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**Pantex Plant Site Environmental Report for
Calendar Year 1989**

Prepared by

**Engineering-Science, Inc. and
Mason & Hanger-Silas Mason Co., Inc.**

May 1990

MASTER

ALL INFORMATION CONTAINED HEREIN IS UNLIMITED

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ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
AL	Albuquerque Operations Office
Be	Beryllium
BG	Burning Ground
BMP	Best management practice
BOD ₅	5-day Biochemical oxygen demand
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cfm	Cubic feet per minute
CWA	Clean Water Act
DAC	Derived air concentration
DCG	Derived concentration guides
DOE	U.S. Department of Energy
DOE/AAO	U.S. Department of Energy Amarillo Area Office
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ES&H	Environment, Safety and Health
ES&HMB	Environment, Safety and Health Management Branch
FA	Area FS-4 High Explosive Test-Fire Site
FB	Area FS-5 High Explosive Test-Fire Site
FC	Area FS-10 High Explosive Test-Fire Site
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
gpm	Gallons per minute
GOCO	Government-owned, Contractor-operated
HE	High explosive
HSWA	Hazardous and Solid Waste Amendments
H-3	Tritium
HMX	High melting explosive
HWTS	Hazardous Waste Tank System
IOP	Internal Operating Procedure
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goals
MHSM	Mason & Hanger-Silas Mason Co., Inc.
MAT	EG&G Mound Applied Technologies
μCi	Microcuries
μCi/mL	Microcuries per milliliter
μCi/g	Microcuries per gram

Acronyms, continued

mg/L	Milligrams per liter
N	Nitrate
NAAQS	National Ambient Air Quality Standards
NCDC	National Climatic Data Center
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOD	Notice of Deficiency
NOR	Notice of Registration
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NSPS	New Source Performance Standards
NTS	Nevada Test Site
PCBs	Polychlorinated Biphenyls
pCi/mL	Picocuries per milliliter
PETN	Pentaerythritol tetranitrate
ppb	Parts per billion
ppm	Parts per million
PSD	Prevention of significant deterioration
Pu	Plutonium
QA	Quality Assurance
Ra	Radium
RCG	Radioactivity concentration guides
RCRA	Resource Conservation and Recovery Act
RDX	Research Development Explosive
RIP	Remedial Investigation Plan
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SIPs	State implementation plans
SOP	Standard operating procedure
TACB	Texas Air Control Board
TCAA	Texas Clean Air Act
TDH	Texas Department of Health
TNT	Trinitrotoluene
TRC	Texas Railroad Commission
TSCA	Toxic Substances Control Act
TWC	Texas Water Commission
TWDB	Texas Water Development Board
U	Uranium
USDA	United States Department of Agriculture
USTs	Underground Storage Tanks
VOC	Volatile organic compound
WQA	Water Quality Act

PANTEX PLANT SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1989

Engineering-Science, Inc.

Mason & Hanger-Silas Mason Co., Inc.

Environmental, Safety and Health Division

May 1990

ABSTRACT

This report summarizes the environmental monitoring program at Pantex Plant for 1989. It has been prepared in accordance with the United States Department of Energy Order 5400.1. This report presents monitoring data for both radioactive and nonradioactive species in the local environment.

Plant activities involve the handling of significant quantities of uranium, plutonium, and tritium in the form of completed parts received from other DOE facilities, resulting in a very low potential for release of these radionuclides to the atmosphere. In May 1989, there was an accidental release of 40,000 curies (Ci) of tritium (conservatively estimated). The normal releases during the year were 0.12 Ci of tritium and 21 μ Ci of uranium-238.

The USEPA issued a draft Administrative Order of Consent under section 3008(h) in 1988. Negotiations between DOE and EPA are still continuing. Chromium at a level above drinking water standards was found in a perched groundwater well in zone 12. Also, trace amounts of solvents and high explosives were found in the perched groundwater in zone 12.

EXECUTIVE SUMMARY

The purpose of this report is to present a summary of the environmental data on the Pantex Plant, to characterize site environmental management performance, investigate compliance with applicable environmental standards and requirements, and highlight significant programs and efforts. This report is required by U.S. Department of Energy (DOE) Orders 5400.1 (General Environmental Protection Program) and 5484.1 (Environmental Protection, Safety, and Health Protection Information Reporting Requirements).

Information presented in this report is based on an environmental monitoring program conducted at the Pantex Plant in 1989. This monitoring program is designed to detect possible releases of radioactive material to the air, water (surface and ground), and soil, during routine operations and to detect any accidental release of radioactive contamination from plant operations. In addition, nonradiological measurements are made to assess environmental quality and compliance on the plant from other pollutant sources. Over 100 sampling points including onsite and offsite locations are used in the monitoring program. Data from sites at the Bushland Agricultural Experimental Station are presented to show a control level for each analysis. The major sections of the report are highlighted in the topics that follow. They cover regulatory compliance questions as well as the affected environmental media for both radiological and nonradiological contaminants.

COMPLIANCE SUMMARY AND ENVIRONMENTAL PROGRAM INFORMATION

A review of the Pantex operation, applicable laws and regulations, and regulatory inspection reports revealed several instances of noncompliance. Two minor violations of Pantex's wastewater discharge exist, nineteen discrepancies were found during the 1989 Texas Water Commission/U.S. Environmental Protection Agency (EPA) Resource Conservation and Recovery Act annual inspection and two minor discrepancies found by Texas Department of Health during the drinking water inspection. Corrective actions have been formulated for all violations or discrepancies, several of which have already been resolved.

An examination of state and/or federal permits or construction approval requirements for pollution control or industrial solid waste management activities showed only two permits/approvals were pending.

A summary assessment of environmental compliance activity for the period January through October 1990 is located on page 141.

ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

The current environmental radiological program at Pantex covers air, water, soil, and vegetation samples which were collected on and off site. Fauna samples are normally collected and analyzed, but due to the extremely low population of jack rabbits on the Pantex Plant, specimens were not collected for analysis.

The air monitoring program consists of ten offsite and seven onsite air sampling stations. The samples are analyzed for uranium-234, uranium-238, plutonium-239, tritium, and gross alpha and gross beta. The radionuclides which were detected in the air were well below the standards set by DOE.

The only radionuclide detected in a significant quantity in 1989 was tritium. The high readings can be attributed to a conservatively estimated release of 40,000 curies (Ci) of deuterium-tritium gas (in addition to the normal yearly release of 0.12 Ci of tritium and 21 μ Ci of uranium-238) that occurred on May 17, 1989, during a routine weapon disassembly operation. As a result of the tritium release, an investigation was initiated in June 1989 to review tritium operations at the Pantex Plant.

Environmental sampling (air, water, soil) was performed in response to the accident to determine the impact, if any, on the surrounding environment. Results of the sampling program are under review and will be included in the results from the ongoing investigation of the incident.

During the investigation, it was determined that several procedures should be followed to prevent recurrence of a release. Before disassembling a weapon, operators should review procedures for this operation and study all cautions, alerts, and warning signs. Well-informed disassembly operators can help to detect and avoid potential problems. Operational precautions such as self-contained breathing apparatus will be used during especially hazardous stages of disassembly. Other operational precautions have already been implemented that will provide significant additional protection for the public and the Pantex staff.

Consequences of the accidental tritium release include the need to decontaminate the facility and the need to consider the psychological trauma of the exposed individuals. Sampling results indicate that the annual whole-body dose estimate to the maximally exposed individual, considering the accidental tritium release, was 1.43 mrem. The whole-body dose estimate resulting from normal operational releases of tritium and uranium-238 during the year was 0.257×10^{-3} mrem. The natural background exposure level is 100 mrem, as established by Pantex's field dosimetry program. Population and individual radiation doses received from Pantex Plant emissions were calculated using the U.S. Environmental Protection Agency EPA-AIRDOS/RADISK computer program.

The annual whole-body dose to the population within 80 kilometers (50 miles) related to the accidental tritium release was 2.07 person-rem and from the annual whole-body dose to the population due to releases of tritium and uranium-238 during normal operations was 9.95×10^{-4} person-rem. The natural background whole-body exposure to the population is 3×10^4 person-rem.

The surface water radiological monitoring program evaluates the industrial effluents, sanitary wastewater treatment plant effluents, and surface drainage discharges to ditches. Treated water from the wastewater treatment plant is used for irrigation and is also evaluated under the surface water monitoring program.

Surface water grab samples are collected from eleven onsite locations and analyzed for tritium, uranium-234, uranium-238, plutonium-239, and dissolved and suspended particles that are alpha and beta emitters. The radionuclides which were detected in the waters were below DOE and EPA standards. Increases in levels of tritium were noted at two onsite water sampling locations which were approximately ten times higher than readings at other stations (12×10^{-6} to 18×10^{-6} $\mu\text{Ci/mL}$); however, these values are lower than the DOE and EPA standards of 2.0×10^{-3} $\mu\text{Ci/mL}$ and 2.0×10^{-5} $\mu\text{Ci/mL}$, respectively. These elevated levels can be attributed to the accidental release of tritium during the May incident.

The soil radiological monitoring program evaluates the migration, if any, of radioactive materials leaving the site, since radioactive particles are transported by air and water. Thirty-two offsite and nineteen onsite soil samples were collected and analyzed for uranium-234, uranium-238, and plutonium-239. Of these radionuclides, uranium-238 was the most prevalent in the soil. The highest readings occurred mostly in the soils at the firing sites (FS-5 sites). Historically, the firing sites exhibit higher readings of uranium due to fragments of depleted uranium in the soil.

The vegetation radiological monitoring program is similar to the soil monitoring program in that it evaluates the migration of radioactive materials transported by air and water to vegetation. Samples were collected from seventeen offsite and five onsite locations and analyzed for uranium-234, uranium-238, and tritium. There are no standards for uranium or tritium in vegetation; however, DOE standards for water are sometimes used for comparison. As with soil, the firing sites typically exhibit higher readings of uranium-238 than other sites. For 1989, the values for the radionuclides detected in vegetation samples remained within the historical ranges of previous years.

ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

Nonradiological pollutants are also measured in soil, surface water, air, and vegetation as a part of the ongoing environmental monitoring programs. These media are regularly sampled and analyzed for heavy metals, organics, and explosives. Sampling and analysis of effluent from the wastewater treatment facility are also described.

The Pantex Plant operates a sanitary wastewater treatment facility which consists of a facultative lagoon system. Effluent from the facility flows into Playa 1 or is used by Texas Tech University for irrigation. The Texas Water Commission wastewater discharge permit requires that effluent from the wastewater treatment facility be sampled and tested regularly for 5-day biochemical oxygen demand

(BOD₅) and pH. Effluent permit requirements were met during 1989 except during January when BOD₅ values exceeded permitted limits.

Soil samples collected from nineteen onsite sampling locations and one offsite location were analyzed for beryllium. Beryllium is used in fabrication of components for nuclear weapons at Pantex and was the only nonradiological contaminant for which soil samples were analyzed. Concentrations of beryllium detected in soil samples ranged from 0.56 to 1.40 ppm by weight, values well under regulatory guidelines.

No ambient air monitoring is currently being conducted at Pantex Plant. Air emissions permit exemptions and "grandfathered registrations" of emission sources are discussed in the report. An environmental consulting firm is currently under contract to develop a comprehensive air emissions inventory of the Pantex Plant.

Texas Air Control Board Regulation III requires that vegetation be sampled and analyzed monthly and gives fluoride limits for samples collected over periods of twelve, three, and two consecutive months. The vegetation monitoring program at Pantex was found to be deficient by the DOE "Tiger Team" because sampling intervals did not meet regulatory duration requirements. Data collected at only one sampling location met regulatory duration requirements. Analytical data for vegetation samples collected at BG-VS-01 showed fluoride concentrations exceeding regulatory limits during the period from April to June and to be below regulatory limits during the period from July through September. The vegetation monitoring program at Pantex is being evaluated and will be corrected to address the "Tiger Team" findings and to ensure compliance with Texas Air Control Board regulations. The purpose of this monitoring is to assess whether fluoride emissions from the plant impact cattle grazing on land at and adjacent to the plant.

Surface water samples collected at eleven locations at Pantex were analyzed for heavy metals, organics, and explosives. The majority of samples collected contained no pollutants at concentrations exceeding regulatory limits or guidelines. Exceptions to regulatory limits or guidelines, and detection of constituents for which not standards exist, are discussed below.

Total chromium and lead were each detected at concentrations slightly above EPA drinking water standards in a surface water sample collected at Playa 3 (OW-WR-36). Cyanide, for which no standards exist, was detected in samples collected from four locations at concentrations ranging from 0.06 to 0.55 mg/L. Iron was detected in samples from five locations at concentrations exceeding irrigation water standards. The impact of these results is unknown at this time.

Explosives were detected in some surface water samples. HMX was detected in samples collected from six locations. PETN was detected in samples collected at building 12-43 (OW-WR-13) and building 12-64 (OW-WR-25).

Phosphates were detected in samples collected at nine locations ranged in average concentrations from 0.06 to 1.178 mg/L. There are no water quality standards for phosphates. Sulfates were detected at seven locations at concentrations

exceeding irrigation waters and TEXAS WATER DEVELOPMENT BOARD (TWDB) inland waters standards.

GROUNDWATER PROTECTION

Groundwater samples were collected on site and off site and were analyzed for radiological and nonradiological constituents. The radiological samples were analyzed for specific radionuclides including plutonium-239, uranium-234, uranium-238, radium-226, radium-228, tritium, and gross alpha and beta. Adequate purging of sampling wells was started in October and performed again in December. The nonradiological substances for which tests were run fall into several categories including heavy metals, explosives, and organics. One sample from perched well OW-WR-20 contained 1,2-Dichloroethane and one sample contained concentrations of high explosives. The concentrations in both samples are well below EPA drinking water standards. Two samples collected from perched well OW-WR-45 contained trichloroethene at levels below the EPA drinking water standards. Two samples from perched groundwater wells OW-WR-20 and OW-WR-45 and one sample from perched well OW-WR-38 had concentrations of total chromium that exceeded the EPA drinking water standards. However, the average concentrations and total amounts of constituents detected in these and other water samples are believed to have no significant environmental impact when compared with drinking water standards.

NONRECURRING DATA

Nonrecurring samples from air, water, and soil were collected at the Pantex Plant that were not part of the environmental monitoring program. These samples were collected as a proactive response to actions, spills, or investigations of the plant. A summary of the data showing those constituents which were detected is also presented.

QUALITY ASSURANCE

The "Tiger Team" assessment of Pantex Plant found that the Pantex environmental monitoring program lacked QA project plans and a written environmental monitoring plan; and that environmental sampling protocols and techniques were inadequate. Steps are being taken to correct deficiencies in the Pantex Plant QA program.

SECTION 1

INTRODUCTION

This report presents summary data for the environmental monitoring program at the Pantex Plant. The report also investigates compliance with environmental standards and requirements, and highlights significant environmental programs and efforts. It has been prepared in conformance with guidelines given in U.S. Department of Energy (DOE) Orders 5400.1 and 5484.1. This document is provided to regulatory agencies and the public as a tool for assessing the environmental performance of the Pantex Plant.

