen (TOH)	0.02	3.00	mg/L	0.01	0.01	0.275	N/A
Total suspended solids (TSS)	45.00	1.00	mg/L	10.00	1.00	59.00	N/A
Calcium	1600.00	1560.00	mg/L	0.012	0.50	1790.00	N/A
Potassium	760.00	1370.00	mg/L	0.074	0.50	841.00	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.5 - WQSP-4 (continued)							
Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
Iron	0.320	3.00	mg/L	0.011	0.30	1.32	N/A
1,2-Dichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Chlorobenzene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,1-Dichloroethane	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
1,1,2,2-Tetrachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,1-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,4-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
cis-1,2-Dichloroethylene	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
2,4-Dinitrotoluene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Hexachlorobenzene	11.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Methyl ethyl ketone	10.00	50.00	ug/L	10.00	50.00	< MDL†	N/A
Pentachlorophenol	11.00	5.00	ug/L	10.00	5.00	< MDL†	N/A
Tetrachloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Xylenes	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Vinyl chloride	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Barium	0.059	1.00	mg/L	0.004	1.00	N/A	1.0
Chromium	0.062	2.00	mg/L	0.001	0.05	N/A	0.05
Mercury	0.0010	0.001	mg/L	0.0001	0.001	N/A	0.002
Silver	0.519	0.500	mg/L	0.001	0.050	N/A	0.05
Beryllium	0.010	0.250	mg/L	0.001	0.001	<0.08	N/A
Thallium	0.010	1.00	mg/L	0.001	0.005	<0.05	N/A
Gross beta	400 ± 700	660 ± 420	pCi/L	1200	650	*	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.6 - WQSP-5

Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95^{th} Upper Tolerance Limit Value or 95^{th} Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
pH	7.70	7.70	S.U.	N/A	N/A	7.51-7.8	N/A
Total organic carbon (TOC)	1.00	5.00	mg/L	0.10	5.00	3.13	N/A
Total dissolved solids (TDS)	32000.00	34000.00	mg/L	20.00	10.00	44100.00	N/A
Density	1.00	1.031	g/mL	N/A	N/A	1.04	N/A
Magnesium	485.00	508.00	mg/L	0.072	0.50	470.00	N/A
Chloride	15300.00	19000.00	mg/L	0.016	0.500	16200.00	N/A
Chloroform	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Carbon tetrachloride	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,1-Dichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Methylene chloride	10.00	5.00	ug/L	10.00	5.00	< MDL†	N/A
Toluene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Cresols	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,2-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
2,4-Dinitrophenol	25.00	1.00	ug/L	25.00	1.00	< MDL†	N/A
Hexachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Isobutanol	N.R.	500.00	ug/L	N.R.	500.00	< MDL†	N/A
Pyridine	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,2-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichlorofluoromethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Nitrobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Arsenic	0.020	0.50	mg/L	0.001	0.05	N/A	0.05
Cadmium	0.010	0.050	mg/L	0.001	0.005	N/A	0.01
Lead	0.010	0.050	mg/L	0.001	0.005	N/A	0.05
Selenium	0.020	0.10	mg/L	0.001	0.01	N/A	0.01
Antimony	0.010	0.05	mg/L	0.001	0.05	0.05	N/A
Nickel	0.080	0.10	mg/L	0.008	0.10	0.050	N/A
Gross alpha	330 ± 230	290 ± 230	pCi/L	300	320	*	N/A
Specific conductance	42950.00	58000.00	umhos/cm	N/A	N/A	47900.00	N/A
Total organic halogen (TOH)	0.013	0.80	mg/L	0.010	0.01	0.094	N/A
Total suspended solids (TSS)	10.00	1.00	mg/L	10.00	1.00	10.00	N/A
Calcium	1040.00	1100.00	mg/L	0.012	0.50	1070	N/A
Potassium	304.00	360.00	mg/L	0.074	0.50	298.00	N/A
Iron	0.247	0.30	mg/L	0.011	0.30	1.0	N/A
1,2-Dichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Chlorobenzene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A

* Not enough data points to establish 95^{th} upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.6 - WQSP-5

Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
1,1-Dichloroethane	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
1,1,2,2-Tetrachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,1-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,4-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
cis-1,2-Dichloroethylene	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
2,4-Dinitrotoluene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Hexachlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Methyl ethyl ketone	10.00	50.00	ug/L	10.00	50.00	< MDL†	N/A
Pentachlorophenol	10.00	1.00	ug/L	10.00	5.00	< MDL†	N/A
Tetrachloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Xylenes	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Vinyl chloride	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Barium	0.040	1.00	mg/L	0.004	1.00	N/A	1.0
Chromium	0.024	0.50	mg/L	0.001	0.05	N/A	0.05
Mercury	0.0010	0.001	mg/L	0.0001	0.001	N/A	0.002
Silver	0.014	0.500	mg/L	0.001	0.050	N/A	0.05
Beryllium	0.010	0.01	mg/L	0.001	0.01	0.02	N/A
Thallium	0.010	0.170	mg/L	0.001	0.005	0.05	N/A
Gross beta	22 ± 170	230 ± 130	pCi/L	290	190	*	N/A290 ±

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.7 - WQSP-6							
Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
pH	7.80	7.80	S.U.	N/A	N/A	7.45-7.95	N/A
Total organic carbon (TOC)	0.37	5.00	mg/L	0.10	5.00	10.22	N/A
Total dissolved solids (TDS)	16900.00	14000.00	mg/L	20.00	10.00	21600.00	N/A
Density	1.00	1.014	g/mL	N/A	N/A	1.02	N/A
Magnesium	219.00	200.00	mg/L	0.072	0.50	253.00	N/A
Chloride	6070.00	6000.00	mg/L	0.016	0.500	6200.00	N/A
Chloroform	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Carbon tetrachloride	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,1-Dichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Methylene chloride	10.00	5.00	ug/L	10.00	5.00	< MDL†	N/A
Toluene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Cresols	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,2-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
2,4-Dinitrophenol	25.00	1.00	ug/L	25.00	1.00	< MDL†	N/A
Hexachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Isobutanol	N.R.	500.00	ug/L	N.R.	500.00	< MDL†	N/A
Pyridine	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,2-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichlorofluoromethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Nitrobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Arsenic	0.020	0.50	mg/L	0.001	0.05	N/A	0.05
Cadmium	0.010	0.050	mg/L	0.001	0.005	N/A	0.01
Lead	0.010	0.120	mg/L	0.001	0.005	N/A	0.05
Selenium	0.020	0.10	mg/L	0.001	0.01	N/A	0.01
Antimony	0.010	0.05	mg/L	0.001	0.05	0.05	N/A
Nickel	0.080	0.10	mg/L	0.008	0.10	0.1	N/A
Gross alpha	81 ± 74	210 ± 120	pCi/L	110	130	*	N/A
Specific conductance	23900.00	22000.00	umhos/cm	N/A	N/A	30600	N/A
Total organic halogen (TOH)	N.R.	0.47	mg/L	N.R.	0.01	0.065	N/A
Total suspended solids (TSS)	10.00	1.00	mg/L	10.00	1.00	15.00	N/A
Calcium	714.00	680.00	mg/L	0.012	0.50	818	N/A
Potassium	161.00	144.00	mg/L	0.074	0.50	199.00	N/A
Iron	0.708	0.38	mg/L	0.011	0.30	1.0	N/A
1,2-Dichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Chlorobenzene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.7 - WQSP-6							
Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
1,1-Dichloroethane	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
1,1,2,2-Tetrachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,1-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,4-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
cis-1,2-Dichloroethylene	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
2,4-Dinitrotoluene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Hexachlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Methyl ethyl ketone	10.00	50.00	ug/L	10.00	50.00	< MDL†	N/A
Pentachlorophenol	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Tetrachloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Xylenes	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Vinyl chloride	10.00	2.00	ug/L	10.00	2.00	< MDL†	N/A
Barium	0.040	1.00	mg/L	0.004	1.00	N/A	1.0
Chromium	0.012	0.50	mg/L	0.001	0.05	N/A	0.05
Mercury	0.0010	0.0010	mg/L	0.0001	0.0001	N/A	0.002
Silver	0.010	0.500	mg/L	0.001	0.050	N/A	0.05
Beryllium	0.010	0.010	mg/L	0.001	0.001	0.02	N/A
Thallium	0.010	0.560	mg/L	0.001	0.005	0.05	N/A
Gross beta	140 ± 81	210 ± 87	pCi/L	120	120	*	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.8 - WQSP-6A

Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95th Upper Tolerance Limit Value or 95th Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
pH	7.47	7.30	S.U.	N/A	N/A	6.71-8.39	N/A
Total organic carbon (TOC)	0.10	5.00	mg/L	0.10	5.00	15.60	N/A
Total dissolved solids (TDS)	4120.00	4100.00	mg/L	20.00	10.00	4500.00	N/A
Density	1.00	1.00	g/mL	N/A	N/A	1.01	N/A
Magnesium	173.00	166.00	mg/L	0.068	0.50	200.00	N/A
Chloride	644.00	770.00	mg/L	0.016	0.500	1040.00	N/A
Chloroform	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Carbon tetrachloride	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,1-Dichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Methylene chloride	10.00	5.00	ug/L	10.00	5.00	< MDL†	N/A
Toluene	5.00	1.10	ug/L	5.00	1.00	< MDL†	N/A
Cresols	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,2-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
2,4-Dinitrophenol	25.00	1.00	ug/L	25.00	1.00	< MDL†	N/A
Hexachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Isobutanol	N.R.	500.00	ug/L	N.R	500.00	< MDL†	N/A
Pyridine	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,2-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichlorofluoromethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Nitrobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Arsenic	0.001	0.50	mg/L	0.001	0.50	N/A	0.05
Cadmium	0.010	0.05	mg/L	0.001	0.05	N/A	0.01
Lead	0.001	0.050	mg/L	0.001	0.005	N/A	0.05
Selenium	0.016	0.22	mg/L	0.001	0.01	N/A	0.01
Antimony	0.001	0.05	mg/L	0.001	0.05	0.05	N/A
Nickel	0.019	0.10	mg/L	0.017	0.10	0.1	N/A
Gross alpha	19 ± 22	23 ± 21	pCi/L	35	31	*	N/A
Specific conductance	4770.00	4600.00	umhos/cm	N/A	N/A	5290.00	N/A
Total organic halogen (TOH)	N.R.	0.05	mg/L	N.R.	0.01	0.181	N/A
Total suspended solids (TSS)	10.00	1.00	mg/L	10.00	1.00	91.00	N/A
Calcium	649.00	646.00	mg/L	0.011	0.50	681	N/A
Potassium	4.49	7.50	mg/L	0.037	0.50	5.96	N/A
Iron	0.019	0.30	mg/L	0.009	0.30	1.0	N/A
1,2-Dichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Chlorobenzene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A

* Not enough data points to establish 95th upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.8 - WQSP-6A							
Constituent	Concentration/ Activity		Units	Method/ Minimum Detection Limit		95^{th} Upper Tolerance Limit Value or 95^{th} Percentile	Maximum Contamination Level 40 CFR § 264.94
	Round 6	Round 7		Round 6	Round 7		
1,1-Dichloroethane	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
1,1,2,2-Tetrachloroethane	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
1,1,1-Trichloroethane	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
1,4-Dichlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
cis-1,2-Dichloroethylene	5.00	N.R.	ug/L	5.00	N.R.	< MDL†	N/A
2,4-Dinitrotoluene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Hexachlorobenzene	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Methyl ethyl ketone	10.00	50.00	ug/L	10.00	50.00	< MDL†	N/A
Pentachlorophenol	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Tetrachloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Trichloroethylene	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Xylenes	5.00	1.00	ug/L	5.00	1.00	< MDL†	N/A
Vinyl chloride	10.00	1.00	ug/L	10.00	1.00	< MDL†	N/A
Barium	0.007	1.00	mg/L	0.004	1.00	N/A	1.0
Chromium	0.0015	0.50	mg/L	0.0010	0.05	N/A	0.05
Mercury	0.0002	0.001	mg/L	0.0001	0.001	N/A	0.002
Silver	0.001	0.50	mg/L	0.001	0.50	N/A	0.05
Beryllium	0.001	0.01	mg/L	0.001	0.01	0.01	N/A
Thallium	0.001	0.10	mg/L	0.001	0.01	0.05	N/A
Gross beta	12 ± 22	1.2 ± 23	pCi/L	37	39	*	N/A

* Not enough data points to establish 95^{th} upper tolerance limit value.
N.R. = Not reported
† MDL = Method Detection Limit

Table 7.9 - Groundwater Surface Elevations for CY 1998										
Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
AEC-7	CUL	3657.25	01/14/98	06:38	620.42	0.98	619.44	188.81	3037.81	925.92
AEC-7	CUL	3657.25	02/11/98	06:12	620.40	0.98	619.42	188.80	3037.83	925.93
AEC-7	CUL	3657.25	03/11/98	06:02	619.83	0.98	618.85	188.63	3038.40	926.10
AEC-7	CUL	3657.25	04/15/98	06:12	619.04	0.98	618.06	188.38	3039.19	926.35
AEC-7	CUL	3657.25	05/13/98	06:00	618.89	0.98	617.91	188.34	3039.34	926.39
AEC-7	CUL	3657.25	06/11/98	06:05	618.94	0.98	617.96	188.35	3039.29	926.38
AEC-7	CUL	3657.25	07/15/98	10:52	619.01	0.98	618.03	188.38	3039.22	926.35
AEC-7	CUL	3657.25	08/12/98	06:23	619.22	0.98	618.24	188.44	3039.01	926.29
AEC-7	CUL	3657.25	09/10/98	11:58	619.24	0.98	618.26	188.45	3038.99	926.28
AEC-7	CUL	3657.25	10/14/98	06:14	619.13	0.98	618.15	188.41	3039.10	926.32
AEC-7	CUL	3657.25	11/11/98	09:30	619.54	0.98	618.56	188.54	3038.69	926.19
AEC-7	CUL	3657.25	12/07/98	11:06	619.32	0.98	618.34	188.47	3038.91	926.26
AEC-8	B/C	3537.10	01/14/98	07:42	553.30	0.00	553.30	168.65	2983.80	909.46
AEC-8	B/C	3537.10	02/11/98	06:40	552.20	0.00	552.20	168.31	2984.90	909.80
AEC-8	B/C	3537.10	03/11/98	06:59	551.21	0.00	551.21	168.01	2985.89	910.10
AEC-8	B/C	3537.10	04/15/98	07:15	549.94	0.00	549.94	167.62	2987.16	910.49
AEC-8	B/C	3537.10	05/13/98	06:43	548.95	0.00	548.95	167.32	2988.15	910.79
AEC-8	B/C	3537.10	06/11/98	07:00	547.91	0.00	547.91	167.00	2989.19	911.11
AEC-8	B/C	3537.10	07/15/98	11:18	546.66	0.00	546.66	166.62	2990.44	911.49
AEC-8	B/C	3537.10	08/12/98	07:16	545.62	0.00	545.62	166.30	2991.48	911.80
AEC-8	B/C	3537.10	09/10/98	12:21	544.54	0.00	544.54	165.98	2992.56	912.13
AEC-8	B/C	3537.10	10/14/98	07:02	543.27	0.00	543.27	165.59	2993.83	912.52
AEC-8	B/C	3537.10	11/09/98	11:36	542.28	0.00	542.28	165.29	2994.82	912.82
AEC-8	B/C	3537.10	12/07/98	11:36	540.74	0.00	540.74	164.82	2996.36	913.29
C-2505	SR	3413.05	01/15/98	08:30	44.39	0.00	44.39	13.53	3368.66	1026.77
C-2505	SR	3413.05	02/12/98	07:25	44.30	0.00	44.30	13.50	3368.75	1026.80
C-2505	SR	3413.05	03/12/98	12:10	44.36	0.00	44.36	13.52	3368.69	1026.78
C-2505	SR	3413.05	04/16/98	08:42	44.35	0.00	44.35	13.52	3368.70	1026.78
C-2505	SR	3413.05	05/13/98	10:27	44.32	0.00	44.32	13.51	3368.73	1026.79
C-2505	SR	3413.05	06/11/98	12:50	44.44	0.00	44.44	13.55	3368.61	1026.75
C-2505	SR	3413.05	07/15/98	14:26	44.61	0.00	44.61	13.60	3368.44	1026.70
C-2505	SR	3413.05	08/12/98	13:45	44.71	0.00	44.71	13.63	3368.34	1026.67

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
C-2505	SR	3413.05	09/11/98	07:41	44.76	0.00	44.76	13.64	3368.29	1026.65
C-2505	SR	3413.05	10/15/98	07:15	44.67	0.00	44.67	13.62	3368.38	1026.68
C-2505	SR	3413.05	11/13/98	07:39	44.93	0.00	44.93	13.69	3368.12	1026.60
C-2505	SR	3413.05	12/09/98	11:01	44.87	0.00	44.87	13.68	3368.18	1026.62
C-2506	SR	3412.87	01/15/98	08:33	43.76	0.00	43.76	13.34	3369.11	1026.90
C-2506	SR	3412.87	02/12/98	07:40	43.66	0.00	43.66	13.31	3369.21	1026.94
C-2506	SR	3412.87	03/12/98	12:14	43.72	0.00	43.72	13.33	3369.15	1026.92
C-2506	SR	3412.87	04/16/98	08:39	43.72	0.00	43.72	13.33	3369.15	1026.92
C-2506	SR	3412.87	05/13/98	10:22	43.67	0.00	43.67	13.31	3369.20	1026.93
C-2506	SR	3412.87	06/11/98	12:53	43.79	0.00	43.79	13.35	3369.08	1026.90
C-2506	SR	3412.87	07/15/98	14:22	43.94	0.00	43.94	13.39	3368.93	1026.85
C-2506	SR	3412.87	08/12/98	13:49	44.05	0.00	44.05	13.43	3368.82	1026.82
C-2506	SR	3412.87	09/11/98	07:37	44.10	0.00	44.10	13.44	3368.77	1026.80
C-2506	SR	3412.87	10/15/98	07:00	44.04	0.00	44.04	13.42	3368.83	1026.82
C-2506	SR	3412.87	11/13/98	07:42	44.29	0.00	44.29	13.50	3368.58	1026.74
C-2506	SR	3412.87	12/09/98	11:04	44.21	0.00	44.21	13.48	3368.66	1026.77
C-2507	SR	3410.01	01/15/98	08:40	45.15	0.00	45.15	13.76	3364.86	1025.61
C-2507	SR	3410.01	02/12/98	07:59	45.09	0.00	45.09	13.74	3364.92	1025.63
C-2507	SR	3410.01	03/12/98	12:20	45.15	0.00	45.15	13.76	3364.86	1025.61
C-2507	SR	3410.01	04/16/98	08:50	45.20	0.00	45.20	13.78	3364.81	1025.59
C-2507	SR	3410.01	05/13/98	10:34	45.21	0.00	45.21	13.78	3364.80	1025.59
C-2507	SR	3410.01	06/11/98	13:00	45.37	0.00	45.37	13.83	3364.64	1025.54
C-2507	SR	3410.01	07/15/98	14:34	45.54	0.00	45.54	13.88	3364.47	1025.49
C-2507	SR	3410.01	08/12/98	14:00	45.58	0.00	45.58	13.89	3364.43	1025.48
C-2507	SR	3410.01	09/11/98	07:45	45.61	0.00	45.61	13.90	3364.40	1025.47
C-2507	SR	3410.01	10/15/98	07:30	45.48	0.00	45.48	13.86	3364.53	1025.51
C-2507	SR	3410.01	11/13/98	07:49	45.76	0.00	45.76	13.95	3364.25	1025.42
C-2507	SR	3410.01	12/09/98	11:09	45.64	0.00	45.64	13.91	3364.37	1025.46
CB-1	CUL	3328.38	01/13/98	12:36	363.07	0.00	363.07	110.66	2965.31	903.83
CB-1	CUL	3328.38	02/10/98	14:47	362.73	0.00	362.73	110.56	2965.65	903.93
CB-1	CUL	3328.38	03/10/98	14:28	362.65	0.00	362.65	110.54	2965.73	903.95
CB-1	CUL	3328.38	04/14/98	13:40	362.17	0.00	362.17	110.39	2966.21	904.10

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
CB-1	CUL	3328.38	05/12/98	11:07	362.03	0.00	362.03	110.35	2966.35	904.14
CB-1	CUL	3328.38	06/10/98	11:39	362.00	0.00	362.00	110.34	2966.38	904.15
CB-1	CUL	3328.38	07/14/98	12:39	361.97	0.00	361.97	110.33	2966.41	904.16
CB-1	CUL	3328.38	08/11/98	12:22	361.89	0.00	361.89	110.30	2966.49	904.19
CB-1	CUL	3328.38	09/09/98	13:30	361.69	0.00	361.69	110.24	2966.69	904.25
CB-1	CUL	3328.38	10/13/98	13:03	361.55	0.00	361.55	110.20	2966.83	904.29
CB-1	CUL	3328.38	11/10/98	12:34	361.29	0.00	361.29	110.12	2967.09	904.37
CB-1	CUL	3328.38	12/08/98	12:02	361.13	0.00	361.13	110.07	2967.25	904.42
D-268	CUL	3280.70	01/14/98	15:00	275.32	0.75	274.57	83.69	3006.13	916.27
D-268	CUL	3280.70	02/11/98	14:12	275.26	0.75	274.51	83.67	3006.19	916.29
D-268	CUL	3280.70	03/11/98	14:12	275.57	0.75	274.82	83.77	3005.88	916.19
D-268	CUL	3280.70	04/15/98	13:46	275.12	0.75	274.37	83.63	3006.33	916.33
D-268	CUL	3280.70	05/12/98	14:28	275.27	0.75	274.52	83.67	3006.18	916.28
D-268	CUL	3280.70	06/11/98	10:02	275.49	0.75	274.74	83.74	3005.96	916.22
D-268	CUL	3280.70	07/15/98	06:10	275.69	0.75	274.94	83.80	3005.76	916.16
D-268	CUL	3280.70	08/10/98	13:09	275.71	0.75	274.96	83.81	3005.74	916.15
D-268	CUL	3280.70	09/11/98	06:03	275.69	0.75	274.94	83.80	3005.76	916.16
D-268	CUL	3280.70	10/13/98	14:15	275.71	0.75	274.96	83.81	3005.74	916.15
D-268	CUL	3280.70	11/11/98	14:36	275.73	0.75	274.98	83.81	3005.72	916.14
D-268	CUL	3280.70	12/08/98	14:22	275.82	0.75	275.07	83.84	3005.63	916.12
DOE-1	CUL	3466.04	01/13/98	13:13	492.56	0.00	492.56	150.13	2973.48	906.32
DOE-1	CUL	3466.04	02/11/98	10:59	492.01	0.00	492.01	149.96	2974.03	906.48
DOE-1	CUL	3466.04	03/11/98	11:36	491.99	0.00	491.99	149.96	2974.05	906.49
DOE-1	CUL	3466.04	04/15/98	11:20	492.06	0.00	492.06	149.98	2973.98	906.47
DOE-1	CUL	3466.04	05/12/98	12:03	492.12	0.00	492.12	150.00	2973.92	906.45
DOE-1	CUL	3466.04	06/10/98	12:11	492.32	0.00	492.32	150.06	2973.72	906.39
DOE-1	CUL	3466.04	07/15/98	08:41	492.46	0.00	492.46	150.10	2973.58	906.35
DOE-1	CUL	3466.04	08/12/98	09:53	492.48	0.00	492.48	150.11	2973.56	906.34
DOE-1	CUL	3466.04	09/10/98	08:07	492.72	0.00	492.72	150.18	2973.32	906.27
DOE-1	CUL	3466.04	10/13/98	13:23	492.71	0.00	492.71	150.18	2973.33	906.27
DOE-1	CUL	3466.04	11/11/98	12:42	492.67	0.00	492.67	150.17	2973.37	906.28
DOE-1	CUL	3466.04	12/08/98	12:20	492.39	0.00	492.39	150.08	2973.65	906.37

Table 7.9 - Groundwater Surface Elevations for CY 1998										
Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
DOE-2	CUL	3419.09	01/12/98	11:55	366.33	0.00	366.33	111.66	3052.76	930.48
DOE-2	CUL	3419.09	02/09/98	11:47	363.69	0.00	363.69	110.85	3055.40	931.29
DOE-2	CUL	3419.09	03/11/98	10:00	362.55	0.00	362.55	110.51	3056.54	931.63
DOE-2	CUL	3419.09	04/15/98	09:19	362.90	0.00	362.90	110.61	3056.19	931.53
DOE-2	CUL	3419.09	05/11/98	11:24	363.43	0.00	363.43	110.77	3055.66	931.37
DOE-2	CUL	3419.09	06/11/98	08:08	363.88	0.00	363.88	110.91	3055.21	931.23
DOE-2	CUL	3419.09	07/15/98	12:19	364.06	0.00	364.06	110.97	3055.03	931.17
DOE-2	CUL	3419.09	08/12/98	08:27	364.65	0.68	363.97	110.94	3055.12	931.20
DOE-2	CUL	3419.09	09/10/98	11:22	358.88	0.68	358.20	109.18	3060.89	932.96
DOE-2	CUL	3419.09	10/14/98	09:00	363.05	0.68	362.37	110.45	3056.72	931.69
DOE-2	CUL	3419.09	11/11/98	08:50	364.07	0.00	364.07	110.97	3055.02	931.17
DOE-2	CUL	3419.09	12/08/98	13:14	359.78	0.00	359.78	109.66	3059.31	932.48
ERDA-9	CUL	3410.10	01/14/98	09:03	407.58	0.65	406.93	124.03	3003.17	915.37
ERDA-9	CUL	3410.10	02/11/98	09:41	407.16	0.65	406.51	123.90	3003.59	915.49
ERDA-9	CUL	3410.10	03/11/98	10:13	406.81	0.65	406.16	123.80	3003.94	915.60
ERDA-9	CUL	3410.10	04/15/98	10:34	406.08	0.65	405.43	123.58	3004.67	915.82
ERDA-9	CUL	3410.10	05/13/98	08:30	405.89	0.65	405.24	123.52	3004.86	915.88
ERDA-9	CUL	3410.10	06/10/98	12:30	405.70	0.65	405.05	123.46	3005.05	915.94
ERDA-9	CUL	3410.10	07/15/98	09:27	405.43	0.65	404.78	123.38	3005.32	916.02
ERDA-9	CUL	3410.10	08/12/98	09:16	405.33	0.65	404.68	123.35	3005.42	916.05
ERDA-9	CUL	3410.10	09/10/98	09:28	405.11	0.65	404.46	123.28	3005.64	916.12
ERDA-9	CUL	3410.10	10/14/98	09:43	405.14	0.65	404.49	123.29	3005.61	916.11
ERDA-9	CUL	3410.10	11/11/98	12:24	405.13	0.65	404.48	123.29	3005.62	916.11
ERDA-9	CUL	3410.10	12/09/98	09:33	405.01	0.65	404.36	123.25	3005.74	916.15
H-01 (ANNULUS)	MAG	3399.53	01/14/98	09:38	206.69	0.00	206.69	63.00	3192.84	973.18
H-01 (ANNULUS)	MAG	3399.53	02/11/98	09:53	191.18	0.00	191.18	58.27	3208.35	977.91
H-01 (ANNULUS)	MAG	3399.53	03/11/98	10:30	187.95	0.00	187.95	57.29	3211.58	978.89
H-01 (ANNULUS)	MAG	3399.53	04/15/98	10:51	172.69	0.00	172.69	52.64	3226.84	983.54
H-01 (ANNULUS)	MAG	3399.53	05/13/98	08:47	174.33	0.00	174.33	53.14	3225.20	983.04
H-01 (ANNULUS)	MAG	3399.53	06/10/98	12:55	178.63	0.00	178.63	54.45	3220.90	981.73
H-01 (ANNULUS)	MAG	3399.53	07/15/98	09:45	180.12	0.00	180.12	54.90	3219.41	981.28
H-01 (ANNULUS)	MAG	3399.53	08/12/98	09:34	179.47	0.00	179.47	54.70	3220.06	981.47

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-01 (ANNULUS)	MAG	3399.53	09/10/98	09:46	181.50	0.00	181.50	55.32	3218.03	980.86
H-01 (ANNULUS)	MAG	3399.53	10/12/98	11:27	181.91	0.00	181.91	55.45	3217.62	980.73
H-01 (ANNULUS)	MAG	3399.53	11/09/98	12:19	169.27	0.65	168.62	51.40	3230.91	984.78
H-01 (ANNULUS)	MAG	3399.53	12/09/98	09:38	170.68	1.27	169.41	51.64	3230.12	984.54
H-01 (PIP)	CUL	3399.53	01/14/98	09:26	378.79	0.65	378.14	115.26	3021.39	920.92
H-01 (PIP)	CUL	3399.53	02/11/98	09:44	378.51	0.65	377.86	115.17	3021.67	921.01
H-01 (PIP)	CUL	3399.53	03/11/98	10:24	378.33	0.65	377.68	115.12	3021.85	921.06
H-01 (PIP)	CUL	3399.53	04/15/98	10:46	377.42	0.65	376.77	114.84	3022.76	921.34
H-01 (PIP)	CUL	3399.53	05/13/98	08:41	377.20	0.65	376.55	114.77	3022.98	921.40
H-01 (PIP)	CUL	3399.53	06/10/98	12:43	377.30	0.65	376.65	114.80	3022.88	921.37
H-01 (PIP)	CUL	3399.53	07/15/98	09:38	377.07	0.65	376.42	114.73	3023.11	921.44
H-01 (PIP)	CUL	3399.53	08/12/98	09:26	376.92	0.65	376.27	114.69	3023.26	921.49
H-01 (PIP)	CUL	3399.53	09/10/98	09:40	376.72	0.65	376.07	114.63	3023.46	921.55
H-01 (PIP)	CUL	3399.53	10/12/98	11:22	376.83	0.65	376.18	114.66	3023.35	921.52
H-01 (PIP)	CUL	3399.53	11/09/98	12:14	376.71	0.65	376.06	114.62	3023.47	921.55
H-01 (PIP)	CUL	3399.53	12/09/98	09:51	379.35	1.28	378.07	115.24	3021.46	920.94
H-02a	CUL	3378.09	03/11/98	12:15	346.41	0.00	346.41	105.59	3031.68	924.06
H-02a	CUL	3378.09	06/10/98	13:26	345.59	0.00	345.59	105.34	3032.50	924.31
H-02a	CUL	3378.09	09/10/98	09:00	345.03	0.00	345.03	105.17	3033.06	924.48
H-02a	CUL	3378.09	12/09/98	10:44	344.53	0.00	344.53	105.01	3033.56	924.63
H-02b1	MAG	3378.46	01/14/98	11:59	242.36	0.00	242.36	73.87	3136.10	955.88
H-02b1	MAG	3378.46	02/11/98	09:22	242.26	0.00	242.26	73.84	3136.20	955.91
H-02b1	MAG	3378.46	03/11/98	12:08	242.12	0.00	242.12	73.80	3136.34	955.96
H-02b1	MAG	3378.46	04/15/98	12:34	241.88	0.00	241.88	73.73	3136.58	956.03
H-02b1	MAG	3378.46	05/13/98	08:17	241.64	0.00	241.64	73.65	3136.82	956.10
H-02b1	MAG	3378.46	06/10/98	13:12	241.37	0.00	241.37	73.57	3137.09	956.19
H-02b1	MAG	3378.46	07/15/98	10:07	241.00	0.00	241.00	73.46	3137.46	956.30
H-02b1	MAG	3378.46	08/12/98	11:56	240.62	0.00	240.62	73.34	3137.84	956.41
H-02b1	MAG	3378.46	09/10/98	09:13	240.22	0.00	240.22	73.22	3138.24	956.54
H-02b1	MAG	3378.46	10/14/98	09:32	239.73	0.00	239.73	73.07	3138.73	956.68
H-02b1	MAG	3378.46	11/11/98	13:39	239.32	0.00	239.32	72.94	3139.14	956.81
H-02b1	MAG	3378.46	12/09/98	10:39	238.89	0.00	238.89	72.81	3139.57	956.94

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-02b2	CUL	3378.31	01/14/98	11:51	344.77	0.00	344.77	105.09	3033.54	924.62
H-02b2	CUL	3378.31	02/11/98	09:09	344.65	0.00	344.65	105.05	3033.66	924.66
H-02b2	CUL	3378.31	03/11/98	12:02	344.61	0.00	344.61	105.04	3033.70	924.67
H-02b2	CUL	3378.31	04/15/98	12:21	343.79	0.00	343.79	104.79	3034.52	924.92
H-02b2	CUL	3378.31	05/13/98	08:05	343.60	0.00	343.60	104.73	3034.71	924.98
H-02b2	CUL	3378.31	06/10/98	13:19	343.61	0.00	343.61	104.73	3034.70	924.98
H-02b2	CUL	3378.31	07/15/98	09:59	343.64	0.00	343.64	104.74	3034.67	924.97
H-02b2	CUL	3378.31	08/12/98	11:48	343.56	0.00	343.56	104.72	3034.75	924.99
H-02b2	CUL	3378.31	09/10/98	09:06	343.33	0.00	343.33	104.65	3034.98	925.06
H-02b2	CUL	3378.31	10/14/98	09:20	343.10	0.00	343.10	104.58	3035.21	925.13
H-02b2	CUL	3378.31	11/11/98	13:33	343.30	0.00	343.30	104.64	3035.01	925.07
H-02b2	CUL	3378.31	12/09/98	10:34	343.26	0.00	343.26	104.63	3035.05	925.08
H-02c	CUL	3378.41	03/11/98	11:54	344.82	0.00	344.82	105.10	3033.59	924.64
H-02c	CUL	3378.41	06/10/98	13:04	343.82	0.00	343.82	104.80	3034.59	924.94
H-02c	CUL	3378.41	09/10/98	08:53	343.60	0.00	343.60	104.73	3034.81	925.01
H-02c	CUL	3378.41	12/09/98	10:28	343.54	0.00	343.54	104.71	3034.87	925.03
H-03b1	MAG	3390.64	01/14/98	09:52	244.91	0.00	244.91	74.65	3145.73	958.82
H-03b1	MAG	3390.64	02/11/98	10:13	244.49	0.00	244.49	74.52	3146.15	958.95
H-03b1	MAG	3390.64	03/11/98	10:41	244.24	0.00	244.24	74.44	3146.40	959.02
H-03b1	MAG	3390.64	04/15/98	11:53	243.36	0.00	243.36	74.18	3147.28	959.29
H-03b1	MAG	3390.64	05/13/98	09:26	242.94	0.00	242.94	74.05	3147.70	959.42
H-03b1	MAG	3390.64	06/10/98	08:28	242.62	0.00	242.62	73.95	3148.02	959.52
H-03b1	MAG	3390.64	07/15/98	08:53	242.20	0.00	242.20	73.82	3148.44	959.64
H-03b1	MAG	3390.64	08/12/98	12:11	241.95	0.00	241.95	73.75	3148.69	959.72
H-03b1	MAG	3390.64	09/10/98	08:16	244.64	0.00	244.64	74.57	3146.00	958.90
H-03b1	MAG	3390.64	10/14/98	10:10	241.36	0.00	241.36	73.57	3149.28	959.90
H-03b1	MAG	3390.64	11/11/98	13:03	241.09	0.00	241.09	73.48	3149.55	959.98
H-03b1	MAG	3390.64	12/09/98	09:01	240.94	0.00	240.94	73.44	3149.70	960.03
H-03b2	CUL	3390.03	01/14/98	10:14	396.11	0.00	396.11	120.73	2993.92	912.55
H-03b2	CUL	3390.03	02/11/98	10:47	395.70	0.00	395.70	120.61	2994.33	912.67
H-03b2	CUL	3390.03	03/11/98	11:11	395.65	0.00	395.65	120.59	2994.38	912.69
H-03b2	CUL	3390.03	04/15/98	12:08	394.81	0.00	394.81	120.34	2995.22	912.94