This report is organized into seven sections. Section 1 is an introduction and general description of the Pantex Plant. Included within this section are discussions of the population, climate, geology, hydrogeology, seismology, and land and water uses.

Section 2 discusses regulatory requirements for environmental compliance. It presents the results of various regulatory inspections and environmental activities.

Section 3 describes the radiological monitoring program. Discussed in this section are the types of monitoring performed, resulting data, and apparent trends.

Section 4 discusses the nonradiological monitoring program. It includes data analysis of soil, vegetation, and surface water.

Section 5 deals with the groundwater protection program. Included within this section are a brief description of the groundwater monitoring program and an analysis of the results.

Section 6 discusses the nonrecurring environmental sampling program. This program calls for sampling in response to a major spill or release, as part of the Environmental Restoration Program, or as a result of a unique opportunity to gather information (e.g., sampling during excavation for construction).

Section 7 is a discussion of Pantex Plant's quality assurance (QA) activities initiated under DOE Order 5700.6B.

Normally throughout this report, the data tables or figures are presented immediately following their first mention. However, in several instances, clarity requires the data be placed at the end of the discussion section.

COMMITMENT TO ENVIRONMENTAL PROTECTION

The Department of Energy Amarillo Area Office's (DOE/AAO) ongoing environmental protection program at the Pantex Plant is implemented by Mason & Hanger-Silas Mason Co., Inc. (MHSM) in its day-to-day operations.

DOE/AAO has negotiated a 3008(h) draft Administrative Order on Consent with EPA Region 6. The order has been forwarded to DOE headquarters and EPA headquarters for finalization and approval. This order will have a significant impact on Pantex Plant operations. Concurrently, Environmental, Safety and Health Management Branch (ES&HMB) and the contractor's Environmental, Safety and Health (ES&H) division are pursuing discussions with the Texas Water Commission (TWC), the Texas Air Control Board (TACB), the Texas Department of Health (TDH), and local entities to ensure that the Pantex Plant complies with both the letter and the spirit of environmental protection regulations.

SITE LOCATION

The Pantex Plant is located in the Texas Panhandle in Carson County, on Highway 60, about 17 miles northeast of downtown Amarillo (figure 1.1) at 101°22' west longitude and 35°19' north latitude. The Pantex facility consists of 10,080 acres of DOE-owned land and 5,856 acres of land leased from Texas Tech University. The latter is used as a security buffer zone.

The Pantex Plant lies on the Llano Estacado (staked plains). The topography at Pantex is relatively flat, characterized by rolling grassy plains and numerous natural playa basins. The term "playa basin" refers here to the more than 30,000 ephemeral lakes, mostly less than 1 kilometer in diameter. The region is a semiarid farming and ranching area. The Pantex Plant is surrounded by agricultural land.

FACILITY HISTORY AND MISSION

The Pantex Plant is a government-owned, contractor-operated facility (GOCO). MHSM has been the operating contractor since 1957.

Pantex was first used in 1942 by the Army Ordnance Corps for loading conventional ammunition shells and bombs. In 1949, the Atomic Energy Commission (AEC) started rehabilitating portions of the original plant and building new facilities for nuclear weapons operations (DOE, 1983). In 1974, the Energy Research and Development Administration (ERDA) assumed responsibility for the Pantex Plant. In 1977, ERDA was converted to the Cabinet Level DOE.

The principal operations performed at Pantex are the assembly of nuclear weapons from components received from other DOE plants; fabrication of chemical high-explosive (HE) components for nuclear weapons; operation of the chemical HE Development Division; surveillance testing and disposal of chemical HE; disassembly of obsolete nuclear weapons for retirement; and maintenance, modification, repair, and nonexplosive testing of nuclear weapons components. Weapons assembly and stockpile surveillance activities involve handling significant quantities

FIGURE 1.1
PANTEX PLANT
VICINITY MAP

PANTEX PLANT AMARILLO, TEXAS

of uranium, plutonium, and tritium, as well as a variety of nonradioactive toxic chemicals.

FACILITY DESCRIPTION

There are more than 400 buildings at Pantex. The site is composed of several functional areas, commonly referred to as numbered zones for security (figure 1.2). Currently defined are a weapons assembly area, a staging area, a high-explosives development area, test-firing sites, a burning ground, fire department burning pits, a land disposal area, a water treatment plant, a wastewater treatment plant, and vehicle maintenance and administrative areas.

The weapons assembly area covers approximately 200 acres and contains more than 100 buildings. Components made at other facilities are assembled into weapons here.

The staging area is where Pantex stages chemical hazardous waste shipments.

The high-explosive development area consists of facilities that contain several bays with heavy reinforced-concrete walls. These facilities are used for synthesizing new high explosives and fabricating them into experimental shapes (DOE, 1983).

The test-firing site has several reinforced-concrete bunkers containing control rooms and camera areas. Experimental high-explosive configurations are detonated on firing pads surrounded by earthen bunkers. Selected samples of high-explosive components are detonated for quality assurance testing (DOE, 1983).

The burning ground is used for disposal of scrap high explosives. From 1954 to 1980, waste oils and other waste chemicals were disposed of in a chemical burn pit at the burning ground. The quantity of liquid waste disposed of at this site is unknown. From 1981 to 1989, waste oils and waste chemicals were placed in metal stock tanks at the burning ground area, where they have been allowed to evaporate (DOE, 1989). Currently, waste oils and waste chemicals are sent off site for contract disposal at a permitted disposal facility in accordance with applicable regulations.

Two fire department unlined burning pits were constructed between 1973 and 1974 as a fire training tool. These pits were designed to allow Pantex fire fighters to ignite and extinguish different types of fuel or chemical fires in a controlled environment. One pit was abandoned and filled in 1987. The other pit is still in use. Solvents, fuels, and waste oils deposited in the pits were allowed to reside there before being ignited. Currently, only fuel oils are burned.

The land disposal area is divided into several landfill sites. Some of the landfill sites ceased active operation during 1989. The plant's domestic solid waste was formerly sent to onsite sanitary landfills for disposal. Beginning in late-1989, sanitary waste has been sent to the Amarillo landfill. Other types of solid waste formerly disposed at onsite landfills include, but are not limited to, ashes and residue produced from operations conducted at the burning ground, asbestos and asbestos-covered pipe, floor tiles, paint cans and drums, batteries, transformers, tires, and chemical containers. Currently, hazardous materials are transported off site for

LEGEND

- +---+ RAIL ROAD
- FENCE
- PANTEX SITE BOUNDARY
- PANTEX PLANT BOUNDARY
- P1 PLAYA #1

NOTE:
BASE MAP INFORMATION FROM PANTEX
DRAWING NO. G00062011.DGN

FIGURE 1.2
PANTEX PLANT
FACILITY SITE

PANTEX PLANT AMARILLO, TEXAS

disposal in accordance with applicable regulations. Current practices preclude disposal of hazardous materials in onsite landfills (DOE, 1989).

Wastewater generated at Pantex is routed to a new wastewater treatment plant (WWTP). An older WWTP was taken out of service in 1988. Effluent from the new WWTP is discharged to an open ditch that drains to an onsite playa. Many of the high-explosive processing operations discharge wastewater, after it has been processed through settling cones and carbon filters for removal of residual HE material, into open ditches that drain into playas. Various materials, mostly from the discontinued TNT melt-and-pour operations, were also discharged into these playas previously. Investigation and remediation of the playas and ditches are being addressed through the ER Program. In accordance with DOE Order 5400.5, a best available technology (BAT) analysis is not required due to the low level of radioactive materials present in the wastewater.

As part of industrial wastewater treatment, Pantex currently operates five hazardous waste tank systems (HWTs) located at buildings 11-44, 12-43, and 12-68. Two of the HWTs (at building 11-44) have been removed from service but remain on the TWC Notice of Registration. These HWTs are used for treatment of water contaminated with high explosives, solvents, or metals.

CLIMATOLOGY

The climate at the Pantex Plant, located on the Texas High Plains, is typical of continental interiors. It is characterized by large variations in daily temperature extremes, low relative humidity, and irregularly spaced rainfall of moderate amounts. This climate in Texas is mainly semiarid with mild winters. The Pantex Plant is in a windy area, with the prevailing wind direction from the south-southwest. Rainfall averaged 18 to 20 inches per year during the years 1951 through 1980. The annual average gross lake surface evaporation rate during the period 1950 through 1975 was 73 inches. Thunderstorms occur about 49 days per year and can produce tornadoes. The Pantex Plant is located in a moderate to high hazard zone for tornadoes (DOE, 1989d).

The most important meteorological data for this report are wind direction, wind speed, precipitation, and temperature. Wind direction and speed are used for calculating radiation doses related to airborne radionuclide emissions and for the siting of ambient air sampling instrumentation.

The 1989 meteorological information reported by the National Oceanic and Atmospheric Administration (NOAA) National Climate Data Center (NCDC) are reported below.

Precipitation	19.55 inches (49.66 cm)
Average temperature	56.6°F (31.44°C)
Average wind speed	12.52 mph (5.60 m/sec)

Accurate estimates for the dispersion of contaminants in the atmosphere, should such dispersion occur, require knowledge of the frequency and distribution of wind speed and direction. The characteristic air patterns associated with a local

area can be presented in tabular or graphical form. Wind data are usually collected at hourly intervals and reported for the sixteen points of the compass. Wind speed is normally divided into ranges.

The graphical form of the data, known as a wind rose, is used in this report. Figure 1.3 is a wind rose of the 1989 average annual wind speed and direction for the local area. On the polar coordinates of the wind rose, the frequencies of various observed wind directions are proportional to the total length of the spokes. The distribution of wind speeds within each direction is indicated by the length of the individual sections of a particular spoke. As can be seen on figure 1.3, local winds were predominantly from the south-southwest approximately 36 percent of the time. This wind speed and direction are similar to previous years.

GEOLOGY

The Pantex Plant is situated on the Southern High Plains. The primary surface deposits at Pantex are the Pullman and Randall soil series, which grade downward to the Blackwater Draw Formation. This formation consists of a sequence of buried soils with an upper unit of mostly silty clay and caliche, and a 20-foot-thick lower unit of very fine silty sand with caliche.

The Ogallala Formation, consisting of sand, silt, clay, gravel, and some caliche, underlies the Blackwater Draw Formation. The base of the Ogallala is an irregular surface which represents the pre-Ogallala topography. As a result, depths to the base of the Ogallala vary. At Pantex, the base of the Ogallala is present at a depth of less than 400 feet at the southwest section of the plant and at a depth of over 700 feet near the northeast boundary.

Underlying the Ogallala Formation are the sedimentary rocks of the Lower Dockum Group. These rocks consist of shale, clayey siltstone, and 20 to 40 percent sandstone. The Lower Dockum Group is less than 100 feet thick beneath Pantex, and is underlain by Permian rocks.

HYDROGEOLOGY

There are two principal water-bearing units beneath the Pantex Plant and adjacent areas. These are the Ogallala aquifer and the underlying Dockum Group aquifer. The vadose, or unsaturated zone, consists of up to 460 feet of sediments which lie between the land surface and the Ogallala aquifer. The general direction of soil water flow in the vadose zone is controlled by gravity and differential moisture content and is vertically downward until the water reaches a barrier (zone of very low permeability) or the Ogallala water table.

Ogallala Aquifer

Two water-bearing units are present in the Ogallala Formation at Pantex. A perched water zone is present in the middle of the Ogallala Formation, above the main zone of saturation. The perched water zone is above a 25- to 40-foot-thick layer of fine-grained material that functions as a vertical barrier. Data collected from these wells indicate a 15- to 25-foot-thick zone of saturation in the perched zone (DOE, 1989b).

LEGEND

WIND SPEED (m/sec)

1.13% = CALM (0.00-0.50 m/sec)
 BASED ON NOAA 1989 MONTHLY SUMMARY

FIGURE 1.3
 1989 WIND ROSE

PANTEX PLANT AMARILLO, TEXAS

The lateral extent of this perched water zone is unknown. The main Ogallala aquifer lies below this perched water zone. The Ogallala aquifer is defined as the basal water-saturated portion of the Ogallala Formation and is the principal water supply on the Southern High Plains. It is an unconfined aquifer which can yield 700 to 1,200 gpm of high-quality water to wells in the Pantex vicinity (DOE, 1989b). At the Pantex Plant, the Ogallala aquifer is thickest to the northeast. Pantex's five production wells are located on the northeast portion of the plant property, and the Amarillo municipal well field is located approximately 1 mile north of Pantex's well field. During the 1950s, the normal direction of groundwater flow in the Ogallala beneath the Pantex Plant was to the east (Purtyman and Becker, 1982). Subsequent pumpage from the aquifer created a large cone of water table depression northeast of the Pantex Plant. Groundwater in the Ogallala aquifer beneath the Pantex Plant now flows northeast, toward the well fields. The water table level of the Ogallala in the vicinity of Pantex is declining at a rate of approximately 2.0 feet per year (DOE, 1989b).

Dockum Group Aquifer

The Dockum Group aquifer lies under the Ogallala at Pantex and south of the plant. Water contained in the sandstone layers within Lower Dockum Group rocks supplies domestic and livestock wells south and southeast of Pantex. Other Dockum aquifer wells are located 10 miles south and west of Pantex (DOE, 1989b). The Dockum aquifer may be semiconfined with respect to the overlying Ogallala aquifer because of lateral variations in the Ogallala and shale layers within the Dockum.

Regionally, Dockum aquifer wells yield an average of 100 gpm, and water quality is typically poor. However, near Pantex, water quality is better (DOE, 1989b), possibly due to recharge from the overlying Ogallala aquifer. No detailed information is available on the potentiometric surface of the Dockum aquifer for the Pantex area, but the direction of the groundwater flow may be to the southwest along the dip of Triassic beds (DOE, 1989b).

SEISMOLOGY

The Pantex location and surrounding area are relatively free of earthquakes. The Uniform Building Code places the Pantex area in zone 1, which rates second lowest in earthquake occurrence on a scale from zone 0 to zone 4. Since 1882, there have been four earthquakes in the area of the plant. These seismic events occurred on March 27, 1917; July 25, 1925; June 19, 1931; and July 20, 1966. Their epicenters were 16 to 32 kilometers (10 to 20 miles) east to northeast of the plant site, and all were estimated to have intensities of V or VI on the modified Mercalli intensity scale.

LAND USE

The area around the Pantex Plant is semiarid. Land is used mainly for farming and ranching operations. Although dryland farming is dominant, some fields are irrigated from local playas or from the Ogallala aquifer. Ranching in the region is primarily cow-calf operations (DOE, 1983).

POPULATION

A study of the 1980 residential population surrounding the Pantex Plant shows that the majority of the population is located west-southwest of Pantex Plant in the Amarillo metropolitan area (DOE, 1983). Amarillo has about 150,000 residents. Pampa, Texas, located about 40 miles northeast of the plant, is the second largest population concentration, with about 21,000 residents. The remaining population surrounding Pantex Plant is somewhat evenly distributed at a density of about three people per square mile. The total population within a 50-mile radius of Pantex Plant was 259,300 in 1980 (DOE, 1983). Figure 1.4 shows the estimated population within an 80-kilometer (50-mile) radius of Pantex.