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-03b2	CUL	3390.03	05/13/98	09:58	395.37	0.00	395.37	120.51	2994.66	912.77
H-03b2	CUL	3390.03	06/10/98	08:58	395.30	0.00	395.30	120.49	2994.73	912.79
H-03b2	CUL	3390.03	07/15/98	09:14	394.87	0.00	394.87	120.36	2995.16	912.92
H-03b2	CUL	3390.03	08/12/98	12:28	394.70	0.00	394.70	120.30	2995.33	912.98
H-03b2	CUL	3390.03	09/10/98	08:40	394.38	0.00	394.38	120.21	2995.65	913.07
H-03b2	CUL	3390.03	10/14/98	10:32	394.89	0.00	394.89	120.36	2995.14	912.92
H-03b2	CUL	3390.03	11/11/98	13:23	394.36	0.00	394.36	120.20	2995.67	913.08
H-03b2	CUL	3390.03	12/09/98	09:18	394.10	0.00	394.10	120.12	2995.93	913.16
H-03b3	CUL	3388.67	03/11/98	11:04	394.12	0.00	394.12	120.13	2994.55	912.74
H-03b3	CUL	3388.67	06/10/98	08:49	393.89	0.00	393.89	120.06	2994.78	912.81
H-03b3	CUL	3388.67	09/10/98	08:34	392.97	0.00	392.97	119.78	2995.70	913.09
H-03b3	CUL	3388.67	12/09/98	09:14	392.58	0.00	392.58	119.66	2996.09	913.21
H-03d/49 (PIP)	49ER	3390.01	01/14/98	10:04	307.13	2.22	304.91	92.94	3085.10	940.34
H-03d/49 (PIP)	49ER	3390.01	02/11/98	10:27	306.97	2.22	304.75	92.89	3085.26	940.39
H-03d/49 (PIP)	49ER	3390.01	03/11/98	10:51	306.84	2.22	304.62	92.85	3085.39	940.43
H-03d/49 (PIP)	49ER	3390.01	04/15/98	11:58	306.69	2.22	304.47	92.80	3085.54	940.47
H-03d/49 (PIP)	49ER	3390.01	05/13/98	09:35	306.67	2.22	304.45	92.80	3085.56	940.48
H-03d/49 (PIP)	49ER	3390.01	06/10/98	08:36	306.71	2.22	304.49	92.81	3085.52	940.47
H-03d/49 (PIP)	49ER	3390.01	07/15/98	09:00	306.77	2.22	304.55	92.83	3085.46	940.45
H-03d/49 (PIP)	49ER	3390.01	08/12/98	12:16	306.64	2.22	304.42	92.79	3085.59	940.49
H-03d/49 (PIP)	49ER	3390.01	09/10/98	08:22	306.60	2.22	304.38	92.78	3085.63	940.50
H-03d/49 (PIP)	49ER	3390.01	10/14/98	10:25	306.58	2.22	304.36	92.77	3085.65	940.51
H-03d/49 (PIP)	49ER	3390.01	11/11/98	13:11	306.38	2.22	304.16	92.71	3085.85	940.57
H-03d/49 (PIP)	49ER	3390.01	12/09/98	09:06	306.28	2.22	304.06	92.68	3085.95	940.60
H-03d/DL (PVC)	DL	3390.01	01/14/98	10:09	319.82	2.22	317.60	96.80	3072.41	936.47
H-03d/DL (PVC)	DL	3390.01	02/11/98	10:38	319.78	2.22	317.56	96.79	3072.45	936.48
H-03d/DL (PVC)	DL	3390.01	03/11/98	10:46	319.78	2.22	317.56	96.79	3072.45	936.48
H-03d/DL (PVC)	DL	3390.01	04/15/98	12:02	319.79	2.22	317.57	96.80	3072.44	936.48
H-03d/DL (PVC)	DL	3390.01	05/13/98	09:42	319.78	2.22	317.56	96.79	3072.45	936.48
H-03d/DL (PVC)	DL	3390.01	06/10/98	08:41	319.78	2.22	317.56	96.79	3072.45	936.48
H-03d/DL (PVC)	DL	3390.01	07/15/98	09:07	319.88	2.22	317.66	96.82	3072.35	936.45
H-03d/DL (PVC)	DL	3390.01	08/12/98	12:22	319.80	2.22	317.58	96.80	3072.43	936.48

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-03d/DL (PVC)	DL	3390.01	09/10/98	08:25	319.80	2.22	317.58	96.80	3072.43	936.48
H-03d/DL (PVC)	DL	3390.01	10/14/98	10:19	319.88	2.22	317.66	96.82	3072.35	936.45
H-03d/DL (PVC)	DL	3390.01	11/11/98	13:16	319.84	2.22	317.62	96.81	3072.39	936.46
H-03d/DL (PVC)	DL	3390.01	12/09/98	09:09	319.91	2.22	317.69	96.83	3072.32	936.44
H-04b	CUL	3333.35	01/14/98	11:28	334.21	0.00	334.21	101.87	2999.14	914.14
H-04b	CUL	3333.35	02/11/98	13:13	334.06	0.00	334.06	101.82	2999.29	914.18
H-04b	CUL	3333.35	03/11/98	13:11	334.14	0.00	334.14	101.85	2999.21	914.16
H-04b	CUL	3333.35	04/15/98	13:09	333.62	0.00	333.62	101.69	2999.73	914.32
H-04b	CUL	3333.35	05/12/98	13:43	333.79	0.00	333.79	101.74	2999.56	914.27
H-04b	CUL	3333.35	06/10/98	06:02	334.07	0.00	334.07	101.82	2999.28	914.18
H-04b	CUL	3333.35	07/15/98	07:14	334.15	0.00	334.15	101.85	2999.20	914.16
H-04b	CUL	3333.35	08/12/98	11:15	334.20	0.00	334.20	101.86	2999.15	914.14
H-04b	CUL	3333.35	09/10/98	13:25	334.08	0.00	334.08	101.83	2999.27	914.18
H-04b	CUL	3333.35	10/14/98	11:47	334.02	0.00	334.02	101.81	2999.33	914.20
H-04b	CUL	3333.35	11/11/98	13:54	333.99	0.00	333.99	101.80	2999.36	914.20
H-04b	CUL	3333.35	12/09/98	06:28	333.99	0.00	333.99	101.80	2999.36	914.20
H-04c	MAG	3334.04	01/14/98	11:34	191.20	0.00	191.20	58.28	3142.84	957.94
H-04c	MAG	3334.04	02/11/98	13:29	191.15	0.00	191.15	58.26	3142.89	957.95
H-04c	MAG	3334.04	03/11/98	13:16	191.11	0.00	191.11	58.25	3142.93	957.97
H-04c	MAG	3334.04	04/15/98	13:14	191.04	0.00	191.04	58.23	3143.00	957.99
H-04c	MAG	3334.04	05/12/98	13:49	191.03	0.00	191.03	58.23	3143.01	957.99
H-04c	MAG	3334.04	06/10/98	06:19	191.13	0.00	191.13	58.26	3142.91	957.96
H-04c	MAG	3334.04	07/15/98	07:23	191.15	0.00	191.15	58.26	3142.89	957.95
H-04c	MAG	3334.04	08/12/98	11:09	191.08	0.00	191.08	58.24	3142.96	957.97
H-04c	MAG	3334.04	09/10/98	13:32	191.11	0.00	191.11	58.25	3142.93	957.97
H-04c	MAG	3334.04	10/14/98	11:55	191.08	0.00	191.08	58.24	3142.96	957.97
H-04c	MAG	3334.04	11/11/98	14:00	190.93	0.00	190.93	58.20	3143.11	958.02
H-04c	MAG	3334.04	12/09/98	06:22	191.02	0.00	191.02	58.22	3143.02	957.99
H-05a	CUL	3506.24	03/11/98	08:01	476.23	0.00	476.23	145.15	3030.01	923.55
H-05a	CUL	3506.24	06/10/98	13:57	475.96	0.00	475.96	145.07	3030.28	923.63
H-05a	CUL	3506.24	09/10/98	12:46	475.87	0.00	475.87	145.05	3030.37	923.66
H-05a	CUL	3506.24	12/07/98	10:37	475.76	0.00	475.76	145.01	3030.48	923.69

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-05b	CUL	3506.04	01/14/98	08:25	478.66	0.00	478.66	145.90	3027.38	922.75
H-05b	CUL	3506.04	02/11/98	08:10	478.55	0.00	478.55	145.86	3027.49	922.78
H-05b	CUL	3506.04	03/11/98	07:50	478.72	0.00	478.72	145.91	3027.32	922.73
H-05b	CUL	3506.04	04/15/98	08:20	478.35	0.00	478.35	145.80	3027.69	922.84
H-05b	CUL	3506.04	05/13/98	07:30	478.34	0.00	478.34	145.80	3027.70	922.84
H-05b	CUL	3506.04	06/10/98	13:49	478.42	0.00	478.42	145.82	3027.62	922.82
H-05b	CUL	3506.04	07/15/98	11:36	478.39	0.00	478.39	145.81	3027.65	922.83
H-05b	CUL	3506.04	08/12/98	07:49	478.42	0.00	478.42	145.82	3027.62	922.82
H-05b	CUL	3506.04	09/10/98	12:38	478.34	0.00	478.34	145.80	3027.70	922.84
H-05b	CUL	3506.04	10/14/98	07:50	478.34	0.00	478.34	145.80	3027.70	922.84
H-05b	CUL	3506.04	11/11/98	11:57	478.38	0.00	478.38	145.81	3027.66	922.83
H-05b	CUL	3506.04	12/07/98	10:31	478.24	0.00	478.24	145.77	3027.80	922.87
H-05c	MAG	3506.04	01/14/98	08:34	349.81	0.00	349.81	106.62	3156.23	962.02
H-05c	MAG	3506.04	02/11/98	08:29	349.75	0.00	349.75	106.60	3156.29	962.04
H-05c	MAG	3506.04	03/11/98	08:10	349.91	0.00	349.91	106.65	3156.13	961.99
H-05c	MAG	3506.04	04/15/98	08:29	349.52	0.00	349.52	106.53	3156.52	962.11
H-05c	MAG	3506.04	05/13/98	07:39	349.63	0.00	349.63	106.57	3156.41	962.07
H-05c	MAG	3506.04	06/10/98	14:03	349.76	0.00	349.76	106.61	3156.28	962.03
H-05c	MAG	3506.04	07/15/98	11:45	349.81	0.00	349.81	106.62	3156.23	962.02
H-05c	MAG	3506.04	08/12/98	07:59	349.89	0.00	349.89	106.65	3156.15	961.99
H-05c	MAG	3506.04	09/10/98	12:54	349.82	0.00	349.82	106.63	3156.22	962.02
H-05c	MAG	3506.04	10/14/98	08:10	349.85	0.00	349.85	106.63	3156.19	962.01
H-05c	MAG	3506.04	11/11/98	12:06	349.86	0.00	349.86	106.64	3156.18	962.00
H-05c	MAG	3506.04	12/07/98	10:44	349.75	0.00	349.75	106.60	3156.29	962.04
H-06a	CUL	3348.11	03/11/98	08:50	296.48	0.00	296.48	90.37	3051.63	930.14
H-06a	CUL	3348.11	06/11/98	08:40	297.10	0.00	297.10	90.56	3051.01	929.95
H-06a	CUL	3348.11	09/10/98	10:38	297.29	0.00	297.29	90.61	3050.82	929.89
H-06a	CUL	3348.11	12/07/98	09:12	297.48	0.00	297.48	90.67	3050.63	929.83
H-06b	CUL	3348.25	01/12/98	11:06	298.52	0.00	298.52	90.99	3049.73	929.56
H-06b	CUL	3348.25	02/09/98	10:56	297.20	0.00	297.20	90.59	3051.05	929.96
H-06b	CUL	3348.25	03/11/98	09:03	297.12	0.00	297.12	90.56	3051.13	929.98
H-06b	CUL	3348.25	04/15/98	10:00	296.92	0.00	296.92	90.50	3051.33	930.05

Table 7.9 - Groundwater Surface Elevations for CY 1998										
Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-06b	CUL	3348.25	05/11/98	10:22	297.25	0.00	297.25	90.60	3051.00	929.94
H-06b	CUL	3348.25	06/11/98	09:06	297.52	0.00	297.52	90.68	3050.73	929.86
H-06b	CUL	3348.25	07/15/98	12:58	297.56	0.00	297.56	90.70	3050.69	929.85
H-06b	CUL	3348.25	08/12/98	08:58	297.58	0.00	297.58	90.70	3050.67	929.84
H-06b	CUL	3348.25	09/10/98	10:51	297.61	0.00	297.61	90.71	3050.64	929.84
H-06b	CUL	3348.25	10/14/98	13:46	297.62	0.00	297.62	90.71	3050.63	929.83
H-06b	CUL	3348.25	11/11/98	08:04	297.84	0.00	297.84	90.78	3050.41	929.76
H-06b	CUL	3348.25	12/07/98	09:33	297.79	0.00	297.79	90.77	3050.46	929.78
H-06c	MAG	3348.52	01/12/98	11:00	285.21	0.00	285.21	86.93	3063.31	933.70
H-06c	MAG	3348.52	02/09/98	10:41	285.10	0.00	285.10	86.90	3063.42	933.73
H-06c	MAG	3348.52	03/11/98	08:57	285.37	0.00	285.37	86.98	3063.15	933.65
H-06c	MAG	3348.52	04/15/98	09:54	284.98	0.00	284.98	86.86	3063.54	933.77
H-06c	MAG	3348.52	05/11/98	10:10	285.04	0.00	285.04	86.88	3063.48	933.75
H-06c	MAG	3348.52	06/11/98	08:51	285.07	0.00	285.07	86.89	3063.45	933.74
H-06c	MAG	3348.52	07/15/98	12:50	285.17	0.00	285.17	86.92	3063.35	933.71
H-06c	MAG	3348.52	08/12/98	08:46	285.22	0.00	285.22	86.94	3063.30	933.69
H-06c	MAG	3348.52	09/10/98	10:45	285.14	0.00	285.14	86.91	3063.38	933.72
H-06c	MAG	3348.52	10/14/98	13:25	285.06	0.00	285.06	86.89	3063.46	933.74
H-06c	MAG	3348.52	11/11/98	07:55	285.15	0.00	285.15	86.91	3063.37	933.72
H-06c	MAG	3348.52	12/07/98	09:23	285.03	0.00	285.03	86.88	3063.49	933.75
H-07b1	CUL	3164.17	01/13/98	06:32	167.28	0.00	167.28	50.99	2996.89	913.45
H-07b1	CUL	3164.17	02/10/98	06:12	167.12	0.00	167.12	50.94	2997.05	913.50
H-07b1	CUL	3164.17	03/10/98	07:15	167.58	0.00	167.58	51.08	2996.59	913.36
H-07b1	CUL	3164.17	04/14/98	06:16	167.06	0.00	167.06	50.92	2997.11	913.52
H-07b1	CUL	3164.17	05/12/98	05:51	167.04	0.00	167.04	50.91	2997.13	913.53
H-07b1	CUL	3164.17	06/09/98	05:38	167.23	0.00	167.23	50.97	2996.94	913.47
H-07b1	CUL	3164.17	07/14/98	05:55	167.35	0.00	167.35	51.01	2996.82	913.43
H-07b1	CUL	3164.17	09/09/98	06:18	167.38	0.00	167.38	51.02	2996.79	913.42
H-07b1	CUL	3164.17	12/08/98	06:12	167.70	0.00	167.70	51.11	2996.47	913.32
H-07b2	CUL	3164.40	03/10/98	07:22	168.01	0.00	168.01	51.21	2996.39	913.30
H-07b2	CUL	3164.40	06/09/98	05:50	167.67	0.00	167.67	51.11	2996.73	913.40
H-07b2	CUL	3164.40	08/11/98	06:02	167.85	0.00	167.85	51.16	2996.55	913.35

Table 7.9 - Groundwater Surface Elevations for CY 1998										
Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-07b2	CUL	3164.40	09/09/98	06:12	167.82	0.00	167.82	51.15	2996.58	913.36
H-07b2	CUL	3164.40	10/13/98	06:12	168.00	0.00	168.00	51.21	2996.40	913.30
H-07b2	CUL	3164.40	11/10/98	06:11	167.99	0.00	167.99	51.20	2996.41	913.31
H-07b2	CUL	3164.40	12/08/98	06:08	168.15	0.00	168.15	51.25	2996.25	913.26
H-08a	MAG	3432.99	01/13/98	07:35	405.40	0.00	405.40	123.57	3027.59	922.81
H-08a	MAG	3432.99	02/10/98	07:09	405.32	0.00	405.32	123.54	3027.67	922.83
H-08a	MAG	3432.99	03/10/98	09:22	405.31	0.00	405.31	123.54	3027.68	922.84
H-08a	MAG	3432.99	04/14/98	07:28	405.29	0.00	405.29	123.53	3027.70	922.84
H-08a	MAG	3432.99	05/12/98	07:00	405.32	0.00	405.32	123.54	3027.67	922.83
H-08a	MAG	3432.99	06/09/98	08:08	405.37	0.00	405.37	123.56	3027.62	922.82
H-08a	MAG	3432.99	07/14/98	07:42	405.46	0.00	405.46	123.58	3027.53	922.79
H-08a	MAG	3432.99	08/11/98	08:16	405.50	0.00	405.50	123.60	3027.49	922.78
H-08a	MAG	3432.99	09/09/98	08:19	405.57	0.00	405.57	123.62	3027.42	922.76
H-08a	MAG	3432.99	10/13/98	07:06	405.59	0.00	405.59	123.62	3027.40	922.75
H-08a	MAG	3432.99	11/10/98	07:38	405.62	0.00	405.62	123.63	3027.37	922.74
H-08a	MAG	3432.99	12/08/98	08:01	405.64	0.00	405.64	123.64	3027.35	922.74
H-08c	RUS/SAL	3432.90	01/13/98	07:38	453.39	0.00	453.39	138.19	2979.51	908.15
H-08c	RUS/SAL	3432.90	02/10/98	07:29	453.32	0.00	453.32	138.17	2979.58	908.18
H-08c	RUS/SAL	3432.90	03/10/98	09:30	453.33	0.00	453.33	138.17	2979.57	908.17
H-08c	RUS/SAL	3432.90	04/14/98	07:36	453.34	0.00	453.34	138.18	2979.56	908.17
H-08c	RUS/SAL	3432.90	05/12/98	07:20	453.35	0.00	453.35	138.18	2979.55	908.17
H-08c	RUS/SAL	3432.90	06/09/98	08:30	453.29	0.00	453.29	138.16	2979.61	908.19
H-08c	RUS/SAL	3432.90	07/14/98	07:36	453.33	0.00	453.33	138.17	2979.57	908.17
H-08c	RUS/SAL	3432.90	08/11/98	08:28	453.56	0.00	453.56	138.25	2979.34	908.10
H-08c	RUS/SAL	3432.90	09/09/98	08:25	453.40	0.00	453.40	138.20	2979.50	908.15
H-08c	RUS/SAL	3432.90	10/13/98	07:33	453.44	0.00	453.44	138.21	2979.46	908.14
H-08c	RUS/SAL	3432.90	11/10/98	07:49	453.53	0.00	453.53	138.24	2979.37	908.11
H-08c	RUS/SAL	3432.90	12/08/98	08:06	453.55	0.00	453.55	138.24	2979.35	908.11
H-09a	CUL	3406.68	03/10/98	10:34	417.22	0.00	417.22	127.17	2989.46	911.19
H-09a	CUL	3406.68	06/09/98	09:28	419.09	0.00	419.09	127.74	2987.59	910.62
H-09a	CUL	3406.68	09/09/98	10:14	417.90	0.00	417.90	127.38	2988.78	910.98
H-09a	CUL	3406.68	12/08/98	08:50	417.49	0.00	417.49	127.25	2989.19	911.11

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-09b	CUL	3406.86	01/13/98	08:31	417.92	0.54	417.38	127.22	2989.48	911.19
H-09b	CUL	3406.86	02/10/98	08:18	417.48	0.54	416.94	127.08	2989.92	911.33
H-09b	CUL	3406.86	03/10/98	10:05	417.86	0.54	417.32	127.20	2989.54	911.21
H-09b	CUL	3406.86	04/14/98	08:58	417.89	0.54	417.35	127.21	2989.51	911.20
H-09b	CUL	3406.86	05/12/98	08:00	419.32	0.54	418.78	127.64	2988.08	910.77
H-09b	CUL	3406.86	06/09/98	09:02	419.74	0.54	419.20	127.77	2987.66	910.64
H-09b	CUL	3406.86	07/14/98	08:44	418.94	0.54	418.40	127.53	2988.46	910.88
H-09b	CUL	3406.86	08/11/98	09:14	418.74	0.54	418.20	127.47	2988.66	910.94
H-09b	CUL	3406.86	09/09/98	10:01	418.50	0.54	417.96	127.39	2988.90	911.02
H-09b	CUL	3406.86	10/13/98	08:37	418.01	0.54	417.47	127.24	2989.39	911.17
H-09b	CUL	3406.86	11/10/98	09:54	417.74	0.54	417.20	127.16	2989.66	911.25
H-09b	CUL	3406.86	12/08/98	08:36	418.12	0.54	417.58	127.28	2989.28	911.13
H-09c	CUL	3407.30	03/10/98	10:20	417.84	0.00	417.84	127.36	2989.46	911.19
H-09c	CUL	3407.30	06/09/98	09:20	419.71	0.00	419.71	127.93	2987.59	910.62
H-09c	CUL	3407.30	09/09/98	10:07	418.48	0.00	418.48	127.55	2988.82	910.99
H-09c	CUL	3407.30	12/08/98	08:43	418.12	0.00	418.12	127.44	2989.18	911.10
H-10a	MAG	3688.67	01/13/98	10:20	529.02	0.00	529.02	161.25	3159.65	963.06
H-10a	MAG	3688.67	02/10/98	09:11	528.85	0.00	528.85	161.19	3159.82	963.11
H-10a	MAG	3688.67	03/10/98	11:35	528.85	0.00	528.85	161.19	3159.82	963.11
H-10a	MAG	3688.67	04/14/98	09:46	528.83	0.00	528.83	161.19	3159.84	963.12
H-10a	MAG	3688.67	05/12/98	08:43	528.85	0.00	528.85	161.19	3159.82	963.11
H-10a	MAG	3688.67	06/09/98	10:19	528.90	0.00	528.90	161.21	3159.77	963.10
H-10a	MAG	3688.67	07/14/98	09:48	528.97	0.00	528.97	161.23	3159.70	963.08
H-10a	MAG	3688.67	08/11/98	10:00	529.02	0.00	529.02	161.25	3159.65	963.06
H-10a	MAG	3688.67	09/09/98	11:02	529.02	0.00	529.02	161.25	3159.65	963.06
H-10a	MAG	3688.67	10/13/98	10:05	529.03	0.00	529.03	161.25	3159.64	963.06
H-10a	MAG	3688.67	11/10/98	09:51	529.07	0.00	529.07	161.26	3159.60	963.05
H-10a	MAG	3688.67	12/08/98	09:36	529.03	0.00	529.03	161.25	3159.64	963.06
H-10b	CUL	3689.47	01/13/98	10:32	694.61	0.00	694.61	211.72	2994.86	912.83
H-10b	CUL	3689.47	02/10/98	09:33	694.49	0.00	694.49	211.68	2994.98	912.87
H-10b	CUL	3689.47	03/10/98	11:50	694.86	0.00	694.86	211.79	2994.61	912.76
H-10b	CUL	3689.47	04/14/98	10:04	694.67	0.00	694.67	211.74	2994.80	912.82

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-10b	CUL	3689.47	05/12/98	09:12	694.71	0.00	694.71	211.75	2994.76	912.80
H-10b	CUL	3689.47	06/09/98	10:31	694.89	0.00	694.89	211.80	2994.58	912.75
H-10b	CUL	3689.47	07/14/98	10:01	695.09	0.00	695.09	211.86	2994.38	912.69
H-10b	CUL	3689.47	08/11/98	10:11	695.21	0.00	695.21	211.90	2994.26	912.65
H-10b	CUL	3689.47	09/09/98	11:10	695.17	0.00	695.17	211.89	2994.30	912.66
H-10b	CUL	3689.47	10/13/98	10:25	695.29	0.00	695.29	211.92	2994.18	912.63
H-10b	CUL	3689.47	11/10/98	10:01	695.20	0.00	695.20	211.90	2994.27	912.65
H-10b	CUL	3689.47	12/08/98	09:44	695.28	0.00	695.28	211.92	2994.19	912.63
H-11b1	CUL	3411.62	03/10/98	13:11	433.07	0.00	433.07	132.00	2978.55	907.86
H-11b1	CUL	3411.62	06/09/98	13:41	433.12	0.00	433.12	132.01	2978.50	907.85
H-11b1	CUL	3411.62	09/09/98	12:39	432.93	0.00	432.93	131.96	2978.69	907.90
H-11b1	CUL	3411.62	12/08/98	11:07	432.85	0.00	432.85	131.93	2978.77	907.93
H-11b2	CUL	3411.64	01/13/98	11:49	433.48	0.00	433.48	132.12	2978.16	907.74
H-11b2	CUL	3411.64	02/10/98	13:57	433.07	0.00	433.07	132.00	2978.57	907.87
H-11b2	CUL	3411.64	03/10/98	13:03	433.17	0.00	433.17	132.03	2978.47	907.84
H-11b2	CUL	3411.64	04/14/98	13:02	432.22	0.00	432.22	131.74	2979.42	908.13
H-11b2	CUL	3411.64	05/12/98	10:22	432.90	0.00	432.90	131.95	2978.74	907.92
H-11b2	CUL	3411.64	06/09/98	13:33	433.20	0.00	433.20	132.04	2978.44	907.83
H-11b2	CUL	3411.64	07/14/98	11:42	433.16	0.00	433.16	132.03	2978.48	907.84
H-11b2	CUL	3411.64	08/11/98	11:28	433.07	0.00	433.07	132.00	2978.57	907.87
H-11b2	CUL	3411.64	09/09/98	12:31	432.96	0.00	432.96	131.97	2978.68	907.90
H-11b2	CUL	3411.64	10/13/98	11:53	433.02	0.00	433.02	131.98	2978.62	907.88
H-11b2	CUL	3411.64	11/10/98	11:35	432.82	0.00	432.82	131.92	2978.82	907.94
H-11b2	CUL	3411.64	12/08/98	10:54	432.83	0.00	432.83	131.93	2978.81	907.94
H-11b3	CUL	3412.42	03/10/98	13:25	434.18	0.00	434.18	132.34	2978.24	907.77
H-11b3	CUL	3412.42	06/09/98	13:48	434.21	0.00	434.21	132.35	2978.21	907.76
H-11b3	CUL	3412.42	09/09/98	12:49	434.00	0.00	434.00	132.28	2978.42	907.82
H-11b3	CUL	3412.42	12/08/98	11:02	433.84	0.00	433.84	132.23	2978.58	907.87
H-11b4	CUL	3410.89	08/11/98	11:36	429.01	0.00	429.01	130.76	2981.88	908.88
H-11b4	CUL	3410.89	09/09/98	12:24	428.83	0.00	428.83	130.71	2982.06	908.93
H-11b4	CUL	3410.89	10/13/98	12:07	428.85	0.00	428.85	130.71	2982.04	908.93
H-11b4	CUL	3410.89	11/10/98	11:45	428.66	0.00	428.66	130.66	2982.23	908.98

Table 7.9 - Groundwater Surface Elevations for CY 1998										
Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-11b4	CUL	3410.89	12/08/98	11:15	428.66	0.00	428.66	130.66	2982.23	908.98
H-12	CUL	3427.19	01/13/98	11:14	458.19	0.00	458.19	139.66	2969.00	904.95
H-12	CUL	3427.19	02/10/98	10:20	457.89	0.00	457.89	139.56	2969.30	905.04
H-12	CUL	3427.19	03/10/98	12:29	458.14	0.00	458.14	139.64	2969.05	904.97
H-12	CUL	3427.19	04/14/98	10:45	457.71	0.00	457.71	139.51	2969.48	905.10
H-12	CUL	3427.19	05/12/98	09:42	457.65	0.00	457.65	139.49	2969.54	905.12
H-12	CUL	3427.19	06/09/98	11:21	457.72	0.00	457.72	139.51	2969.47	905.09
H-12	CUL	3427.19	07/14/98	10:54	457.83	0.00	457.83	139.55	2969.36	905.06
H-12	CUL	3427.19	08/11/98	10:55	457.89	0.00	457.89	139.56	2969.30	905.04
H-12	CUL	3427.19	09/09/98	11:54	457.79	0.00	457.79	139.53	2969.40	905.07
H-12	CUL	3427.19	10/13/98	11:15	457.87	0.00	457.87	139.56	2969.32	905.05
H-12	CUL	3427.19	11/10/98	10:55	457.75	0.00	457.75	139.52	2969.44	905.09
H-12	CUL	3427.19	12/08/98	10:19	457.82	0.00	457.82	139.54	2969.37	905.06
H-14	CUL	3347.11	01/14/98	11:10	340.08	0.00	340.08	103.66	3007.03	916.54
H-14	CUL	3347.11	02/11/98	12:56	339.83	0.00	339.83	103.58	3007.28	916.62
H-14	CUL	3347.11	03/12/98	07:30	339.96	0.00	339.96	103.62	3007.15	916.58
H-14	CUL	3347.11	04/16/98	06:11	339.36	0.00	339.36	103.44	3007.75	916.76
H-14	CUL	3347.11	05/12/98	13:32	339.20	0.00	339.20	103.39	3007.91	916.81
H-14	CUL	3347.11	06/11/98	10:18	340.21	0.00	340.21	103.70	3006.90	916.50
H-14	CUL	3347.11	07/14/98	13:27	340.67	0.00	340.67	103.84	3006.44	916.36
H-14	CUL	3347.11	08/12/98	11:31	339.45	0.00	339.45	103.46	3007.66	916.73
H-14	CUL	3347.11	09/10/98	06:00	339.28	0.00	339.28	103.41	3007.83	916.79
H-14	CUL	3347.11	10/13/98	13:34	339.20	0.00	339.20	103.39	3007.91	916.81
H-14	CUL	3347.11	11/13/98	09:38	339.80	0.00	339.80	103.57	3007.31	916.63
H-14	CUL	3347.11	12/09/98	07:21	339.43	0.00	339.43	103.46	3007.68	916.74
H-15	CUL	3481.63	01/14/98	12:31	523.00	0.00	523.00	159.41	2958.63	901.79
H-15	CUL	3481.63	02/12/98	06:43	522.61	0.00	522.61	159.29	2959.02	901.91
H-15	CUL	3481.63	03/12/98	11:22	522.57	0.00	522.57	159.28	2959.06	901.92
H-15	CUL	3481.63	04/16/98	07:31	521.98	0.00	521.98	159.10	2959.65	902.10
H-15	CUL	3481.63	05/13/98	09:09	521.89	0.00	521.89	159.07	2959.74	902.13
H-15	CUL	3481.63	06/11/98	12:09	521.99	0.00	521.99	159.10	2959.64	902.10
H-15	CUL	3481.63	07/15/98	10:18	521.96	0.00	521.96	159.09	2959.67	902.11

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-15	CUL	3481.63	08/12/98	12:41	521.91	0.00	521.91	159.08	2959.72	902.12
H-15	CUL	3481.63	09/10/98	10:01	521.71	0.00	521.71	159.02	2959.92	902.18
H-15	CUL	3481.63	10/14/98	09:57	521.66	0.00	521.66	159.00	2959.97	902.20
H-15	CUL	3481.63	11/13/98	09:25	521.62	0.00	521.62	158.99	2960.01	902.21
H-15	CUL	3481.63	12/09/98	10:03	521.48	0.00	521.48	158.95	2960.15	902.25
H-16 (PIP)	ULM	3406.77	01/15/98	09:03	364.09	3.89	360.20	109.79	3046.57	928.59
H-16 (PIP)	ULM	3406.77	02/12/98	09:15	364.37	3.89	360.48	109.87	3046.29	928.51
H-16 (PIP)	ULM	3406.77	03/12/98	12:52	365.02	3.89	361.13	110.07	3045.64	928.31
H-16 (PIP)	ULM	3406.77	04/16/98	09:41	366.07	3.89	362.18	110.39	3044.59	927.99
H-16 (PIP)	ULM	3406.77	05/13/98	10:48	366.89	3.89	363.00	110.64	3043.77	927.74
H-16 (PIP)	ULM	3406.77	06/11/98	13:29	367.69	3.89	363.80	110.89	3042.97	927.50
H-16 (PIP)	ULM	3406.77	07/15/98	15:00	368.17	3.89	364.28	111.03	3042.49	927.35
H-16 (PIP)	ULM	3406.77	08/12/98	13:26	368.35	3.89	364.46	111.09	3042.31	927.30
H-16 (PIP)	ULM	3406.77	09/11/98	07:15	368.65	3.89	364.76	111.18	3042.01	927.20
H-16 (PIP)	ULM	3406.77	10/15/98	08:02	367.63	3.89	363.74	110.87	3043.03	927.52
H-16 (PIP)	ULM	3406.77	11/13/98	08:12	367.06	3.89	363.17	110.69	3043.60	927.69
H-16 (PIP)	ULM	3406.77	12/09/98	11:36	366.68	3.89	362.79	110.58	3043.98	927.81
H-16 (PVC)	DL	3406.77	01/15/98	09:11	95.62	3.70	91.92	28.02	3314.85	1010.37
H-16 (PVC)	DL	3406.77	02/12/98	09:33	96.52	3.70	92.82	28.29	3313.95	1010.09
H-16 (PVC)	DL	3406.77	03/12/98	12:59	97.42	3.70	93.72	28.57	3313.05	1009.82
H-16 (PVC)	DL	3406.77	04/16/98	09:50	98.53	3.70	94.83	28.90	3311.94	1009.48
H-16 (PVC)	DL	3406.77	05/13/98	11:07	99.37	3.70	95.67	29.16	3311.10	1009.22
H-16 (PVC)	DL	3406.77	06/11/98	13:34	100.29	3.70	96.59	29.44	3310.18	1008.94
H-16 (PVC)	DL	3406.77	07/15/98	15:06	101.40	3.70	97.70	29.78	3309.07	1008.60
H-16 (PVC)	DL	3406.77	08/12/98	13:33	102.40	3.70	98.70	30.08	3308.07	1008.30
H-16 (PVC)	DL	3406.77	09/11/98	07:22	103.33	3.70	99.63	30.37	3307.14	1008.02
H-16 (PVC)	DL	3406.77	10/15/98	08:17	104.34	3.70	100.64	30.68	3306.13	1007.71
H-16 (PVC)	DL	3406.77	11/13/98	08:22	105.25	3.70	101.55	30.95	3305.22	1007.43
H-16 (PVC)	DL	3406.77	12/09/98	11:42	106.02	3.70	102.32	31.19	3304.45	1007.20
H-17	CUL	3385.31	01/13/98	12:05	427.21	0.00	427.21	130.21	2958.10	901.63
H-17	CUL	3385.31	02/10/98	14:14	426.84	0.00	426.84	130.10	2958.47	901.74
H-17	CUL	3385.31	03/10/98	13:41	426.86	0.00	426.86	130.11	2958.45	901.74

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-17	CUL	3385.31	04/14/98	13:12	426.40	0.00	426.40	129.97	2958.91	901.88
H-17	CUL	3385.31	05/12/98	10:32	426.34	0.00	426.34	129.95	2958.97	901.89
H-17	CUL	3385.31	06/10/98	10:35	426.57	0.00	426.57	130.02	2958.74	901.82
H-17	CUL	3385.31	07/14/98	12:00	426.63	0.00	426.63	130.04	2958.68	901.81
H-17	CUL	3385.31	08/11/98	11:38	426.60	0.00	426.60	130.03	2958.71	901.81
H-17	CUL	3385.31	09/09/98	12:03	426.45	0.00	426.45	129.98	2958.86	901.86
H-17	CUL	3385.31	10/13/98	12:26	426.42	0.00	426.42	129.97	2958.89	901.87
H-17	CUL	3385.31	11/10/98	12:00	426.23	0.00	426.23	129.91	2959.08	901.93
H-17	CUL	3385.31	12/08/98	11:26	426.23	0.00	426.23	129.91	2959.08	901.93
H-18	CUL	3414.21	01/12/98	11:23	356.51	0.00	356.51	108.66	3057.70	931.99
H-18	CUL	3414.21	02/09/98	11:07	354.39	0.00	354.39	108.02	3059.82	932.63
H-18	CUL	3414.21	03/09/98	11:37	353.78	0.00	353.78	107.83	3060.43	932.82
H-18	CUL	3414.21	04/15/98	09:35	353.62	0.00	353.62	107.78	3060.59	932.87
H-18	CUL	3414.21	05/11/98	13:36	354.10	0.00	354.10	107.93	3060.11	932.72
H-18	CUL	3414.21	06/10/98	14:30	354.57	0.00	354.57	108.07	3059.64	932.58
H-18	CUL	3414.21	07/15/98	13:16	355.08	0.00	355.08	108.23	3059.13	932.42
H-18	CUL	3414.21	08/11/98	14:16	354.80	0.00	354.80	108.14	3059.41	932.51
H-18	CUL	3414.21	09/10/98	11:08	354.96	0.00	354.96	108.19	3059.25	932.46
H-18	CUL	3414.21	10/14/98	13:00	355.15	0.00	355.15	108.25	3059.06	932.40
H-18	CUL	3414.21	11/11/98	08:23	355.33	0.00	355.33	108.30	3058.88	932.35
H-18	CUL	3414.21	12/07/98	09:43	355.40	0.00	355.40	108.33	3058.81	932.33
H-19b0	CUL	3418.38	01/13/98	13:30	433.22	0.00	433.22	132.05	2985.16	909.88
H-19b0	CUL	3418.38	02/11/98	11:51	432.84	0.00	432.84	131.93	2985.54	909.99
H-19b0	CUL	3418.38	03/12/98	09:04	432.71	0.00	432.71	131.89	2985.67	910.03
H-19b0	CUL	3418.38	04/15/98	11:34	432.00	0.00	432.00	131.67	2986.38	910.25
H-19b0	CUL	3418.38	05/12/98	12:43	432.80	0.00	432.80	131.92	2985.58	910.00
H-19b0	CUL	3418.38	06/10/98	09:15	432.47	0.00	432.47	131.82	2985.91	910.11
H-19b0	CUL	3418.38	07/14/98	13:11	432.12	0.00	432.12	131.71	2986.26	910.21
H-19b0	CUL	3418.38	08/11/98	13:31	431.95	0.00	431.95	131.66	2986.43	910.26
H-19b0	CUL	3418.38	09/10/98	07:10	433.07	0.00	433.07	132.00	2985.31	909.92
H-19b0	CUL	3418.38	10/14/98	10:43	432.05	0.00	432.05	131.69	2986.33	910.23
H-19b0	CUL	3418.38	11/11/98	12:55	431.76	0.00	431.76	131.60	2986.62	910.32

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
H-19b0	CUL	3418.38	12/09/98	08:16	431.53	0.00	431.53	131.53	2986.85	910.39
H-19b2	CUL	3419.01	03/12/98	09:41	434.03	0.00	434.03	132.29	2984.98	909.82
H-19b2	CUL	3419.01	06/10/98	09:34	433.74	0.00	433.74	132.20	2985.27	909.91
H-19b2	CUL	3419.01	09/10/98	07:23	431.80	0.00	431.80	131.61	2987.21	910.50
H-19b2	CUL	3419.01	12/09/98	08:06	432.80	0.00	432.80	131.92	2986.21	910.20
H-19b3	CUL	3419.09	03/12/98	09:59	434.25	0.00	434.25	132.36	2984.84	909.78
H-19b3	CUL	3419.09	06/10/98	10:03	433.97	0.00	433.97	132.27	2985.12	909.86
H-19b3	CUL	3419.09	09/10/98	07:43	433.30	0.00	433.30	132.07	2985.79	910.07
H-19b3	CUL	3419.09	12/09/98	08:22	433.04	0.00	433.04	131.99	2986.05	910.15
H-19b4	CUL	3419.03	03/12/98	09:55	433.50	0.00	433.50	132.13	2985.53	909.99
H-19b4	CUL	3419.03	06/10/98	09:49	433.23	0.00	433.23	132.05	2985.80	910.07
H-19b4	CUL	3419.03	09/10/98	07:35	432.55	0.00	432.55	131.84	2986.48	910.28
H-19b4	CUL	3419.03	12/09/98	08:32	432.28	0.00	432.28	131.76	2986.75	910.36
H-19b5	CUL	3418.63	03/12/98	09:47	433.71	0.00	433.71	132.19	2984.92	909.80
H-19b5	CUL	3418.63	06/10/98	09:41	433.43	0.00	433.43	132.11	2985.20	909.89
H-19b5	CUL	3418.63	09/10/98	07:28	432.76	0.00	432.76	131.91	2985.87	910.09
H-19b5	CUL	3418.63	12/09/98	08:38	432.44	0.00	432.44	131.81	2986.19	910.19
H-19b6	CUL	3419.07	03/12/98	10:07	434.06	0.00	434.06	132.30	2985.01	909.83
H-19b6	CUL	3419.07	06/10/98	09:56	433.80	0.00	433.80	132.22	2985.27	909.91
H-19b6	CUL	3419.07	09/10/98	07:48	433.13	0.00	433.13	132.02	2985.94	910.11
H-19b6	CUL	3419.07	12/09/98	08:23	432.88	0.00	432.88	131.94	2986.19	910.19
H-19b7	CUL	3418.99	03/12/98	09:11	434.31	0.00	434.31	132.38	2984.68	909.73
H-19b7	CUL	3418.99	06/10/98	09:25	434.02	0.00	434.02	132.29	2984.97	909.82
H-19b7	CUL	3418.99	09/10/98	07:16	433.36	0.00	433.36	132.09	2985.63	910.02
H-19b7	CUL	3418.99	12/09/98	08:11	433.09	0.00	433.09	132.01	2985.90	910.10
P-14	CUL	3361.06	01/12/98	10:41	317.35	0.00	317.35	96.73	3043.71	927.72
P-14	CUL	3361.06	02/09/98	10:25	317.09	0.00	317.09	96.65	3043.97	927.80
P-14	CUL	3361.06	03/09/98	11:04	317.27	0.00	317.27	96.70	3043.79	927.75
P-14	CUL	3361.06	04/13/98	11:16	316.96	0.00	316.96	96.61	3044.10	927.84
P-14	CUL	3361.06	05/11/98	09:50	316.88	0.00	316.88	96.59	3044.18	927.87
P-14	CUL	3361.06	06/08/98	11:10	317.01	0.00	317.01	96.62	3044.05	927.83
P-14	CUL	3361.06	07/13/98	11:08	317.04	0.00	317.04	96.63	3044.02	927.82

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
P-14	CUL	3361.06	08/10/98	10:03	316.97	0.00	316.97	96.61	3044.09	927.84
P-14	CUL	3361.06	09/08/98	10:11	316.84	0.00	316.84	96.57	3044.22	927.88
P-14	CUL	3361.06	10/12/98	10:15	317.21	0.00	317.21	96.69	3043.85	927.77
P-14	CUL	3361.06	11/11/98	06:21	317.10	0.00	317.10	96.65	3043.96	927.80
P-14	CUL	3361.06	12/07/98	09:03	316.89	0.00	316.89	96.59	3044.17	927.86
P-15	CUL	3311.38	01/14/98	12:54	298.86	0.00	298.86	91.09	3012.52	918.22
P-15	CUL	3311.38	02/11/98	13:41	298.83	0.00	298.83	91.08	3012.55	918.23
P-15	CUL	3311.38	03/11/98	13:33	299.01	0.00	299.01	91.14	3012.37	918.17
P-15	CUL	3311.38	04/14/98	14:22	298.53	0.00	298.53	90.99	3012.85	918.32
P-15	CUL	3311.38	05/12/98	14:00	298.51	0.00	298.51	90.99	3012.87	918.32
P-15	CUL	3311.38	06/09/98	14:39	298.62	0.00	298.62	91.02	3012.76	918.29
P-15	CUL	3311.38	07/15/98	06:52	298.65	0.00	298.65	91.03	3012.73	918.28
P-15	CUL	3311.38	08/10/98	12:50	298.73	0.00	298.73	91.05	3012.65	918.26
P-15	CUL	3311.38	09/08/98	12:45	298.70	0.00	298.70	91.04	3012.68	918.26
P-15	CUL	3311.38	10/13/98	13:49	298.80	0.00	298.80	91.07	3012.58	918.23
P-15	CUL	3311.38	11/11/98	14:16	298.79	0.00	298.79	91.07	3012.59	918.24
P-15	CUL	3311.38	12/08/98	13:40	298.86	0.00	298.86	91.09	3012.52	918.22
P-17	CUL	3337.24	01/13/98	12:21	355.86	0.54	355.32	108.30	2981.92	908.89
P-17	CUL	3337.24	02/10/98	14:23	355.60	0.54	355.06	108.22	2982.18	908.97
P-17	CUL	3337.24	03/10/98	14:00	355.78	0.54	355.24	108.28	2982.00	908.91
P-17	CUL	3337.24	04/14/98	13:29	355.28	0.54	354.74	108.12	2982.50	909.07
P-17	CUL	3337.24	05/12/98	10:51	355.31	0.54	354.77	108.13	2982.47	909.06
P-17	CUL	3337.24	06/09/98	14:07	355.59	0.54	355.05	108.22	2982.19	908.97
P-17	CUL	3337.24	07/14/98	12:22	355.72	0.54	355.18	108.26	2982.06	908.93
P-17	CUL	3337.24	08/11/98	12:06	355.81	0.54	355.27	108.29	2981.97	908.90
P-17	CUL	3337.24	09/09/98	13:16	355.76	0.54	355.22	108.27	2982.02	908.92
P-17	CUL	3337.24	10/13/98	12:52	355.86	0.54	355.32	108.30	2981.92	908.89
P-17	CUL	3337.24	11/10/98	12:19	355.78	0.54	355.24	108.28	2982.00	908.91
P-17	CUL	3337.24	12/08/98	11:46	355.88	0.54	355.34	108.31	2981.90	908.88
P-18	CUL	3478.42	01/13/98	11:34	327.57	0.68	326.89	99.64	3151.53	960.59
P-18	CUL	3478.42	02/10/98	13:33	327.04	0.68	326.36	99.47	3152.06	960.75
P-18	CUL	3478.42	03/10/98	12:49	326.62	0.68	325.94	99.35	3152.48	960.88

Table 7.9 - Groundwater Surface Elevations for CY 1998										
Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
P-18	CUL	3478.42	04/14/98	11:11	326.06	0.68	325.38	99.18	3153.04	961.05
P-18	CUL	3478.42	05/12/98	10:07	325.61	0.68	324.93	99.04	3153.49	961.18
P-18	CUL	3478.42	06/09/98	11:41	325.23	0.68	324.55	98.92	3153.87	961.30
P-18	CUL	3478.42	07/14/98	11:16	324.73	0.68	324.05	98.77	3154.37	961.45
P-18	CUL	3478.42	08/11/98	11:14	324.37	0.68	323.69	98.66	3154.73	961.56
P-18	CUL	3478.42	09/09/98	12:11	323.95	0.68	323.27	98.53	3155.15	961.69
P-18	CUL	3478.42	10/13/98	11:38	323.46	0.68	322.78	98.38	3155.64	961.84
P-18	CUL	3478.42	11/10/98	11:19	323.09	0.68	322.41	98.27	3156.01	961.95
P-18	CUL	3478.42	12/08/98	10:44	322.73	0.68	322.05	98.16	3156.37	962.06
WIPP-12	CUL	3472.06	01/12/98	13:06	441.57	0.00	441.57	134.59	3030.49	923.69
WIPP-12	CUL	3472.06	02/09/98	13:18	440.81	0.00	440.81	134.36	3031.25	923.92
WIPP-12	CUL	3472.06	03/12/98	10:45	439.30	0.00	439.30	133.90	3032.76	924.39
WIPP-12	CUL	3472.06	04/13/98	12:45	438.97	0.00	438.97	133.80	3033.09	924.49
WIPP-12	CUL	3472.06	05/11/98	12:37	439.23	0.00	439.23	133.88	3032.83	924.41
WIPP-12	CUL	3472.06	06/08/98	13:09	439.61	0.00	439.61	133.99	3032.45	924.29
WIPP-12	CUL	3472.06	07/13/98	12:56	440.10	0.00	440.10	134.14	3031.96	924.14
WIPP-12	CUL	3472.06	08/10/98	11:49	440.30	0.00	440.30	134.20	3031.76	924.08
WIPP-12	CUL	3472.06	09/08/98	11:56	440.25	0.00	440.25	134.19	3031.81	924.10
WIPP-12	CUL	3472.06	10/12/98	13:00	440.43	0.00	440.43	134.24	3031.63	924.04
WIPP-12	CUL	3472.06	11/09/98	13:15	440.61	0.00	440.61	134.30	3031.45	923.99
WIPP-12	CUL	3472.06	12/07/98	12:38	440.63	0.00	440.63	134.30	3031.43	923.98
WIPP-13	CUL	3405.71	01/12/98	11:45	348.23	0.00	348.23	106.14	3057.48	931.92
WIPP-13	CUL	3405.71	02/09/98	11:35	345.29	0.00	345.29	105.24	3060.42	932.82
WIPP-13	CUL	3405.71	03/09/98	13:26	344.89	0.00	344.89	105.12	3060.82	932.94
WIPP-13	CUL	3405.71	04/13/98	13:34	345.59	0.00	345.59	105.34	3060.12	932.72
WIPP-13	CUL	3405.71	05/11/98	11:00	345.98	0.00	345.98	105.45	3059.73	932.61
WIPP-13	CUL	3405.71	06/08/98	13:26	346.41	0.00	346.41	105.59	3059.30	932.47
WIPP-13	CUL	3405.71	07/13/98	13:15	347.11	0.00	347.11	105.80	3058.60	932.26
WIPP-13	CUL	3405.71	08/10/98	10:41	346.85	0.00	346.85	105.72	3058.86	932.34
WIPP-13	CUL	3405.71	09/08/98	10:58	346.91	0.00	346.91	105.74	3058.80	932.32
WIPP-13	CUL	3405.71	10/12/98	11:07	347.48	0.00	347.48	105.91	3058.23	932.15
WIPP-13	CUL	3405.71	11/09/98	10:52	347.55	0.64	346.91	105.74	3058.80	932.32

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
WIPP-13	CUL	3405.71	12/07/98	10:02	348.21	0.64	347.57	105.94	3058.14	932.12
WIPP-18	CUL	3458.76	01/12/98	13:16	427.09	0.00	427.09	130.18	3031.67	924.05
WIPP-18	CUL	3458.76	02/09/98	13:13	427.19	0.00	427.19	130.21	3031.57	924.02
WIPP-18	CUL	3458.76	03/09/98	14:58	426.35	0.00	426.35	129.95	3032.41	924.28
WIPP-18	CUL	3458.76	04/13/98	12:36	425.70	0.00	425.70	129.75	3033.06	924.48
WIPP-18	CUL	3458.76	05/11/98	12:23	425.96	0.00	425.96	129.83	3032.80	924.40
WIPP-18	CUL	3458.76	06/08/98	12:59	426.12	0.00	426.12	129.88	3032.64	924.35
WIPP-18	CUL	3458.76	07/13/98	12:43	426.27	0.00	426.27	129.93	3032.49	924.30
WIPP-18	CUL	3458.76	08/10/98	11:38	426.26	0.00	426.26	129.92	3032.50	924.31
WIPP-18	CUL	3458.76	09/08/98	11:41	426.33	0.00	426.33	129.95	3032.43	924.28
WIPP-18	CUL	3458.76	10/12/98	13:09	426.64	0.00	426.64	130.04	3032.12	924.19
WIPP-18	CUL	3458.76	11/09/98	13:05	426.41	0.00	426.41	129.97	3032.35	924.26
WIPP-18	CUL	3458.76	12/07/98	12:30	426.49	0.00	426.49	129.99	3032.27	924.24
WIPP-19	CUL	3435.14	01/12/98	13:27	398.46	0.00	398.46	121.45	3036.68	925.58
WIPP-19	CUL	3435.14	02/09/98	13:05	397.83	0.00	397.83	121.26	3037.31	925.77
WIPP-19	CUL	3435.14	03/09/98	14:45	397.20	0.00	397.20	121.07	3037.94	925.96
WIPP-19	CUL	3435.14	04/13/98	12:29	396.51	0.00	396.51	120.86	3038.63	926.17
WIPP-19	CUL	3435.14	05/11/98	12:10	396.49	0.00	396.49	120.85	3038.65	926.18
WIPP-19	CUL	3435.14	06/08/98	12:50	396.64	0.00	396.64	120.90	3038.50	926.13
WIPP-19	CUL	3435.14	07/13/98	12:34	396.75	0.00	396.75	120.93	3038.39	926.10
WIPP-19	CUL	3435.14	08/10/98	11:30	396.74	0.00	396.74	120.93	3038.40	926.10
WIPP-19	CUL	3435.14	09/08/98	11:33	396.68	0.00	396.68	120.91	3038.46	926.12
WIPP-19	CUL	3435.14	10/12/98	13:17	397.04	0.00	397.04	121.02	3038.10	926.01
WIPP-19	CUL	3435.14	11/09/98	12:57	396.71	0.00	396.71	120.92	3038.43	926.11
WIPP-19	CUL	3435.14	12/07/98	12:18	396.98	0.00	396.98	121.00	3038.16	926.03
WIPP-21	CUL	3418.96	01/12/98	13:46	407.49	0.00	407.49	124.20	3011.47	917.90
WIPP-21	CUL	3418.96	02/09/98	12:42	407.05	0.00	407.05	124.07	3011.91	918.03
WIPP-21	CUL	3418.96	03/09/98	14:23	406.60	0.00	406.60	123.93	3012.36	918.17
WIPP-21	CUL	3418.96	04/13/98	12:13	405.82	0.00	405.82	123.69	3013.14	918.41
WIPP-21	CUL	3418.96	05/11/98	11:57	405.61	0.00	405.61	123.63	3013.35	918.47
WIPP-21	CUL	3418.96	06/08/98	12:23	405.44	0.00	405.44	123.58	3013.52	918.52
WIPP-21	CUL	3418.96	07/13/98	12:11	405.33	0.00	405.33	123.54	3013.63	918.55

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
WIPP-21	CUL	3418.96	08/10/98	11:11	405.29	0.00	405.29	123.53	3013.67	918.57
WIPP-21	CUL	3418.96	09/08/98	11:14	405.13	0.00	405.13	123.48	3013.83	918.62
WIPP-21	CUL	3418.96	10/12/98	12:25	405.28	0.00	405.28	123.53	3013.68	918.57
WIPP-21	CUL	3418.96	11/09/98	12:31	405.14	0.00	405.14	123.49	3013.82	918.61
WIPP-21	CUL	3418.96	12/07/98	12:02	405.14	0.00	405.14	123.49	3013.82	918.61
WIPP-22	CUL	3428.12	01/12/98	13:36	402.14	0.00	402.14	122.57	3025.98	922.32
WIPP-22	CUL	3428.12	02/09/98	12:53	401.68	0.00	401.68	122.43	3026.44	922.46
WIPP-22	CUL	3428.12	03/09/98	14:35	401.07	0.00	401.07	122.25	3027.05	922.64
WIPP-22	CUL	3428.12	04/13/98	12:24	400.29	0.00	400.29	122.01	3027.83	922.88
WIPP-22	CUL	3428.12	05/11/98	12:02	400.16	0.00	400.16	121.97	3027.96	922.92
WIPP-22	CUL	3428.12	06/08/98	12:39	400.19	0.00	400.19	121.98	3027.93	922.91
WIPP-22	CUL	3428.12	07/13/98	12:25	400.22	0.00	400.22	121.99	3027.90	922.90
WIPP-22	CUL	3428.12	08/10/98	11:21	400.22	0.00	400.22	121.99	3027.90	922.90
WIPP-22	CUL	3428.12	09/08/98	11:25	400.11	0.00	400.11	121.95	3028.01	922.94
WIPP-22	CUL	3428.12	10/12/98	13:30	400.32	0.00	400.32	122.02	3027.80	922.87
WIPP-22	CUL	3428.12	11/09/98	12:47	400.16	0.00	400.16	121.97	3027.96	922.92
WIPP-22	CUL	3428.12	12/07/98	12:11	400.24	0.00	400.24	121.99	3027.88	922.90
WIPP-25 (ANNULUS)	MAG	3214.39	01/12/98	10:15	156.61	0.00	156.61	47.73	3057.78	932.01
WIPP-25 (ANNULUS)	MAG	3214.39	02/09/98	09:52	156.71	0.00	156.71	47.77	3057.68	931.98
WIPP-25 (ANNULUS)	MAG	3214.39	03/09/98	10:15	156.75	0.00	156.75	47.78	3057.64	931.97
WIPP-25 (ANNULUS)	MAG	3214.39	04/13/98	10:50	156.81	0.00	156.81	47.80	3057.58	931.95
WIPP-25 (ANNULUS)	MAG	3214.39	05/11/98	09:20	156.84	0.00	156.84	47.80	3057.55	931.94
WIPP-25 (ANNULUS)	MAG	3214.39	06/08/98	09:58	156.88	0.00	156.88	47.82	3057.51	931.93
WIPP-25 (ANNULUS)	MAG	3214.39	07/13/98	10:41	156.93	0.00	156.93	47.83	3057.46	931.91
WIPP-25 (ANNULUS)	MAG	3214.39	08/10/98	09:44	156.90	0.00	156.90	47.82	3057.49	931.92
WIPP-25 (ANNULUS)	MAG	3214.39	09/08/98	09:50	156.90	0.00	156.90	47.82	3057.49	931.92
WIPP-25 (ANNULUS)	MAG	3214.39	10/12/98	09:35	156.90	0.00	156.90	47.82	3057.49	931.92
WIPP-25 (ANNULUS)	MAG	3214.39	11/09/98	10:01	156.90	0.00	156.90	47.82	3057.49	931.92
WIPP-25 (ANNULUS)	MAG	3214.39	12/07/98	08:41	156.93	0.00	156.93	47.83	3057.46	931.91
WIPP-25 (PIP)	CUL	3214.39	01/12/98	10:12	157.90	0.42	157.48	48.00	3056.91	931.75
WIPP-25 (PIP)	CUL	3214.39	02/09/98	09:33	157.63	0.42	157.21	47.92	3057.18	931.83
WIPP-25 (PIP)	CUL	3214.39	03/09/98	10:09	157.72	0.42	157.30	47.95	3057.09	931.80

Table 7.9 - Groundwater Surface Elevations for CY 1998										
Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
WIPP-25 (PIP)	CUL	3214.39	04/13/98	10:42	158.07	0.42	157.65	48.05	3056.74	931.69
WIPP-25 (PIP)	CUL	3214.39	05/11/98	08:50	157.34	0.42	156.92	47.83	3057.47	931.92
WIPP-25 (PIP)	CUL	3214.39	06/08/98	09:52	157.38	0.42	156.96	47.84	3057.43	931.90
WIPP-25 (PIP)	CUL	3214.39	07/13/98	10:30	157.35	0.42	156.93	47.83	3057.46	931.91
WIPP-25 (PIP)	CUL	3214.39	08/10/98	09:39	157.13	0.42	156.71	47.77	3057.68	931.98
WIPP-25 (PIP)	CUL	3214.39	09/08/98	09:45	157.06	0.42	156.64	47.74	3057.75	932.00
WIPP-25 (PIP)	CUL	3214.39	10/12/98	09:20	157.41	0.42	156.99	47.85	3057.40	931.90
WIPP-25 (PIP)	CUL	3214.39	11/09/98	10:06	156.87	0.42	156.45	47.69	3057.94	932.06
WIPP-25 (PIP)	CUL	3214.39	12/07/98	08:38	157.00	0.42	156.58	47.73	3057.81	932.02
WIPP-26	CUL	3153.20	01/12/98	14:33	132.90	0.00	132.90	40.51	3020.30	920.59
WIPP-26	CUL	3153.20	02/09/98	14:29	132.79	0.00	132.79	40.47	3020.41	920.62
WIPP-26	CUL	3153.20	03/10/98	06:38	133.15	0.00	133.15	40.58	3020.05	920.51
WIPP-26	CUL	3153.20	04/13/98	14:01	132.97	0.00	132.97	40.53	3020.23	920.57
WIPP-26	CUL	3153.20	05/11/98	14:12	133.05	0.00	133.05	40.55	3020.15	920.54
WIPP-26	CUL	3153.20	06/08/98	13:58	133.22	0.00	133.22	40.61	3019.98	920.49
WIPP-26	CUL	3153.20	07/13/98	13:54	133.63	0.00	133.63	40.73	3019.57	920.36
WIPP-26	CUL	3153.20	08/10/98	13:45	133.32	0.00	133.32	40.64	3019.88	920.46
WIPP-26	CUL	3153.20	09/08/98	13:26	133.20	0.00	133.20	40.60	3020.00	920.50
WIPP-26	CUL	3153.20	10/12/98	14:00	133.54	0.00	133.54	40.70	3019.66	920.39
WIPP-26	CUL	3153.20	11/09/98	14:00	133.10	0.00	133.10	40.57	3020.10	920.53
WIPP-26	CUL	3153.20	12/07/98	13:21	133.42	0.00	133.42	40.67	3019.78	920.43
WIPP-27 (PIP)	CUL	3178.98	01/12/98	07:00	100.23	0.42	99.81	30.42	3079.17	938.53
WIPP-27 (PIP)	CUL	3178.98	02/09/98	06:20	100.09	0.42	99.67	30.38	3079.31	938.57
WIPP-27 (PIP)	CUL	3178.98	03/09/98	06:06	99.99	0.42	99.57	30.35	3079.41	938.60
WIPP-27 (PIP)	CUL	3178.98	04/13/98	06:07	100.90	0.42	100.48	30.63	3078.50	938.33
WIPP-27 (PIP)	CUL	3178.98	05/11/98	05:50	100.15	0.42	99.73	30.40	3079.25	938.56
WIPP-27 (PIP)	CUL	3178.98	06/08/98	06:38	100.23	0.42	99.81	30.42	3079.17	938.53
WIPP-27 (PIP)	CUL	3178.98	07/13/98	06:12	100.21	0.42	99.79	30.42	3079.19	938.54
WIPP-27 (PIP)	CUL	3178.98	08/10/98	06:04	99.91	0.42	99.49	30.32	3079.49	938.63
WIPP-27 (PIP)	CUL	3178.98	09/08/98	06:05	99.61	0.42	99.19	30.23	3079.79	938.72
WIPP-27 (PIP)	CUL	3178.98	10/12/98	06:15	99.61	0.42	99.19	30.23	3079.79	938.72
WIPP-27 (PIP)	CUL	3178.98	11/09/98	06:11	99.31	0.42	98.89	30.14	3080.09	938.81

Table 7.9 - Groundwater Surface Elevations for CY 1998										
Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
WIPP-27 (PIP)	CUL	3178.98	12/07/98	06:11	98.03	0.42	97.61	29.75	3081.37	939.20
WIPP-28 (PIP)	RUS/SAL	3349.21	01/12/98	08:16	299.54	0.42	299.12	91.17	3050.09	929.67
WIPP-28 (PIP)	RUS/SAL	3349.21	02/09/98	07:25	299.44	0.42	299.02	91.14	3050.19	929.70
WIPP-28 (PIP)	RUS/SAL	3349.21	03/09/98	07:04	299.86	0.42	299.44	91.27	3049.77	929.57
WIPP-28 (PIP)	RUS/SAL	3349.21	04/13/98	08:01	300.28	0.42	299.86	91.40	3049.35	929.44
WIPP-28 (PIP)	RUS/SAL	3349.21	05/11/98	06:38	299.61	0.42	299.19	91.19	3050.02	929.65
WIPP-28 (PIP)	RUS/SAL	3349.21	06/08/98	08:00	299.64	0.42	299.22	91.20	3049.99	929.64
WIPP-28 (PIP)	RUS/SAL	3349.21	07/13/98	07:15	299.82	0.42	299.40	91.26	3049.81	929.58
WIPP-28 (PIP)	RUS/SAL	3349.21	08/10/98	07:12	299.97	0.42	299.55	91.30	3049.66	929.54
WIPP-28 (PIP)	RUS/SAL	3349.21	09/08/98	07:02	299.83	0.42	299.41	91.26	3049.80	929.58
WIPP-28 (PIP)	RUS/SAL	3349.21	10/12/98	07:04	300.04	0.42	299.62	91.32	3049.59	929.52
WIPP-28 (PIP)	RUS/SAL	3349.21	11/09/98	07:29	299.71	0.42	299.29	91.22	3049.92	929.62
WIPP-28 (PIP)	RUS/SAL	3349.21	12/07/98	07:23	299.98	0.42	299.56	91.31	3049.65	929.53
WIPP-29	CUL	2978.26	01/12/98	15:18	10.84	0.00	10.84	3.30	2967.42	904.47
WIPP-29	CUL	2978.26	02/09/98	14:48	10.93	0.00	10.93	3.33	2967.33	904.44
WIPP-29	CUL	2978.26	03/10/98	05:58	11.12	0.00	11.12	3.39	2967.14	904.38
WIPP-29	CUL	2978.26	04/13/98	14:32	11.02	0.00	11.02	3.36	2967.24	904.41
WIPP-29	CUL	2978.26	05/11/98	14:42	11.12	0.00	11.12	3.39	2967.14	904.38
WIPP-29	CUL	2978.26	06/08/98	14:25	11.32	0.00	11.32	3.45	2966.94	904.32
WIPP-29	CUL	2978.26	07/13/98	14:36	11.20	0.00	11.20	3.41	2967.06	904.36
WIPP-29	CUL	2978.26	08/10/98	14:22	11.28	0.00	11.28	3.44	2966.98	904.34
WIPP-29	CUL	2978.26	09/08/98	14:18	11.49	0.00	11.49	3.50	2966.77	904.27
WIPP-29	CUL	2978.26	10/12/98	14:28	11.25	0.00	11.25	3.43	2967.01	904.34
WIPP-29	CUL	2978.26	11/09/98	14:28	11.04	0.00	11.04	3.36	2967.22	904.41
WIPP-29	CUL	2978.26	12/07/98	14:03	11.53	0.00	11.53	3.51	2966.73	904.26
WIPP-30 (PIP)	CUL	3429.05	01/12/98	09:30	365.20	1.20	364.00	110.95	3065.05	934.23
WIPP-30 (PIP)	CUL	3429.05	02/09/98	08:44	361.36	1.20	360.16	109.78	3068.89	935.40
WIPP-30 (PIP)	CUL	3429.05	03/09/98	09:18	360.49	1.20	359.29	109.51	3069.76	935.66
WIPP-30 (PIP)	CUL	3429.05	04/13/98	09:42	361.53	1.20	360.33	109.83	3068.72	935.35
WIPP-30 (PIP)	CUL	3429.05	05/11/98	07:23	361.98	1.20	360.78	109.97	3068.27	935.21
WIPP-30 (PIP)	CUL	3429.05	06/08/98	09:04	362.55	1.20	361.35	110.14	3067.70	935.03
WIPP-30 (PIP)	CUL	3429.05	07/13/98	08:20	362.85	1.20	361.65	110.23	3067.40	934.94

Table 7.9 - Groundwater Surface Elevations for CY 1998										
Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
WIPP-30 (PIP)	CUL	3429.05	08/10/98	08:58	361.67	2.08	359.59	109.60	3069.46	935.57
WIPP-30 (PIP)	CUL	3429.05	09/08/98	09:00	364.08	2.08	362.00	110.34	3067.05	934.84
WIPP-30 (PIP)	CUL	3429.05	10/12/98	07:55	364.79	2.08	362.71	110.55	3066.34	934.62
WIPP-30 (PIP)	CUL	3429.05	11/09/98	09:19	364.58	2.08	362.50	110.49	3066.55	934.68
WIPP-30 (PIP)	CUL	3429.05	12/07/98	08:04	365.02	2.08	362.94	110.62	3066.11	934.55
WQSP-1	CUL	3419.20	01/12/98	11:31	367.66	0.21	367.45	112.00	3051.75	930.17
WQSP-1	CUL	3419.20	02/09/98	11:23	364.72	0.21	364.51	111.10	3054.69	931.07
WQSP-1	CUL	3419.20	03/09/98	12:16	364.38	0.21	364.17	111.00	3055.03	931.17
WQSP-1	CUL	3419.20	04/13/98	11:42	364.90	0.21	364.69	111.16	3054.51	931.01
WQSP-1	CUL	3419.20	05/11/98	10:42	365.32	0.21	365.11	111.29	3054.09	930.89
WQSP-1	CUL	3419.20	06/08/98	11:39	365.76	0.21	365.55	111.42	3053.65	930.75
WQSP-1	CUL	3419.20	07/13/98	06:40	366.09	0.21	365.88	111.52	3053.32	930.65
WQSP-1	CUL	3419.20	08/10/98	10:21	366.10	0.21	365.89	111.52	3053.31	930.65
WQSP-1	CUL	3419.20	09/08/98	10:29	366.19	0.21	365.98	111.55	3053.22	930.62
WQSP-1	CUL	3419.20	10/12/98	10:35	366.73	0.21	366.52	111.72	3052.68	930.46
WQSP-1	CUL	3419.20	11/13/98	10:34	366.66	0.21	366.45	111.69	3052.75	930.48
WQSP-1	CUL	3419.20	12/07/98	09:52	366.81	0.21	366.60	111.74	3052.60	930.43
WQSP-2	CUL	3463.90	01/12/98	14:04	402.83	0.21	402.62	122.72	3061.28	933.08
WQSP-2	CUL	3463.90	02/09/98	12:04	399.54	0.21	399.33	121.72	3064.57	934.08
WQSP-2	CUL	3463.90	03/09/98	13:45	399.00	0.21	398.79	121.55	3065.11	934.25
WQSP-2	CUL	3463.90	04/13/98	06:30	402.45	0.21	402.24	122.60	3061.66	933.19
WQSP-2	CUL	3463.90	05/11/98	11:45	403.20	0.21	402.99	122.83	3060.91	932.97
WQSP-2	CUL	3463.90	06/08/98	12:06	403.03	0.21	402.82	122.78	3061.08	933.02
WQSP-2	CUL	3463.90	07/13/98	11:45	402.63	0.21	402.42	122.66	3061.48	933.14
WQSP-2	CUL	3463.90	08/10/98	06:40	402.11	0.21	401.90	122.50	3062.00	933.30
WQSP-2	CUL	3463.90	09/08/98	10:48	404.10	0.21	403.89	123.11	3060.01	932.69
WQSP-2	CUL	3463.90	10/12/98	10:53	403.95	0.21	403.74	123.06	3060.16	932.74
WQSP-2	CUL	3463.90	11/13/98	10:49	403.31	0.21	403.10	122.86	3060.80	932.93
WQSP-2	CUL	3463.90	12/07/98	10:16	403.15	0.21	402.94	122.82	3060.96	932.98
WQSP-3	CUL	3480.30	01/12/98	12:54	467.59	0.21	467.38	142.46	3012.92	918.34
WQSP-3	CUL	3480.30	02/09/98	13:30	466.38	0.21	466.17	142.09	3014.13	918.71
WQSP-3	CUL	3480.30	03/12/98	11:06	464.83	0.21	464.62	141.62	3015.68	919.18

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
WQSP-3	CUL	3480.30	04/13/98	13:00	463.53	0.21	463.32	141.22	3016.98	919.58
WQSP-3	CUL	3480.30	05/11/98	12:47	470.07	0.21	469.86	143.21	3010.44	917.58
WQSP-3	CUL	3480.30	06/11/98	12:28	468.55	0.21	468.34	142.75	3011.96	918.05
WQSP-3	CUL	3480.30	07/15/98	13:36	467.78	0.21	467.57	142.52	3012.73	918.28
WQSP-3	CUL	3480.30	08/10/98	12:00	467.21	0.21	467.00	142.34	3013.30	918.45
WQSP-3	CUL	3480.30	09/08/98	12:10	471.57	0.21	471.36	143.67	3008.94	917.12
WQSP-3	CUL	3480.30	10/12/98	12:42	469.69	0.21	469.48	143.10	3010.82	917.70
WQSP-3	CUL	3480.30	11/13/98	11:28	468.91	0.21	468.70	142.86	3011.60	917.94
WQSP-3	CUL	3480.30	12/07/98	12:48	468.32	0.21	468.11	142.68	3012.19	918.12
WQSP-4	CUL	3433.00	01/14/98	10:25	450.51	0.21	450.30	137.25	2982.70	909.13
WQSP-4	CUL	3433.00	02/11/98	11:33	450.11	0.21	449.90	137.13	2983.10	909.25
WQSP-4	CUL	3433.00	03/12/98	08:39	449.99	0.21	449.78	137.09	2983.22	909.29
WQSP-4	CUL	3433.00	04/16/98	07:51	449.37	0.21	449.16	136.90	2983.84	909.47
WQSP-4	CUL	3433.00	05/12/98	12:30	450.09	0.21	449.88	137.12	2983.12	909.25
WQSP-4	CUL	3433.00	06/11/98	11:55	449.83	0.21	449.62	137.04	2983.38	909.33
WQSP-4	CUL	3433.00	07/15/98	08:26	449.49	0.21	449.28	136.94	2983.72	909.44
WQSP-4	CUL	3433.00	08/12/98	10:09	449.34	0.21	449.13	136.89	2983.87	909.48
WQSP-4	CUL	3433.00	09/10/98	06:56	449.11	0.21	448.90	136.82	2984.10	909.55
WQSP-4	CUL	3433.00	10/14/98	10:59	449.36	0.21	449.15	136.90	2983.85	909.48
WQSP-4	CUL	3433.00	11/13/98	10:15	449.16	0.21	448.95	136.84	2984.05	909.54
WQSP-4	CUL	3433.00	12/09/98	07:53	448.87	0.21	448.66	136.75	2984.34	909.63
WQSP-5	CUL	3384.40	01/14/98	10:41	386.31	0.21	386.10	117.68	2998.30	913.88
WQSP-5	CUL	3384.40	02/11/98	12:26	385.88	0.21	385.67	117.55	2998.73	914.01
WQSP-5	CUL	3384.40	03/12/98	08:24	385.70	0.21	385.49	117.50	2998.91	914.07
WQSP-5	CUL	3384.40	04/16/98	08:03	384.93	0.21	384.72	117.26	2999.68	914.30
WQSP-5	CUL	3384.40	05/12/98	12:53	385.18	0.21	384.97	117.34	2999.43	914.23
WQSP-5	CUL	3384.40	06/11/98	10:58	386.02	0.21	385.81	117.59	2998.59	913.97
WQSP-5	CUL	3384.40	07/15/98	08:10	385.48	0.21	385.27	117.43	2999.13	914.13
WQSP-5	CUL	3384.40	08/12/98	10:30	385.24	0.21	385.03	117.36	2999.37	914.21
WQSP-5	CUL	3384.40	09/10/98	06:46	384.97	0.21	384.76	117.27	2999.64	914.29
WQSP-5	CUL	3384.40	10/14/98	11:11	385.91	0.21	385.70	117.56	2998.70	914.00
WQSP-5	CUL	3384.40	11/13/98	10:04	385.20	0.21	384.99	117.34	2999.41	914.22