WATER

The major surface water source near the Pantex Plant is the Canadian River, which flows into Lake Meredith 25 miles north of the plant. Water from this man-made lake is diverted, mixed with groundwater pumped from the Ogallala aquifer, and used as municipal and industrial supplies for cities and towns in the High Plains (DOE, 1983). In the period June 1988 through June 1989, Amarillo used 6.5 billion gallons of water from Lake Meredith and 4.6 billion gallons from the municipal well field located approximately 1 mile north of Pantex's well field.

During 1989, Pantex pumped a total of 278 million gallons from its Ogallala aquifer well field. Pantex sold 69 million gallons to Texas Tech University for irrigation, and used approximately 80 million gallons as cooling water. Devices to measure exact usage of cooling water are currently being installed. The remaining water, approximately 129 million gallons, was used for industrial and domestic purposes. On average, 340,000 gallons per day were treated in the wastewater treatment plant.

SECTION 2

COMPLIANCE SUMMARY AND ENVIRONMENTAL PROGRAM INFORMATION

It is the policy of Pantex to conduct its operations so as to comply with all applicable environmental laws and regulations. The following is a review of those environmental requirements that are relevant to the functions at Pantex. Table 2.1 is a summary of existing or pending state and/or federal permits or construction approvals for pollution control or industrial solid waste management activities conducted by Pantex. A summary assessment, providing updated information on environmental compliance activities for the period January through October 1990, is presented in section 8.

CLEAN AIR ACT

The Clean Air Act (CAA) is a broad federal statute which, among other things, specifies national ambient air quality standards (NAAQS) and sets emission limits for specific air pollutants from certain sources. These standards are to be achieved by the states through development and adoption of state implementation plans (SIP). SIPs set emission limitations, schedules, and timetables for compliance by stationary sources (a building, structure, facility, or installation which emits or may emit any air pollutant), and mobile sources. The CAA also authorizes the U.S. Environmental Protection Agency (EPA) to set new source performance standards (NSPS) and national emission standards for hazardous air pollutants (NESHAP). The EPA has also developed special programs for prevention of significant deterioration (PSD) of air quality. The NAAQS, NESHAP, NSPS, SIPs, and PSD requirements are implemented in Texas under the Texas Clean Air Act (TCAA).

TEXAS CLEAN AIR ACT

The Texas Air Control Board administers standards for prevention and control of air emissions. These standards have been adopted by the State of Texas in the Texas Health and Safety Code, chapter 382, regulations I-XI. The TACB has adopted the NAAQS and administers NSPS (40 CFR 60) as well as NESHAP (40 CFR 61), except for NESHAP Subpart H (radiological), which is regulated by EPA. Texas also regulates inorganic fluoride and beryllium emissions in regulation III.

Pantex has one air quality permit from the TACB, a construction permit for the new steam plant. The Pantex Plant is in the process of obtaining an operating permit for the steam plant. Pantex is assessing all facilities to ensure that all of its

Table 2.1 Permits

Relevant Program and/or Law	Permit	Regulating Agency*	Expiration Date
Texas Solid Waste Disposal Act	30459	TWC	
Wastewater discharge under the Texas Water Code	02296	TWC	5/3/93
Texas Clean Air Act	C-18379	TACB	Upon approval or rejection of operating permit
Hazardous waste management program under the Resource Conservation and Recovery Act	30459 (interim status)	TWC	N/A
	50131 (proposed)	TWC	10 years from issuance
	TX 4890110527	EPA	

- * TWC = Texas Water Commission
TACB = Texas Air Control Board
EPA = U.S. Environmental Protection Agency

units are in compliance with the Texas Clean Air Act, the regulations of the TACB, and Subpart H of the NESHAP.

Several facilities at the Pantex Plant have been granted air permit exemptions by either the TACB or EPA Region 6. In addition to the air permit exemptions, the site has a "Written Grant of Authority" from the TACB for open burning of high-explosive materials at the Pantex burning grounds.

CLEAN WATER ACT

The Federal Water Pollution Control Act (FWPCA) of 1972, as amended by the Clean Water Act (CWA) and the Water Quality Act (WQA) of 1987, forms a legal framework intended to support the maintenance and restoration of water quality in surface water, with the ultimate goal of "fishable and swimmable" water quality. The FWPCA established the National Pollutant Discharge Elimination System (NPDES) as the regulatory mechanism to achieve this goal by regulating discharge to navigable streams, rivers, and lakes.

The WQA has significantly changed the thrust of enforcement activities. In the future, much greater emphasis will be placed on monitoring and control of toxic constituents in wastewater, permitting of outfalls composed entirely of stormwater, and imposition of regulations governing sewage sludge disposal. Best management practices (BMP) will influence waste handling from point of discharge back to the source.

The CWA implementing regulations are 40 CFR 100-140 and 40 CFR 400-470. This program is administered (except for enforcement) by the Texas Water Commission and the Texas Railroad Commission under contract to the EPA pursuant to the Texas Water Code. This legislation sets the standards for all discharges to surface waters within Texas, including requirements for spill control. Discharges to navigable waters within Texas require both NPDES and TWC permits. The Pantex Plant currently holds a TWC wastewater discharge permit in compliance with the Texas Clean Water Act. Discharges to nonnavigable waters or groundwaters generally require only a TWC permit; however, Pantex has requested a determination from EPA Region 6 on the applicability of an NPDES permit at Pantex for discharges to onsite playas. At this time, the provisions of the U.S. Clean Water Act are not thought to be applicable to the operations of the Pantex Plant since the plant is regulated by the statutes and regulations of the Texas Clean Water Act. Pantex is currently resolving two minor violations of the conditions of its wastewater discharge listed below.

Violations of the Wastewater Discharge	Corrective Actions
1. TWC was not notified of BOD excursions which occurred.	Corrective measures are being implemented to quickly identify BOD and pH excursions and inform the TWC in a prompt and timely manner.
2. Flow records to Playas 1 and 2 exhibit that in the past year the WWTP flows were at least 220 percent of the permitted 0.650 million gallons per day average flow parameter.	

SAFE DRINKING WATER ACT

The Safe Drinking Water Act (SDWA) of 1974 established a program to ensure that public drinking water supplies are free of potentially harmful amounts of various chemicals. This mandate is carried out by establishing drinking water quality standards as maximum contaminant levels (MCL) and maximum contaminant level goals (MCLG), as well as wellhead protection requirements, monitoring requirements, treatment standards, and regulation of underground injection activities. The act established primary and secondary national drinking water standards to protect human health (primary standards) and provide aesthetically acceptable water (secondary standards).

The SDWA implementing regulations are 40 CFR 141-149. The Texas Department of Health (TDH) has primacy for regulation of community water supplies, and the TWC has primacy for waste injection wells and sole-source aquifer protection programs.

The Pantex Plant receives its drinking water supply from the Ogallala aquifer via five groundwater wells located on the northeast corner of the site. The water is treated on site and tested in accordance with the requirements for public drinking water systems. The domestic water supply at the Pantex Plant meets all the national interim primary drinking water standards. Pantex is considered a noncommunity, nontransient water supply system. As a noncommunity, nontransient system, Pantex is required to meet secondary drinking water standards. There are no underground injection activities at Pantex.

The drinking water system at the Pantex Plant is regulated by the TDH. Minor discrepancies found by TDH during the drinking water inspection have been addressed.

RESOURCE CONSERVATION AND RECOVERY ACT

The Resource Conservation and Recovery Act (RCRA) was enacted in 1976, and implementing regulations were promulgated in May of 1980. This body of regulations is intended to ensure that hazardous wastes are disposed of in an environ-

mentally safe manner, and that facilities that store, treat, or dispose of hazardous waste do so in a way that protects human health and the environment. The Hazardous and Solid Waste Amendments (HSWA) of 1984 created a set of restrictions on land disposal of hazardous wastes unless certain treatment standards can be satisfied. This act also places increased emphasis on waste minimization activities and serves as a mechanism to enforce cleanup.

Delegation of authority for RCRA enforcement to the State of Texas is implemented by the Texas solid waste management regulations promulgated under the Texas Solid Waste Disposal Act. These regulations require facilities that store, treat, or dispose of hazardous waste to comply with the regulations of the TWC and the EPA. To comply with these regulations, the Pantex Plant has submitted several RCRA Part A and Part B applications over the years. The latest submission was on November 8, 1989. The plant has received two administrative notices of deficiency (NOD) to which the plant has responded with modifications to the applications. The Notice of Registration (NOR), which is also submitted to the TWC, has been revised to coincide with the revision to the hazardous waste permit application.

The TWC has primacy for administering most elements of RCRA controls within Texas. All underground storage tanks (USTs) containing petroleum products or hazardous wastes are regulated by TWC. RCRA requires permitting of all hazardous waste facilities. Separate federal permits under RCRA are required for some facilities. These permits are prepared by TWC and issued by EPA under a joint permitting agreement. In compliance with the RCRA hazardous waste management program, Pantex is registered with the TWC (solid waste registration number 30459) and is operating under interim status as a hazardous waste storage/processing facility (EPA identification number TX4890110527). Texas also requires registration of all storage tanks (with few exceptions).

The major hazardous waste streams generated at the Pantex Plant are HE organics-contaminated wastewater, HE-contaminated wastewater, HE-contaminated solid waste, spent and HE-contaminated organic solvents, and wastes generated from investigation and remediation of onsite inactive waste sites. These wastes are generally managed by onsite accumulation and storage, followed by either onsite treatment using wastewater filtering, evaporation, burning, or offsite treatment and disposal at permitted facilities.

Mixed wastes (wastes with radioactive and hazardous constituents) generated at the Pantex Plant consist primarily of wastes from the remediation of onsite inactive waste sites, small quantities of classified components from disassembled weapons, radioactively contaminated solvents, and wipes contaminated by such solvents. These wastes are being stored in onsite RCRA interim-status facilities pending the potential future availability of RCRA treatment and disposal facilities for mixed waste and classified mixed waste. The primary radioactive constituent in these wastes is depleted uranium.

Nonhazardous solid waste generated on site consists primarily of paper and cardboard, construction wastes, and cafeteria waste. Only construction wastes are disposed on site. Prior to late-1989, sanitary waste was disposed of at the onsite

sanitary landfill. Since late-1989 sanitary waste has been transported to the Amarillo landfill for disposal.

Groundwater investigation was conducted through the Albuquerque Operations Office (AL) Environmental Restoration (ER) Program to assess local areas of contamination resulting from two gasoline leaks near buildings 12-35 and 16-1 as well as other solid waste management units on the Pantex site. AAO currently administers the ER program and has retained the U.S. Army Corps of Engineers, Tulsa District, to perform RCRA Facility Investigations required by the 3008(h) order. Groundwater monitoring is performed not only through the ER Program, but also through MHSM's routine monitoring program.

The Pantex Plant has interim status for ten hazardous waste units and has submitted a Part B application for those units. One inactive hazardous waste unit and five other active solid waste units are registered with the TWC. The Pantex Plant has twenty-three regulated underground storage tanks. Pantex Plant is resolving nineteen discrepancies found during the last TWC/EPA RCRA annual inspection. Findings and corrective actions are listed in table 2.2.

On September 7, 1989, the Pantex Plant received a draft section 3008(h) Administrative Order of Consent." This order was issued by EPA Region 6 under 42 USC 6928. The order was composed of two sections, an interim measures section and a facility investigation section.

The interim measures section calls for:

1. Immediate cessation of the disposal of four liquid waste streams to the playas at the plant, or analysis to prove the aqueous waste streams do not contain hazardous waste or hazardous waste constituents.
2. Submittal of a sampling and analysis plan to prove that three other buildings are not discharging hazardous waste or hazardous waste constituents to the playas.
3. Submittal of a report detailing the actions and analytical results from the above two measures.

The facility investigation section requires an investigation to define those units at the Pantex Plant where the past management of waste or hazardous materials was done in a manner that could have caused a release to the environment. This section of the order, in effect, ranks the units to be investigated.

The facility investigation section also sets schedules for the various phases of the investigations and remediations, should they be necessary.

The current status of the draft section 3008(h) order is that the Albuquerque Operations Office has forwarded the draft order to DOE headquarters for resolution of one remaining issue.

Table 2.3 shows hazardous waste shipments made in 1989.

Table 2.2 TWC/EPA RCRA Annual Inspection Findings

Finding Number	Finding	Actions Underway
TWC-1	Closure of Playa 1 has not been addressed.	Action has been assigned to Corps of Engineers with oversight by AAO.
TWC-2	A hazardous waste surface impoundment has not been implemented at Playa 1.	Action has been assigned to Corps of Engineers with oversight by AAO.
TWC-3	A groundwater monitoring program has not been implemented at Playa 1.	Action has been assigned to Corps of Engineers with oversight by AAO.
TWC-4	A groundwater monitoring program has not been implemented at facility 13 (11-14).	Discharge to the pond was discontinued 3/89. Pond was drained and liner disposed off site. Soil samples have been collected.
TWC-5	11-14 pond does not meet criteria for a hazardous waste surface impoundment.	Discharge to the pond was discontinued 3/89. Pond was drained and liner disposed of off site. Soil samples were collected.
TWC-6	Spent lead acid batteries stored at 10-9 show evidence of minor releases.	Batteries were removed in 6/89. Batteries are being stored in secondary containment.
TWC-7	Manifested offsite shipments have not been reported on a monthly basis in all cases.	In an inspection of the hazardous waste manifest, two shipments were not followed by monthly summary reports, but were included in the 1/89 annual report.
TWC-8	A 90-day accumulation container at building 11-36 was not properly labeled.	Tank wagon has been properly labeled. Inspection program has been started.
TWC-9	Facility 09 (outdoor tank) at building 12-43 does not have either secondary containment or an integrity test.	An integrity assessment was conducted in September 1989.
TWC-10	Facility 10 (out door tank) at building 11-44 does not have either secondary containment or an integrity test.	An integrity assessment was conducted in September 1989.
TWC-11	Tank in building 12-43 is not listed on the NOR.	This tank was listed on a revised NOR dated June 1989.
TWC-12	Tank in building 11-44 is not listed on the NOR.	This tank was listed on a revised NOR dated June 1989.

Table 2.2, continued

Finding Number	Finding	Actions Underway
TWC-13	Facility 11 (Batchmaster) is not listed as a tank on the NOR.	This tank was listed on a revised NOR dated June 1989.
TWC-14	Facility 11 (Batchmaster) inspection records do not document all leaks or releases.	Present inspection records are now indicative of the actual condition of the unit.
TWC-15	Satellite accumulation area at building 12-41 had more than 55 gallons.	This accumulation site is to be made a 90-day accumulation site with secondary containment and a closure plan.
TWC-16	Facility 08 (Conex containers) was not properly labeled.	Each of the Conex containers has been marked in accordance with 31 TAC 335.69(a)(3).
TWC-17	The latest approved NOR is not the most current.	The facility has modified its NOR and it has been submitted.
TWC-18	Waste 003 is not listed on the NOR as being managed at facility 02.	The facility has modify its NOR, and it has been submitted.
TWC-19	Emergency coordinators new addresses have not been updated.	The contingency plan has been modified and has been submitted.