Table 7.9 - Groundwater Surface Elevations for CY 1998

Well Number	Zone	Top of Casing Elevation	Date	Time	TP_FT_TOC	ADJ_FT	WL_FT	WL_METERS	WL_MSL_FT	WL_MSL_M
WQSP-5	CUL	3384.40	12/09/98	07:44	384.85	0.21	384.64	117.24	2999.76	914.33
WQSP-6	CUL	3363.80	01/14/98	10:54	353.17	0.21	352.96	107.58	3010.84	917.70
WQSP-6	CUL	3363.80	02/11/98	12:36	352.91	0.21	352.70	107.50	3011.10	917.78
WQSP-6	CUL	3363.80	03/12/98	08:13	352.86	0.21	352.65	107.49	3011.15	917.80
WQSP-6	CUL	3363.80	04/16/98	08:15	352.19	0.21	351.98	107.28	3011.82	918.00
WQSP-6	CUL	3363.80	05/12/98	13:13	351.97	0.21	351.76	107.22	3012.04	918.07
WQSP-6	CUL	3363.80	06/11/98	10:35	355.45	0.21	355.24	108.28	3008.56	917.01
WQSP-6	CUL	3363.80	07/15/98	07:53	352.39	0.21	352.18	107.34	3011.62	917.94
WQSP-6	CUL	3363.80	08/12/98	10:46	352.02	0.21	351.81	107.23	3011.99	918.05
WQSP-6	CUL	3363.80	09/10/98	06:31	351.73	0.21	351.52	107.14	3012.28	918.14
WQSP-6	CUL	3363.80	10/14/98	11:21	351.46	0.21	351.25	107.06	3012.55	918.23
WQSP-6	CUL	3363.80	11/13/98	09:54	352.39	0.21	352.18	107.34	3011.62	917.94
WQSP-6	CUL	3363.80	12/09/98	07:29	351.56	0.21	351.35	107.09	3012.45	918.19
WQSP-6a	DL	3364.70	01/14/98	11:00	166.00	0.18	165.82	50.54	3198.88	975.02
WQSP-6a	DL	3364.70	02/11/98	12:47	165.99	0.18	165.81	50.54	3198.89	975.02
WQSP-6a	DL	3364.70	03/12/98	07:53	165.26	0.18	165.08	50.32	3199.62	975.24
WQSP-6a	DL	3364.70	04/16/98	08:22	165.90	0.18	165.72	50.51	3198.98	975.05
WQSP-6a	DL	3364.70	05/12/98	13:21	165.85	0.18	165.67	50.50	3199.03	975.06
WQSP-6a	DL	3364.70	06/11/98	10:41	166.08	0.18	165.90	50.57	3198.80	974.99
WQSP-6a	DL	3364.70	07/15/98	07:42	166.02	0.18	165.84	50.55	3198.86	975.01
WQSP-6a	DL	3364.70	08/12/98	10:55	166.09	0.18	165.91	50.57	3198.79	974.99
WQSP-6a	DL	3364.70	09/10/98	06:36	166.01	0.18	165.83	50.54	3198.87	975.02
WQSP-6a	DL	3364.70	10/14/98	11:35	165.92	0.18	165.74	50.52	3198.96	975.04
WQSP-6a	DL	3364.70	11/13/98	09:48	166.16	0.18	165.98	50.59	3198.72	974.97
WQSP-6a	DL	3364.70	12/09/98	07:33	166.10	0.18	165.92	50.57	3198.78	974.99