Table 2.3 1989 Hazardous Waste Shipments

Approximate Quantity	Unit	Description	Destination
1,050	Gallons	Crankcase oil	GSX, Greenbrier, Tennessee
6,114	Gallons	Crankcase oil	Systech, Inc., Tredonia, Kansas
68,928	Pounds	Construction debris and noncombustible waste	Chem Waste, Sulfur, Louisiana
5,225	Gallons	Crankcase oil	Amarillo City Landfill, Amarillo, Texas
2,488	Pounds	Lab-packs	Rollins Environmental Services, Baton Rouge, Louisiana
6,470	Pounds	Lab-packs	USPCI, Waynoka, Oklahoma
6,000	Pounds	Asbestos insulation	Rollins Environmental Services, Deer Park, Texas
14,100	Pounds	Asbestos insulation	GSX, Greenbrier, Tennessee
35,190	Pounds	Empty containers	MSP, Inc., Morgan City, Louisiana
253	Cubic yards	Contaminated soil	USPCI, Waynoka, Oklahoma
2,800	Pounds	Sodium hydroxide solution	GSX, Greenbrier, Tennessee
627	Pounds	Sodium hydroxide solution	Rollins Environmental Services, Baton Rouge, Louisiana
4,000	Pounds	Metal cleaning wastes	GSX, Greenbrier, Tennessee
8,976	Pounds	Chrome plating waste	GSX, Greenbrier, Tennessee
30,404	Pounds	Chrome plating wastes	Chem Wastes, Sulphur, Louisiana
22,670	Pounds	Chrome plating wates	Inmetco, Elwood City, Pennsylvania
62,347	Gallons	Etching solution	Chem Waste, Sulphur, Louisiana
969	Pounds	Liquid paint waste	Rollins Environmental Services Baton Rouge, Louisiana

LOW-LEVEL RADIOACTIVE WASTE REQUIREMENTS

DOE Order 5820.2A regulates low-level radioactive wastes. Low-level radioactive contaminated solid waste is typically generated in small quantities at the Pantex Plant and consists of classified weapons components and materials contaminated with depleted uranium and tritium. However, remediation of a cell caused by an accidental tritium release early in 1989 is resulting in generation of an additional tritium-contaminated solid waste stream. This release is described under "Accidental Releases" on page 29. Low-level radioactive wastes are stored on site pending periodic offsite shipment to the Nevada Test Site for disposal.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, as amended, is implemented by 40 CFR subchapter J. The TWC has primacy for administering CERCLA within Texas. CERCLA requires identification, characterization, and cleanup of inactive waste sites or other releases of hazardous materials by the responsible party. The Superfund Amendments and Reauthorization Act (SARA) Title III provisions added significant public notification requirements to CERCLA. There are no declared CERCLA sites at Pantex. At this time, all of the inactive solid waste units and release sites at the Pantex Plant are being investigated/remediated under regulations of RCRA and not CERCLA. The summary toxic chemical inventory data required under SARA Title III will be prepared in June 1990.

TOXIC SUBSTANCES CONTROL ACT

The Toxic Substances Control Act (TSCA) defines requirements to safely regulate the manufacture, processing, distribution in commerce, use, or disposal of chemical substances and mixtures which may present an unreasonable risk to either human health or the environment. This act specifically identifies polychlorinated biphenyls (PCBs) and requires that all PCBs be used in a "totally enclosed manner" to ensure no exposure of human beings or the environment.

The Pantex Plant uses large quantities of chemical substances to support its production, development, and maintenance operations. The chemicals used in the greatest quantities are organic solvents, which are stored in drums in various locations throughout the plant. Other materials used and stored include compressed gases, a wide variety of chemical reagents for laboratory use, pesticides and herbicides, and vehicle maintenance fluids. Oils containing a high concentration of PCBs are no longer used on site. There are 300 transformers in service that contain generally less than 50 parts per million (ppm) PCBs, which conform to federal regulations. However, the oil in one transformer exceeds the regulatory limit of 50 ppm and will be removed and disposed of properly.

Because of the hazardous nature of aspects of Pantex Plant production and development operations, chemical materials are generally stored and handled in a manner that will minimize the risk of igniting high-explosive materials. Material

Safety Data Sheets are available in the departments where chemicals are used. Smaller quantities and containers of flammable chemicals are stored in steel cabinets designed for that purpose, some of which have built-in fire control devices, and are located throughout the plant. Larger quantities of chemicals are generally stored in outdoor storage sheds. Most of these sheds have steel roofs and open sides, providing ventilation and at least partial protection from the elements, and are generally equipped with lightning rods and grounding straps. These facilities are inspected regularly by the Pantex Fire Department and ES&H. Efforts are under way to upgrade the storage facilities by installing steel secure storage buildings equipped with fire protection, ventilation equipment, and built-in secondary containment for spilled materials.

FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended, contains federal regulations governing the manufacture and use of biocides. Procedures promulgated under this act (40 CFR 150-180) govern the use, storage, and disposal of all pesticides, pesticide containers, and pesticide residues. At the Pantex Plant, pesticides are used in accordance with these regulations.

ACCIDENTAL RELEASES

The Pantex Plant had only one accidental release into the environment during 1989. Approximately 40,000 curies of tritium (conservatively estimated) was released at the south end of zone 12 on May 17, 1989, during a routine weapon disassembly operation. As a result of the tritium release, an investigation began in June 1989 to review tritium operations at the Pantex Plant. All state and federal regulatory agencies were promptly notified of the release. The annual dose due to the tritium release is shown in tables 3.11 and 3.12.

INVESTIGATIONS, INSPECTIONS, AND RESPONSES

Several investigations, inspections, and responses were conducted or completed in 1989. This section provides details on those activities.

An action plan was published in February 1989 in response to the Environmental Survey conducted by the Office of the Assistant Secretary of Environment, Safety, and Health at the Pantex Plant November 3 through 14, 1986.

A DOE "Tiger Team" has completed its inspection of the Pantex Plant for compliance with health, safety, and environmental statutes and regulations. The draft report detailing the results of this inspection has been received by Pantex Plant and includes fifty-nine environmental findings. A draft action plan in response to the "Tiger Team Report" has been completed and transmitted to DOE Headquarters for review and approval. Table 2.4 is a summary of the "Tiger Team" findings.

The RCRA Compliance Inspection action plan was developed in response to the 1989 annual RCRA compliance inspection conducted on March 14 and 15, 1989, by the TWC and EPA. The actions presented in this plan are based on the nineteen

Table 2.4 Summary of "Tiger Team" Findings

Type	Compliance Findings ¹	BMP Findings ²
Air	2	2
Surface water	3	4
Groundwater	0	2
Waste management	13	2
Toxic and chemical materials	2	1
Quality assurance	1	3
Radiation	1	7
Inactive waste sites	5	4
National Environmental Policy Act	4	2
Cultural and natural resources	1	0

1 Compliance findings are those activities not in compliance with federal, state, and local environmental requirements, and DOE environmental orders.

2 BMP (best management practice) findings are conditions where, in the judgement of the assessment team, best management practices were not employed.

discrepancies noted in the April 10, 1989, TWC letter. Findings and corrective actions are listed in table 2.2.

The Pantex Plant has received a 3007 request from EPA Region 6 on the materials received at a now inactive hazardous waste unit (11-14 pond). Also requested are the nature and extent of operations at the generation point of the waste that was treated in the unit in question.

The ER Program released phase 1, stage 2 of the remedial investigation (RI) of a group of three release sites known as task AL-PX-1 in June 1989. Task AL-PX-1 has been given the highest priority of the sites catalogued at the Pantex Plant to be remediated by the ER program. At the present time, most of the ER Program has been suspended due to issuance of the draft 3008(h) corrective action order from EPA Region 6.

SECTION 3

ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

The environmental radiological program at Pantex currently evaluates air, water, groundwater, soil, vegetation, and specific fauna samples. Analyses of area samples are specific for radionuclides that are alpha or beta emitters, plutonium-239, uranium-234, and uranium-238, and tritium (isotopes of concern in the assembly of nuclear weapons), as well as for naturally occurring radium-226 and radium-228. Due to the magnitude of the radiological monitoring program for groundwater, it is discussed in section 5 as a separate program.

The sampling program at the Pantex facility measures concentrations of radionuclides in naturally occurring materials. These measurements are made on and off the site for comparison purposes. Since radioactive particles are transported by air and water, sample collections and measurements are focused on these media. Soil and vegetation samples are also collected and analyzed to determine the migration, if any, of radioactive materials leaving the site.

The basic requirements for all environmental monitoring activities at DOE facilities are contained in the 5400 series of the DOE orders. Chapter III of DOE Order 5484.1 identifies specific effluent monitoring requirements. Pantex has implemented the Environmental Safety & Health Division's internal operating procedure (IOP) 3405, "Environmental Sampling Procedures: Air, Water, Soil, Vegetation, and Biota," to comply with the intent of these orders (Mason and Hanger). Sampling methods for hazardous or mixed waste are in accordance with EPA guidance contained in SW-846, and under the authority of TWC permit 30459 (EPA TX4890110527).

The results of radioactivity measurements for air and water samples are expressed in terms of microcuries per milliliter ($\mu\text{Ci/mL}$). Soil, vegetation, and fauna sample results are expressed in microcuries per gram ($\mu\text{Ci/g}$). Individual dose radiological airborne emissions are reported in units of millirem (mrem) per year and population doses are reported in units of person-rem.

Radioactive measurements are subject to the statistical nature of radioactive decay and are presented in conjunction with an associated statistical error. All errors presented represent counting errors at the 95-percent confidence level only; no attempt has been made to quantify systematic errors. The minimum detection limits of the measured radioactive parameters were calculated based on the U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 4.14. Negative numbers can arise when the radioactivity of the sample is less than the statistical

mean of the background value which is used in determining the net quantity of radioactivity in a sample. Minimum detection limits are inserted in place of negative averages when these occur.

Standards for radioactivity in air and water are derived from DOE Order 5480.11 for occupational workers (controlled area exposures) and from the August 5, 1985, memo "Radiation Standards Protection of the Public in the Vicinity of DOE Facilities" for offsite uncontrolled or general population (DOE, 1988). A new DOE Order 5400.5, which became effective in February 1990, is now the governing document for radiation protection of the public and the environment.

Table 3.1 lists derived air concentration (DAC) screening values for controlling radiation exposure to workers at the Pantex Plant and other DOE facilities (DOE Order 5480.11). Also listed in table 3.1 are the derived concentration guide (DCG) screening values (DOE Order 5400.5) for internal exposure of radionuclides due to ingestion of water and inhalation of air. The DCG values are used for conducting radiological environmental protection programs at DOE facilities. These standards will be compared with the results of the radiological samples presented in subsequent paragraphs.

Occupational exposures are set at the levels presented in table 3.2. Offsite exposure levels are set to limit the effective dose equivalents from all pathways due to routine plant operations to 100 mrem per year; this exposure is considered continual. The "National Emission Standard for Radionuclide Emissions" (40 CFR 61 Subpart H) further restricts the air pathway dose resulting from the operations of a DOE facility to 25 mrem per year whole-body or 75 mrem per year to any organ. Subpart H of 40 CFR 61 was changed in December 1989 to limit the effective dose equivalent to any member of the public to 10 mrem per year, although the limit applies only to 1990 releases.

The sample monitoring programs for air, surface water, soil, vegetation, and fauna are discussed below. The sampling results of each program are presented in tables within each discussion. At the time this report was written, all of the data may not have been received from the laboratories or entered into the computer data base. Therefore, the required number of samples for each program may not agree with the actual number of samples shown in the tables.

AIR MONITORING PROGRAM

Ten offsite air sampling locations and seven plant-site locations were used during 1989 in the air sampling program. Sampling locations are shown in figures 3.1 and 3.2. The offsite units are all located within an approximate 5-mile radius of the Pantex Plant. A control site, which is used for collecting background air samples, is located 34 miles west of Pantex at the Bushland Agricultural Research Station. Table 3.3 lists the site ID number and location for each sampling site. Each site has both a high-volume and a low-volume sampler, except for the control site, which has only a high-volume sampler. Air monitoring samples are currently collected weekly. These samples are analyzed at an offsite laboratory for uranium-234, uranium-238, plutonium-239, tritium, and on site for gross alpha and gross beta determination.

Table 3.1 Radioactivity Standards for Air and Water

Radionuclide	Derived Air*	Derived**	
	Concentrations	Concentration Guides	
	Air ($\mu\text{Ci/mL}$)	Air ($\mu\text{Ci/mL}$)	Water ($\mu\text{Ci/mL}$)
Plutonium-239	6×10^{-12}	4×10^{-14}	2×10^{-6}
Tritium	2×10^{-5}	1×10^{-7}	2×10^{-3}
Uranium-234	2×10^{-11}	9×10^{-14}	5×10^{-6}
Uranium-238	2×10^{-11}	1×10^{-13}	6×10^{-6}
Radium-226	3×10^{-10}	1×10^{-12}	1×10^{-7}
Radium-228	5×10^{-10}	3×10^{-12}	1×10^{-7}

* DOE order 5480.11, attachment 1, table 1.

** DOE order 5400.5, chapter III.

Table 3.2 Radiation Protection Standards Limiting Values for Assessed Dose from
Exposure of Occupational Workers to Radiation

Stochastic effects	5 rem (annual effective dose equivalent)
Non-stochastic effects	
Lens of eye	15 rem (annual dose equivalent)
Extremity	50 rem (annual dose equivalent)
Skin of the whole body	50 rem (annual dose equivalent)
Organ or tissue	50 rem (annual dose equivalent)

Reference: DOE order 5480.11, page 12, figure 1.

LEGEND

- +—+—+ RAIL ROAD
- FENCE
- PANTEX SITE BOUNDARY
- PANTEX PLANT BOUNDARY
- P1 PLAYA #1
- PA-AR-01 AIR SAMPLES

NOTE:
BASE MAP INFORMATION FROM PANTEX
DRAWING NO. G00062011.DGN

FIGURE 3.2
PLANT SITE AIR
SAMPLING LOCATIONS

PANTEX PLANT AMARILLO, TEXAS

Table 3.3 1989 Radiological Air Monitoring

Pantex Sample Location ID	Location/Description
Onsite	
PA-AR-01	Water well #17
PA-AR-02	Water treatment building
PA-AR-03	Water well #6
PA-AR-04	Adjacent to north fence of zone 4
PA-AR-05	Adjacent to Plant's north fence
PA-AR-06	East of 12-42
PA-AR-07	NE of building 4-26
Offsite	
OA-AR-01	3.1 miles west of City of Amarillo well #616
OA-AR-02	City of Amarillo well #616
OA-AR-03	2.0 miles east of City of Amarillo well #616
OA-AR-04	NE of OA-AR-03
OA-AR-05	NE of intersection of FM 293 and FM 2373
OA-AR-06	NE of intersection of FM 2373 and U.S. 60
OA-AR-08	South of intersection FM 2373 and U.S. 60
OA-AR-09	Intersection of FM 683 and U.S. 60
OA-AR-10	2.0 miles from intersection of FM 245 and FM 683
OA-AR-13	Bushland, Texas

The high-volume samplers, which are equipped with automatic flow-rate controllers, operate at a sampling rate of approximately 1.1 cubic meters per minute (40 cfm). Particles are collected on 20- by 25-centimeter (8- by 10-inch) filters. The filters are changed weekly, weather permitting. A weekly air sample represents about 11,400 cubic meters. Weekly air filter samples are collected for plutonium-239, uranium-234, and uranium-238 and composited every two months with other filter samples from the same air sampling station. These samples are then sent off site for laboratory analyses.

Each low-volume sampler contains a silica gel column in the sampling line for collection of environmental tritium oxide. The silica gel acts as a desiccant to remove water vapor from the air stream. Any tritium oxide present is captured with the water vapor and recovered for analysis. Silica gel columns are exchanged weekly. Nominal air flow is about 42.5 liters per minute (1.5 cfm). Silica gel samples are collected and analyzed weekly by an offsite laboratory to determine the tritium content. Low volume prefilters are analyzed for gross alpha and beta.

Air monitoring stations must be sited in accordance with guidelines that provide minimum clearance from buildings, trees, or other obstructions to prevent wake effects. Such guidelines are stated in DOE Order 5400.1, chapter IV, as well as in "Ambient Air Monitoring Guidelines for PSD" in the *Federal Register*. As previously stated, all of the air monitoring stations except the control site station are located within a 5-mile radius of the Pantex Plant. The locations are sited according to the directions of the prevailing winds as well as upwind to provide background information.

In the 1989 assessment, the "Tiger Team" observed two Pantex air monitoring stations with siting problems: PA-AR-02 and OA-AR-03. Station PA-AR-02 is located on site, and station OA-AR-03 is located off site. These two stations were found to be too close to buildings. The siting may affect the ability of each station to collect representative samples. The locations of the two air monitoring stations were evaluated by Pantex for proper siting and relocated.

Table 3.4 is a summary of the results of the radiological air sampling program. The radionuclides which were detected in the air in 1989 are well below the DAC and DCG standards set by DOE. There has been no general increase or decrease in average gross alpha readings between 1987 and 1989; however, the maximum recorded values during 1989 were approximately three to five times higher than 1987 and 1988. The maximum recorded values ranged from about 40×10^{-16} to 90×10^{-16} $\mu\text{Ci/mL}$ for 1987 and 1988 and from about 200×10^{-16} to 320×10^{-16} $\mu\text{Ci/mL}$ for 1989. Air sampling station OA-AR-06 was apparently an exception to the higher readings in 1989; the maximum and average values were approximately 35×10^{-16} and 14×10^{-16} $\mu\text{Ci/mL}$, respectively. The increase in alpha readings can not be explained at this time.

Gross beta readings steadily increased from 1987 to 1989 with the average values for 1989 being approximately 1.5 to 2 times greater than 1987 values. The average values ranged from about 90×10^{-16} to 110×10^{-16} $\mu\text{Ci/mL}$ for 1987 and 1988 and from about 160×10^{-16} to 246×10^{-16} $\mu\text{Ci/mL}$ for 1989. The highest mean value

Table 3.4 Pantex Air Monitoring Radiological Data Summary for 1989

Page 1

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-7}$)
OA-AR-01					
Gross Alpha	52	0.70 $\pm$ 3.40	275.4 $\pm$ 23.75	20.09 $\pm$ 6.23	-16
Gross Beta	49	66.12 $\pm$ 20.27	649.0 $\pm$ 36.90	211.0 $\pm$ 23.79	-16
Tritium	50	<0.3 $\pm$ 0.97	19.40 $\pm$ 2.55	1.80 $\pm$ 1.67	-12
Plutonium-239	4	<1.0 $\pm$ 0.15	0.09 $\pm$ 0.13	<1.00 $\pm$ 0.16	-17
Uranium-234	4	1.80 $\pm$ 0.35	5.43 $\pm$ 0.49	3.06 $\pm$ 0.39	-17
Uranium-238	4	1.23 $\pm$ 0.31	5.43 $\pm$ 0.49	2.70 $\pm$ 0.37	-17
OA-AR-02					
Gross Alpha	50	0.64 $\pm$ 2.40	225.8 $\pm$ 21.54	17.57 $\pm$ 5.97	-16
Gross Beta	50	22.91 $\pm$ 9.54	525.8 $\pm$ 33.35	200.5 $\pm$ 23.19	-16
Tritium	51	<0.31 $\pm$ 0.67	34.71 $\pm$ 2.55	2.21 $\pm$ 1.65	-12
Plutonium-239	4	<1.0 $\pm$ 0.18	0.00 $\pm$ 0.15	<1.00 $\pm$ 0.15	-17
Uranium-234	4	1.32 $\pm$ 0.35	2.86 $\pm$ 0.39	1.91 $\pm$ 0.36	-17
Uranium-238	4	1.84 $\pm$ 0.31	2.96 $\pm$ 0.39	1.12 $\pm$ 0.37	-17
OA-AR-03					
Gross Alpha	50	4.48 $\pm$ 3.68	295.8 $\pm$ 24.60	19.67 $\pm$ 6.16	-16
Gross Beta	50	46.77 $\pm$ 18.89	677.3 $\pm$ 37.66	219.1 $\pm$ 23.96	-16
Tritium	49	<0.3 $\pm$ 0.54	15.82 $\pm$ 2.55	1.88 $\pm$ 1.78	-12
Plutonium-239	4	<1.0 $\pm$ 0.20	0.00 $\pm$ 0.09	<1.00 $\pm$ 0.16	-17
Uranium-234	4	1.36 $\pm$ 0.35	7.89 $\pm$ 0.49	3.21 $\pm$ 0.39	-17
Uranium-238	4	1.27 $\pm$ 0.35	8.39 $\pm$ 0.49	3.35 $\pm$ 0.39	-17
OA-AR-04					
Gross Alpha	49	0.00 $\pm$ 1.98	302.1 $\pm$ 24.86	19.07 $\pm$ 5.96	-16
Gross Beta	49	25.69 $\pm$ 16.02	739.4 $\pm$ 39.29	202.4 $\pm$ 23.25	-16
Tritium	50	<0.3 $\pm$ 0.70	68.96 $\pm$ 5.75	2.54 $\pm$ 2.10	-12
Plutonium-239	4	<1.0 $\pm$ 0.15	0.04 $\pm$ 0.18	<1.00 $\pm$ 0.15	-17
Uranium-234	4	1.40 $\pm$ 0.35	6.41 $\pm$ 0.49	2.96 $\pm$ 0.39	-17
Uranium-238	4	1.45 $\pm$ 0.35	5.92 $\pm$ 0.49	2.81 $\pm$ 0.39	-17

* Value $\pm$ counting error.

Table 3.4, continued

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-7}$)
OA-AR-05					
Gross Alpha	51	0.00 $\pm$ 1.58	229.6 $\pm$ 21.71	18.15 $\pm$ 5.95	-16
Gross Beta	51	0.44 $\pm$ 6.86	674.7 $\pm$ 37.59	202.4 $\pm$ 23.14	-16
Tritium	51	<0.3 $\pm$ 0.97	12.76 $\pm$ 2.55	1.61 $\pm$ 1.66	-12
Plutonium-239	4	<1.0 $\pm$ 0.18	0.05 $\pm$ 0.15	<1.00 $\pm$ 0.16	-17
Uranium-234	4	3.11 $\pm$ 0.39	7.40 $\pm$ 0.49	4.34 $\pm$ 0.61	-17
Uranium-238	4	3.68 $\pm$ 0.83	6.91 $\pm$ 0.49	4.54 $\pm$ 0.65	-17
OA-AR-06					
Gross Alpha	51	0.00 $\pm$ 3.01	35.58 $\pm$ 8.82	14.23 $\pm$ 5.75	-16
Gross Beta	51	13.85 $\pm$ 9.99	501.9 $\pm$ 35.08	196.0 $\pm$ 23.09	-16
Tritium	51	<0.3 $\pm$ 0.99	9.70 $\pm$ 2.04	1.16 $\pm$ 1.61	-12
Plutonium-239	4	<1.0 $\pm$ 0.13	0.26 $\pm$ 0.18	<1.00 $\pm$ 0.15	-17
Uranium-234	4	1.80 $\pm$ 0.39	3.55 $\pm$ 0.44	2.52 $\pm$ 0.38	-17
Uranium-238	4	1.58 $\pm$ 0.35	3.11 $\pm$ 0.39	2.30 $\pm$ 0.35	-17
OA-AR-07					
Gross Alpha	2	4.72 $\pm$ 5.82	19.85 $\pm$ 6.69	12.29 $\pm$ 6.26	-16
Gross Beta	2	110.8 $\pm$ 16.75	153.6 $\pm$ 18.70	132.2 $\pm$ 17.72	-16
OA-AR-08					
Gross Alpha	51	0.00 $\pm$ 3.92	313.6 $\pm$ 25.32	20.08 $\pm$ 6.15	-16
Gross Beta	51	50.53 $\pm$ 12.28	657.0 $\pm$ 37.11	212.1 $\pm$ 23.72	-16
Tritium	51	<0.3 $\pm$ 1.04	32.37 $\pm$ 3.88	1.88 $\pm$ 1.67	-12
Plutonium-239	4	<1.0 $\pm$ 0.15	0.09 $\pm$ 0.22	<1.00 $\pm$ 0.18	-17
Uranium-234	4	1.23 $\pm$ 0.31	4.93 $\pm$ 0.69	2.55 $\pm$ 0.38	-17
Uranium-238	4	1.18 $\pm$ 0.31	4.64 $\pm$ 0.64	2.44 $\pm$ 0.38	-17
OA-AR-09					
Gross Alpha	51	0.00 $\pm$ 3.01	243.6 $\pm$ 22.36	15.87 $\pm$ 5.59	-16
Gross Beta	51	11.25 $\pm$ 8.22	563.9 $\pm$ 34.49	178.8 $\pm$ 22.11	-16
Tritium	51	<0.3 $\pm$ 0.65	61.25 $\pm$ 5.10	3.78 $\pm$ 1.83	-12
Plutonium-239	4	<1.0 $\pm$ 0.15	0.13 $\pm$ 0.13	<1.00 $\pm$ 0.13	-17
Uranium-234	4	1.80 $\pm$ 0.39	2.89 $\pm$ 0.26	2.14 $\pm$ 0.35	-17
Uranium-238	4	1.71 $\pm$ 0.39	3.07 $\pm$ 0.26	2.38 $\pm$ 0.36	-17

* Value $\pm$ counting error.

Table 3.4, continued

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-}$)
OA-AR-10					
Gross Alpha	51	1.92 $\pm$ 2.89	290.7 $\pm$ 24.39	16.84 $\pm$ 5.70	-16
Gross Beta	51	41.79 $\pm$ 17.53	690.6 $\pm$ 38.02	191.9 $\pm$ 22.92	-16
Tritium	51	<0.3 $\pm$ 0.51	18.37 $\pm$ 2.55	1.78 $\pm$ 1.94	-12
Plutonium-239	4	0.00 $\pm$ 0.15	0.39 $\pm$ 0.13	<1.00 $\pm$ 0.16	-17
Uranium-234	4	1.05 $\pm$ 0.31	5.92 $\pm$ 0.49	2.68 $\pm$ 0.36	-17
Uranium-238	4	1.18 $\pm$ 0.31	6.41 $\pm$ 0.49	2.93 $\pm$ 0.37	-17
OA-AR-13					
Gross Alpha	44	0.00 $\pm$ 2.54	317.0 $\pm$ 25.40	34.64 $\pm$ 8.09	-16
Gross Beta	44	13.75 $\pm$ 16.56	428.6 $\pm$ 30.94	245.8 $\pm$ 25.48	-16
Tritium	49	<0.3 $\pm$ 0.53	26.54 $\pm$ 2.55	1.81 $\pm$ 1.71	-12
Plutonium-239	4	0.04 $\pm$ 0.13	0.13 $\pm$ 0.13	<1.00 $\pm$ 0.13	-17
Uranium-234	4	1.32 $\pm$ 0.35	3.75 $\pm$ 0.30	2.27 $\pm$ 0.33	-17
Uranium-238	4	1.40 $\pm$ 0.35	3.45 $\pm$ 0.25	2.21 $\pm$ 0.32	-17
PA-AR-01					
Gross alpha	50	1.92 $\pm$ 2.89	224.6 $\pm$ 21.48	19.03 $\pm$ 6.18	-16
Gross Beta	50	47.88 $\pm$ 12.06	542.6 $\pm$ 33.86	213.8 $\pm$ 23.87	-16
Tritium	50	<0.3 $\pm$ 0.97	19.40 $\pm$ 2.55	2.30 $\pm$ 1.63	-12
Plutonium-239	4	<1.0 $\pm$ 0.15	0.22 $\pm$ 0.18	<1.00 $\pm$ 0.17	-17
Uranium-234	4	2.50 $\pm$ 0.44	5.43 $\pm$ 0.49	3.29 $\pm$ 0.42	-17
Uranium-238	4	2.10 $\pm$ 0.39	5.43 $\pm$ 0.49	3.14 $\pm$ 0.41	-17
PA-AR-02					
Gross alpha	51	0.64 $\pm$ 3.82	201.7 $\pm$ 20.37	18.07 $\pm$ 6.14	-16
Gross Beta	51	65.80 $\pm$ 20.02	514.4 $\pm$ 35.50	208.2 $\pm$ 23.62	-16
Tritium	50	<0.3 $\pm$ 1.04	39.81 $\pm$ 2.55	2.68 $\pm$ 1.63	-12
Plutonium-239	4	0.00 $\pm$ 0.15	0.18 $\pm$ 0.13	<1.00 $\pm$ 0.16	-17
Uranium-234	4	2.06 $\pm$ 0.75	6.41 $\pm$ 0.49	3.45 $\pm$ 0.60	-17
Uranium-238	4	1.75 $\pm$ 0.70	6.41 $\pm$ 0.49	3.29 $\pm$ 0.57	-17

* Value $\pm$ counting error.