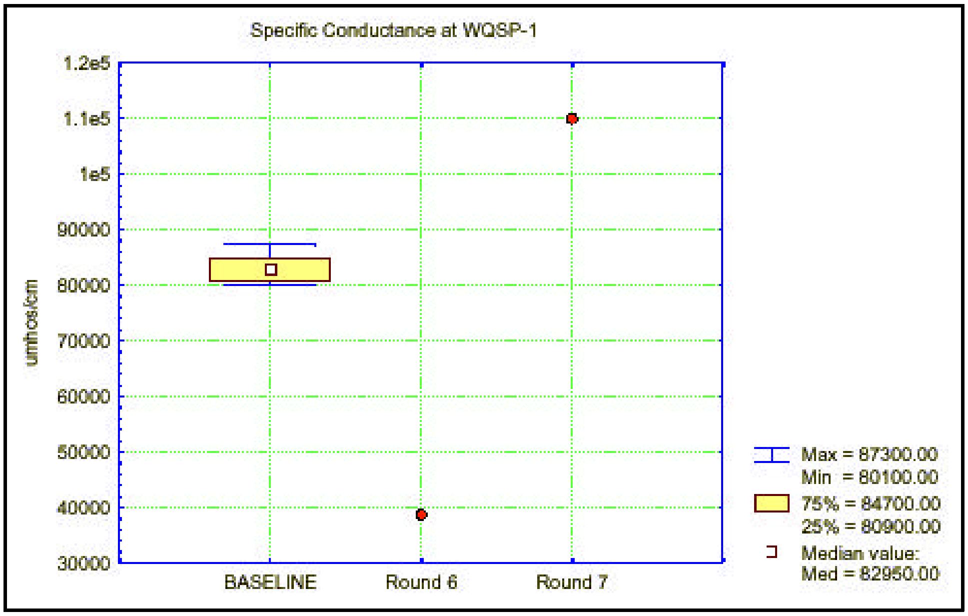


Figure 7.5 - Time Trend Plot for Specific Conductance at WQSP-1

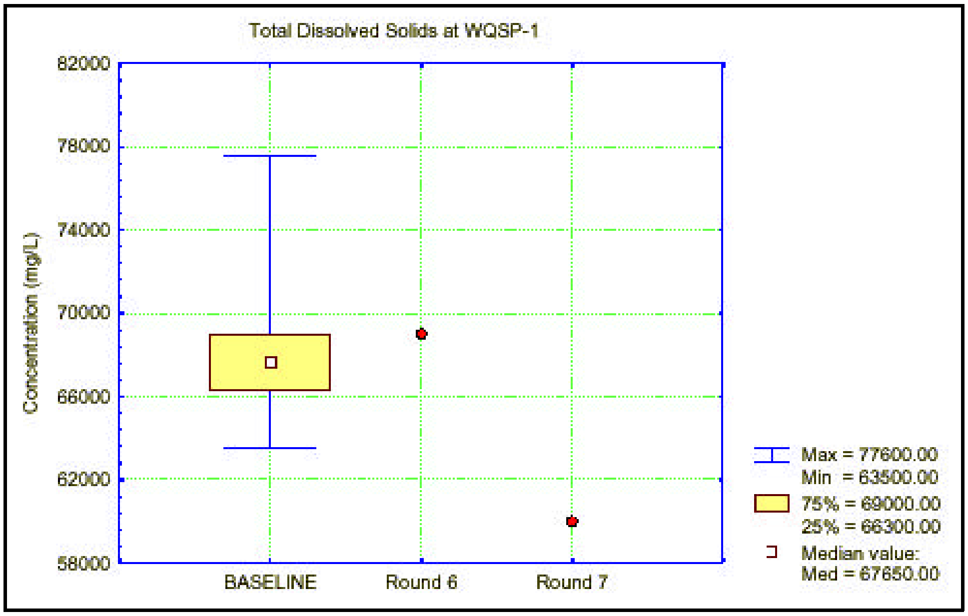


Figure 7.6 - Time Trend Plot for Total Dissolved Solids at WQSP-1

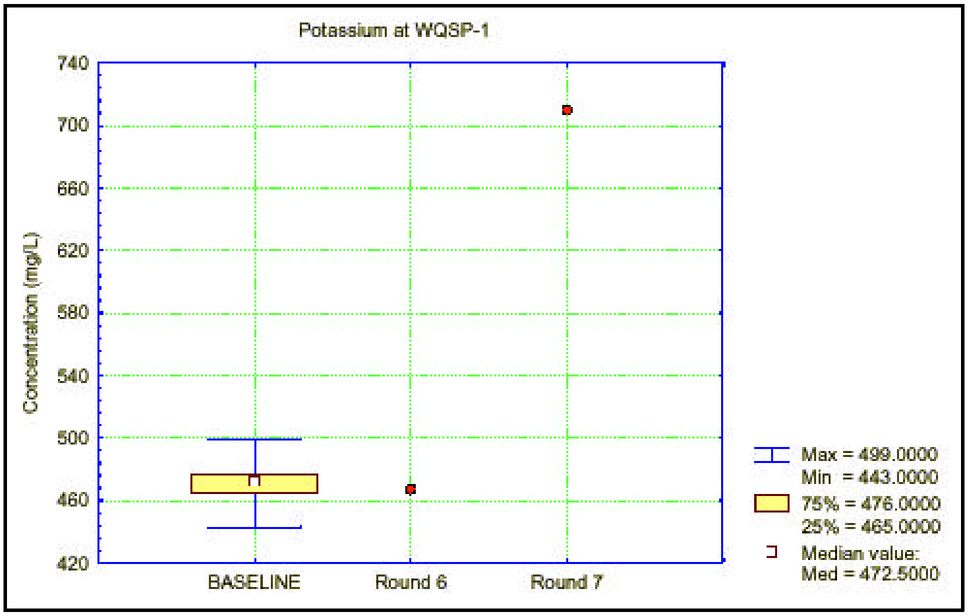


Figure 7.7 - Time Trend Plot for Potassium at WQSP-1

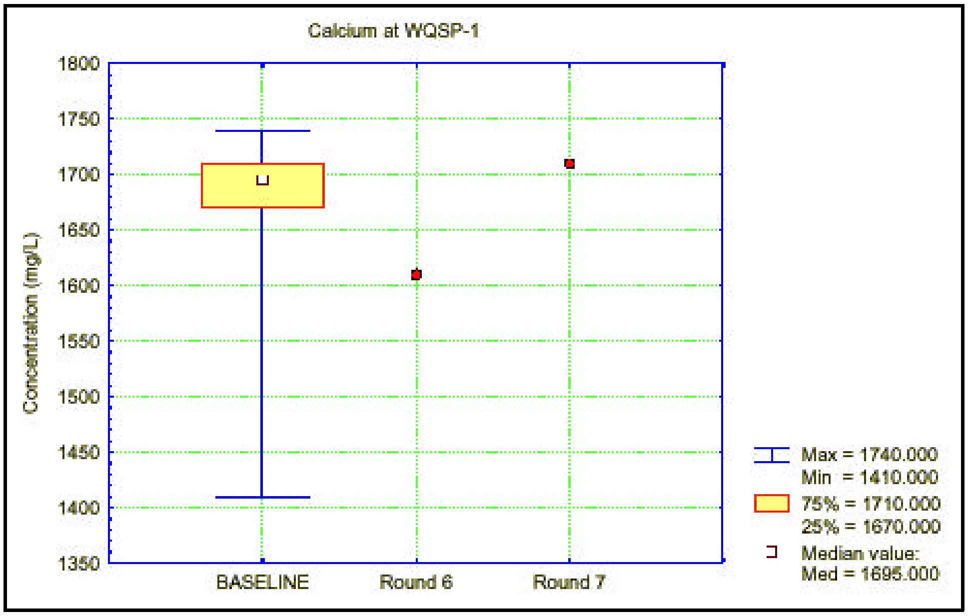


Figure 7.8 - Time Trend Plot for Calcium at WQSP-1

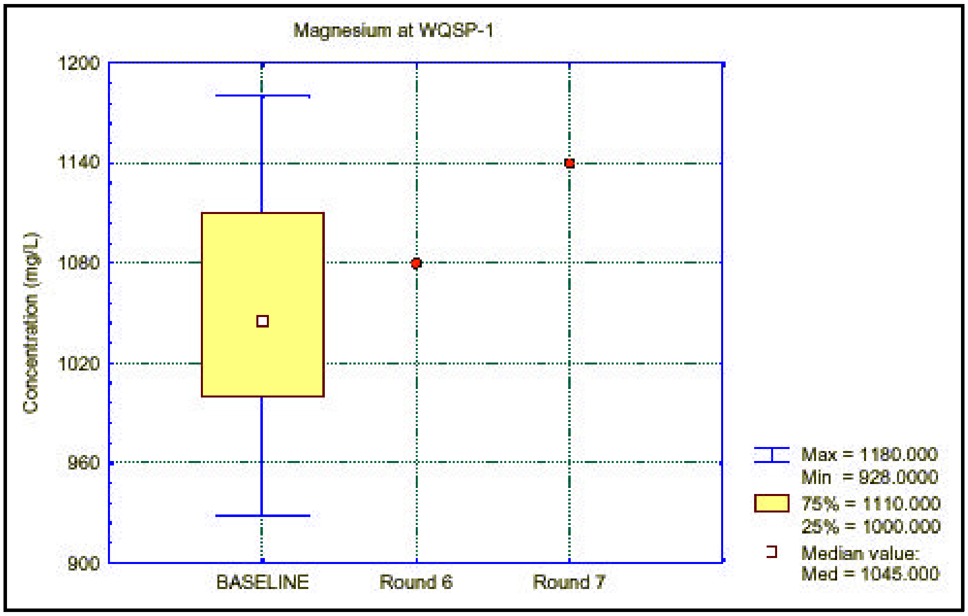


Figure 7.9 - Time Trend Plot for Magnesium at WQSP-1

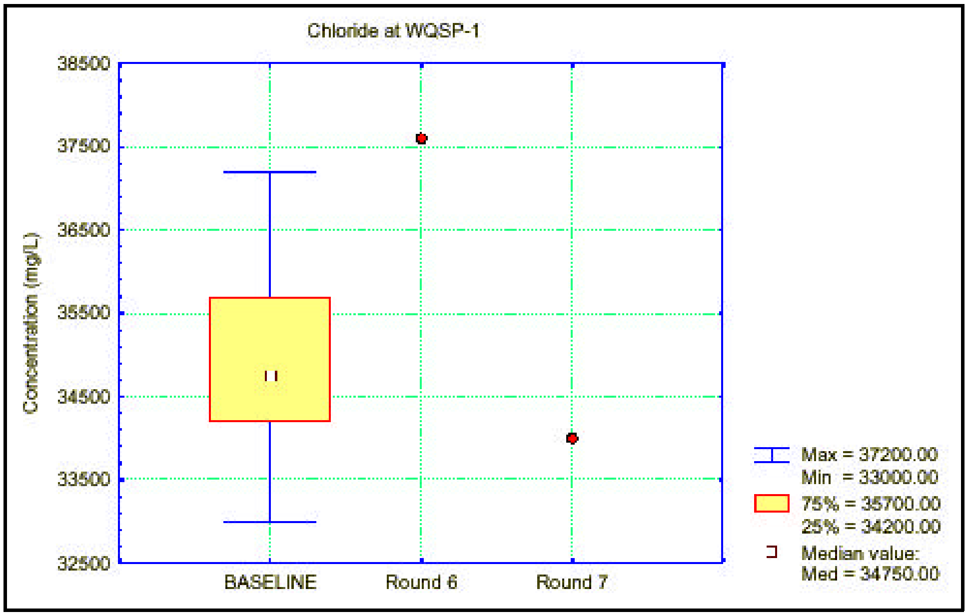


Figure 7.10 - Time Trend Plot for Chloride at WQSP-1

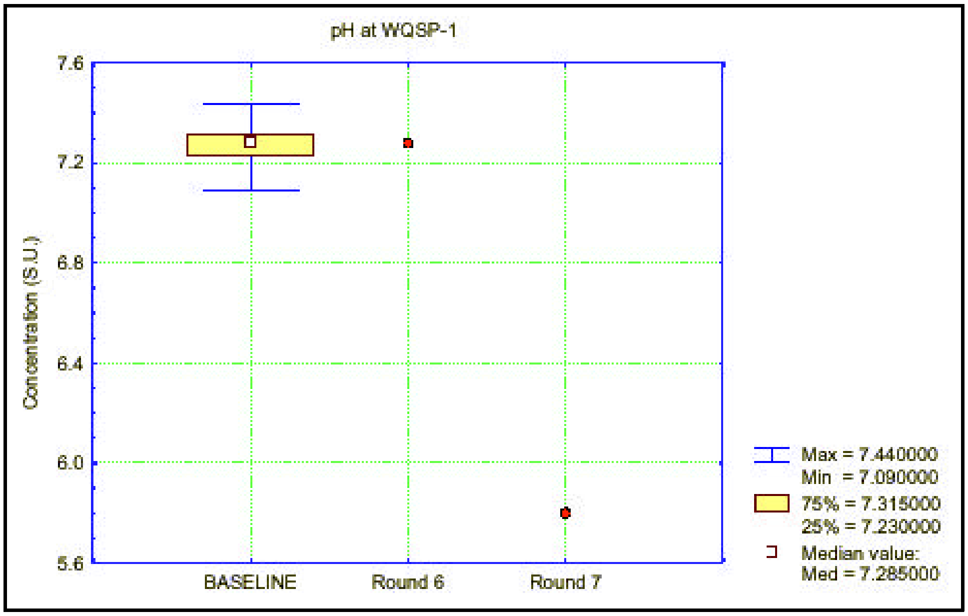


Figure 7.11 - Time Trend Plot for pH WQSP-1

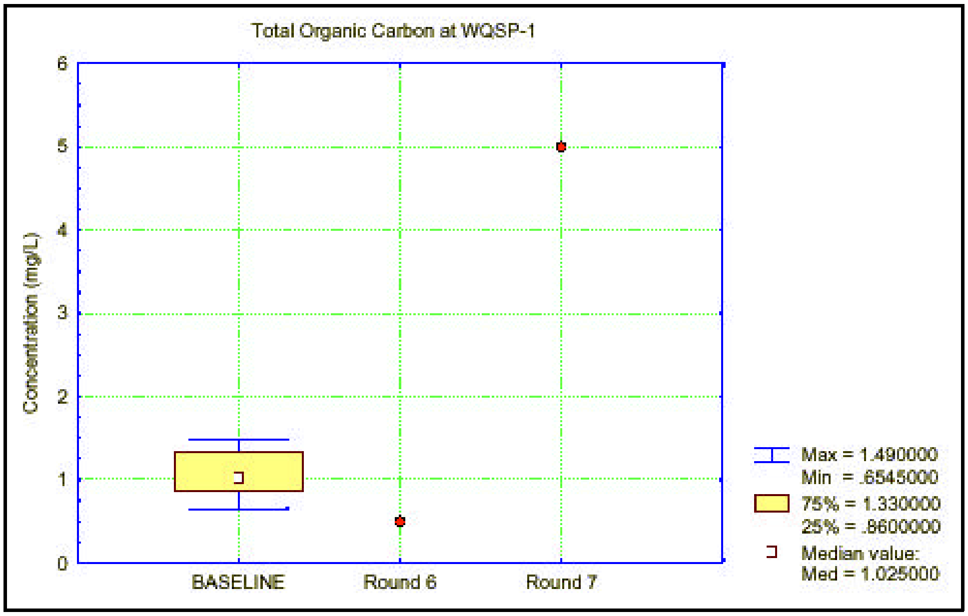


Figure 7.12 - Time Trend Plot for Total Organic Carbon at WQSP-1

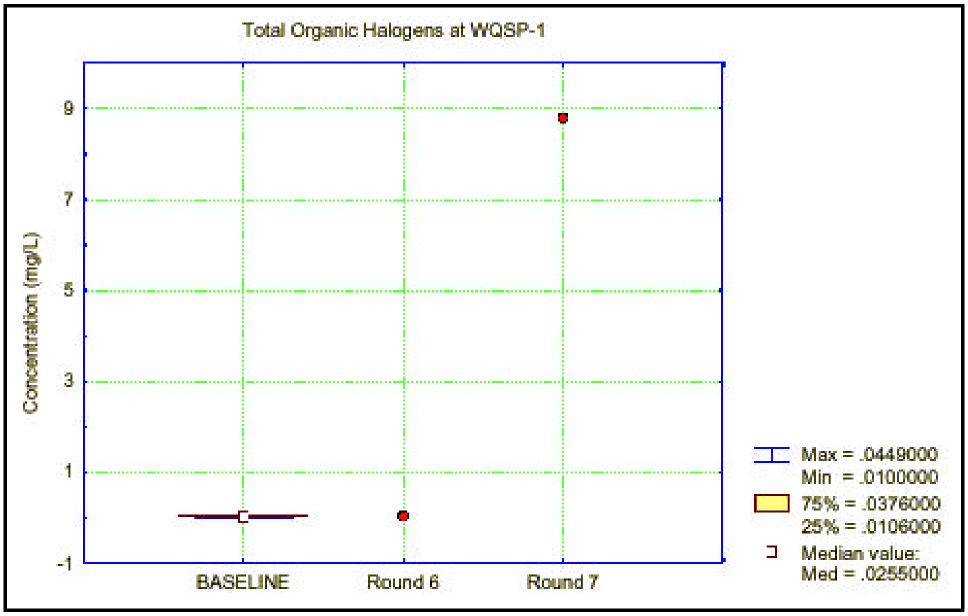


Figure 7.13 - Time Trend Plot for Total Organic Halogens at WQSP-1

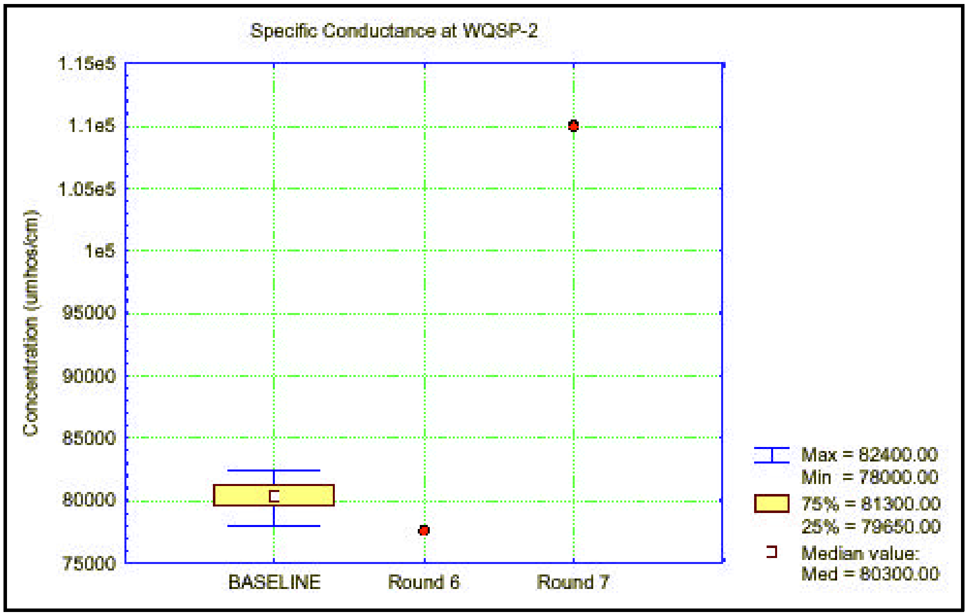


Figure 7.14 - Time Trend Plot for Specific Conductance at WQSP-2

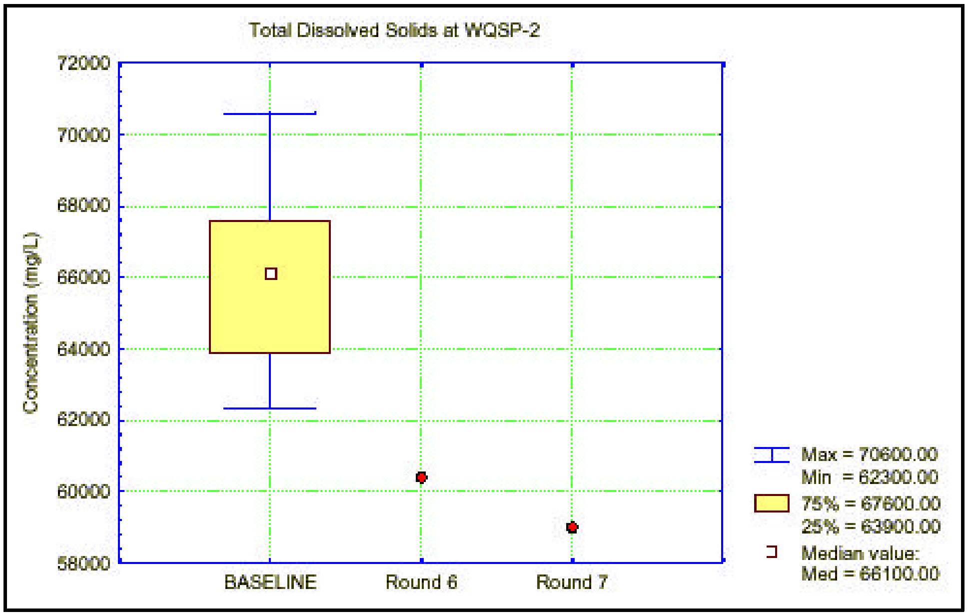


Figure 7.15 - Time Trend Plot for Total Dissolved Solids at WQSP-2

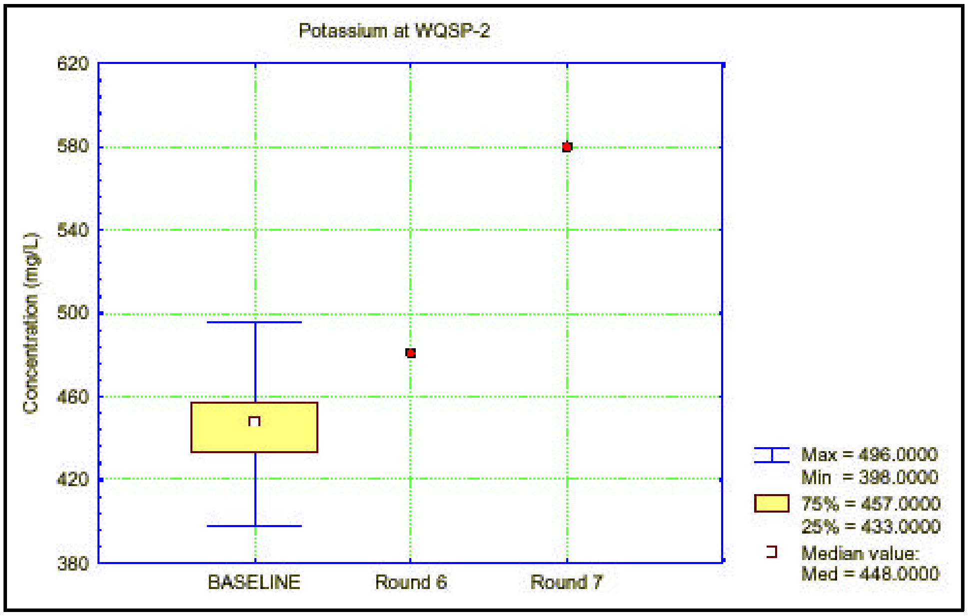


Figure 7.16 - Time Trend Plot for Potassium at WQSP-2

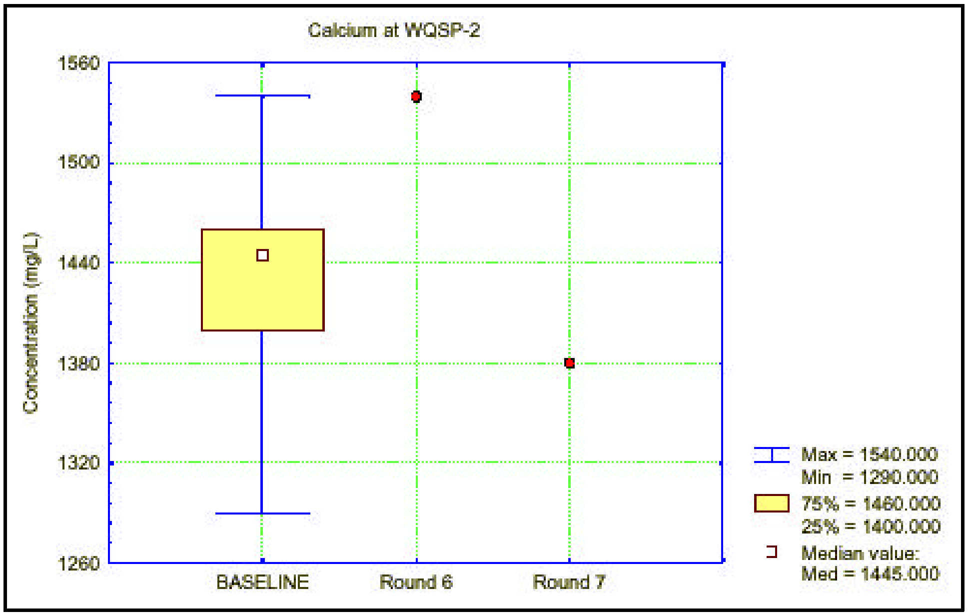


Figure 7.17 - Time Trend Plot for Calcium at WQSP-2

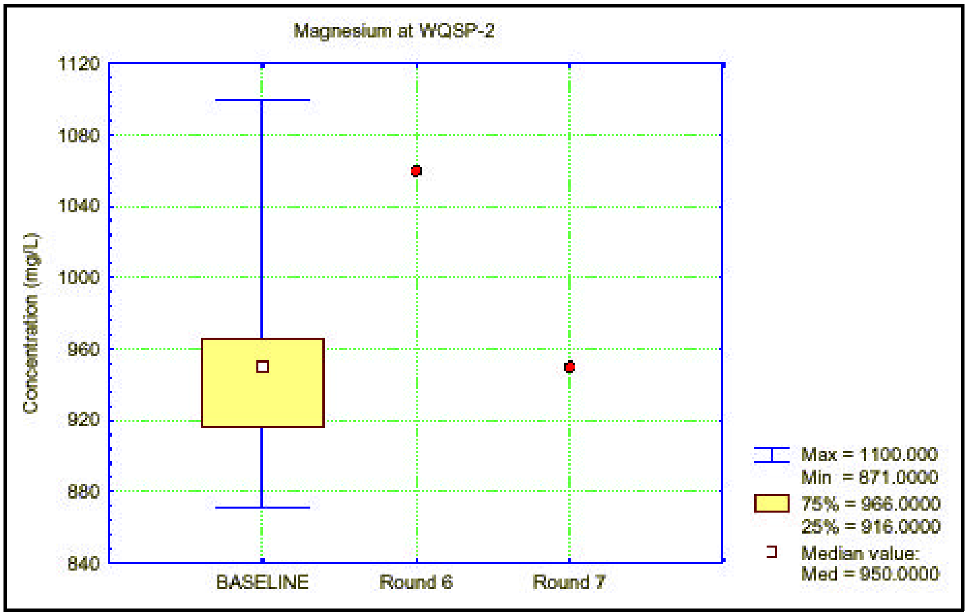


Figure 7.18 - Time Trend Plot for Magnesium at WQSP-2

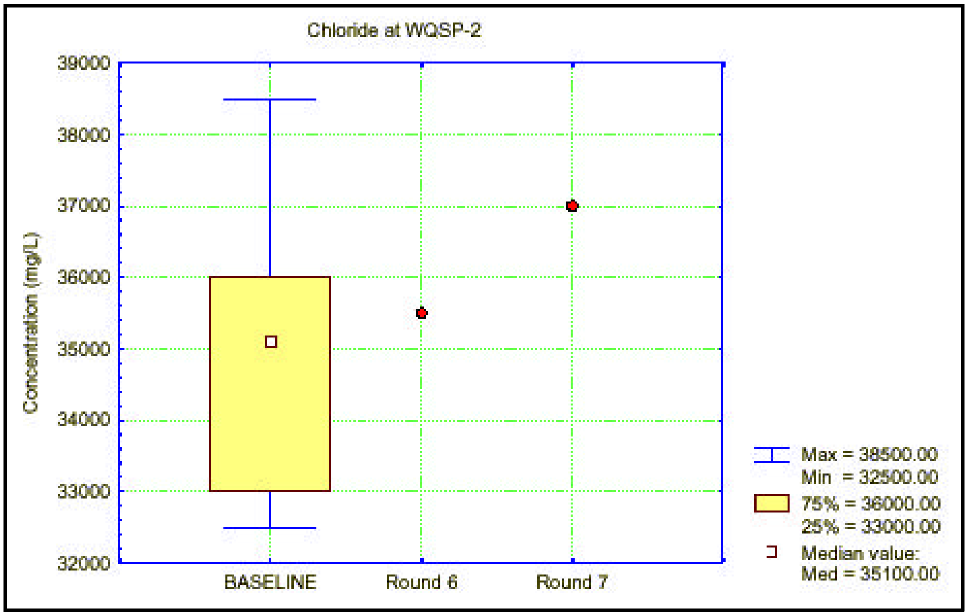


Figure 7.19 - Time Trend Plot for Chloride at WQSP-2

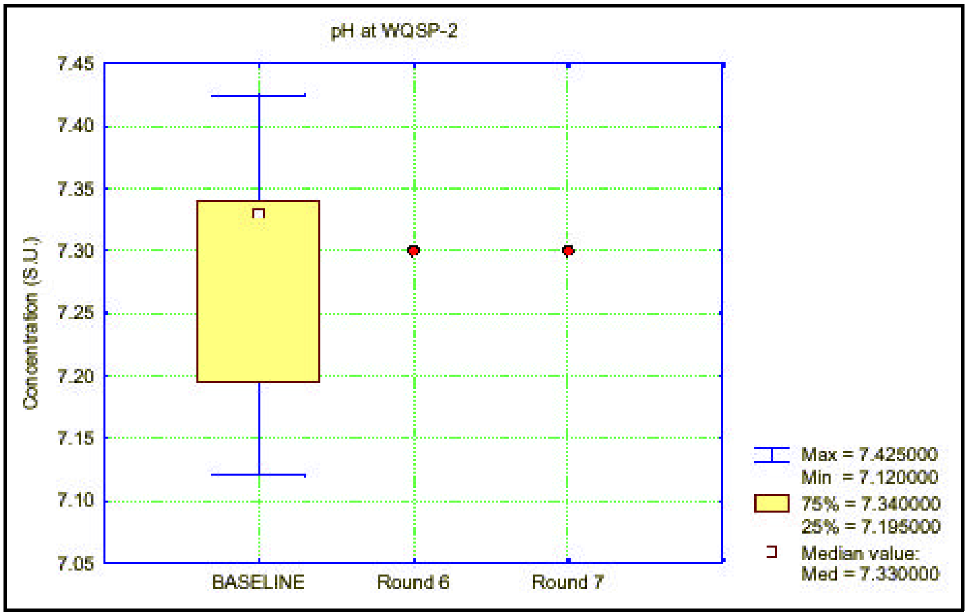


Figure 7.20 - Time Trend Plot for pH at WQSP-2

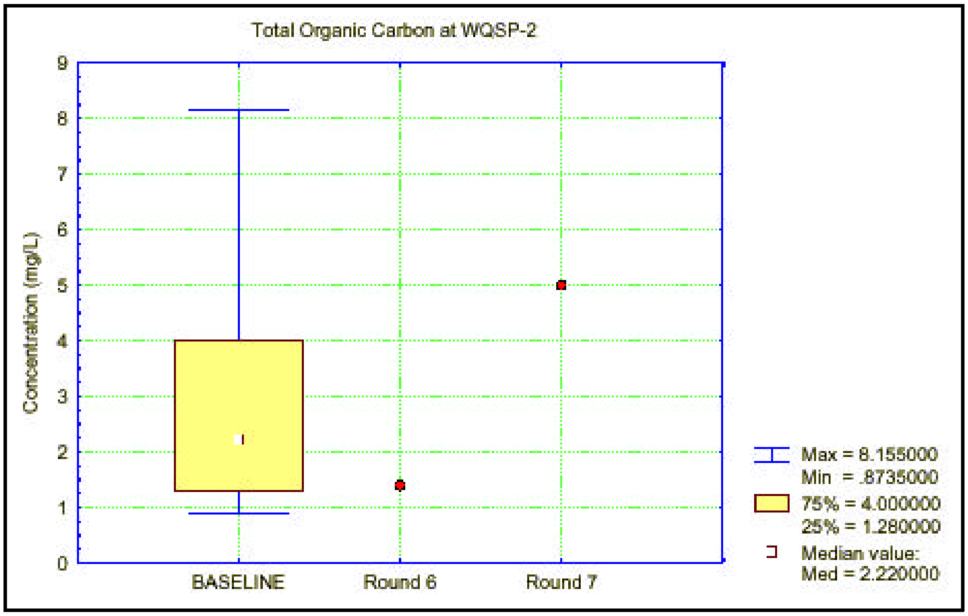


Figure 7.21 - Time Trend Plot for Total Organic Carbon at WQSP-2

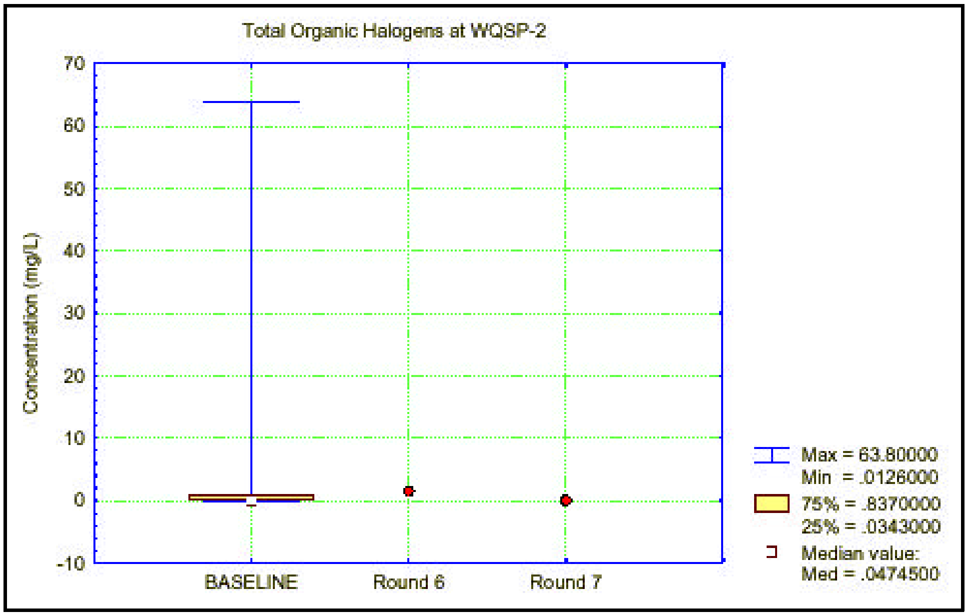


Figure 7.22 - Time Trend Plot for Total Organic Halogens at WQSP-2

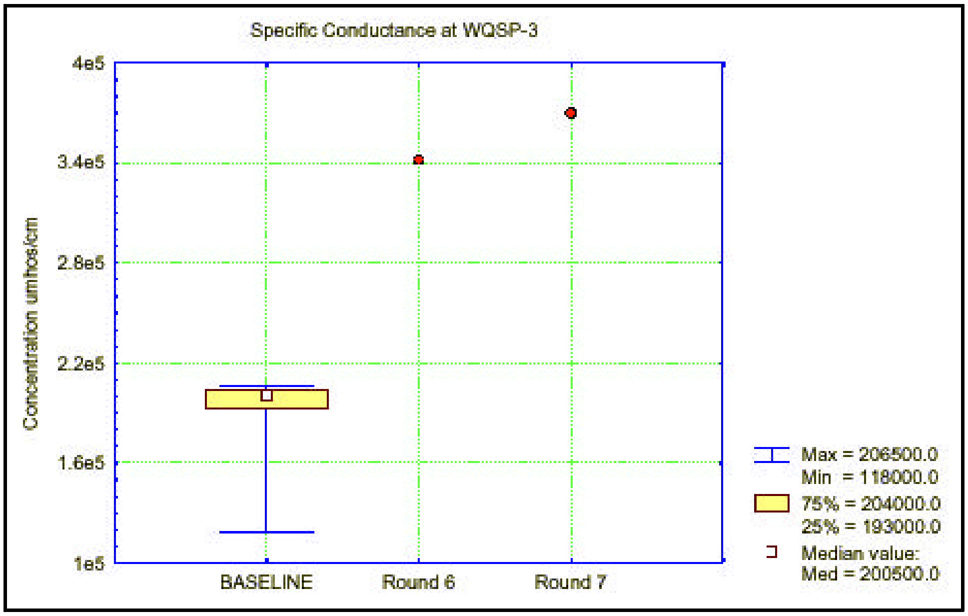


Figure 7.23 - Time Trend Plot for Specific Conductance at WQSP-3

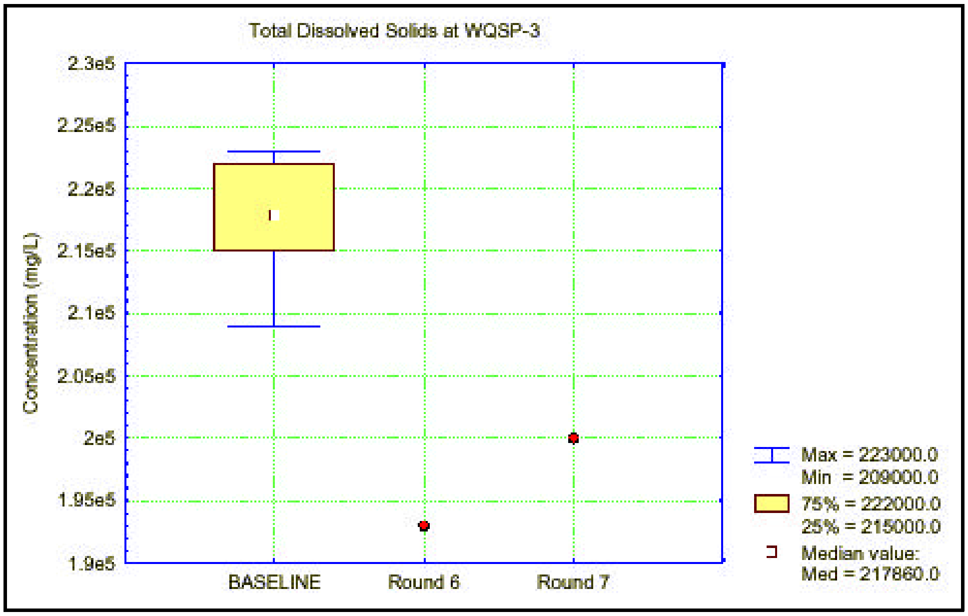


Figure 7.24 - Time Trend Plot for Total Dissolved Solids at WQSP-3

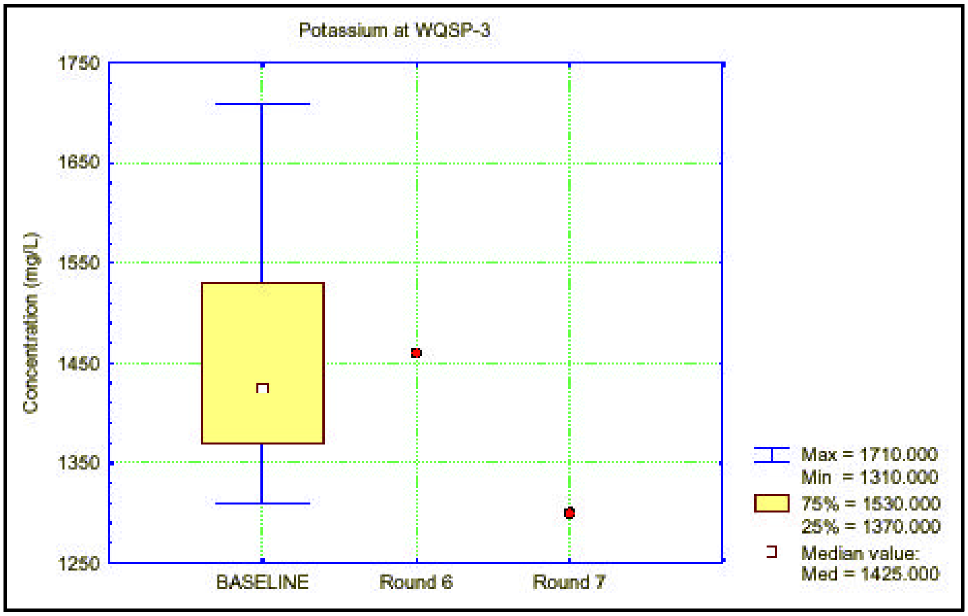


Figure 7.25 - Time Trend Plot for Potassium at WQSP-3

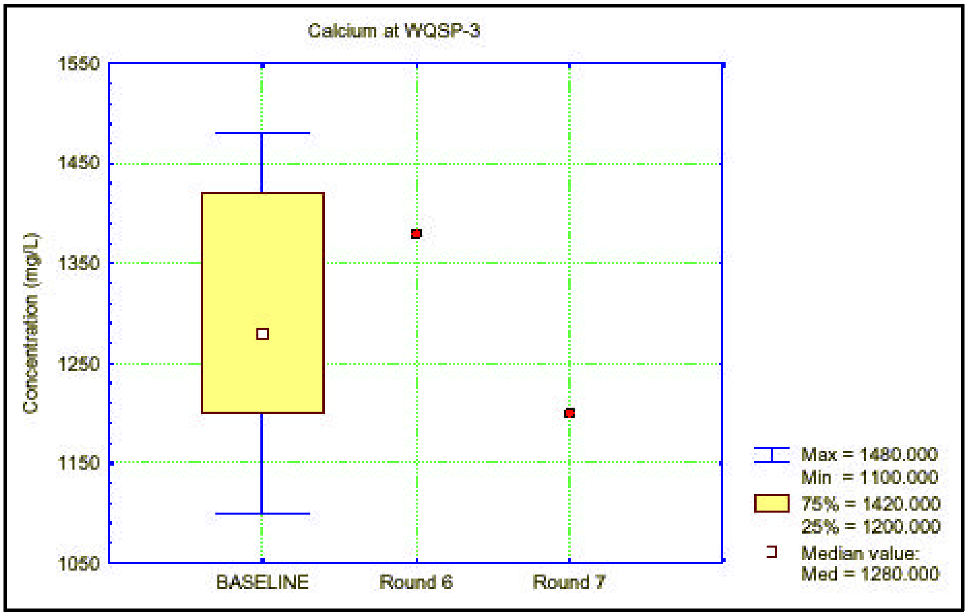


Figure 7.26 - Time Trend Plot for Calcium at WQSP-3

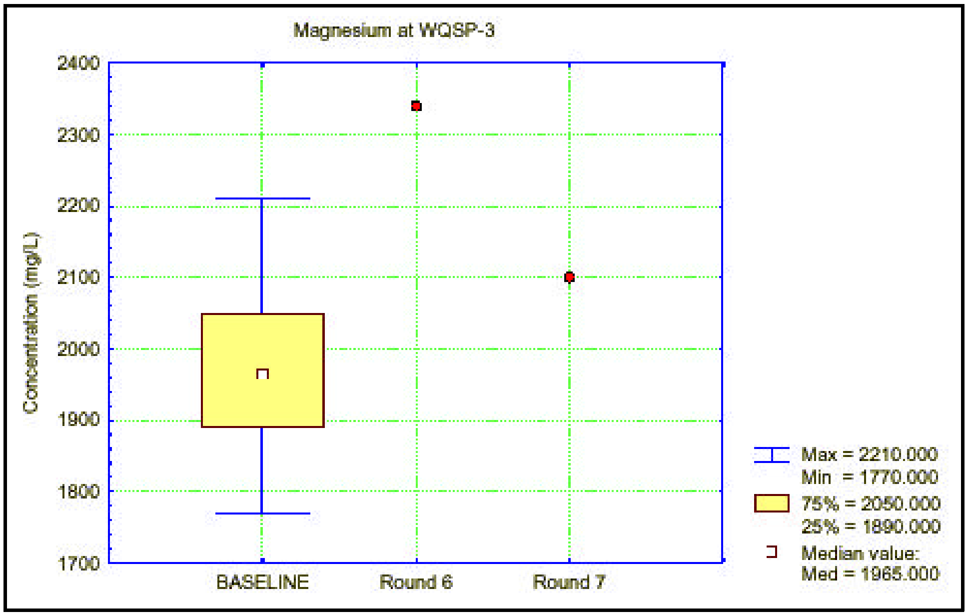


Figure 7.27 - Time Trend Plot for Magnesium at WQSP-3

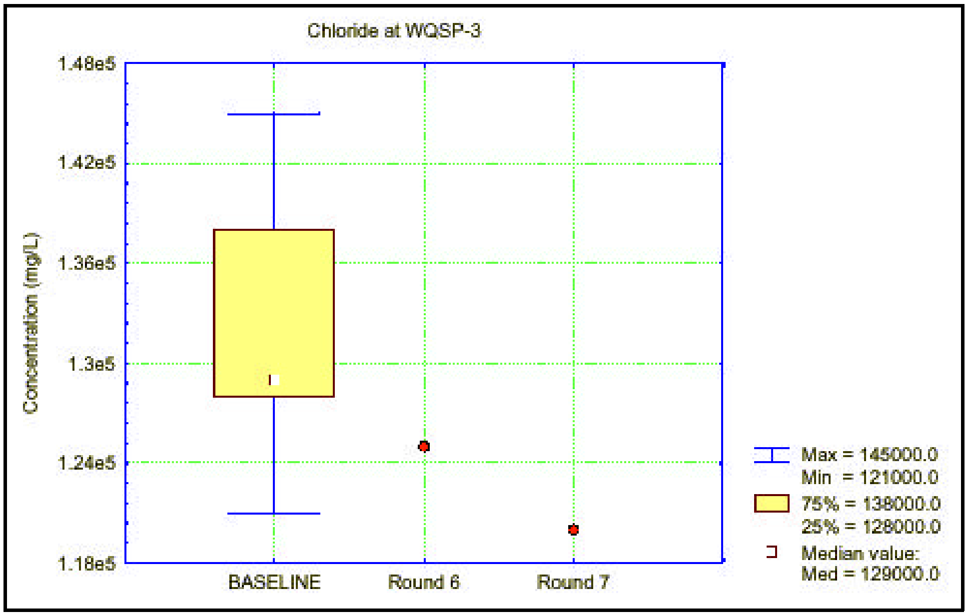


Figure 7.28 - Time Trend Plot for Chloride at WQSP-3

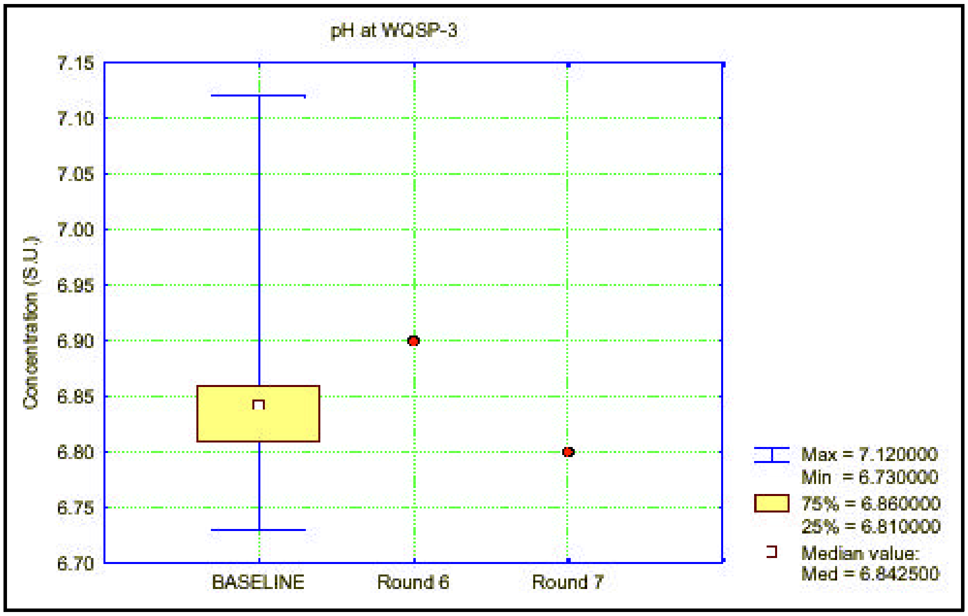


Figure 7.29 - Time Trend Plot for pH at WQSP-3

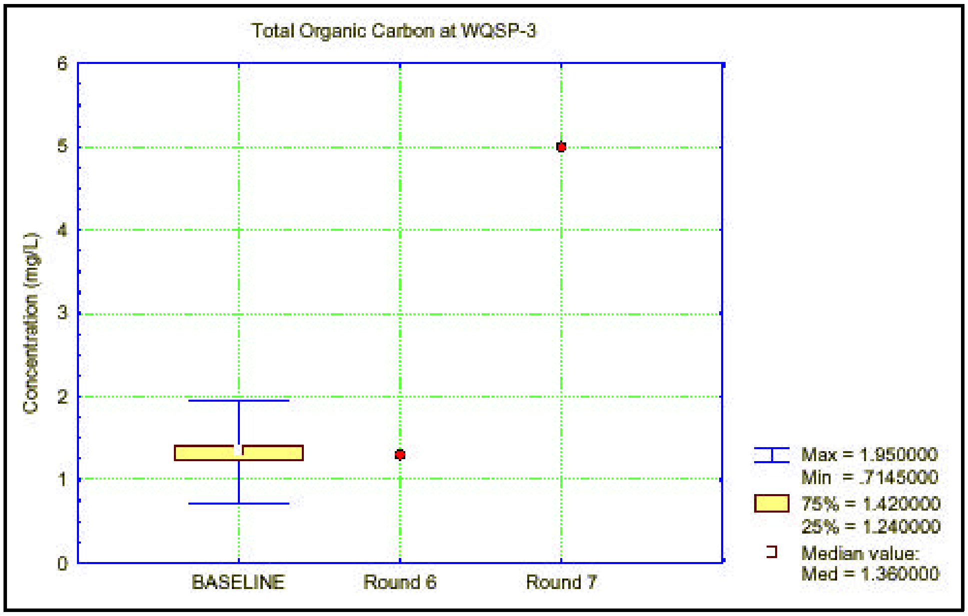


Figure 7.30 - Time Trend Plot for Total Organic Carbon at WQSP-3

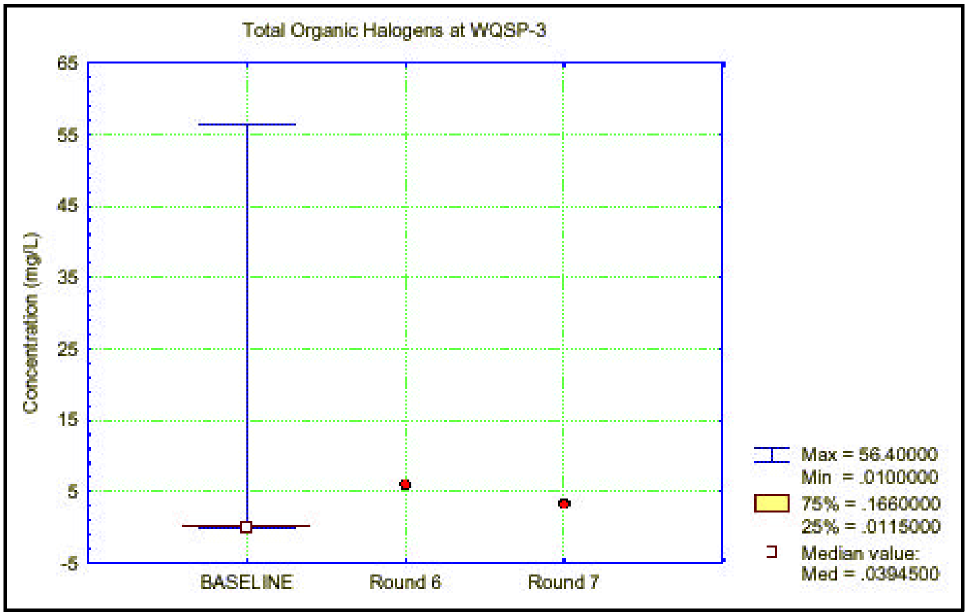


Figure 7.31 - Time Trend Plot for Total Organic Halogens at WQSP-3

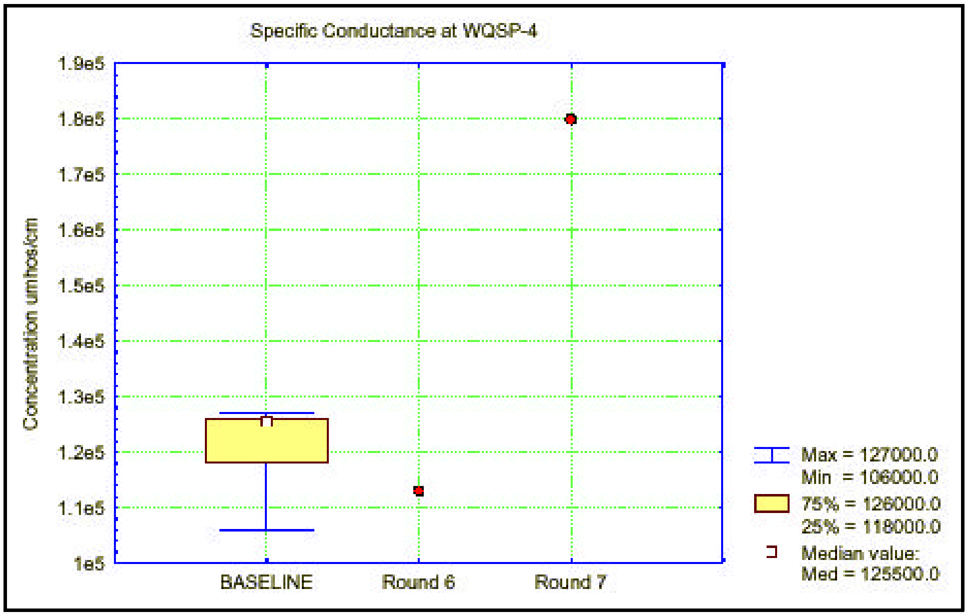


Figure 7.32 - Time Trend Plot for Specific Conductance at WQSP-4

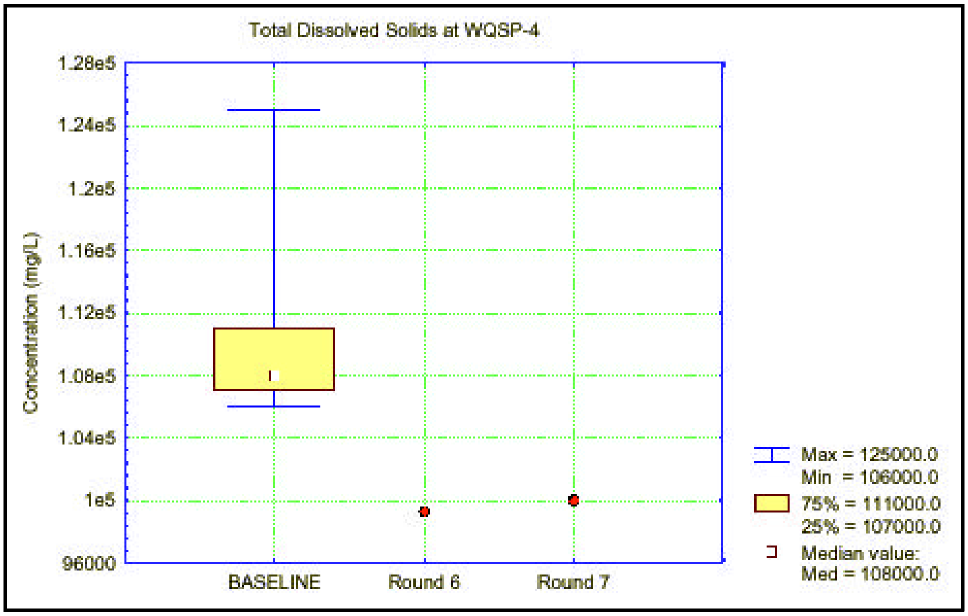


Figure 7.33 - Time Trend Plot for Total Dissolved Solids at WQSP-4

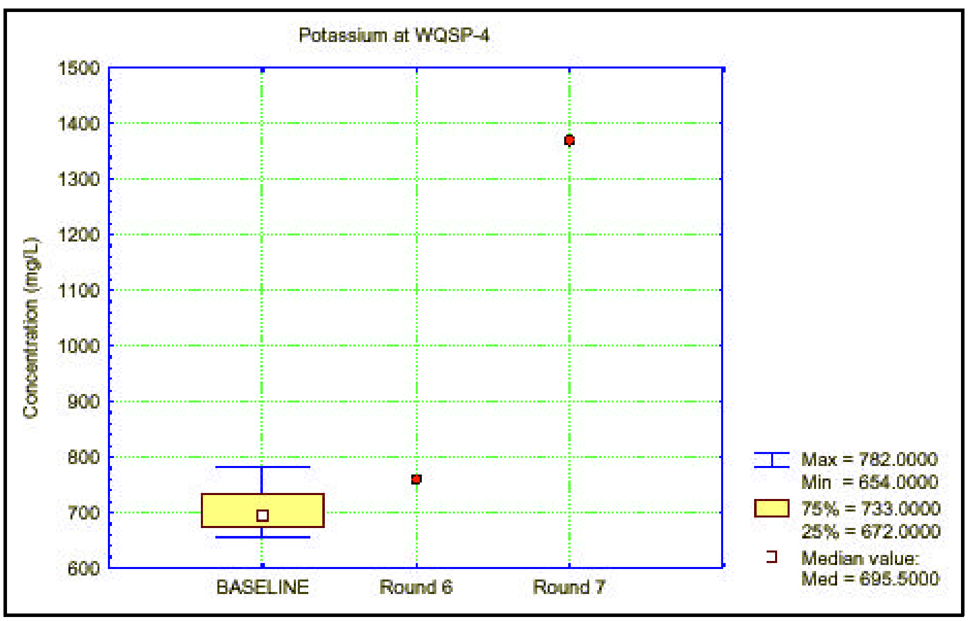


Figure 7.34 - Time Trend Plot for Potassium at WQSP-4

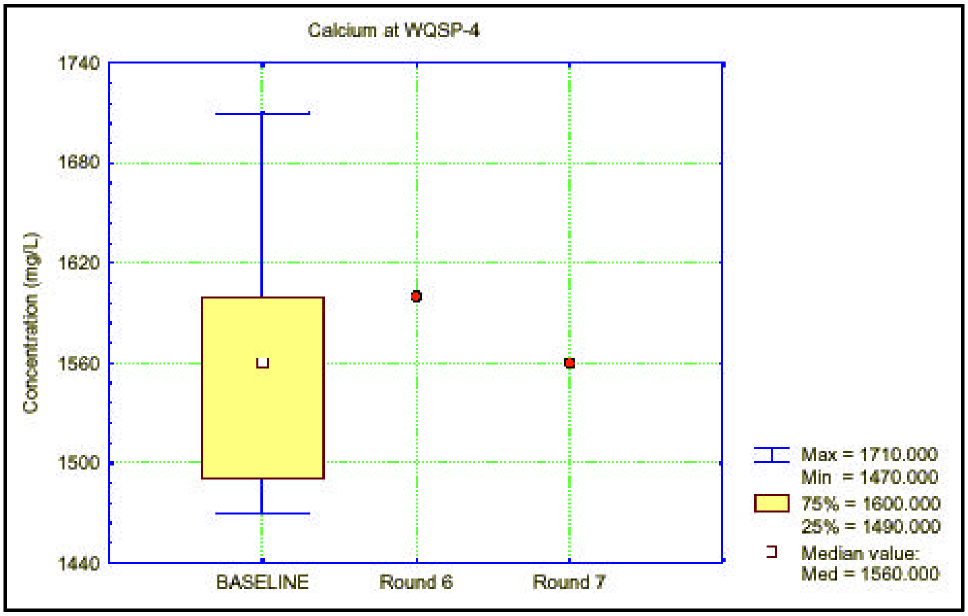


Figure 7.35 - Time Trend Plot for Calcium at WQSP-4

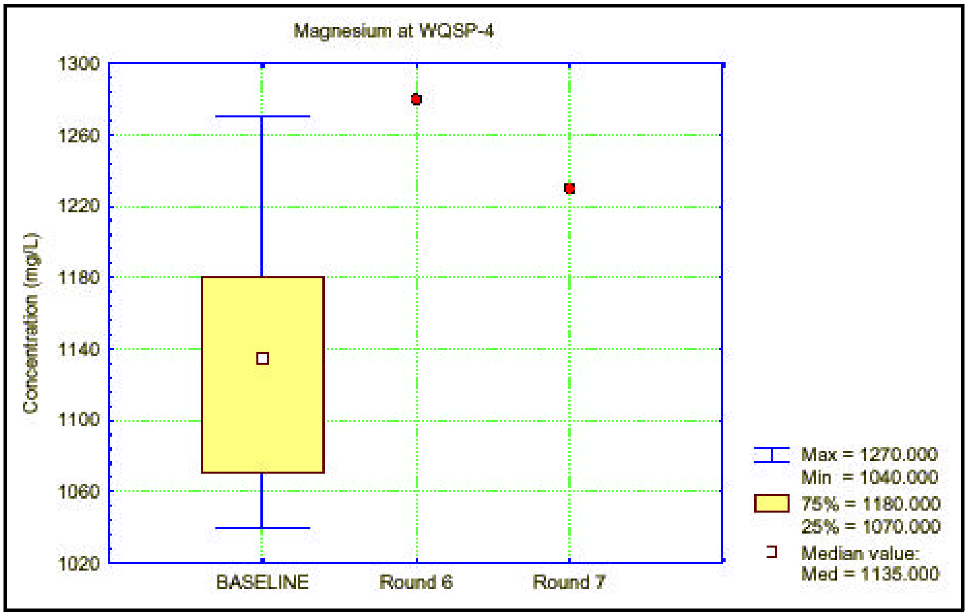


Figure 7.36 - Time Trend Plot for Magnesium at WQSP-4

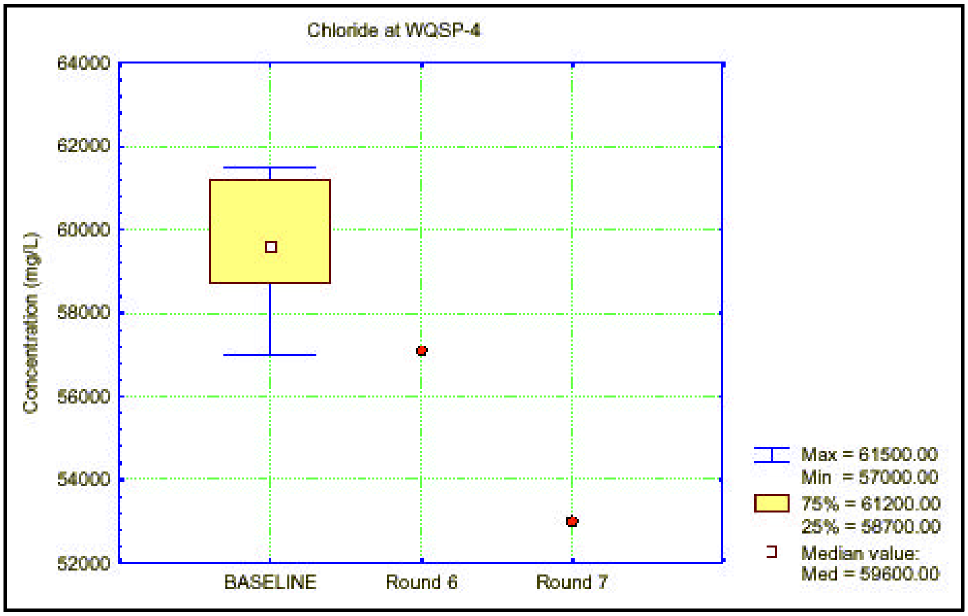


Figure 7.37 - Time Trend Plot for Chloride at WQSP-4

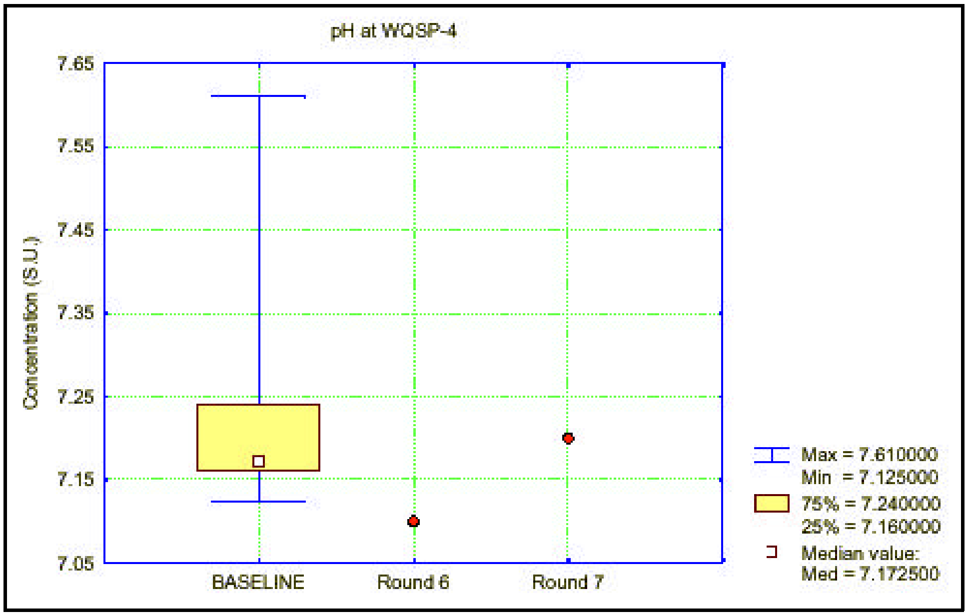


Figure 7.38 -Time Trend Plot for pH at WQSP-4

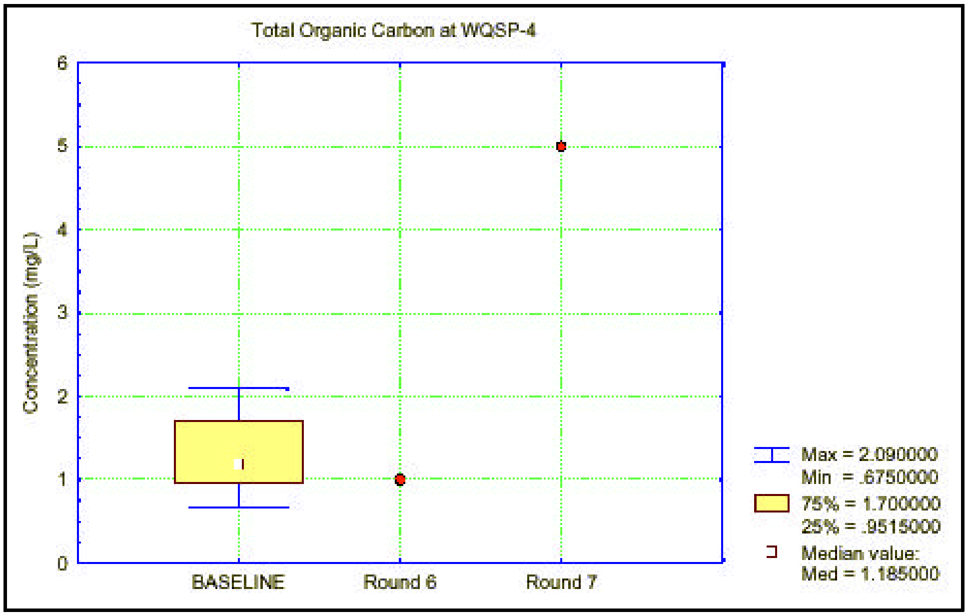


Figure 7.39 - Time Trend Plot for Total Organic Carbon at WQSP-4

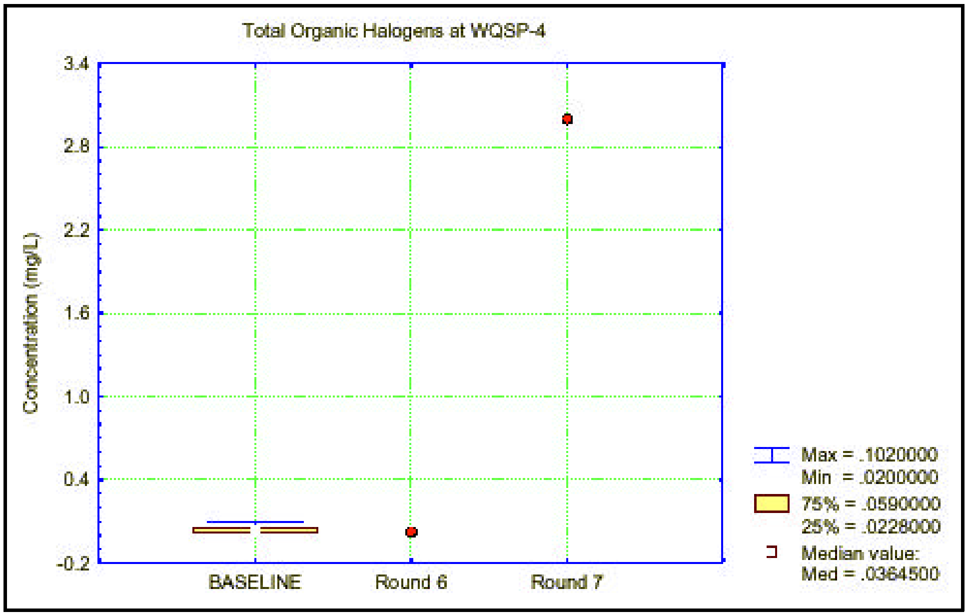


Figure 7.40 - Time Trend Plot for Total Organic Halogens at WQSP-4

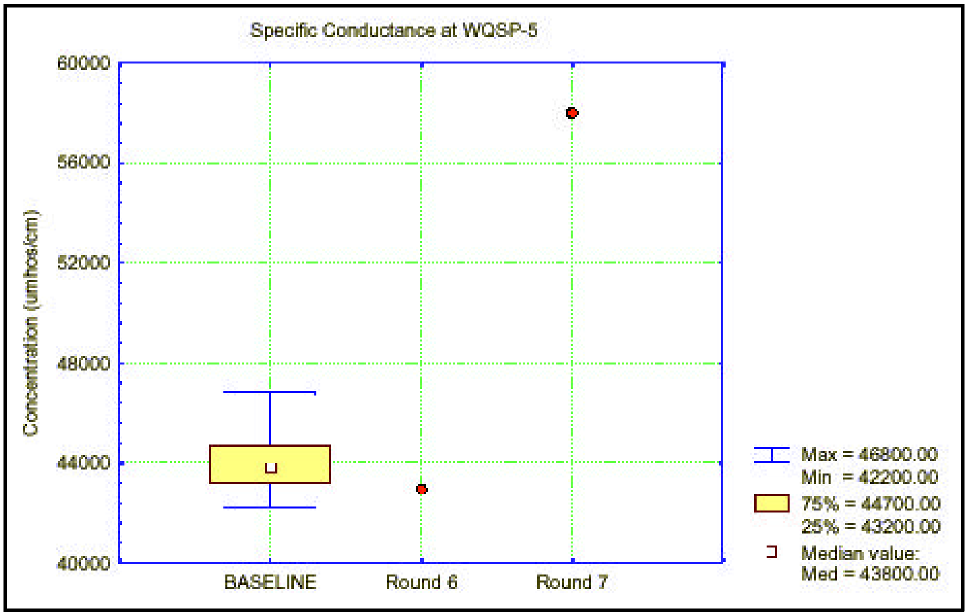


Figure 7.41 - Time Trend Plot for Specific Conductance at WQSP-5

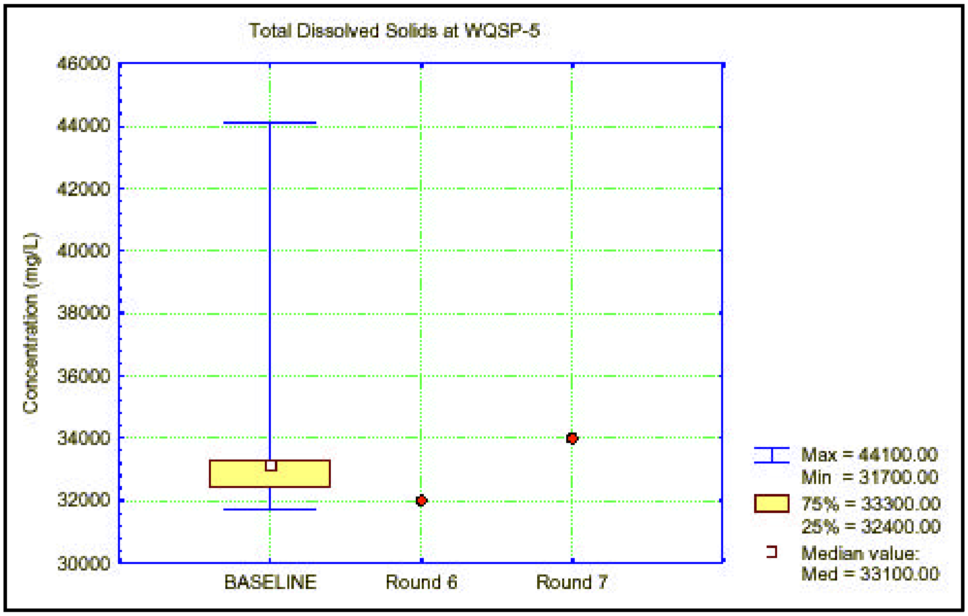


Figure 7.42 - Time Trend Plot for Total Dissolved Solids at WQSP-5

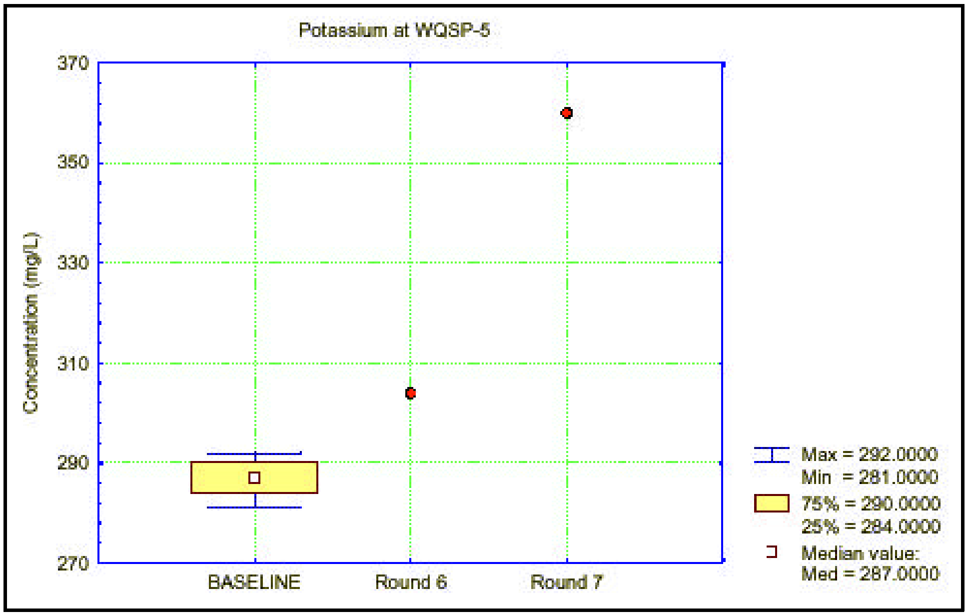


Figure 7.43 - Time Trend Plot for Potassium at WQSP-5

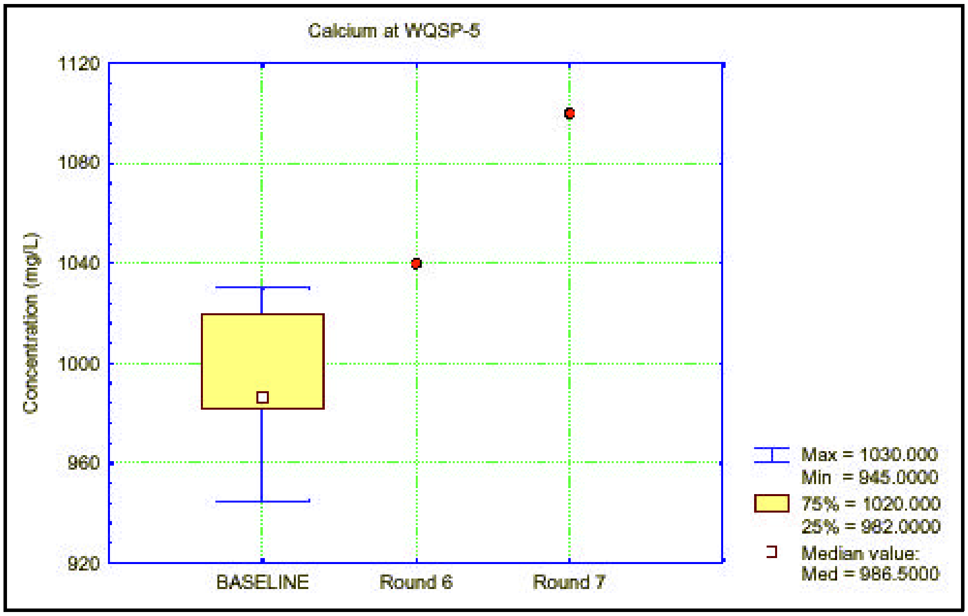


Figure 7.44 - Time Trend Plot for Calcium at WQSP-5

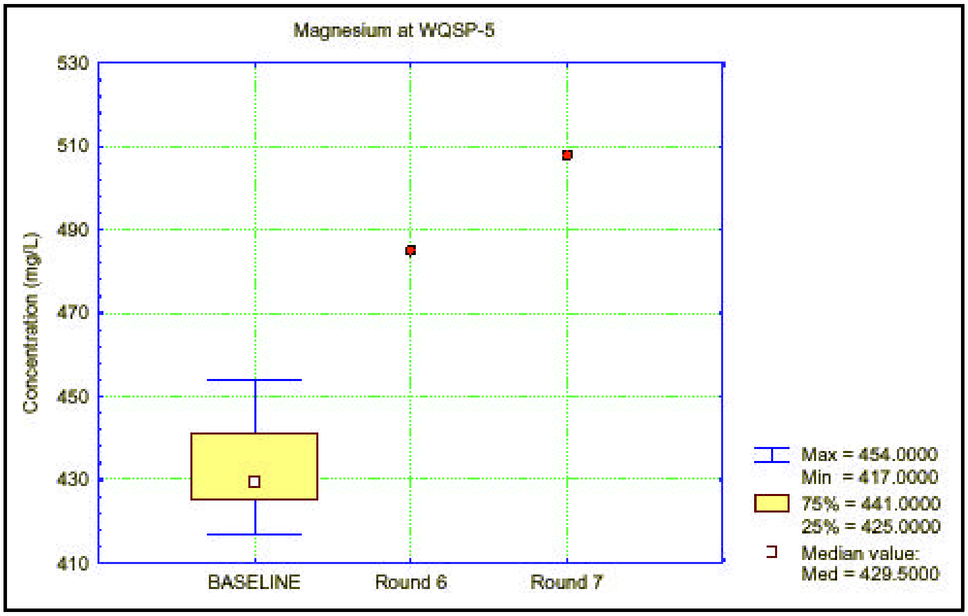


Figure 7.45 - Time Trend Plot for Magnesium at WQSP-5

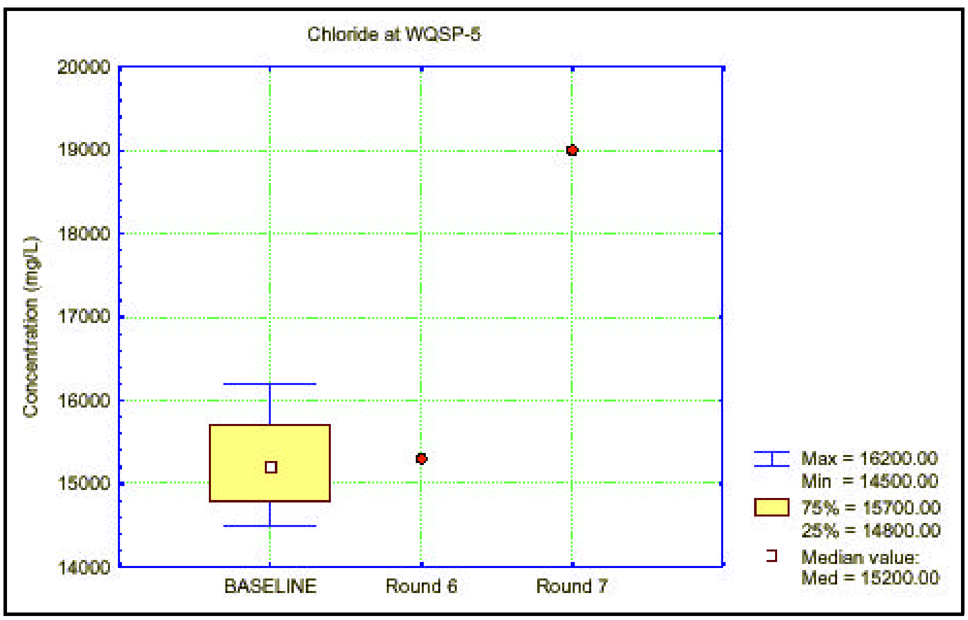


Figure 7.46 - Time Trend Plot for Chloride at WQSP-5

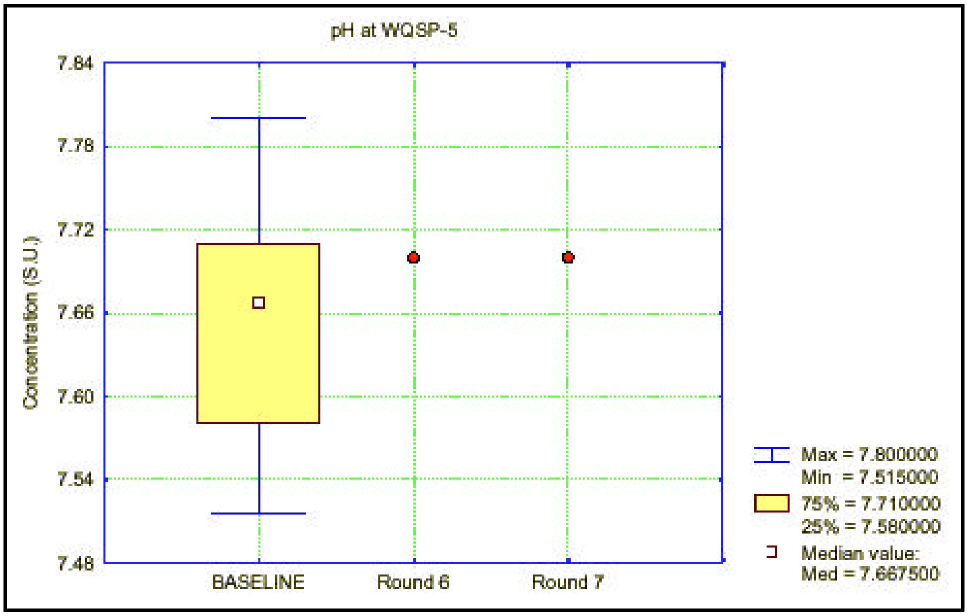


Figure 7.47 - Time Trend Plot for pH at WQSP-5

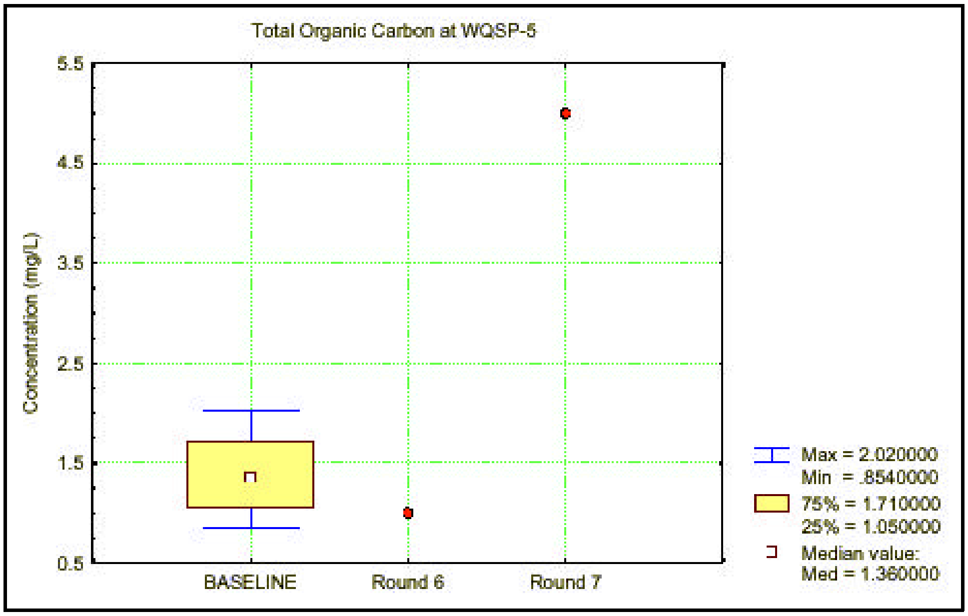


Figure 7.48 - Time Trend Plot for Total Organic Carbon at WQSP-5

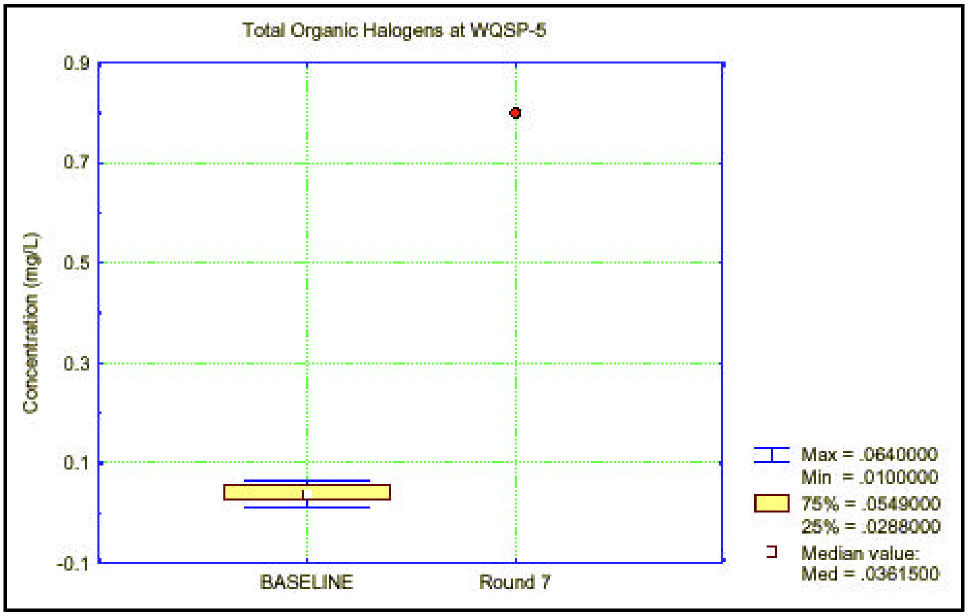


Figure 7.49 - Time Trend Plot for Total Organic Halogens at WQSP-5

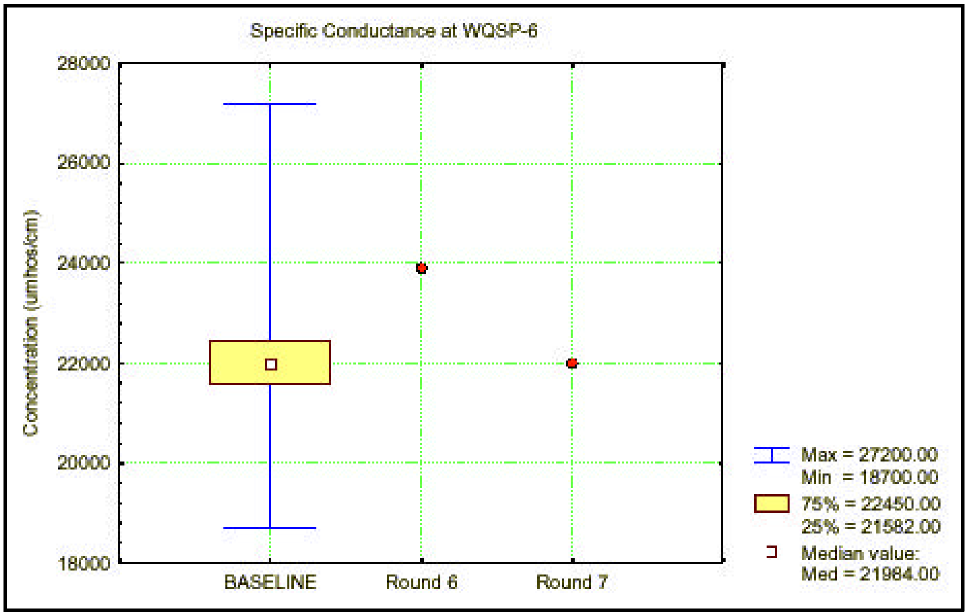


Figure 7.50 - Time Trend Plot for Specific Conductance at WQSP-6

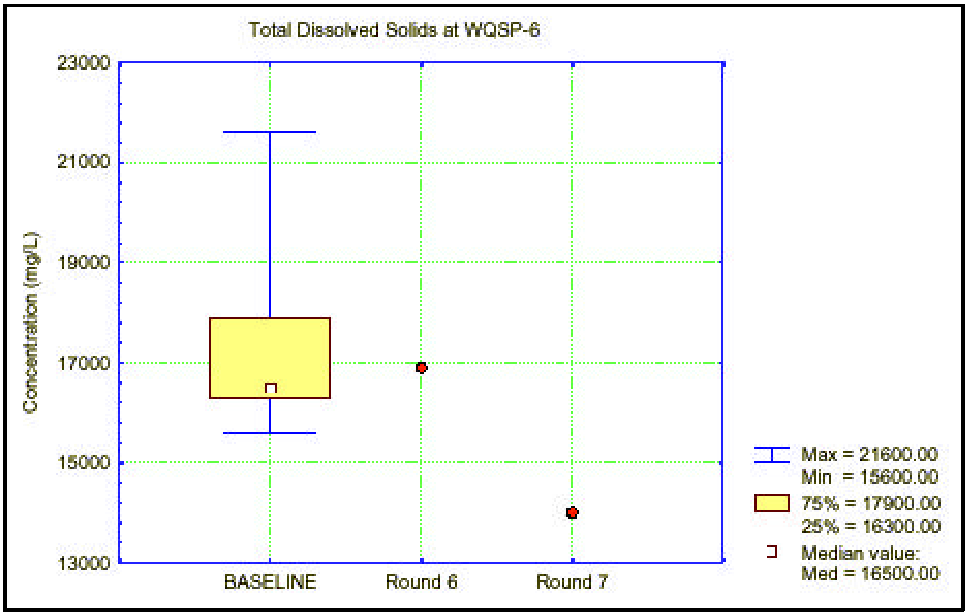


Figure 7.51 - Time Trend Plot for Total Dissolved Solids at WQSP-6

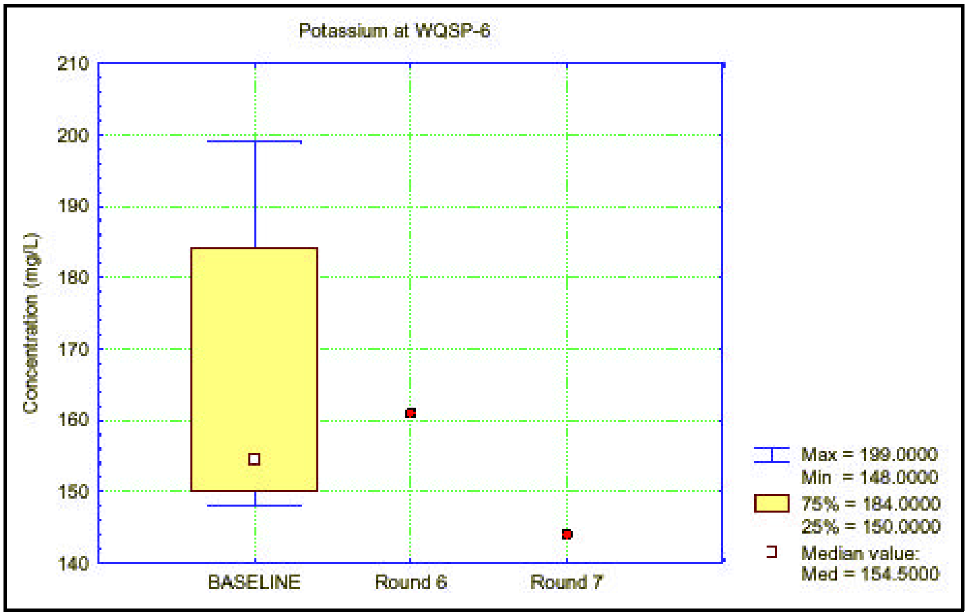


Figure 7.52 - Time Trend Plot for Potassium at WQSP-6

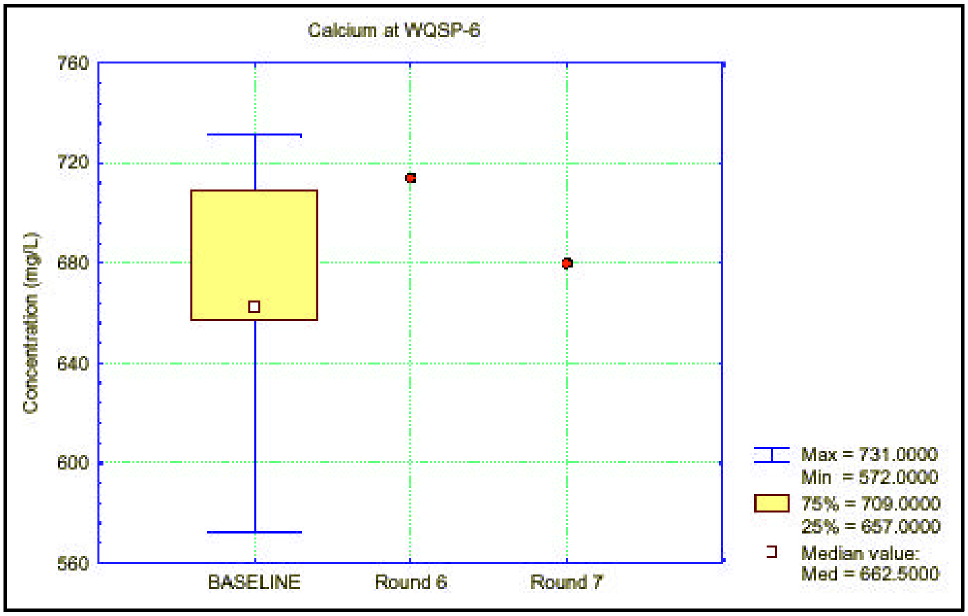


Figure 7.53 - Time Trend Plot for Calcium at WQSP-6

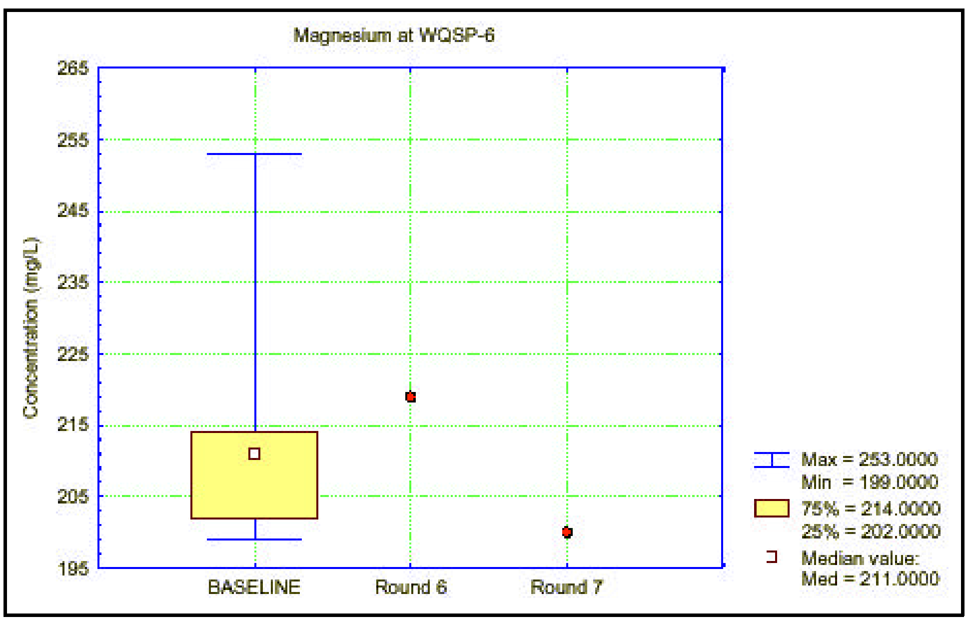


Figure 7.54 - Time Trend Plot for Magnesium at WQSP-6

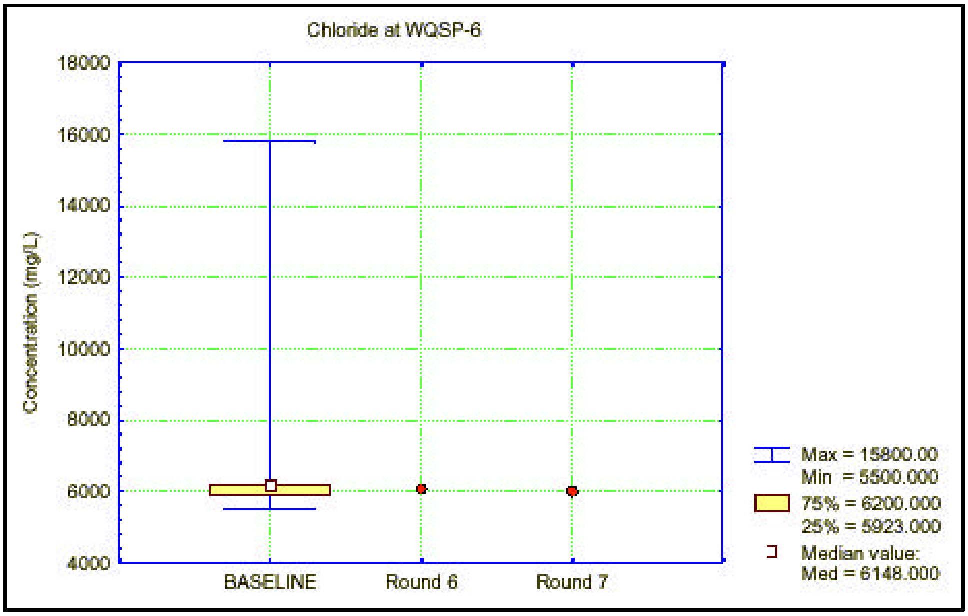


Figure 7.55 - Time Trend Plot for Chloride WQSP-6

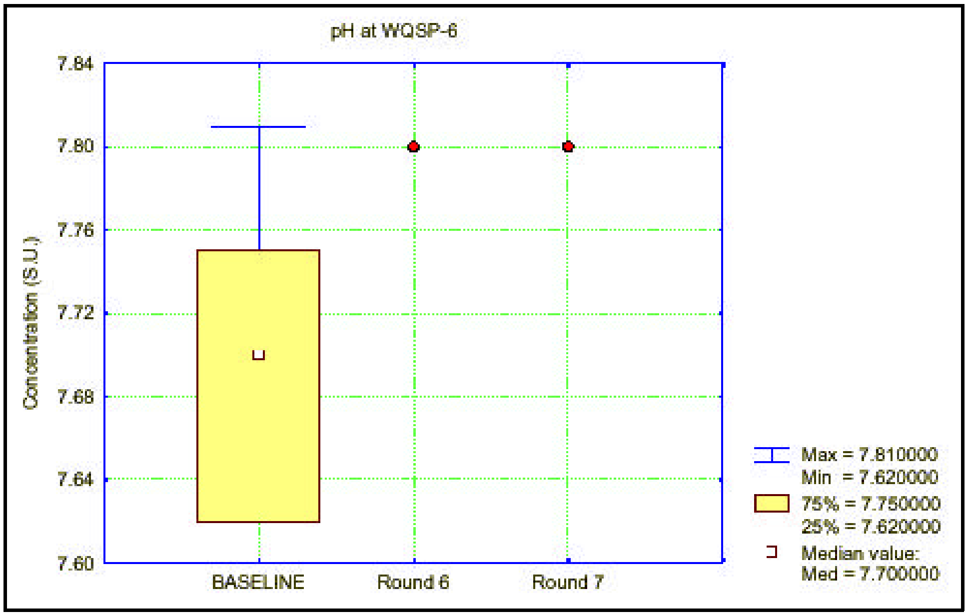


Figure 7.56- Time Trend Plot for pH at WQSP-6

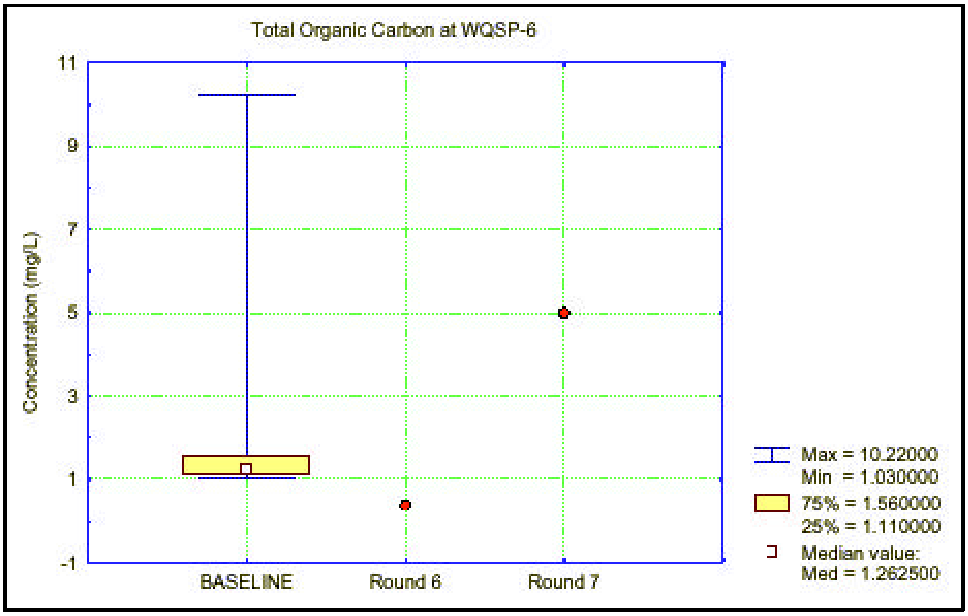


Figure 7.57 - Time Trend Plot for Total Organic Carbon at WQSP-6

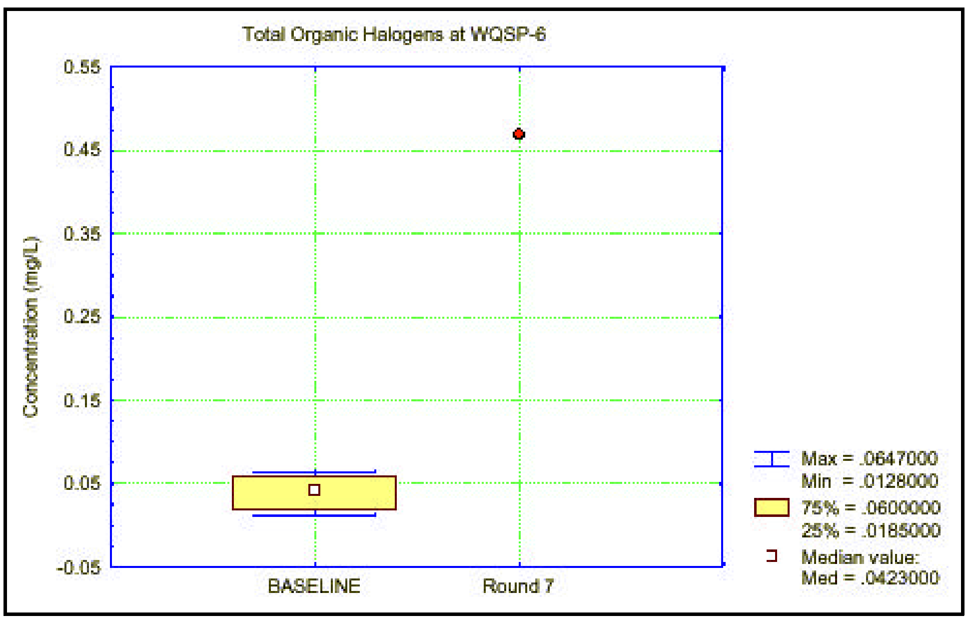


Figure 7.58 - Time Trend Plot for Total Organic Halogens at WQSP-6

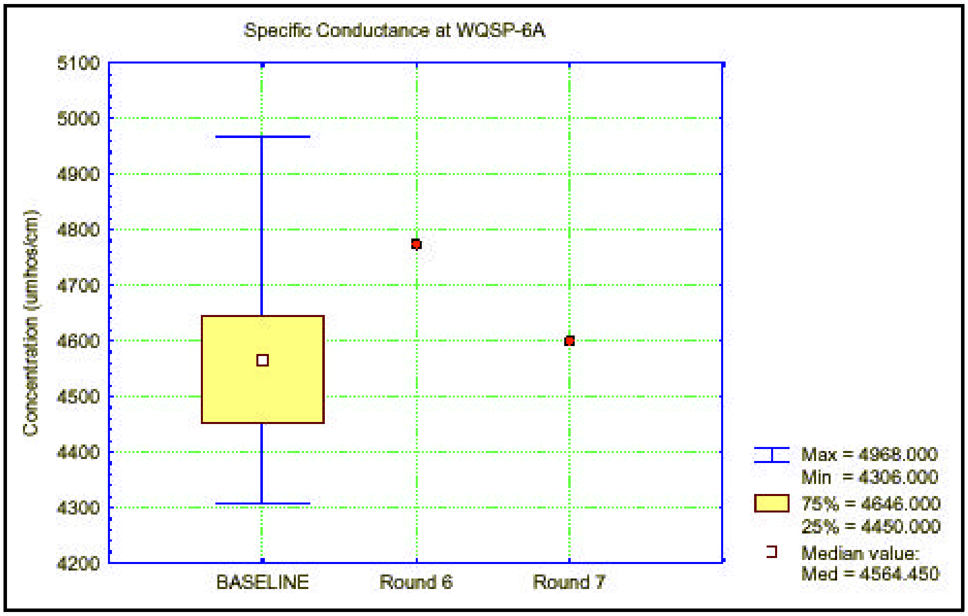


Figure 7.59 - Time Trend Plot for Specific Conductance at WQSP-6A

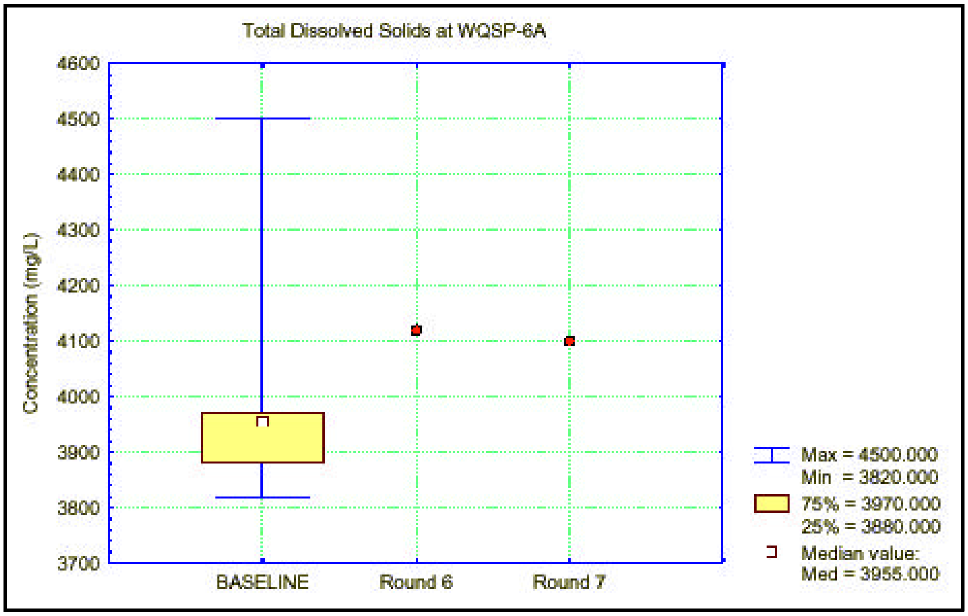


Figure 7.60 - Time Trend Plot for Total Dissolved Solids at WQSP-6A

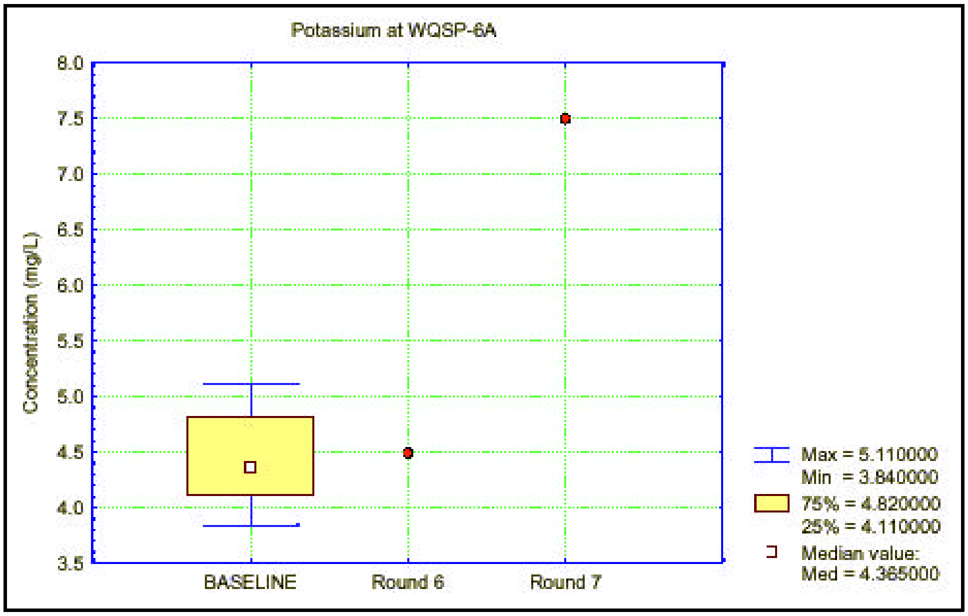


Figure 7.61 - Time Trend Plot for Potassium at WQSP-6A

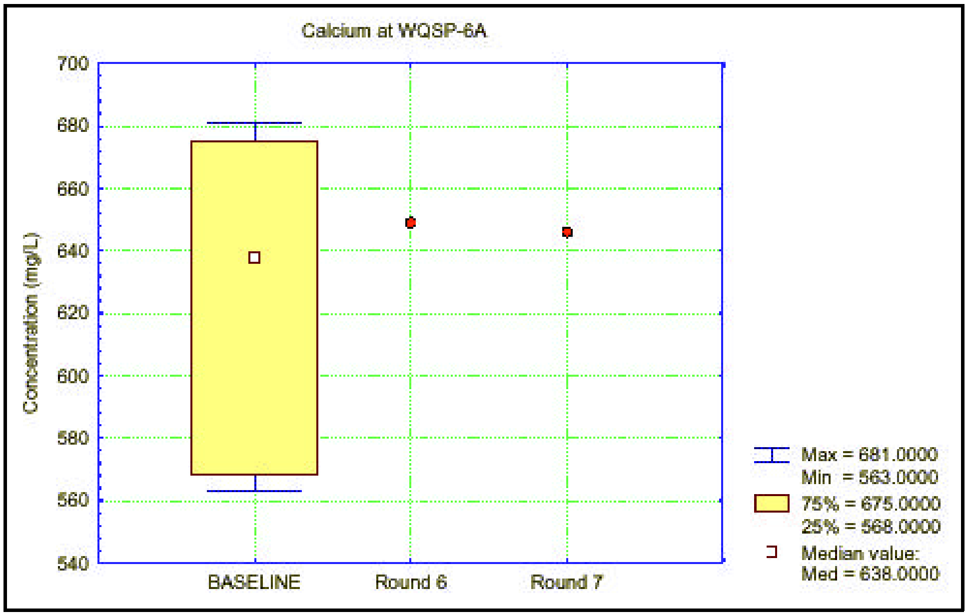


Figure 7.62 - Time Trend Plot for Calcium at WQSP-6A

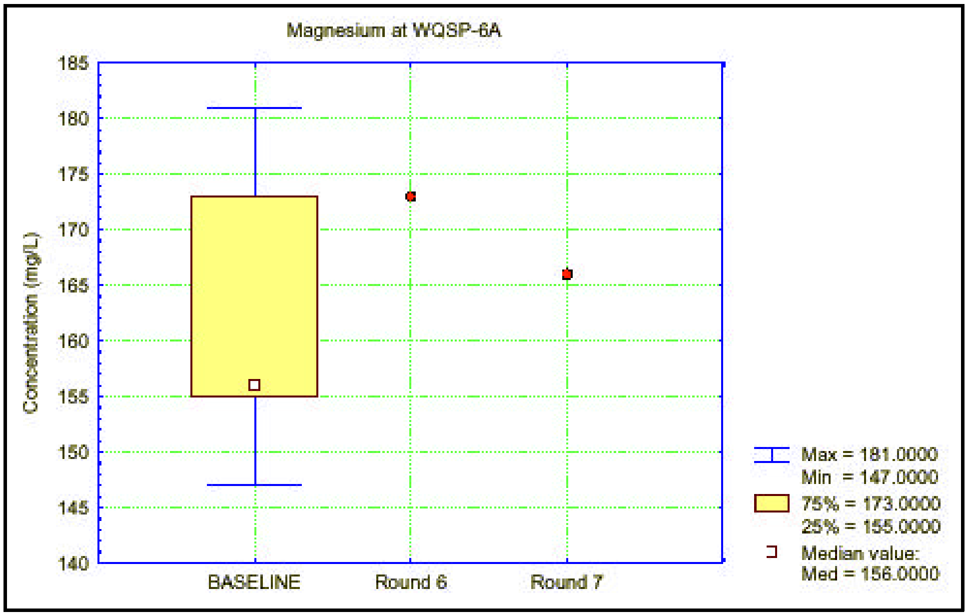


Figure 7.63 - Time Trend Plot for Magnesium at WQSP-6A

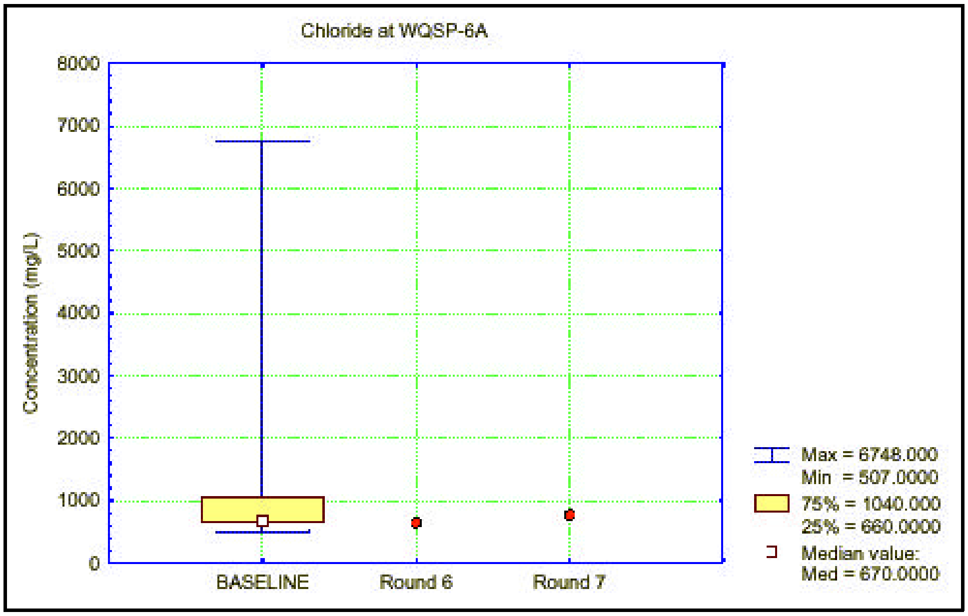


Figure 7.64 - Time Trend Plot for Chloride at WQSP-6A

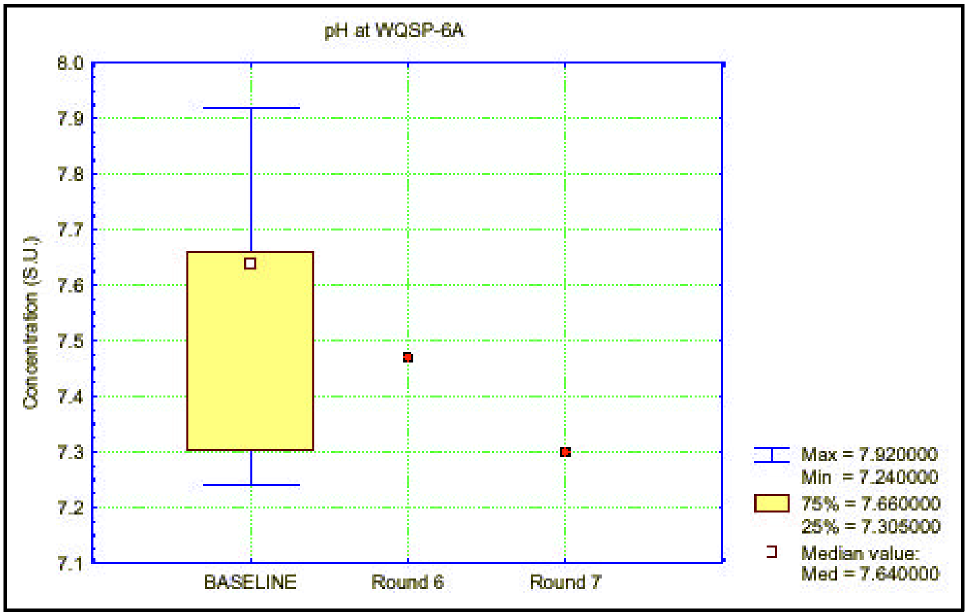


Figure 7.65 - Time Trend Plot for pH WQSP-6A

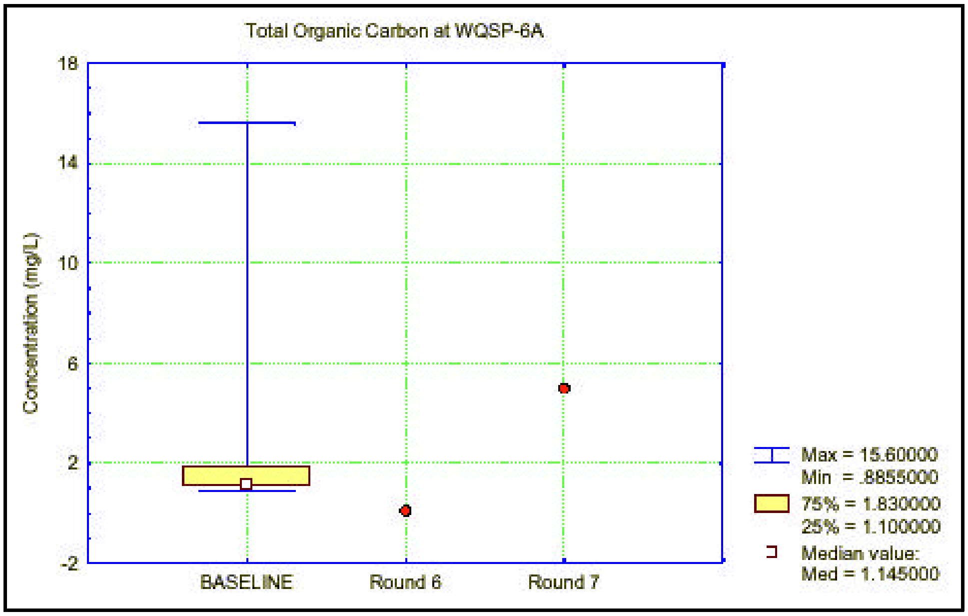


Figure 7.66 - Time Trend Plot for Total Organic Carbon at WQSP-6A

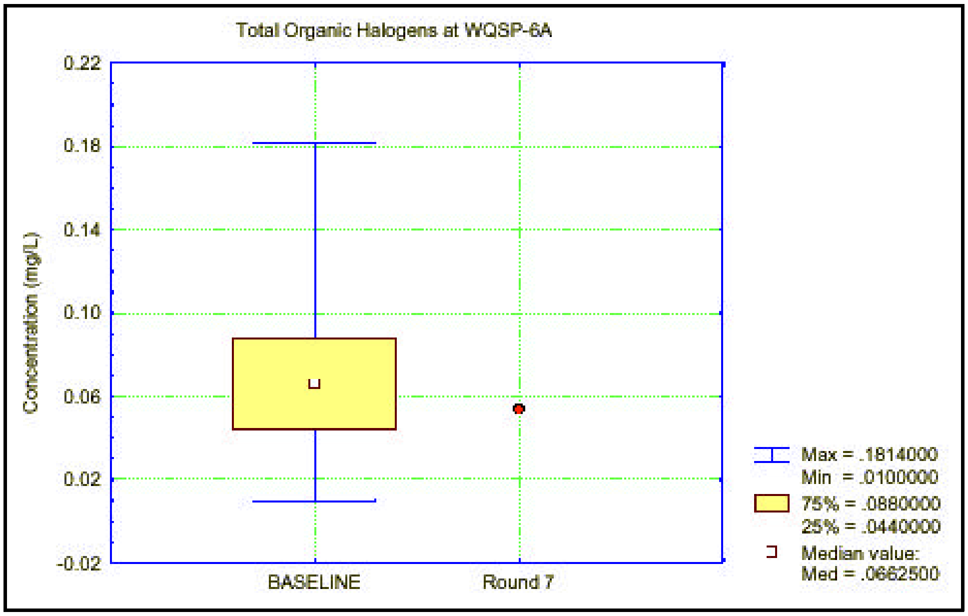


Figure 7.67 - Time Trend Plot for Total Organic Halogens at WQSP-6A

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CHAPTER 8 RADIOLOGICAL DOSE ASSESSMENT

This SER evaluates environmental radiological data for CY 1998. During this period we did not store any TRU waste at the WIPP site, so the radiation dose received by the general public living in the vicinity of the WIPP site would be limited to the background radiation.

The background sources of radiation include radiation from the natural sources, such as cosmic, cosmogenic radionuclides (carbon 14, Be-7, and hydrogen [H-3]), and the naturally occurring radionuclides, such as K-40, and thorium, uranium, and actinium series with their progeny. Background radiation also includes the radiation from the man-made radionuclides present in the environment, such as Sr-90, Cs-137, Pu-239+240, Am-241, etc., from the fallout of the aboveground nuclear tests, and the radionuclides released from nuclear accidents such as Chernobyl.

The radionuclides present in our environment can give both internal and external doses; however, internal dose is caused by the intake of radionuclides in humans. The major routes of intake of radionuclides in general public are ingestion and inhalation. Ingestion includes the intake of the radionuclides from drinking milk and water, and consumption of agricultural and meat products. Inhalation includes the intake of radionuclides through breathing of the dust particles containing radioactive materials.

Table 8.1 - Estimated Total Effective Dose Equivalent Rate for the Members of the General Populations of the United States and Canada from Various Sources of Natural Background Radiation

Sources	Total Effective Dose Equivalent Rate (mrem/y)‡					
	Lung	Gonads	Bone Surface	Bone Marrow	Other Tissues	Total
W_T	0.12	0.25	0.03	0.12	0.48	1.0
Cosmic	3	7	1	3	13	27
Cosmo genic	0.1	0.2	-	0.4	0.3	1