Table 3.4, continued

Page 4

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-}$)
PA-AR-03					
Gross alpha	51	0.00 ± 1.78	208.0 ± 20.68	17.64 ± 5.99	-16
Gross Beta	51	53.01 ± 19.36	531.1 ± 33.51	208.1 ± 23.65	-16
Tritium	50	$< 0.3 \pm 0.96$	51.04 ± 5.10	2.61 ± 1.66	-12
Plutonium-239	4	0.09 ± 0.18	0.35 ± 0.26	$< 1.00 \pm 0.21$	-17
Uranium-234	4	2.24 ± 0.44	4.93 ± 0.49	3.26 ± 0.48	-17
Uranium-238	4	1.40 ± 0.39	4.88 ± 0.59	2.71 ± 0.46	-17
PA-AR-04					
Gross alpha	51	0.00 ± 3.01	262.7 ± 23.20	18.71 ± 6.04	-16
Gross Beta	51	52.28 ± 19.06	643.7 ± 36.75	209.4 ± 23.64	-16
Tritium	50	$< 0.3 \pm 0.67$	68.96 ± 5.75	3.35 ± 1.67	-12
Plutonium-239	4	$< 1.0 \pm 0.09$	0.18 ± 0.18	$< 1.00 \pm 0.15$	-17
Uranium-234	4	1.62 ± 0.39	3.90 ± 0.66	2.75 ± 0.47	-17
Uranium-238	4	1.23 ± 0.35	3.65 ± 0.44	2.20 ± 0.42	-17
PA-AR-05					
Gross alpha	50	3.20 ± 3.31	257.6 ± 22.98	20.69 ± 6.39	-16
Gross Beta	50	8.68 ± 16.80	657.8 ± 37.14	219.2 ± 23.96	-16
Tritium	49	$< 0.3 \pm 0.67$	28.58 ± 2.55	2.50 ± 1.61	-12
Plutonium-239	4	$< 1.0 \pm 0.09$	0.10 ± 0.20	$< 1.00 \pm 0.16$	-17
Uranium-234	4	1.45 ± 0.35	3.80 ± 0.49	2.62 ± 0.44	-17
Uranium-238	4	1.67 ± 0.39	3.55 ± 0.44	2.59 ± 0.44	-17
PA-AR-06					
Gross alpha	51	0.00 ± 1.97	227.1 ± 21.60	15.69 ± 5.50	-16
Gross Beta	51	0.00 ± 14.66	577.2 ± 34.87	174.1 ± 21.90	-16
Tritium	49	0.00 ± 0.00	2384 ± 158.9	196.1 ± 9.37	-12
Plutonium-239	4	0.04 ± 0.13	0.09 ± 0.13	$< 1.00 \pm 0.13$	-17
Uranium-234	4	0.83 ± 0.31	5.43 ± 0.49	2.48 ± 0.38	-17
Uranium-238	4	1.01 ± 0.31	5.92 ± 0.49	2.68 ± 0.38	-17

* Value $\pm$ counting error.

Table 3.4, continued

Page 5

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{\sim}$)
PA-AR-07					
Gross alpha	17	0.00 $\pm$ 3.57	211.8 $\pm$ 20.87	21.71 $\pm$ 6.31	-16
Gross Beta	17	17.02 $\pm$ 9.11	551.5 $\pm$ 34.12	16.25 $\pm$ 18.51	-16
Tritium	17	<0.3 $\pm$ 0.67	12.76 $\pm$ 2.04	1.53 $\pm$ 0.95	-12
Plutonium-239	3	0.00 $\pm$ 0.20	0.04 $\pm$ 0.18	<1.00 $\pm$ 0.19	-17
Uranium-234	3	1.67 $\pm$ 0.57	3.55 $\pm$ 0.44	2.30 $\pm$ 0.53	-17
Uranium-238	3	1.84 $\pm$ 0.61	3.35 $\pm$ 0.39	2.34 $\pm$ 0.54	-17

* Value $\pm$ counting error.

Minimum detectable levels:

Gross alpha and beta
Tritium
Plutonium-239
Uranium-234
Uranium-238

1.0 $\times 10^{-16}$ $\mu\text{Ci/mL}$
0.3 $\times 10^{-12}$ $\mu\text{Ci/mL}$
1.0 $\times 10^{-17}$ $\mu\text{Ci/mL}$
0.04 $\times 10^{-17}$ $\mu\text{Ci/mL}$
0.5 $\times 10^{-17}$ $\mu\text{Ci/mL}$

* Value $\pm$ counting error.

recorded was 246×10^{-16} $\mu\text{Ci/mL}$ at the background air station OA-AR-13 while the highest maximum value recorded was 739×10^{-16} $\mu\text{Ci/mL}$ at air station OA-AR-04. These increased beta readings can not be explained at this time.

A slight increase in U-234 and U-238 values for 1989 is apparent compared to the 1988 values. The highest onsite values for U-234 and U-238 (10.52×10^{-17} and 9.65×10^{-17} $\mu\text{Ci/mL}$ respectively) were recorded at station PA-AR-01 in 1988. The highest offsite values (7.89×10^{-17} and 8.39×10^{-17} $\mu\text{Ci/mL}$) were recorded at station OA-AR-03 in 1989. Background readings at station OA-AR-13 decreased from 6.75×10^{-17} and 7.81×10^{-17} $\mu\text{Ci/mL}$ in 1988 to 3.75×10^{-17} and 3.45×10^{-17} $\mu\text{Ci/mL}$ in 1989 for uranium-234 and uranium-238, respectively. The increase in uranium value at air station OA-AR-03 can be attributed to the use of depleted uranium during past test firings. Recorded values for plutonium-239 have been below the minimum detection limit since 1985.

The only radionuclide detected in a significant quantity in 1989 was tritium. These relatively high readings can be attributed to a release of deuterium-tritium gas that occurred in building 12-44 at 2:35 P.M. on May 17, 1989, during a routine weapon disassembly operation. The air station adjacent to the building, PA-AR-06, recorded a maximum value of $2,384 \times 10^{-12}$ $\mu\text{Ci/mL}$ of tritium for the month of May. As a result of the tritium release, an investigation began in June 1989 to review tritium operations at the Pantex Plant. The review will evaluate tritium operations associated with airborne effluent monitoring and protection. Pantex is presently addressing the recommended actions.

SURFACE WATER MONITORING PROGRAM

Local hydrologic characteristics of the Pantex vicinity are such that no streams or rivers flow through or near the plant site. Most industrial effluents, sanitary wastewater treatment plant effluents, and surface drainage are discharged to ditches. Treated water from the wastewater treatment plant is used for irrigation. The industrial discharges from the west side of zone 11 are collected in Playa 2 for disposal through solar evaporation. Sample locations for Playas 1 and 2 are designated as OW-WR-08 and OW-WR-27, respectively.

Samples were taken from surface water at eleven plant sites, including Playas 1 and 2 and treated sanitary effluents. Surface water samples were also collected from plant drainage ditches which flow into the playas. Table 3.5 lists the site ID numbers and onsite locations sampled in 1989. The locations and sample identification numbers are shown in figure 3.3. No offsite sampling of surface water was done in 1989.

Surface water grab samples are collected monthly and sent to an offsite laboratory for analysis of tritium, uranium-234, uranium-238, plutonium-239, and dissolved and suspended alpha or beta emitters.

The annual summaries of the results obtained from the surface water sampling program are shown in table 3.6. The radionuclides which were detected in the surface waters in 1989 are below the DCG and EPA standards. Concentrations of plutonium and uranium isotopes were fairly consistent with concentrations found in

Table 3.5 1989 Radiological Surface Water Monitoring

Panther Sample Location ID	Onsite Location/Description
Playas	
OW-WR-01	Pantex Playa Lake (northeast of plant)
OW-WR-08	East bank of north retention basin playa
OW-WR-24	South playa, due south of zone 12
OW-WR-27	West playa near sanitary landfill
OW-WR-36	Burning ground playa lake
Industrial waters	
OW-WR-09	Main drainage ditch (east side of zone 12)
OW-WR-13	Building 12-43 HE filter building effluent
OW-WR-15	Building 11-44 HE filter building effluent
OW-WR-25	Drainage from building 12-64 to south playa
Wastewater	
OW-WR-17	Sewage treatment discharge
OW-WR-31	Effluent pond, zone 11 east

FM-293

LEGEND

- +—+— RAIL ROAD
- FENCE
- PANTEX SITE BOUNDARY
- PANTEX PLANT BOUNDARY
- P1 PLAYA #1

OW-WR-08
 WATER SAMPLE LOCATION

NOTE:
 OW-WR-01 LOCATION OF WELL LOCATED AT SW CORNER OF LAKE PANTEX
 BASE MAP INFORMATION FROM PANTEX
 DRAWING NO. G00062011.DGN

FIGURE 3.3
PLANT SITE SURFACE WATER
SAMPLING LOCATIONS

PANTEX PLANT AMARILLO, TEXAS

the past. Increases in levels of tritium were noted at stations OW-WR-17 and OW-WR-24 which were approximately 10 times higher than readings at other stations (12×10^{-6} to 18×10^{-6} $\mu\text{Ci/mL}$, as compared to 0.2×10^{-6} to 1.0×10^{-6} $\mu\text{Ci/mL}$). These increased levels can be attributed to the accidental release of tritium during May.

Alpha and beta activity is similar for most of the sampling locations except for site OW-WR-01 and OW-WR-36 which had approximately two to three times the maximum and average concentration values for 1989 as in the previous years. Station OW-WR-36 had higher suspended alpha and beta (46×10^{-9} and 58×10^{-9} $\mu\text{Ci/mL}$) and station OW-WR-01 had higher dissolved beta (54×10^{-9} $\mu\text{Ci/mL}$). Site OW-WR-25, however, had concentrations of alpha and beta particles that were below detection limits of 1.0×10^{-9} $\mu\text{Ci/mL}$. These increased levels can not be explained at this time. Station OW-WR-01 and OW-WR-36 are located immediately downwind of the burning grounds. Also, at the time this report was prepared, all of the sampling data was not received from the laboratories in time to enter it into the data base, thereby causing the averages to appear higher than normal.

SOIL MONITORING PROGRAM

Thirty-two offsite environmental soil sampling locations and nineteen plant-site soil sampling locations were sampled during 1989. The sampling locations ID numbers and descriptions are listed in table 3.7. The sampling locations are shown on figures 3.4 and 3.5.

The purpose of offsite soil sampling was to measure radioactive content in the soil for comparison with perimeter samples. These comparisons will determine if the surface soil at Pantex is within a similar range of values. Soil samples were collected according to sampling procedures outlined in IOP 3405 and the EPA sampling protocol for soil. There are no standards or guidelines for uranium in soil.

Plant-site soil samples were collected monthly, and offsite soil samples were collected quarterly. Samples were collected from the surface of the ground using a 3½-inch-diameter by 3-inch-deep soil sampler. Soil samples were also collected at the USDA Bushland site (designated as OS-SS-32). After collection, the soil samples were sent to an offsite laboratory and analyzed for uranium-234, uranium-238, and plutonium-239. The annual summary results of the soil sampling program are shown in table 3.8.

Of the radionuclides present in the soils at Pantex, uranium-238 appears to be the most prevalent. The highest readings occur mostly in the soils at firing site 5 and can be attributed to the use of depleted uranium containment vessels during past test firings. The readings at the firing sites are approximately ten to thirty times higher than the readings at the burning grounds and offsite sampling locations. Uranium-238 readings at the firing sites ranged from 8 to 450×10^{-7} $\mu\text{Ci/g}$, while the readings at the burning grounds and offsite locations ranged from 6 to 13×10^{-7} $\mu\text{Ci/g}$ and 4 to 13×10^{-7} $\mu\text{Ci/g}$, respectively. Historical data have shown that FC-SS-05 (firing site 10) and its immediate area have exhibited occasionally high readings of

Table 3.6 Pantex Surface Water Monitoring Radiological Data Summary for 1989

Page 1

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-6}$)
OW-WR-01					
Gross alpha (dissolved)	4	$<1.00 \pm 3.00$	5.00 ± 4.00	1.50 ± 2.50	-9
Gross alpha (suspended)	4	0.00 ± 2.00	18.00 ± 9.00	5.75 ± 3.75	-9
Gross beta (dissolved)	4	0.00 ± 0.00	54.00 ± 4.00	22.50 ± 2.25	-9
Gross beta (suspended)	4	0.00 ± 0.00	43.00 ± 6.00	14.00 ± 2.50	-9
Tritium	4	$<0.2 \pm 0.16$	0.13 ± 0.15	$<0.20 \pm 0.14$	-6
Plutonium-239	4	0.00 ± 0.00	0.40 ± 0.20	$<0.20 \pm 0.15$	-10
Uranium-234	4	0.00 ± 0.00	1.80 ± 0.70	0.93 ± 0.30	-9
Uranium-238	4	0.00 ± 0.00	1.20 ± 0.60	0.60 ± 0.28	-9
OW-WR-08					
Gross alpha (dissolved)	5	0.00 ± 0.00	10.00 ± 6.00	5.40 ± 4.80	-9
Gross alpha (suspended)	5	0.00 ± 0.00	2.00 ± 2.00	$<1.00 \pm 1.00$	-9
Gross beta (dissolved)	5	0.00 ± 0.00	26.00 ± 4.00	12.40 ± 10.00	-9
Gross beta (suspended)	5	0.00 ± 0.00	6.00 ± 2.00	2.00 ± 1.60	-9
Tritium	5	$<0.2 \pm 0.16$	2.30 ± 0.20	0.44 ± 0.10	-6
Plutonium-239	5	0.00 ± 0.00	0.10 ± 0.10	$<0.20 \pm 0.10$	-10
Uranium-234	5	0.00 ± 0.00	3.80 ± 0.80	2.04 ± 0.40	-9
Uranium-238	5	0.00 ± 0.00	2.20 ± 0.60	1.02 ± 0.30	-9
OW-WR-09					
Gross alpha (dissolved)	4	1.00 ± 3.00	8.00 ± 6.00	5.50 ± 4.75	-9
Gross alpha (suspended)	4	0.00 ± 2.00	2.00 ± 1.00	$<1.00 \pm 1.25$	-9
Gross beta (dissolved)	4	6.00 ± 3.00	10.00 ± 3.00	7.75 ± 3.25	-9
Gross beta (suspended)	4	$<1.00 \pm 2.00$	4.00 ± 2.00	1.25 ± 2.00	-9
Tritium	4	0.00 ± 0.00	1.50 ± 0.20	0.46 ± 0.17	-6
Plutonium-239	4	0.00 ± 0.10	0.20 ± 0.20	$<0.20 \pm 0.15$	-10
Uranium-234	4	0.70 ± 0.20	5.20 ± 0.90	2.88 ± 0.48	-9
Uranium-238	4	0.30 ± 0.20	2.00 ± 0.60	1.27 ± 0.35	-9

* Value $\pm$ counting error.