Terrestrial	3	7	1	3	14	28
Inhaled	200	-	-	-	-	200
In the body	4	9	3	6	17	40
Rounded totals	**210**	**23**	**5**	**12**	**44**	**300**

‡ 1 mrem (millirem) = 0.01 mSv (millisievert)

It is evident from the above table that the members of the general population of the United States, on the average, receive a background radiation dose of approximately

3 mSv/yr, or 300 mrem/yr (NCRP-94). United Nations Scientific Committee on the Effects of Atomic Radiation, however, estimated the background radiation dose of 2.2 mSv/yr or 220 mrem/yr (UNSCEAR-1986). A person living in Colorado would receive dose as high as 900 mrem/yr. It is therefore quite appropriate to say that the background radiation dose received by the general public living around the WIPP site would most likely be between 200-300 mrem/yr range.

TRU wastes to be disposed at the WIPP site have been divided into two categories based on surface dose rate: contact-handled (CH) TRU waste was less than 200 mrem/hr; and remote-handled (RH) TRU waste was greater than or equal to 200 mrem/hr. The CH TRU and RH TRU wastes contain TRU radionuclides, such as Pu-238, Pu-239+240, and Am-241, in concentrations of 100 nCi/g or greater, but the RH TRU wastes typically have greater levels of gamma-emitting radionuclides. These greater levels of gamma-emitting radionuclides result in the higher surface dose rates.

Ingestion is not a significant route of intake for TRU elements in human because the fractional uptake from the small intestine to the blood for common chemical forms of these radionuclides is very low. The fractions absorbed are on the order of 10^{-3} to 10^{-5}. Also, the concentrations of Pu-238, Pu-239+240, and Am-241 in food items are very low (lower than their MDA), which can be inferred from the measurements of these radionuclides in fish, deer, quail, rabbit, and vegetation. Therefore, the intake and uptake of TRU elements in the general population through ingestion, and the radiation dose to tissue or organs, would be very low, mostly negligible.

8.1 Derived Concentration Guides

Derived Concentration Guides are reference values for conducting radiological protection programs at operational DOE facilities. The DCG values are for an EDE of 0.1 mSv (10 mrem) (inhalation) for a year as required by 40 CFR § 61 and DOE Order 5400.5. Inhalation is the major potential route of intake for TRU elements disposed at the WIPP site. Therefore, the radiological environmental data for air particulates were analyzed in detail. The results for the measurements of TRU elements in air particulate samples revealed that the concentrations of Pu-238, Pu-239+240, and Am-241 were below their MDAs. However, to perform dose assessment the best estimated mean concentrations of these radionuclides in air particulate samples were taken. The concentrations were as follows:

Radionuclide	Mean Concentration (Bq/m^3)
Am-241	2.23 E-07
Pu-238	<0
Pu-239+240	1.36 E-07

These concentrations were converted into µCi/ml (microcurie per milliliter) of air and compared with the DCG values. The resulting concentrations and the DCG values are given below.

Radionuclide	DCG Values	Mean Concentration (MC)	Ratio MC/DCG
	(µCi/ml)		
Am-241	2E-15	6E-18	0.003
Pu-238	3E-15	<0	N/A
Pu-239+240	2E-15	3E-18	0.0015

These results clearly indicate that mean activities of Pu-238, Pu-239+240, and Am-241 reported in air particulate samples were only <0.02,0.15, 0.30 percent of DCG values, respectively. The Pu-239+240 concentration was 0.0015, or 0.15 percent, of DCG; and Am-241 concentration was 0.0030, or 0.30 percent, of DCG. However, we must keep in mind that the reported activities of TRU elements in air particulate samples are very low concentration in the environment with large measurement uncertainties.

CHAPTER 9 QUALITY ASSURANCE

The fundamental objective of QA programs is to ensure that high-quality measurements are produced and reported from the analytical laboratory. The defensibility of data generated by laboratories must be based on sound scientific principles, method evaluations, and data verification and validation. Thermo NuTech, in Albuquerque, New Mexico, and Trace Analysis, in Lubbock, Texas, were the contract laboratories that performed the radiological and nonradiological analyses for WIPP environmental samples.

The laboratories were required to have documented QA programs and standard procedures to perform the work, and to participate in comparison programs with the National Institute of Standards and Technology (NIST), Environmental Monitoring Laboratory, and/or any other reputable intercomparison programs. Elements of the requirements outlined in the following documents were included in the contract laboratory's QA program.

- ASME NQA-1-1994, "Quality Assurance Program Requirements for Nuclear Facilities"
- 10 CFR § 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,"
- EPA/600 14-83-004, QAMS-005/80, "Interim Guidelines and Specification for Preparing Quality Assurance Project Plans"
- NRC Regulatory Guide 4.15, Rev. 1, "Quality Assurance for Radiological Monitoring Program-Effluent Streams and the Environment"
- HPS N13.30 ANSI [American National Standards Institute], "Performance Criteria for Radiobioassay"
- Proposed ANSI/ASQC-E4, "Quality Assurance Program Requirements for Environmental Programs"

The WID Environmental Monitoring Section performed assessments and audits to ensure that the quality of the systems, processes, and deliverables was maintained or improved. Along with these regulatory requirements, Environmental Monitoring also implements DOE O 414.1, "Quality Assurance." The parameters for performance evaluations are completeness, reproducibility, accuracy, comparability, and representativeness.

Completeness: The completeness parameter was calculated as the ratio of number of measurements that were valid to the total number of measurements completed. The gross alpha/beta analyses were 98 percent complete for CY 1998. The measurements reported for various radionuclides in different matrices, such as composite air samples, groundwater, surface water, soil, and vegetation, were 100 percent complete. The data quality objective (DQO) established for environmental samples was at 95 percent completeness of analyses. The environmental group not only achieved that goal but was at 100 percent, which was a recognized achievement. The samples that yielded low/high recovery (50 to 120 percent outside this range) were reanalyzed.

Reproducibility: The reproducibility of the measurements was validated through duplicate analyses of the samples. A low-volume air sampler was rotated in each quarter from location to location, and sampled along with routine samples. The duplicate samples for each matrix were collected at the same time, same place, and under similar conditions as routine samples. These samples were analyzed in the same analytical batch and/or sample delivery group (SDG) using similar methods for radiochemical separation and counting as the original samples. Reproducibility is partially influenced by statistical counting uncertainty, so variances were expected between samples with very low activities (environmental levels). The reproducibility was evaluated with RER, which was less than unity:

$$RER = \frac{(Mean\ Activity)_{ori} - (Mean\ Activity)_{dup}}{\sqrt{(S.D.)^2_{ori} + (S.D.)^2_{dup}}}$$

Where:
ori. = Mean Activity of Original Sample
dup. = Mean Activity of Duplicate Sample
S.D. = Standard Deviation of Original and Duplicate Samples

Accuracy: The accuracy of the analyses were assured/controlled by using NIST-traceable standards for instrument calibration. Internal checks were performed by using spiked matrix samples. Intercomparisons were performed with the Environmental Monitoring laboratory to ensure the reliability of radiochemical separation methods and counting instruments. Accuracy, expressed as percent bias, was calculated by:

$$\%\ BIAS = [\frac{A_m - A_k}{A_k}] * 100$$

Where:
% BIAS = Percent Bias
A_m = Measured Sample Activity
A_k = Known Sample Activity

Comparability: The EPA Performance Evaluation Program provides results to each participant in the study for comparison. The Thermo NuTech contract laboratory also participated in this program; the results are provided in tables 9.1.1, 9.1.2, and 9.1.3 for air, soil, and vegetation respectively.