Table 3.6, continued

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-9}$)
OW-WR-13					
Gross alpha (dissolved)	8	0.00 $\pm$ 0.00	15.00 $\pm$ 7.00	7.00 $\pm$ 4.38	-9
Gross alpha (suspended)	8	<1.00 $\pm$ 1.00	0.00 $\pm$ 1.00	<1.00 $\pm$ 0.88	-9
Gross beta (dissolved)	8	0.00 $\pm$ 0.00	16.00 $\pm$ 4.00	8.00 $\pm$ 2.75	-9
Gross beta (suspended)	8	0.00 $\pm$ 0.00	3.00 $\pm$ 2.00	<1.00 $\pm$ 1.75	-9
Tritium	8	<0.2 $\pm$ 0.14	0.74 $\pm$ 0.18	<0.20 $\pm$ 0.14	-6
Plutonium-239	8	<0.2 $\pm$ 0.20	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.15	-10
Uranium-234	8	0.00 $\pm$ 0.00	5.10 $\pm$ 0.60	3.13 $\pm$ 0.53	-9
Uranium-238	8	0.00 $\pm$ 0.00	2.80 $\pm$ 0.40	1.58 $\pm$ 0.36	-9
OW-WR-15					
Gross alpha (dissolved)	6	0.00 $\pm$ 1.00	14.00 $\pm$ 7.00	7.50 $\pm$ 4.33	-9
Gross alpha (suspended)	6	0.00 $\pm$ 1.00	0.00 $\pm$ 1.00	<1.00 $\pm$ 1.00	-9
Gross beta (dissolved)	6	5.00 $\pm$ 3.00	9.00 $\pm$ 3.00	7.50 $\pm$ 3.17	-9
Gross beta (suspended)	6	<1.0 $\pm$ 2.00	2.00 $\pm$ 2.00	<1.00 $\pm$ 2.00	-9
Tritium	6	<1.0 $\pm$ 0.00	0.78 $\pm$ 0.18	<0.20 $\pm$ 0.14	-6
Plutonium-239	6	<0.2 $\pm$ 0.20	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.18	-10
Uranium-234	6	3.00 $\pm$ 0.50	4.00 $\pm$ 0.50	3.52 $\pm$ 0.57	-9
Uranium-238	6	1.10 $\pm$ 0.30	2.30 $\pm$ 0.40	1.80 $\pm$ 0.42	-9
OW-WR-17					
Gross alpha (dissolved)	6	<1.0 $\pm$ 7.00	16.00 $\pm$ 10.00	6.33 $\pm$ 7.33	-9
Gross alpha (suspended)	6	<1.0 $\pm$ 1.00	2.00 $\pm$ 2.00	<1.00 $\pm$ 1.35	-9
Gross beta (dissolved)	6	10.00 $\pm$ 4.00	18.00 $\pm$ 4.00	13.50 $\pm$ 4.17	-9
Gross beta (suspended)	6	0.00 $\pm$ 2.00	2.00 $\pm$ 2.00	1.50 $\pm$ 2.00	-9
Tritium	6	<0.2 $\pm$ 0.16	18.00 $\pm$ 1.00	3.20 $\pm$ 0.30	-6
Plutonium-239	6	0.00 $\pm$ 0.40	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.22	-10
Uranium-234	6	1.60 $\pm$ 0.30	5.50 $\pm$ 0.60	3.72 $\pm$ 0.52	-9
Uranium-238	6	1.20 $\pm$ 0.30	2.60 $\pm$ 0.50	1.85 $\pm$ 0.38	-9

* Value $\pm$ counting error.

Table 3.6, continued

Page 3

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-9}$)
OW-WR-24					
Gross alpha (dissolved)	1	3.00 ± 4.00	3.00 ± 4.00	3.00 ± 4.00	-9
Gross alpha (suspended)	1	13.00 ± 8.00	13.00 ± 8.00	13.00 ± 8.00	-9
Gross beta (dissolved)	1	18.00 ± 4.00	18.00 ± 4.00	18.00 ± 4.00	-9
Gross beta (suspended)	1	18.00 ± 5.00	18.00 ± 5.00	18.00 ± 5.00	-9
Tritium	1	12.00 ± 1.00	12.00 ± 1.00	12.00 ± 1.00	-6
Plutonium-239	1	0.20 ± 0.50	0.20 ± 0.50	0.20 ± 0.50	-10
Uranium-234	1	1.00 ± 0.10	1.00 ± 0.10	1.00 ± 0.10	-9
Uranium-238	1	0.60 ± 0.10	0.60 ± 0.10	0.60 ± 0.10	-9
OW-WR-25					
Gross alpha (dissolved)	1	0.00 ± 0.00	0.00 ± 0.00	$<1.00 \pm 0.00$	-9
Gross alpha (suspended)	1	0.00 ± 0.00	0.00 ± 0.00	$<1.00 \pm 0.00$	-9
Gross beta (dissolved)	1	0.00 ± 0.00	0.00 ± 0.00	$<1.00 \pm 0.00$	-9
Gross beta (suspended)	1	0.00 ± 0.00	0.00 ± 0.00	$<1.00 \pm 0.00$	-9
Tritium	1	0.00 ± 0.00	0.00 ± 0.00	$<0.20 \pm 0.00$	-6
Plutonium-239	1	0.00 ± 0.00	0.00 ± 0.00	$<0.20 \pm 0.00$	-10
Uranium-234	1	0.00 ± 0.00	0.00 ± 0.00	$<0.30 \pm 0.00$	-9
Uranium-238	1	0.00 ± 0.00	0.00 ± 0.00	$<0.30 \pm 0.00$	-9
OW-WR-27					
Gross alpha (dissolved)	2	$<1.0 \pm 2.00$	0.00 ± 3.00	$<1.00 \pm 2.50$	-9
Gross alpha (suspended)	2	1.00 ± 2.00	15.00 ± 14.00	8.00 ± 8.00	-9
Gross beta (dissolved)	2	15.00 ± 3.00	20.00 ± 3.00	17.50 ± 3.00	-9
Gross beta (suspended)	2	5.00 ± 2.00	26.00 ± 5.00	15.50 ± 3.50	-9
Tritium	2	0.10 ± 0.26	0.31 ± 0.16	0.21 ± 0.21	-6
Plutonium-239	2	0.00 ± 0.20	0.20 ± 0.20	$<0.20 \pm 0.20$	-10
Uranium-234	2	0.50 ± 0.20	0.50 ± 0.20	0.50 ± 0.20	-9
Uranium-238	2	0.30 ± 0.20	0.40 ± 0.20	0.35 ± 0.20	-9

* Value $\pm$ counting error.

Table 3.6, continued

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-9}$)
OW-WR-31					
Gross alpha (dissolved)	7	0.00 $\pm$ 0.00	30.00 $\pm$ 23.00	11.14 $\pm$ 19.43	-9
Gross alpha (suspended)	7	0.00 $\pm$ 0.00	1.00 $\pm$ 1.00	<1.00 $\pm$ 0.86	-9
Gross beta (dissolved)	7	0.00 $\pm$ 0.00	15.00 $\pm$ 11.00	8.14 $\pm$ 10.29	-9
Gross beta (suspended)	7	<1.0 $\pm$ 2.00	2.00 $\pm$ 2.00	<1.00 $\pm$ 1.71	-9
Tritium	7	<0.2 $\pm$ 0.14	2.30 $\pm$ 0.20	0.50 $\pm$ 0.12	-6
Plutonium-239	7	<0.2 $\pm$ 0.10	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.14	-10
Uranium-234	7	0.00 $\pm$ 0.00	5.20 $\pm$ 0.60	3.33 $\pm$ 0.50	-9
Uranium-238	7	0.00 $\pm$ 0.00	2.80 $\pm$ 0.50	1.71 $\pm$ 0.37	-9
OW-WR-36					
Gross alpha (dissolved)	4	<1.0 $\pm$ 3.00	5.00 $\pm$ 3.00	1.25 $\pm$ 2.25	-9
Gross alpha (suspended)	4	0.00 $\pm$ 0.00	46.00 $\pm$ 22.00	17.00 $\pm$ 10.25	-9
Gross beta (dissolved)	4	0.00 $\pm$ 0.00	23.00 $\pm$ 3.00	10.75 $\pm$ 2.25	-9
Gross beta (suspended)	4	0.00 $\pm$ 0.00	58.00 $\pm$ 12.00	28.50 $\pm$ 6.00	-9
Tritium	4	<0.2 $\pm$ 0.16	0.43 $\pm$ 0.17	<0.20 $\pm$ 0.12	-6
Plutonium-239	4	0.00 $\pm$ 0.00	0.40 $\pm$ 0.20	<0.20 $\pm$ 0.20	-10
Uranium-234	4	0.00 $\pm$ 0.00	0.60 $\pm$ 0.10	0.33 $\pm$ 0.13	-9
Uranium-238	4	0.00 $\pm$ 0.00	0.60 $\pm$ 0.10	0.40 $\pm$ 0.13	-9

* Value $\pm$ counting error.

Minimum detectable levels:

Gross alpha and beta
 Tritium
 Plutonium-239
 Uranium-234
 Uranium-238

1.0 $\times 10^{-9}$ $\mu\text{Ci/mL}$
 0.2 $\times 10^{-6}$ $\mu\text{Ci/mL}$
 0.2 $\times 10^{-10}$ $\mu\text{Ci/mL}$
 0.3 $\times 10^{-10}$ $\mu\text{Ci/mL}$
 0.3 $\times 10^{-10}$ $\mu\text{Ci/mL}$

* Value $\pm$ counting error.

Table 3.7 1989 Radiological Soil Monitoring

Pantex Sample Location ID	Location/Description
Burning Ground	
BG-SS-01	North of northwest pad
BG-SS-02	Northeast of northwest pad
BG-SS-03	South of southwest pad
BG-SS-04	South of southwest pad
Firing Site 4	
FA-SS-01	Bunker area
Firing Site 5	
FB-SS-01	200 feet north of site
FB-SS-02	300 feet north of site
FB-SS-03	400 feet north of site
FB-SS-04	500 feet north of site
FB-SS-05	200 feet northeast of site
FB-SS-06	300 feet northeast of site
FB-SS-07	400 feet northeast of site
FB-SS-08	500 feet northeast of site
FB-SS-09	100 feet south of site
Firing Site 10	
FC-SS-01	100 feet north of site
FC-SS-02	250 feet north of site
FC-SS-03	400 feet north of site
FC-SS-04	100 feet northeast of site
FC-SS-05	250 feet northeast of site
Offsite	
OS-SS-01	Intersection of FM 683 and FM 293
OS-SS-02	1.5 miles north of intersection of FM 683 and FM 245
OS-SS-03	1 mile north of intersection of FM 683 and FM 245
OS-SS-04	0.5 miles north of intersection of FM 683 and FM 245
OS-SS-05	Intersection of FM 2373 and FM 293
OS-SS-06	0.5 miles south of intersection of FM 2373 and FM 293
OS-SS-07	0.5 miles west of intersection of FM 2373 and FM 293
OS-SS-08	1 mile west of intersection of FM 2373 and FM 293
OS-SS-09	1.5 miles west of intersection of FM 2373 and FM 293
OS-SS-10	2 miles west of intersection of FM 2373 and FM 293
OS-SS-11	1 mile west of OS-SS-17
OS-SS-12	Northeast of OS-SS-20
OS-SS-13	Northeast of intersection of FM 2373 and FM 293
OS-SS-14	Northeast of intersection of FM 2373 and FM 293
OS-SS-15	Northeast of intersection of FM 2373 and FM 293
OS-SS-16	Northeast of intersection of FM 2373 and FM 293
OS-SS-17	Northeast of intersection of FM 2373 and FM 293
OS-SS-18	1.6 miles west of intersection of FM 683 and FM 293

Table 3.7, continued

Pantex Sample Location ID	Location/Description
Offsite (continued)	
OS-SS-19	1 mile west of intersection of FM 683 and FM 293
OS-SS-20	Northeast of intersection of FM 683 and FM 293
OS-SS-21	North of OS-SS-20
OS-SS-22	2.0 miles west of City of Amarillo well #616
OS-SS-23	3.4 miles east of FM 293
OS-SS-24	Southeast of intersection of FM 2373 and FM 293
OS-SS-25	Northeast of intersection of FM 2373 and U.S. 60
OS-SS-26	2.6 miles south of intersection U.S. 60 and FM 2161
OS-SS-27	2.8 miles south of intersection of U.S. 60 and FM 2373
OS-SS-28	Northeast of OS-SS-27
OS-SS-29	Intersection of U.S.60 and FM 683
OS-SS-30	Northeast of City of Amarillo well #616
OS-SS-31	Adjacent to Plant's north fence
OS-SS-32	Bushland, Texas

Table 3.8 Pantex Soil Monitoring Radiological Data Summary for 1989

Page 1

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-7}$)
BG-SS-01					
Plutonium-239	6	0.00 $\pm$ 0.02	0.01 $\pm$ 0.03	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	10.00 $\pm$ 2.00	5.71 $\pm$ 1.71	-7
Uranium-238	6	7.00 $\pm$ 1.00	11.00 $\pm$ 2.00	8.67 $\pm$ 2.00	-7
BG-SS-02					
Plutonium-239	6	<0.02 $\pm$ 0.02	0.03 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	8.00 $\pm$ 2.00	5.71 $\pm$ 1.71	-7
Uranium-238	6	6.00 $\pm$ 2.00	10.00 $\pm$ 2.00	7.83 $\pm$ 2.00	-7
BG-SS-03					
Plutonium-239	6	<0.02 $\pm$ 0.02	0.06 $\pm$ 0.04	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	10.00 $\pm$ 2.00	6.14 $\pm$ 1.86	-7
Uranium-238	6	7.00 $\pm$ 3.00	13.00 $\pm$ 2.00	10.17 $\pm$ 2.33	-7
BG-SS-04					
Plutonium-239	6	0.00 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	10.00 $\pm$ 3.00	6.57 $\pm$ 2.00	-7
Uranium-238	6	7.00 $\pm$ 2.00	11.00 $\pm$ 3.00	9.00 $\pm$ 2.17	-7
FA-SS-01					
Plutonium-239	6	0.00 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	38.00 $\pm$ 6.00	16.57 $\pm$ 3.00	-7
Uranium-238	6	37.00 $\pm$ 4.00	130.0 $\pm$ 10.00	89.67 $\pm$ 8.00	-7
FB-SS-01					
Plutonium-239	6	0.00 $\pm$ 0.03	0.03 $\pm$ 0.03	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	66.00 $\pm$ 6.00	37.00 $\pm$ 3.86	-7
Uranium-238	6	170.0 $\pm$ 10.00	450.0 $\pm$ 20.00	301.7 $\pm$ 13.33	-7
FB-SS-02					
Plutonium-239	6	0.01 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	24.00 $\pm$ 5.00	15.14 $\pm$ 2.57	-7
Uranium-238	6	46.00 $\pm$ 5.00	100.0 $\pm$ 10.00	79.50 $\pm$ 7.33	-7

* Value $\pm$ counting error.

Table 3.8, continued

Page 2

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-7}$)
FB-SS-03					
Plutonium-239	6	0.00 $\pm$ 0.02	0.03 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	39.00 $\pm$ 5.00	18.71 $\pm$ 3.14	-7
Uranium-238	6	43.00 $\pm$ 5.00	350.0 $\pm$ 10.00	135.3 $\pm$ 7.50	-7
FB-SS-04					
Plutonium-239	6	0.00 $\pm$ 0.02	0.05 $\pm$ 0.03	0.02 $\pm$ 0.03	-6
Uranium-234	7	0.00 $\pm$ 0.00	16.00 $\pm$ 3.00	10.43 $\pm$ 2.43	-7
Uranium-238	6	29.00 $\pm$ 3.00	81.00 $\pm$ 6.00	50.33 $\pm$ 5.00	-7
FB-SS-05					
Plutonium-239	6	0.00 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	41.00 $\pm$ 6.00	19.57 $\pm$ 3.29	-7
Uranium-238	6	46.00 $\pm$ 4.00	240.0 $\pm$ 10.00	121.7 $\pm$ 7.50	-7
FB-SS-06					
Plutonium-239	6	0.00 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	18.00 $\pm$ 3.00	11.14 $\pm$ 2.14	-7
Uranium-238	6	23.00 $\pm$ 4.00	110.0 $\pm$ 10.00	52.67 $\pm$ 5.33	-7
FB-SS-07					
Plutonium-239	6	0.00 $\pm$ 0.02	0.02 $\pm$ 0.03	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	17.00 $\pm$ 3.00	10.43 $\pm$ 2.29	-7
Uranium-238	6	25.00 $\pm$ 3.00	78.00 $\pm$ 6.00	46.33 $\pm$ 4.83	-7
FB-SS-08					
Plutonium-239	6	<0.02 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	14.00 $\pm$ 4.00	8.86 $\pm$ 2.29	-7
Uranium-238	6	16.00 $\pm$ 3.00	52.00 $\pm$ 8.00	30.00 $\pm$ 4.33	-7
FB-SS-09					
Plutonium-239	6	0.00 $\pm$ 0.02	0.04 $\pm$ 0.03	<0.02 $\pm$ 0.02	-6
Uranium-234	7	0.00 $\pm$ 0.00	35.00 $\pm$ 7.00	24.43 $\pm$ 3.86	-7
Uranium-238	6	89.00 $\pm$ 8.00	280.0 $\pm$ 20.00	184.8 $\pm$ 11.33	-7

* Value $\pm$ counting error.