The contract laboratory's percent bias in evaluating air filters was -20.93 percent for ^{57}Co and -22.81 percent for ^{137}Cs, which implies a warning in the intercomparison program. The percent bias has to be within -0.25 to +0.50 of the EML (Environmental Measurements

Laboratory) value. The gross alpha/beta analyses for air filters were not acceptable; however, these analyses for WIPP environmental samples were not performed by the contract laboratory.

All the reported values for radionuclides in the soil matrix were acceptable. The vegetation samples had a warning for ^{60}Co with a positive bias of 22.43 percent, ^{244}Cm with a negative bias of 31.32 percent, and ^{90}Sr with a negative bias of 18.78 percent. The gross alpha was not acceptable, but it was not a major concern as gross alpha/beta on vegetation samples are not performed for WIPP environmental samples.

Table 9.1.1 - Performance Evaluation of Thermo NuTech Contract Laboratory

Air (Bq/filter)					
Radionuclide	**Reported Value (Bq/filter)**	**Reported Error**	**EML Value**	**EML Error**	**% Bias**
^{57}Co	2.38	0.10	3.01	0.14	-20.93
^{60}Co	4.06	0.19	4.96	0.28	-18.15
^{90}Sr	0.71	0.19	0.64	0.01	10.75
^{125}Sb	2.98	0.31	3.59	0.31	-16.99
^{137}Cs	4.67	0.21	6.05	0.30	-22.81
^{238}Pu	0.29	0.03	0.27	0.00	6.99
^{239}Pu	0.14	0.02	0.12	0.00	9.68
^{241}Am	0.13	0.02	0.13	0.00	-0.75
Gross Alpha	0.62	0.10	1.61	0.16	-61.55
Gross Beta	0.37	0.07	1.56	0.16	-76.03
ug/filter U	5.21	0.27	4.94	0.23	5.47

Table 9.1.2 - Performance Evaluation of Thermo NuTech Contract Laboratory

Soil (Bq/kg)					
Radionuclide	Reported Value (Bq/filter)	Reported Error	**EML Value**	**EML Error**	**% Bias**
^{40}K	406.00	47.00	363.00	20.00	11.85
^{90}Sr	35.20	7.29	32.40	0.53	8.64
^{137}Cs	711.00	23.50	660.00	25.00	7.73
^{214}Bi	64.90	7.73	69.90	5.70	-7.15
^{214}Pb	78.60	9.91	71.00	7.00	10.70
^{228}Ac	48.10	14.90	47.20	3.00	1.91
^{234}Th	164.00	29.20	138.00	4.10	18.84
^{239}Pu	9.32	1.81	8.11	1.10	14.97
^{241}Am	4.88	1.72	4.89	0.97	-0.12
ug/filter U	11.80	0.61	11.80	0.30	0.00

Table 9.1.3 - Performance Evaluation of Thermo NuTech Contract Laboratory					
Vegetation (Bq/kg)					
Radionuclide	Reported Value (Bq/filter)	Reported Error	EML Value	EML Error	%Bias
^{40}K	681.00	40.70	656.00	20.00	3.81
^{60}Co	26.20	2.63	21.40	1.00	22.43
^{90}Sr	752.00	93.00	736.00	7.80	2.17
^{137}Cs	530.00	15.80	467.00	20.00	13.49
^{239}Pu	5.03	0.63	5.20	0.43	-3.23
^{241}Am	3.33	0.54	3.52	0.59	-5.40
^{244}Cm	1.15	0.26	1.67	0.54	-31.32
^{3}H	113.00	8.28	121.00	6.80	-6.61
^{60}Co	55.80	1.77	51.10	3.00	9.20
^{90}Sr	3.33	0.32	4.10	0.05	-18.78
^{137}Cs	44.70	1.42	39.40	2.40	13.45
^{238}Pu	0.80	0.12	0.77	0.04	3.11
^{239}Pu	1.04	0.15	1.01	0.06	3.17
^{241}Am	1.12	0.14	1.15	0.05	-2.26
Gross Alpha	1560.00	182.00	1090.00	20.00	43.12
Gross Beta	1130.00	91.10	1100.00	40.00	2.73
ug/filter U	0.02	0.00	0.02	0.00	8.49

Representativeness: The primary objective of the environmental monitoring has been to protect the health and safety of the population surrounding the WIPP facility. The quality objective of representativeness was based on potential radiation exposure of the population through inhalation and ingestion. The ambient air samples, surface water and sediment samples, groundwater, and biota samples were collected from areas representative to potential pathways for intake. These samples were analyzed for natural radioactivity from anthropogenic radionuclides and fallout radioactivity from nuclear testings. The reported concentrations at various locations were representative of the baseline information for radionuclides of interest at the WIPP facility.

CHAPTER 10 REFERENCES

10 CFR. "Energy." 1996.

40 CFR. "Protection of the Environment." 1996.

40 CFR § 122. EPA Administered Permit Programs: the National Pollutant Discharge Elimination System.

40 CFR § 300. "National Oil and Hazardous Substances Pollution Contingency Plan."

43 CFR. "Public Lands: Interior." 1996.

49 CFR. "Transportation." 1996.

7 U.S.C. 136-136y. Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

16 U.S.C. 1531-1544, 87 Stat. 884. Endangered Species Act of 1973.

16 U.S.C. § 470 et seq. National Historic Preservation Act.

33 U.S.C. § 1251-1376; Chapter 758; PL 845; 62 Stat. 1155. Federal Water Pollution Control Act of 1948 (Clean Water Act), Section 402.

42 U.S.C. § 2278a. Atomic Energy Act of 1954,

42 U.S.C. § 300f et seq. Safe Drinking Water Act.

42 U.S.C. § 3251 et seq. Resource Conservation and Recovery Act.

42 U.S.C. § 7112. "Organization Act."

42 U.S.C. § 7401 et seq. Clean Air Act

42 U.S.C. § 9601 et seq. Comprehensive Environmental Response, Compensation, and Liability Act (including the Superfund Amendments and Reauthorization Act of 1986).

43 U.S.C. § 1751 et seq. Federal Land Policy and Management Act, 1976.

49 App. U.S.C. § 1801 et seq.; 49 CFR § 106-179. Hazardous Materials Transportation Act.

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APPENDIX A - Location Codes

The location codes identify the sites from which samples were collected.

LOCATION CODES			
BHT	Bottom of the Hill Tank	RCP	Rainwater Catchment Pond
BRA	BRantley Lake	RED	RED tank
CBD	CarlsBaD	RNS	RiNSe aid blank
COW	COyote Well (deionized water blank)	SE1	South East 1
COY	COYote (surface water duplicate)	SE2	South East 2
CT1	ConTrol 1	SEC	South East Control
CT2	ConTrol 2	SMR	SMith Ranch
FWT	Fresh Water Tank	SOO	Sample Of Opportunity
HIL	HILI Tank	SEL	SEwage Lagoons
IDN	InDiaN Tank	TUT	TUT tank
LGS	Laguna Grande del Sol	UPR	Upper Pecos River
LST	LoSt Tank	WAB	WIPP Air Blank
MLR	MiLIs Ranch	WE1	WIPP East 1
NOY	NOYa tank	WEE	WIPP East
NW1	NorthWest1	WIP	WIPP 16 sections
NW2	NorthWest2	WFF	WIPP Far Field
PCN	Pierce CanyoN	WQSP	Water Quality Sample Program
PEC	PECos river	WSS	WIPP South
PKT	PoKer Trap		

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APPENDIX B - Concentrations of Alpha and Beta Activities in Air Particulate

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m^3	(2 Sigma)	Bq/m^3	(2 Sigma)
Carlsbad (CBD)					
1	AL-CBD-19980107 1.1	2.38E-05	3.27E-05	7.77E-04	1.03E-04
2	AL-CBD-19980114 1.1	-1.52E-05	3.74E-05	3.83E-04	9.48E-05
3	AL-CBD-19980121 1.1	5.29E-05	4.26E-05	9.44E-04	1.16E-04
4	AL-CBD-19980128 1.1	5.79E-05	4.90E-05	1.16E-03	1.25E-04
5	AL-CBD-19980204 1.1	1.63E-05	3.59E-05	4.54E-04	8.85E-05
6	AL-CBD-19980211 1.1	3.36E-05	3.72E-05	4.02E-04	8.82E-05
7	AL-CBD-19980218 1.1	-5.38E-06	4.03E-05	4.13E-04	9.55E-05
8	AL-CBD-19980225 1.1	-4.25E-06	3.84E-05	5.51E-04	1.05E-04
9	AL-CBD-19980304 1.1	4.16E-05	4.03E-05	7.59E-04	1.08E-04
10	AL-CBD-19980311 1.1	4.33E-05	3.58E-05	4.94E-04	9.23E-05
11	AL-CBD-19980318 1.1	7.54E-05	4.13E-05	7.40E-04	1.07E-04
12	AL-CBD-19980325 1.1	5.47E-05	3.96E-05	4.97E-04	1.06E-04
13	AL-CBD-19980401 1.2	3.47E-05	3.38E-05	4.52E-04	1.07E-04
14	AL-CBD-19980408 1.2	4.73E-05	4.65E-05	7.56E-04	1.22E-04
15	AL-CBD-19980415 1.2	1.05E-05	4.33E-05	5.79E-04	1.10E-04
16	AL-CBD-19980422 1.2	3.72E-05	4.03E-05	7.44E-04	1.09E-04
17	AL-CBD-19980429 1.2	3.79E-05	5.07E-05	8.03E-04	1.26E-04
18	AL-CBD-19980506 1.2	7.14E-05	4.77E-05	7.11E-04	1.18E-04
19	AL-CBD-19980513 1.2	8.78E-05	4.81E-05	6.93E-04	1.21E-04
20	AL-CBD-19980520 1.2	1.05E-04	5.55E-05	9.21E-04	1.26E-04
21	AL-CBD-19980527 1.2	1.26E-04	5.56E-05	1.08E-03	1.40E-04
22	AL-CBD-19980603 1.2	3.73E-05	4.17E-05	7.99E-04	1.19E-04
23	AL-CBD-19980610 1.2	2.95E-05	4.46E-05	5.39E-04	9.69E-05
24	AL-CBD-19980617 1.2	6.04E-05	5.02E-05	6.11E-04	1.11E-04
25	AL-CBD-19980624 1.2	6.39E-05	4.74E-05	6.04E-04	1.06E-04
26	AL-CBD-19980701 1.1	2.61E-07	3.69E-05	3.91E-04	9.54E-05
27	AL-CBD-19980708 1.1	6.50E-05	4.03E-05	7.55E-04	1.12E-04
28	AL-CBD-19980715 1.1	3.79E-05	4.31E-05	8.03E-04	1.13E-04
29	AL-CBD-19980722 1.1	2.99E-05	4.23E-05	4.17E-04	1.17E-04
30	AL-CBD-19980729 1.1	5.06E-05	3.70E-05	6.34E-04	1.03E-04
31	AL-CBD-19980805 1.1	7.14E-05	4.45E-05	7.79E-04	1.17E-04
32	AL-CBD-19980812 1.1	9.41E-05	4.69E-05	7.99E-04	1.17E-04
33	AL-CBD-19980819 1.1	3.22E-05	3.58E-05	5.63E-04	1.08E-04
34	AL-CBD-19980826 1.1	2.88E-05	4.02E-05	7.20E-04	1.10E-04
35	AL-CBD-19980902 1.1	4.21E-05	4.23E-05	1.12E-03	1.27E-04
36	AL-CBD-19980909 1.1	9.07E-05	4.66E-05	7.47E-04	1.12E-04

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m^3	(2 Sigma)	Bq/m^3	(2 Sigma)
37	AL-CBD-19980916 1.1	8.68E-05	3.24E-05	9.53E-04	9.50E-05
38	AL-CBD-19980923 1.1	6.38E-05	2.57E-05	6.84E-04	8.38E-05
39	AL-CBD-19980930 1.1	4.05E-05	2.26E-05	7.32E-04	8.51E-05
40	AL-CBD-19981007 1.1	3.99E-05	4.31E-05	1.15E-03	1.20E-04
41	AL-CBD-19981014 1.1	8.39E-05	3.67E-05	4.07E-04	9.57E-05
42	AL-CBD-19981021 1.1	9.72E-05	4.74E-05	7.96E-04	1.16E-04
43	AL-CBD-19981028 1.1	3.16E-05	3.46E-05	3.31E-04	8.65E-05
44	AL-CBD-19981104 1.1	3.71E-05	3.76E-05	4.24E-04	9.11E-05
45	AL-CBD-19981111 1.1	1.36E-04	4.18E-05	1.23E-03	1.08E-04
46	AL-CBD-19981118 1.1	3.83E-05	2.47E-05	1.31E-03	1.07E-04
47	AL-CBD-19981125 1.1	N/A	N/A	N/A	N/A
48	AL-CBD-19981202 1.1	2.09E-05	2.31E-05	6.41E-04	7.83E-05
49	AL-CBD-19981209 1.1	4.36E-05	2.41E-05	1.19E-03	1.01E-04
50	AL-CBD-19981216 1.1	4.65E-05	2.76E-05	1.34E-03	1.10E-04
51	AL-CBD-19981223 1.1	3.40E-05	2.16E-05	1.15E-03	9.83E-05
52	AL-CBD-19981230 1.1	3.73E-05	2.46E-05	9.13E-04	9.12E-05
Smith Ranch (SMR)					
1	AL-SMR-19980107 1.2	2.38E-05	3.27E-05	7.77E-04	1.03E-04
2	AL-SMR-19980114 1.2	-2.20E-05	3.68E-05	4.14E-04	9.70E-05
3	AL-SMR-19980121 1.2	5.29E-05	4.26E-05	9.44E-04	1.16E-04
4	AL-SMR-19980128 1.2	3.42E-05	4.62E-05	1.06E-03	1.23E-04
5	AL-SMR-19980204 1.2	3.85E-05	3.94E-05	4.92E-04	9.05E-05
6	AL-SMR-19980211 1.2	5.17E-05	4.08E-05	4.37E-04	9.14E-05
7	AL-SMR-19980218 1.2	1.57E-05	4.36E-05	4.28E-04	9.68E-05
8	AL-SMR-19980225 1.2	1.41E-05	4.41E-08	5.43E-04	1.11E-04
9	AL-SMR-19980304 1.2	3.13E-05	3.91E-05	7.40E-04	1.08E-04
10	AL-SMR-19980311 1.2	4.24E-05	3.62E-05	4.81E-04	9.33E-05
11	AL-SMR-19980318 1.2	4.71E-05	3.67E-05	6.62E-04	1.05E-04
12	AL-SMR-19980325 1.2	4.21E-05	3.69E-05	3.25E-04	9.85E-05
13	AL-SMR-19980401 1.1	5.40E-05	3.61E-05	3.91E-04	1.02E-04
14	AL-SMR-19980408 1.1	4.97E-05	4.49E-05	5.69E-04	1.12E-04
15	AL-SMR-19980415 1.1	3.36E-05	4.71E-05	6.36E-04	1.14E-04
16	AL-SMR-19980422 1.1	N/A	N/A	N/A	N/A
17	AL-SMR-19980429 1.1	7.11E-05	4.95E-05	8.83E-04	1.33E-04
18	AL-SMR-19980506 1.1	9.86E-06	3.60E-05	6.56E-04	1.10E-04
19	AL-SMR-19980513 1.1	N/A	N/A	N/A	N/A
20	AL-SMR-19980520 1.1	8.82E-05	4.97E-05	7.61E-04	1.12E-04
21	AL-SMR-19980527 1.1	1.09E-04	5.32E-05	1.03E-03	1.38E-04

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m^3	(2 Sigma)	Bq/m^3	(2 Sigma)
22	AL-SMR-19980603 1.1	7.11E-05	4.78E-05	8.57E-04	1.25E-04
23	AL-SMR-19980610 1.1	1.41E-05	4.43E-05	7.52E-04	1.09E-04
24	AL-SMR-19980617 1.1	8.98E-05	5.36E-05	5.36E-04	1.08E-04
25	AL-SMR-19980624 1.1	4.77E-05	4.54E-05	4.56E-04	1.01E-04
26	AL-SMR-19980701 1.1	-1.17E-05	3.49E-05	3.49E-04	9.40E-05
27	AL-SMR-19980708 1.1	6.83E-05	4.00E-05	7.01E-04	1.08E-04
28	AL-SMR-19980715 1.1	9.70E-05	5.04E-05	8.43E-04	1.13E-04
29	AL-SMR-19980722 1.1	2.49E-05	3.96E-05	4.91E-04	1.14E-04
30	AL-SMR-19980729 1.1	6.21E-05	4.00E-05	6.68E-04	1.08E-04
31	AL-SMR-19980805 1.1	6.43E-05	4.22E-05	5.79E-04	1.08E-04
32	AL-SMR-19980812 1.1	5.02E-05	3.99E-05	7.19E-04	1.12E-04
33	AL-SMR-19980819 1.1	1.92E-05	3.26E-05	4.44E-04	1.02E-04
34	AL-SMR-19980826 1.1	5.82E-05	4.59E-05	7.91E-04	1.16E-04
35	AL-SMR-19980902 1.1	5.03E-05	4.43E-05	1.21E-03	1.31E-04
36	AL-SMR-19980909 1.1	5.32E-05	4.03E-05	6.11E-04	1.06E-04
37	AL-SMR-19980916 1.1	7.19E-05	3.08E-05	9.22E-04	9.64E-05
38	AL-SMR-19980923 1.1	5.94E-05	2.49E-05	7.05E-04	8.52E-05
39	AL-SMR-19980930 1.1	4.64E-05	2.40E-05	6.58E-04	8.22E-05
40	AL-SMR-19981007 1.1	4.26E-05	4.36E-05	8.86E-04	1.13E-04
41	AL-SMR-19981014 1.1	5.97E-05	3.30E-05	3.69E-04	9.84E-05
42	AL-SMR-19981021 1.1	5.38E-05	3.81E-05	7.71E-04	1.08E-04
43	AL-SMR-19981028 1.1	1.70E-05	4.00E-05	1.72E-04	1.06E-04
44	AL-SMR-19981104 1.1	1.69E-05	3.49E-05	4.60E-04	9.43E-05
45	AL-SMR-19981111 1.1	1.21E-04	3.97E-05	1.18E-03	1.06E-04
46	AL-SMR-19981118 1.1	3.18E-05	2.39E-05	1.32E-03	1.09E-04
47	AL-SMR-19981125 1.1	2.28E-05	1.99E-05	1.15E-03	1.04E-04
48	AL-SMR-19981202 1.1	2.99E-05	2.54E-05	6.20E-04	7.87E-05
49	AL-SMR-19981209 1.1	4.48E-05	2.49E-05	1.33E-03	1.08E-04
50	AL-SMR-19981216 1.1	6.71E-05	2.99E-05	1.42E-03	1.10E-04
51	AL-SMR-19981223 1.1	3.19E-05	2.16E-05	1.21E-03	1.02E-04
52	AL-SMR-19981230 1.1	1.98E-05	2.06E-05	9.64E-04	9.22E-05
WIPP East (WEE)					
1	AL-WEE-19980107 1.1	8.87E-06	3.44E-05	6.19E-04	1.10E-04
2	AL-WEE-19980114 1.1	1.70E-05	4.17E-05	4.49E-04	9.66E-05
3	AL-WEE-19980121 1.1	5.12E-05	4.40E-05	1.01E-03	1.21E-04
4	AL-WEE-19980128 1.1	4.60E-05	4.89E-05	9.94E-04	1.24E-04
5	AL-WEE-19980204 1.1	1.70E-06	3.67E-05	5.01E-04	9.72E-05
6	AL-WEE-19980211 1.1	2.96E-05	4.04E-05	5.32E-04	1.02E-04

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m^3	(2 Sigma)	Bq/m^3	(2 Sigma)
7	AL-WEE-19980218 1.1	-1.22E-05	4.13E-05	4.37E-04	1.00E-04
8	AL-WEE-19980225 1.1	6.41E-05	4.89E-05	5.59E-04	1.07E-04
9	AL-WEE-19980304 1.1	4.30E-05	3.93E-05	6.31E-05	1.01E-04
10	AL-WEE-19980311 1.1	8.06E-05	4.42E-05	5.34E-04	1.01E-04
11	AL-WEE-19980318 1.1	7.83E-05	4.20E-05	6.58E-04	1.05E-04
12	AL-WEE-19980325 1.1	5.86E-05	4.06E-05	3.59E-04	1.03E-04
13	AL-WEE-19980401 1.1	3.97E-05	3.43E-05	3.46E-04	1.04E-04
14	AL-WEE-19980408 1.1	4.55E-05	4.56E-05	6.38E-04	1.17E-04
15	AL-WEE-19980415 1.1	3.19E-05	4.44E-05	4.69E-04	1.03E-04
16	AL-WEE-19980422 1.1	5.68E-05	4.52E-05	6.21E-04	1.11E-04
17	AL-WEE-19980429 1.1	8.14E-05	6.22E-05	7.38E-04	1.38E-04
18	AL-WEE-19980506 1.1	1.20E-04	5.34E-05	7.15E-04	1.17E-04
19	AL-WEE-19980513 1.1	1.42E-04	5.77E-05	7.80E-04	1.32E-04
20	AL-WEE-19980520 1.1	N/A	N/A	N/A	N/A
21	AL-WEE-19980527 1.1	1.23E-04	5.27E-05	9.06E-04	1.27E-04
22	AL-WEE-19980603 1.1	1.04E-04	5.16E-05	7.36E-04	1.19E-04
23	AL-WEE-19980610 1.1	1.93E-05	4.66E-05	6.45E-04	1.08E-04
24	AL-WEE-19980617 1.1	6.71E-05	5.02E-05	4.89E-04	1.05E-04
25	AL-WEE-19980624 1.1	1.04E-05	3.84E-05	4.49E-04	9.72E-05
26	AL-WEE-19980701 1.1	2.08E-05	4.06E-05	3.84E-04	9.59E-05
27	AL-WEE-19980708 1.1	7.75E-05	4.06E-05	5.94E-04	1.02E-04
28	AL-WEE-19980715 1.1	3.67E-05	4.24E-05	7.29E-04	1.10E-04
29	AL-WEE-19980722 1.1	4.67E-05	4.38E-05	3.99E-04	1.13E-04
30	AL-WEE-19980729 1.1	6.72E-05	3.96E-05	6.18E-04	1.03E-04
31	AL-WEE-19980805 1.1	7.59E-05	4.54E-05	7.09E-04	1.16E-04
32	AL-WEE-19980812 1.1	5.31E-05	4.02E-05	7.80E-04	1.14E-04
33	AL-WEE-19980819 1.1	5.08E-05	3.85E-05	4.03E-04	1.01E-04
34	AL-WEE-19980826 1.1	8.15E-05	4.90E-05	7.95E-04	1.16E-04
35	AL-WEE-19980902 1.1	9.24E-05	5.10E-05	1.38E-03	1.39E-04
36	AL-WEE-19980909 1.1	1.09E-05	3.39E-05	7.02E-04	1.10E-04
37	AL-WEE-19980916 1.1	7.10E-05	2.98E-05	9.64E-04	9.55E-05
38	AL-WEE-19980923 1.1	5.06E-05	2.36E-05	7.55E-04	9.04E-05
39	AL-WEE-19980930 1.1	6.64E-05	2.84E-05	8.02E-04	9.04E-05
40	AL-WEE-19981007 1.1	7.36E-05	4.97E-05	1.08E-03	1.22E-04
41	AL-WEE-19981014 1.1	6.73E-05	3.58E-05	4.92E-04	1.06E-04
42	AL-WEE-19981021 1.1	5.68E-05	3.97E-05	7.84E-04	1.12E-04
43	AL-WEE-19981028 1.1	5.19E-05	4.45E-05	2.89E-04	1.03E-04
44	AL-WEE-19981104 1.1	2.88E-05	3.86E-05	5.33E-04	1.00E-04
45	AL-WEE-19981111 1.1	1.03E-04	3.71E-05	1.22E-03	1.08E-04

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m^3	(2 Sigma)	Bq/m^3	(2 Sigma)
46	AL-WEE-19981118 1.1	5.09E-05	2.82E-05	1.37E-03	1.13E-04
47	AL-WEE-19981125 1.1	2.37E-05	2.07E-05	1.04E-03	1.02E-04
48	AL-WEE-19981202 1.1	3.55E-05	2.70E-05	6.23E-04	8.03E-05
49	AL-WEE-19981209 1.1	3.59E-05	2.35E-05	1.19E-03	1.05E-05
50	AL-WEE-19981216 1.1	4.77E-05	3.37E-05	1.61E-03	1.39E-04
51	AL-WEE-19981223 1.1	5.07E-05	2.50E-05	1.23E-03	1.01E-04
52	AL-WEE-19981230 1.1	2.04E-05	2.13E-05	1.09E-03	9.87E-05
Mills Ranch (MLR)					
1	AL-MLR-19980107 1.1	3.71E-05	3.65E-05	6.27E-04	1.03E-04
2	AL-MLR-19980114 1.1	-2.22E-05	3.69E-05	4.24E-04	9.76E-05
3	AL-MLR-19980121 1.1	4.85E-05	4.29E-05	9.60E-04	1.18E-04
4	AL-MLR-19980128 1.1	4.53E-05	4.92E-05	1.10E-03	1.28E-04
5	AL-MLR-19980204 1.1	4.04E-05	3.94E-05	4.37E-04	8.78E-05
6	AL-MLR-19980211 1.1	8.68E-05	4.62E-05	4.02E-04	9.14E-05
7	AL-MLR-19980218 1.1	1.03E-05	4.36E-05	3.37E-04	9.46E-05
8	AL-MLR-19980225 1.1	2.29E-05	4.28E-05	5.12E-04	1.04E-04
9	AL-MLR-19980304 1.1	4.01E-05	3.98E-05	6.12E-04	1.03E-04
10	AL-MLR-19980311 1.1	5.69E-05	3.86E-05	4.46E-04	9.24E-05
11	AL-MLR-19980318 1.1	6.08E-05	3.99E-05	8.18E-04	1.11E-04
12	AL-MLR-19980325 1.1	5.66E-05	4.09E-05	4.40E-04	1.07E-04
13	AL-MLR-19980401 1.1	4.06E-05	3.47E-05	4.52E-04	1.07E-04
14	AL-MLR-19980408 1.1	3.16E-05	4.21E-05	7.30E-04	1.16E-04
15	AL-MLR-19980415 1.1	4.99E-06	4.40E-05	6.60E-04	1.16E-04
16	AL-MLR-19980422 1.1	1.39E-05	3.67E-05	5.29E-04	1.03E-04
17	AL-MLR-19980429 1.1	6.21E-05	5.56E-05	7.54E-04	1.29E-04
18	AL-MLR-19980506 1.1	9.71E-05	4.79E-05	5.88E-04	1.06E-04
19	AL-MLR-19980513 1.1	1.07E-04	5.27E-05	8.02E-04	1.31E-04
20	AL-MLR-19980520 1.1	8.59E-05	4.94E-05	8.53E-04	1.15E-04
21	AL-MLR-19980527 1.1	1.11E-04	5.08E-05	8.30E-04	1.24E-04
22	AL-MLR-19980603 1.1	N/A	N/A	N/A	N/A
23	AL-MLR-19980610 1.1	6.82E-05	4.95E-05	6.26E-04	1.00E-04
24	AL-MLR-19980617 1.1	N/A	N/A	N/A	N/A
25	AL-MLR-19980624 1.1	N/A	N/A	N/A	N/A
26	AL-MLR-19980701 1.1	-1.12E-05	3.26E-05	3.36E-04	8.85E-05
27	AL-MLR-1998-708 1.1	5.93E-05	4.01E-05	6.48E-04	1.11E-04
28	AL-MLR-19980715 1.1	6.56E-05	4.58E-05	7.08E-04	1.07E-04
29	AL-MLR-19980722 1.1	6.00E-05	4.52E-05	3.86E-04	1.11E-04
30	AL-MLR-19980729 1.1	N/A	N/A	N/A	N/A

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m^3	(2 Sigma)	Bq/m^3	(2 Sigma)
31	AL-MLR-19980805 1.1	6.52E-05	4.39E-05	7.25E-04	1.17E-04
32	AL-MLR-19980812 1.1	3.73E-05	3.75E-05	6.32E-04	1.09E-04
33	AL-MLR-19980819 1.1	2.44E-05	3.26E-05	4.41E-04	9.88E-05
34	AL-MLR-19980826 1.1	6.05E-06	3.80E-05	7.60E-04	1.15E-04
35	AL-MLR-19980902 1.1	9.04E-05	4.94E-05	1.17E-03	1.30E-04
36	AL-MLR-19980909 1.1	2.10E-05	3.48E-05	6.05E-04	1.05E-04
37	AL-MLR-19980916 1.1	7.77E-05	3.12E-05	9.55E-04	9.60E-05
38	AL-MLR-19980923 1.1	5.31E-05	2.34E-05	7.16E-04	8.51E-05
39	AL-MLR-19980930 1.1	5.25E-05	2.55E-05	7.87E-04	8.87E-05
40	AL-MLR-19981007 1.2	2.50E-05	4.03E-05	8.52E-04	1.11E-04
41	AL-MLR-19981014 1.2	7.82E-05	3.87E-05	4.41E-04	1.09E-04
42	AL-MLR-19981021 1.2	6.44E-05	3.89E-05	6.55E-04	1.02E-04
43	AL-MLR-19981028 1.2	2.57E-05	3.27E-05	2.67E-04	8.30E-05
44	AL-MLR-19981104 1.2	2.23E-05	3.54E-05	4.08E-04	9.16E-05
45	AL-MLR-19981111 1.2	1.31E-04	4.00E-05	1.21E-03	1.05E-04
46	AL-MLR-19981118 1.2	3.98E-05	2.57E-05	1.26E-03	1.08E-04
47	AL-MLR-19981125 1.2	3.22E-05	2.30E-05	1.07E-03	1.04E-04
48	AL-MLR-19981202 1.2	2.51E-05	2.49E-05	6.59E-05	8.17E-05
49	AL-MLR-19981209 1.2	2.13E-05	1.96E-05	1.21E-03	1.04E-04
50	AL-MLR-19981216 1.2	6.20E-05	2.88E-05	1.29E-03	1.04E-04
51	AL-MLR-19981223 1.2	6.73E-05	2.84E-05	1.31E-03	1.06E-04
52	AL-MLR-19981230 1.2	4.35E-05	2.62E-05	1.01E-03	9.63E-05
South East Control (SEC)					
1	AL-SEC-19980107 1.1	2.39E-05	3.51E-05	5.89E-04	1.04E-04
2	AL-SEC-19980114 1.1	3.01E-06	3.81E-05	5.38E-04	9.70E-05
3	AL-SEC-19980121 1.1	5.84E-05	4.44E-05	9.49E-04	1.18E-04
4	AL-SEC-19980128 1.1	6.30E-05	4.91E-05	1.16E-03	1.24E-04
5	AL-SEC-19980204 1.1	1.03E-05	3.39E-05	5.08E-04	8.83E-05
6	AL-SEC-19980211 1.1	3.22E-05	3.85E-05	5.25E-04	9.57E-05
7	AL-SEC-19980218 1.1	-1.05E-05	3.74E-05	3.78E-04	8.99E-05
8	AL-SEC-19980225 1.1	1.35E-05	4.22E-05	6.13E-04	1.09E-04
9	AL-SEC-19980304 1.1	7.94E-05	4.39E-05	6.81E-04	1.02E-04
10	AL-SEC-19980311 1.1	6.28E-05	3.99E-05	4.75E-04	9.45E-05
11	AL-SEC-19980318 1.1	7.16E-06	2.06E-05	-2.08E-05	6.00E-05
12	AL-SEC-19980325 1.1	4.01E-05	3.93E-05	4.10E-04	1.09E-04
13	AL-SEC-19980401 1.1	8.05E-05	4.23E-05	5.33E-04	1.13E-04
14	AL-SEC-19980408 1.1	6.80E-05	4.76E-05	6.53E-04	1.15E-04
15	AL-SEC-19980415 1.1	6.94E-05	5.06E-05	4.51E-04	1.06E-04

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m^3	(2 Sigma)	Bq/m^3	(2 Sigma)
16	AL-SEC-19980422 1.1	7.42E-05	4.84E-05	7.70E-04	1.18E-04
17	AL-SEC-19980429 1.1	2.64E-05	4.99E-05	8.84E-04	1.30E-04
18	AL-SEC-19980506 1.1	6.86E-05	4.99E-05	9.01E-04	1.30E-04
19	AL-SEC-19980513 1.1	1.31E-04	5.52E-05	8.07E-04	1.29E-04
20	AL-SEC-19980520 1.1	1.18E-04	5.74E-05	9.51E-04	1.43E-04
21	AL-SEC-19980527 1.1	1.71E-04	6.16E-05	1.13E-03	1.43E-04
22	AL-SEC-19980603 1.1	4.74E-05	4.84E-05	7.92E-04	1.33E-04
23	AL-SEC-19980610 1.1	1.48E-05	4.75E-05	7.11E-04	1.13E-04
24	AL-SEC-19980617 1.1	7.34E-05	5.28E-05	6.70E-04	1.15E-04
25	AL-SEC-19980624 1.1	5.99E-05	4.43E-05	4.89E-04	9.62E-05
26	AL-SEC-19980701 1.2	4.86E-06	4.69E-05	4.48E-04	1.03E-04
27	AL-SEC-19980708 1.2	9.00E-05	4.36E-05	8.00E-04	1.12E-04
28	AL-SEC-19980715 1.2	7.08E-05	4.58E-05	8.37E-04	1.10E-04
29	AL-SEC-19980722 1.2	3.57E-05	4.14E-05	5.59E-04	1.16E-04
30	AL-SEC-19980729 1.2	6.97E-05	3.88E-05	6.68E-04	1.01E-04
31	AL-SEC-19980805 1.2	3.80E-05	3.87E-05	6.84E-04	1.12E-04
32	AL-SEC-19980812 1.2	7.29E-05	4.35E-05	7.33E-04	1.13E-04
33	AL-SEC-19980819 1.2	3.50E-05	3.59E-05	4.55E-04	1.03E-04
34	AL-SEC-19980826 1.2	6.83E-05	4.70E-05	8.50E-04	1.17E-04
35	AL-SEC-19980902 1.2	7.20E-05	4.71E-05	1.29E-03	1.33E-04
36	AL-SEC-19980909 1.2	8.47E-05	4.41E-05	6.81E-04	1.06E-04
37	AL-SEC-19980916 1.2	1.07E-04	3.63E-05	1.07E-03	1.02E-04
38	AL-SEC-19980923 1.2	6.48E-05	2.61E-05	8.08E-04	9.04E-05
39	AL-SEC-19980930 1.2	5.16E-05	2.44E-05	8.30E-04	8.74E-05
40	AL-SEC-19981007 1.1	2.69E-05	4.26E-05	1.05E-03	1.22E-04
41	AL-SEC-19981014 1.1	7.42E-05	3.60E-05	4.20E-04	9.99E-05
42	AL-SEC-19981021 1.1	5.90E-05	4.13E-05	7.63E-04	1.15E-04
43	AL-SEC-19981021 1.1	N/A	N/A	N/A	N/A
44	AL-SEC-19981104 1.1	7.15E-05	4.66E-05	4.50E-04	1.01E-04
45	AL-SEC-19981111 1.1	N/A	N/A	N/A	N/A
46	AL-SEC-19981118 1.1	4.63E-05	2.64E-05	1.54E-03	1.16E-04
47	AL-SEC-19981125 1.1	2.73E-05	2.06E-05	1.06E-03	9.89E-05
48	AL-SEC-19981202 1.1	1.94E-05	2.36E-05	7.97E-04	8.74E-05
49	AL-SEC-19981209 1.1	2.09E-05	1.92E-05	1.36E-03	1.08E-04
50	AL-SEC-19981216 1.1	4.22E-05	2.54E-05	1.43E-03	1.09E-04
51	AL-SEC-19981223 1.1	5.91E-05	2.70E-05	1.41E-03	1.09E-04
52	AL-SEC-19981230 1.1	3.12E-05	2.42E-05	1.07E-03	1.00E-04

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m^3	(2 Sigma)	Bq/m^3	(2 Sigma)
WIPP South (WSS)					
1	AL-WSS-19980107 1.1	3.54E-05	3.76E-05	5.57E-04	1.04E-04
2	AL-WSS-19980114 1.1	-9.83E-06	3.89E-05	4.28E-04	9.78E-05
3	AL-WSS-19980121 1.1	4.62E-05	4.38E-05	9.31E-04	1.20E-04
4	AL-WSS-19980128 1.1	7.44E-05	5.40E-05	1.12E-03	1.31E-04
5	AL-WSS-19980204 1.1	2.96E-05	3.78E-05	4.14E-04	8.68E-05
6	AL-WSS-19980211 1.1	3.65E-05	4.08E-05	4.48E-04	9.70E-05
7	AL-WSS-19980218 1.1	-1.98E-05	3.93E-05	4.73E-04	9.99E-05
8	AL-WSS-19980225 1.1	1.27E-05	4.16E-08	5.32E-04	1.06E-04
9	AL-WSS-19980304 1.1	7.56E-05	4.48E-05	6.84E-04	1.09E-04
10	AL-WSS-19980311 1.1	4.95E-05	4.00E-05	4.65E-04	9.98E-05
11	AL-WSS-19980318 1.1	5.42E-05	3.80E-05	7.18E-04	1.07E-04
12	AL-WSS-19980325 1.1	4.08E-05	3.75E-05	3.88E-04	1.03E-04
13	AL-WSS-19980401 1.1	2.41E-05	3.40E-05	4.82E-04	1.15E-04
14	AL-WSS-19980408 1.1	4.37E-05	4.59E-05	6.92E-04	1.20E-04
15	AL-WSS-19980415 1.1	1.02E-05	4.35E-05	5.92E-04	1.11E-04
16	AL-WSS-19980422 1.1	1.08E-04	5.00E-05	7.33E-04	1.11E-04
17	AL-WSS-19980429 1.1	N/A	N/A	N/A	N/A
18	AL-WSS-19980506 1.1	6.27E-05	4.98E-05	7.04E-04	1.26E-04
19	AL-WSS-19980513 1.1	N/A	N/A	N/A	N/A
20	AL-WSS-19980520 1.1	1.34E-04	6.42E-05	8.89E-04	1.37E-04
21	AL-WSS-19980527 1.1	8.42E-05	4.80E-05	9.46E-04	1.30E-04
22	AL-WSS-19980603 1.1	5.31E-05	4.83E-05	6.91E-04	1.27E-04
23	AL-WSS-19980610 1.1	2.99E-05	4.59E-05	5.70E-04	1.01E-04
24	AL-WSS-19980617 1.1	4.78E-05	4.81E-05	4.87E-04	1.05E-04
25	AL-WSS-19980624 1.1	6.90E-05	4.57E-05	6.39E-04	1.02E-04
26	AL-WSS-19980701 1.1	2.66E-05	4.15E-05	4.05E-04	9.67E-05
27	AL-WSS-19980708 1.1	5.11E-05	3.49E-05	5.78E-04	9.74E-05
28	AL-WSS-19980715 1.1	3.68E-05	4.00E-05	6.94E-04	1.03E-04
29	AL-WSS-19980722 1.1	2.59E-05	4.03E-05	2.97E-04	1.09E-04
30	AL-WSS-19980729 1.1	N/A	N/A	N/A	N/A
31	AL-WSS-19980805 1.1	4.14E-05	3.82E-05	7.63E-04	1.12E-04
32	AL-WSS-19980812 1.1	5.31E-05	3.93E-05	6.66E-04	1.08E-04
33	AL-WSS-19980819 1.1	9.72E-05	2.98E-05	2.28E-04	9.21E-05
34	AL-WSS-19980826 1.1	8.08E-05	4.72E-05	8.31E-04	1.13E-04
35	AL-WSS-19980902 1.1	5.09E-05	4.24E-05	7.75E-04	1.14E-04
36	AL-WSS-19980909 1.1	3.65E-05	3.77E-05	5.65E-04	1.05E-04
37	AL-WSS-19980916 1.1	3.63E-05	2.40E-05	6.05E-04	8.22E-05
38	AL-WSS-19980923 1.1	N/A	N/A	N/A	N/A

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m³	(2 Sigma)	Bq/m³	(2 Sigma)
39	AL-WSS-19980930 1.1	4.74E-05	2.45E-05	5.39E-04	7.73E-05
40	AL-WSS-19981007 1.1	7.88E-05	4.87E-05	9.41E-04	1.14E-04
41	AL-WSS-19981014 1.1	5.21E-05	3.07E-05	2.36E-04	9.37E-05
42	AL-WSS-19981021 1.1	7.02E-05	3.96E-05	6.06E-04	1.01E-04
43	AL-WSS-19981028 1.1	5.93E-05	4.08E-05	2.41E-04	8.83E-05
44	AL-WSS-19981104 1.1	1.83E-05	3.63E-05	3.93E-04	9.52E-05
45	AL-WSS-19981111 1.1	1.12E-04	3.78E-05	1.11E-03	1.02E-04
46	AL-WSS-19981118 1.1	2.37E-05	2.36E-05	1.38E-03	1.16E-04
47	AL-WSS-19981125 1.1	1.05E-05	1.70E-05	1.13E-03	1.04E-04
48	AL-WSS-19981202 1.1	5.22E-05	3.04E-05	6.41E-04	8.21E-05
49	AL-WSS-19981209 1.1	2.79E-05	2.06E-05	1.20E-03	1.01E-04
50	AL-WSS-19981216 1.1	3.71E-05	2.54E-05	1.46E-03	1.13E-04
51	AL-WSS-19981223 1.1	3.60E-05	2.20E-05	1.26E-03	1.02E-04
52	AL-WSS-19981230 1.1	N/A	N/A	N/A	N/A
WIPP Far Field (WFF)					
1	AL-WFF-19980107 1.1	N/A	N/A	N/A	N/A
2	AL-WFF-19980114 1.1	-3.26E-06	4.33E-05	4.21E-04	1.04E-04
3	AL-WFF-19980121 1.1	3.25E-05	4.11E-05	9.98E-04	1.20E-04
4	AL-WFF-19980128 1.1	7.25E-05	5.14E-05	1.09E-03	1.25E-04
5	AL-WFF-19980204 1.1	1.53E-05	3.72E-05	5.90E-04	9.67E-05
6	AL-WFF-19980211 1.1	3.47E-05	4.03E-05	5.29E-04	9.92E-05
7	AL-WFF-19980218 1.1	6.81E-06	4.25E-05	4.21E-04	9.67E-05
8	AL-WFF-19980225 1.1	1.86E-05	4.36E-05	5.81E-04	1.10E-04
9	AL-WFF-19980304 1.1	1.42E-05	3.42E-05	6.57E-04	9.98E-05
10	AL-WFF-19980311 1.1	6.47E-05	4.20E-05	5.33E-04	1.01E-04
11	AL-WFF-19980318 1.1	4.53E-05	3.72E-05	7.34E-04	1.09E-04
12	AL-WFF-19980325 1.1	3.61E-05	3.76E-05	4.65E-04	1.08E-04
13	AL-WFF-19980401 1.1	4.46E-05	3.63E-05	4.75E-04	1.10E-04
14	AL-WFF-19980408 1.1	6.40E-05	4.99E-05	7.40E-04	1.25E-04
15	AL-WFF-19980415 1.1	2.03E-05	4.62E-05	6.75E-04	1.17E-04
16	AL-WFF-19980422 1.1	3.99E-05	4.18E-05	6.67E-04	1.10E-04
17	AL-WFF-19980429 1.1	8.70E-05	6.02E-05	9.27E-04	1.39E-04
18	AL-WFF-19980506 1.1	4.68E-05	4.43E-05	6.62E-04	1.16E-04
19	AL-WFF-19980513 1.1	6.90E-05	4.74E-05	7.81E-04	1.29E-04
20	AL-WFF-19980520 1.1	1.17E-04	5.99E-05	1.07E-03	1.37E-04
21	AL-WFF-19980527 1.1	2.02E-04	6.15E-05	8.72E-04	1.25E-04
22	AL-WFF-19980603 1.1	8.05E-05	4.93E-05	8.09E-04	1.24E-04
23	AL-WFF-19980610 1.1	2.52E-05	4.42E-05	6.68E-04	1.03E-04

Week of Sample	Sample ID	Alpha Activity	TPU	Beta Activity	TPU
		Bq/m3	(2 Sigma)	Bq/m3	(2 Sigma)
24	AL-WFF-19980617 1.1	4.12E-05	4.67E-05	5.50E-04	1.07E-04
25	AL-WFF-19980624 1.1	4.61E-05	4.42E-05	4.56E-04	9.88E-05
26	AL-WFF-19980701 1.1	3.98E-05	4.19E-05	3.54E-04	9.14E-05
27	AL-WFF-19980708 1.1	4.81E-05	4.13E-05	5.99E-04	1.20E-04
28	AL-WFF-19980715 1.1	N/A	N/A	N/A	N/A
29	AL-WFF-19980722 1.1	N/A	N/A	N/A	N/A
30	AL-WFF-19980729 1.1	4.85E-05	3.62E-05	5.88E-04	1.00E-04
31	AL-WFF-19980805 1.1	7.35E-05	4.42E-05	7.60E-04	1.15E-04
32	AL-WFF-19980812 1.1	2.37E-05	3.50E-05	7.76E-04	1.12E-04
33	AL-WFF-19980819 1.1	4.86E-05	3.86E-05	4.02E-04	1.03E-04
34	AL-WFF-19980826 1.1	3.91E-05	4.37E-05	7.94E-04	1.17E-04
35	AL-WFF-19980902 1.1	8.98E-05	4.98E-05	1.29E-03	1.34E-04
36	AL-WFF-19980909 1.1	2.75E-05	3.64E-05	7.38E-04	1.10E-04
37	AL-WFF-19980916 1.1	1.07E-04	3.46E-05	1.02E-03	9.55E-05
38	AL-WFF-19980923 1.1	6.48E-05	2.66E-05	7.85E-04	9.15E-05
39	AL-WFF-19980930 1.1	3.53E-05	2.13E-05	8.62E-04	9.00E-05
40	AL-WFF-19981007 1.1	4.59E-05	4.53E-05	9.48E-04	1.18E-04
41	AL-WFF-19981014 1.1	5.64E-05	3.17E-05	4.71E-04	9.67E-05
42	AL-WFF-19981021 1.1	1.06E-04	4.60E-05	7.34E-04	1.07E-04
43	AL-WFF-19981028 1.1	3.65E-05	3.99E-05	2.90E-04	9.80E-05
44	AL-WFF-19981104 1.1	7.24E-05	5.07E-05	6.17E-04	1.16E-04
45	AL-WFF-19981111 1.1	1.22E-04	3.82E-05	1.26E-03	1.05E-04
46	AL-WFF-19981118 1.1	4.28E-05	2.53E-05	1.33E-03	1.07E-04
47	AL-WFF-19981125 1.1	4.03E-05	2.39E-05	1.17E-03	1.05E-04
48	AL-WFF-19981202 1.1	2.66E-05	2.46E-05	6.72E-04	8.06E-05
49	AL-WFF-19981209 1.1	3.82E-05	2.27E-05	1.08E-03	9.62E-05
50	AL-WFF-19981216 1.1	6.93E-05	3.08E-05	1.45E-03	1.13E-04
51	AL-WFF-19981223 1.1	5.37E-05	2.64E-05	1.37E-03	1.09E-04
52	AL-WFF-19981230 1.1	4.29E-05	2.61E-05	1.15E-03	1.02E-04

APPENDIX C - Equations

If the precision of several samples from the same environment differ, then we must weight the more precise measurements more heavily than the less precise measurements in order to arrive at the best estimate of the true mean. So, a weighting factor $W_i = 1/\sigma_i^2$; and the weighted mean is given by:

$$M_w = \frac{\Sigma\ W_i\ M_i}{\Sigma\ W_i}$$

and the standard error of M_w is

$$\sigma_{m_w} = \sqrt{\frac{1}{W_1 + W_2 + \ldots\ldots W_n}}$$

Minimum Detectable Activity (MDA):

MDA is equal to the mean of a distribution such that 95 percent of the measurements of the distribution will produce analytical results that have the activity above that of a blank. It is possible to achieve a very low level of detection by analyzing a large sample size and counting for a very long time.

The laboratory was advised to use the following equation for calculating the MDAs for each radionuclide in various sample matrices:

$$MDA = \frac{4.65\ S_b}{K_{0.05}\ T} + \frac{3}{K_{0.05}\ T}$$

S_b = Standard deviation of the background
$K_{0.05}$ = Type I and Type II errors
T = Counting time

For further evaluation of MDA, refer to HPS N13.30-1996, "Performance Criteria for Bioassay."

Total Propagated Uncertainty:

Total propagated uncertainty (TPU) for each data point must be reported at 2σ level. The TPU should be calculated by using the following equation:

$$TPU_{1\sigma} = \sigma_{ACT} = \frac{\sqrt{\sigma_{NCR_S}{}^2 + (NCR)^2 * (RE^2_{EFF} + RE^2_{ALI} + RE^2_R + \Sigma\ RE^2_{CF})}}{2.22 * EFF * ALI * R * ABN_S * e^{-\lambda t} * CF}$$

Where:	EFF	=	Detector Efficiency
	ALI	=	Sample Aliquot Volume or Mass
	R	=	Sample Tracer/Carrier Recovery
	ABN_s	=	Abundance Fraction of the Emissions Used for Identification/Quantification
	$\sigma^2{}_{NCR_S}$	=	Variance of the Net Sample Count Rate
	NCR	=	Net Sample Count Rate
	$RE^2{}_{EFF}$	=	Square of the Relative Error of the Efficiency Term
	$RE^2{}_{ALI}$	=	Square of the Relative Error of the Aliquot
	$RE^2{}_R$	=	Square of the Relative Error of the Sample Recovery
	$RE^2{}_{CF}$	=	Square of the Relative Error of Other Correction Factors
	λ	=	Analyte Decay Constant - In 2/(half-life) [Same units as the half-life used to compute λ]
	t	=	Time from Sample Collection to Radionuclide Separation or Mid-Point of Count Time (Same units as half-life)
	CF	=	Other Correction Factors as Appropriate (i.e., Ingrowth factor, self-absorption factor, etc.)

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