E1/AU229/TABLES/IT3-8

Table 3.8, continued

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-7}$)
FC-SS-01					
Plutonium-239	6	0.00 ± 0.02	0.02 ± 0.02	$< 0.02 \pm 0.02$	-6
Uranium-234	7	0.00 ± 0.00	11.00 ± 2.00	7.14 ± 1.86	-7
Uranium-238	6	11.00 ± 2.00	28.00 ± 4.00	16.33 ± 2.67	-7
FC-SS-02					
Plutonium-239	6	$< 0.02 \pm 0.02$	0.03 ± 0.02	$< 0.02 \pm 0.02$	-6
Uranium-234	7	0.00 ± 0.00	11.00 ± 2.00	7.86 ± 1.86	-7
Uranium-238	6	10.00 ± 3.00	22.00 ± 3.00	15.50 ± 2.83	-7
FC-SS-03					
Plutonium-239	6	0.00 ± 0.02	0.03 ± 0.03	$< 0.02 \pm 0.02$	-6
Uranium-234	7	0.00 ± 0.00	10.00 ± 2.00	7.57 ± 1.86	-7
Uranium-238	6	8.00 ± 2.00	21.00 ± 3.00	11.83 ± 2.17	-7
FC-SS-04					
Plutonium-239	6	0.00 ± 0.02	0.00 ± 0.02	$< 0.02 \pm 0.02$	-6
Uranium-234	7	0.00 ± 0.00	15.00 ± 3.00	11.00 ± 2.00	-7
Uranium-238	6	26.00 ± 3.00	68.00 ± 5.00	49.83 ± 4.67	-7
FC-SS-05					
Plutonium-239	6	0.00 ± 0.02	0.03 ± 0.02	$< 0.02 \pm 0.02$	-6
Uranium-234	7	0.00 ± 0.00	12.00 ± 2.00	8.71 ± 2.14	-7
Uranium-238	6	14.00 ± 4.00	39.00 ± 5.00	23.17 ± 3.67	-7
OS-SS-01					
Plutonium-239	2	0.00 ± 0.02	0.01 ± 0.02	$< 0.02 \pm 0.02$	-6
Uranium-234	2	8.00 ± 2.00	9.00 ± 1.00	8.50 ± 1.50	-7
Uranium-238	2	6.00 ± 2.00	8.00 ± 1.00	7.00 ± 1.50	-7
OS-SS-02					
Plutonium-239	2	0.01 ± 0.02	0.02 ± 0.02	$< 0.02 \pm 0.02$	-6
Uranium-234	2	7.00 ± 1.00	10.00 ± 2.00	8.50 ± 1.50	-7
Uranium-238	2	7.00 ± 3.00	7.00 ± 3.00	7.00 ± 2.00	-7

* Value $\pm$ counting error.

Table 3.8, continued

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Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^6$)
OS-SS-03					
Plutonium-239	2	0.00 $\pm$ 0.02	0.00 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	8.00 $\pm$ 1.50	-7
Uranium-238	2	7.00 $\pm$ 2.00	7.00 $\pm$ 2.00	7.00 $\pm$ 1.50	-7
OS-SS-04					
Plutonium-239	2	0.01 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	8.00 $\pm$ 1.50	-7
Uranium-238	2	7.00 $\pm$ 1.00	8.00 $\pm$ 2.00	7.50 $\pm$ 1.50	-7
OS-SS-05					
Plutonium-239	2	0.01 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	6.00 $\pm$ 2.00	7.00 $\pm$ 1.00	6.50 $\pm$ 1.50	-7
Uranium-238	2	7.00 $\pm$ 1.00	8.00 $\pm$ 2.00	7.50 $\pm$ 1.50	-7
OS-SS-06					
Plutonium-239	2	0.00 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	7.00 $\pm$ 2.00	8.00 $\pm$ 1.00	7.50 $\pm$ 1.50	-7
Uranium-238	2	5.00 $\pm$ 2.00	7.00 $\pm$ 1.00	6.00 $\pm$ 1.50	-7
OS-SS-07					
Plutonium-239	2	0.01 $\pm$ 0.02	0.04 $\pm$ 0.02	0.03 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	8.00 $\pm$ 1.50	-7
Uranium-238	2	6.00 $\pm$ 2.00	8.00 $\pm$ 1.00	7.00 $\pm$ 1.50	-7
OS-SS-08					
Plutonium-239	2	0.01 $\pm$ 0.02	0.03 $\pm$ 0.02	0.02 $\pm$ 0.02	-6
Uranium-234	2	9.00 $\pm$ 2.00	9.00 $\pm$ 2.00	9.00 $\pm$ 1.50	-7
Uranium-238	2	9.00 $\pm$ 3.00	13.00 $\pm$ 2.00	11.00 $\pm$ 2.50	-7
OS-SS-09					
Plutonium-239	2	0.00 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	8.00 $\pm$ 1.50	-7
Uranium-238	2	5.00 $\pm$ 2.00	8.00 $\pm$ 1.00	6.50 $\pm$ 1.50	-7

* Value $\pm$ counting error.

Table 3.8, continued

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Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-6}$)
OS-SS-10					
Plutonium-239	2	0.00 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	7.00 $\pm$ 2.00	7.00 $\pm$ 2.00	7.00 $\pm$ 1.50	-7
Uranium-238	2	7.00 $\pm$ 3.00	9.00 $\pm$ 2.00	8.00 $\pm$ 2.50	-7
OS-SS-11					
Plutonium-239	2	0.00 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 1.00	11.00 $\pm$ 2.00	9.50 $\pm$ 1.50	-7
Uranium-238	2	7.00 $\pm$ 1.00	10.00 $\pm$ 3.00	8.50 $\pm$ 2.00	-7
OS-SS-12					
Plutonium-239	2	0.01 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	3.00 $\pm$ 2.00	8.00 $\pm$ 1.00	5.50 $\pm$ 1.50	-7
Uranium-238	2	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	8.00 $\pm$ 1.50	-7
OS-SS-13					
Plutonium-239	2	0.00 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 3.00	9.00 $\pm$ 1.00	8.50 $\pm$ 2.00	-7
Uranium-238	2	8.00 $\pm$ 2.00	9.00 $\pm$ 4.00	8.50 $\pm$ 3.00	-7
OS-SS-14					
Plutonium-239	1	0.01 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	1	6.00 $\pm$ 2.00	6.00 $\pm$ 2.00	6.00 $\pm$ 2.00	-7
Uranium-238	1	8.00 $\pm$ 3.00	8.00 $\pm$ 3.00	8.00 $\pm$ 3.00	-7
OS-SS-15					
Plutonium-239	2	0.00 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	5.00 $\pm$ 2.00	8.00 $\pm$ 1.00	6.50 $\pm$ 1.50	-7
Uranium-238	2	7.00 $\pm$ 3.00	8.00 $\pm$ 1.00	7.50 $\pm$ 2.00	-7
OS-SS-16					
Plutonium-239	2	0.00 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	8.00 $\pm$ 1.50	-7
Uranium-238	2	6.00 $\pm$ 2.00	6.00 $\pm$ 2.00	6.00 $\pm$ 1.50	-7

* Value $\pm$ counting error.

Table 3.8, continued

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Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-7}$)
OS-SS-17					
Plutonium-239	2	0.00 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 2.00	9.00 $\pm$ 1.00	8.50 $\pm$ 1.50	-7
Uranium-238	2	9.00 $\pm$ 1.00	10.00 $\pm$ 2.00	9.50 $\pm$ 1.50	-7
OS-SS-18					
Plutonium-239	2	0.00 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 2.00	9.00 $\pm$ 1.00	8.50 $\pm$ 1.50	-7
Uranium-238	2	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	8.00 $\pm$ 1.50	-7
OS-SS-19					
Plutonium-239	2	0.00 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	8.00 $\pm$ 1.50	-7
Uranium-238	2	7.00 $\pm$ 1.00	8.00 $\pm$ 2.00	7.50 $\pm$ 1.50	-7
OS-SS-20					
Plutonium-239	2	0.00 $\pm$ 0.02	0.04 $\pm$ 0.03	0.02 $\pm$ 0.03	-6
Uranium-234	2	9.00 $\pm$ 2.00	9.00 $\pm$ 2.00	9.00 $\pm$ 2.00	-7
Uranium-238	2	9.00 $\pm$ 2.00	9.00 $\pm$ 2.00	9.00 $\pm$ 2.00	-7
OS-SS-21					
Plutonium-239	1	0.02 $\pm$ 0.02	0.02 $\pm$ 0.02	0.02 $\pm$ 0.02	-6
Uranium-234	1	6.00 $\pm$ 2.00	6.00 $\pm$ 2.00	6.00 $\pm$ 2.00	-7
Uranium-238	1	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	8.00 $\pm$ 2.00	-7
OS-SS-22					
Plutonium-239	2	0.02 $\pm$ 0.02	0.02 $\pm$ 0.02	0.02 $\pm$ 0.02	-6
Uranium-234	2	6.00 $\pm$ 1.00	10.00 $\pm$ 3.00	8.00 $\pm$ 2.00	-7
Uranium-238	2	8.00 $\pm$ 1.00	11.00 $\pm$ 3.00	9.50 $\pm$ 2.00	-7
OS-SS-23					
Plutonium-239	2	0.02 $\pm$ 0.02	0.02 $\pm$ 0.02	0.02 $\pm$ 0.02	-6
Uranium-234	2	7.00 $\pm$ 2.00	8.00 $\pm$ 1.00	7.50 $\pm$ 1.50	-7
Uranium-238	2	7.00 $\pm$ 1.00	8.00 $\pm$ 2.00	7.50 $\pm$ 1.50	-7

* Value $\pm$ counting error.

Table 3.8, continued

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Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-7}$)
OS-SS-24					
Plutonium-239	2	0.01 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	9.00 $\pm$ 2.00	10.00 $\pm$ 2.00	9.50 $\pm$ 2.00	-7
Uranium-238	2	7.00 $\pm$ 2.00	8.00 $\pm$ 2.00	7.50 $\pm$ 2.00	-7
OS-SS-25					
Plutonium-239	2	0.02 $\pm$ 0.02	0.04 $\pm$ 0.02	0.03 $\pm$ 0.02	-6
Uranium-234	2	5.00 $\pm$ 2.00	7.00 $\pm$ 1.00	6.00 $\pm$ 1.50	-7
Uranium-238	2	6.00 $\pm$ 2.00	7.00 $\pm$ 1.00	6.50 $\pm$ 1.50	-7
OS-SS-26					
Plutonium-239	2	0.01 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	5.00 $\pm$ 2.00	8.00 $\pm$ 1.00	6.50 $\pm$ 1.50	-7
Uranium-238	2	6.00 $\pm$ 2.00	8.00 $\pm$ 2.00	7.00 $\pm$ 2.00	-7
OS-SS-27					
Plutonium-239	2	0.01 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	6.00 $\pm$ 1.00	7.00 $\pm$ 2.00	6.50 $\pm$ 1.50	-7
Uranium-238	2	6.00 $\pm$ 1.00	9.00 $\pm$ 3.00	7.50 $\pm$ 2.00	-7
OS-SS-28					
Plutonium-239	2	0.01 $\pm$ 0.02	0.02 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	4.00 $\pm$ 1.00	6.00 $\pm$ 1.00	5.00 $\pm$ 1.00	-7
Uranium-238	2	4.00 $\pm$ 2.00	5.00 $\pm$ 1.00	4.50 $\pm$ 1.50	-7
OS-SS-29					
Plutonium-239	2	0.02 $\pm$ 0.02	0.03 $\pm$ 0.02	0.03 $\pm$ 0.02	-6
Uranium-234	2	7.00 $\pm$ 2.00	8.00 $\pm$ 1.00	7.50 $\pm$ 1.50	-7
Uranium-238	2	7.00 $\pm$ 2.00	8.00 $\pm$ 1.00	7.50 $\pm$ 1.50	-7
OS-SS-30					
Plutonium-239	2	0.00 $\pm$ 0.02	0.01 $\pm$ 0.02	<0.02 $\pm$ 0.02	-6
Uranium-234	2	7.00 $\pm$ 3.00	9.00 $\pm$ 1.00	8.00 $\pm$ 2.00	-7
Uranium-238	2	7.00 $\pm$ 3.00	8.00 $\pm$ 1.00	7.50 $\pm$ 2.00	-7

* Value $\pm$ counting error.

Table 3.8, continued

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Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{\sim}$)
OS-SS-31					
Plutonium-239	2	0.01 ± 0.02	0.03 ± 0.02	0.02 ± 0.02	-6
Uranium-234	2	8.00 ± 2.00	8.00 ± 2.00	8.00 ± 1.50	-7
Uranium-238	2	5.00 ± 2.00	8.00 ± 1.00	6.50 ± 1.50	-7
OS-SS-32					
Plutonium-239	6	0.00 ± 0.02	0.02 ± 0.02	$<0.02 \pm 0.02$	-6
Uranium-234	4	7.00 ± 2.00	8.00 ± 3.00	7.50 ± 2.25	-7
Uranium-238	5	6.00 ± 2.00	13.00 ± 3.00	10.20 ± 2.60	-7

Activity is per gram of dry soil.

Dry weight obtained by oven drying.

* Value $\pm$ counting error.

Minimum detectable levels:
 Plutonium-239 $0.2 \times 10^{-7} \mu\text{Ci/mL}$
 Uranium-234 $0.2 \times 10^{-7} \mu\text{Ci/mL}$
 Uranium-238 $0.2 \times 10^{-7} \mu\text{Ci/mL}$

* Value $\pm$ counting error.

uranium-238 in the soil. In 1988, the uranium-238 concentration was $6,100 \times 10^{-7} \mu\text{Ci/g}$, but decreased to $39 \times 10^{-7} \mu\text{Ci/g}$ in 1989. The reason for the decrease cannot be explained at this time.

VEGETATION SAMPLING PROGRAM

Vegetation samples were collected from seventeen offsite locations and five plant-site locations. The sample site ID numbers and locations are presented in table 3.9. The locations are shown on figures 3.4 and 3.5. Samples were collected and analyzed for uranium-234, uranium-238, and tritium. Onsite samples are collected monthly and offsite samples quarterly. These samples consist primarily of native and domestic grasses. A small amount of other vascular plants may be present in some samples. Sampling procedures outlined in IOP 3405 and the EPA sampling protocol were used when collecting vegetation samples. Samples were sent to an offsite laboratory for analysis of radioactive contents. The analytical procedures used were essentially the same as for analysis of radionuclides in soil. In previous years, samples of grain heads from winter wheat or milo were collected and sent to both the offsite laboratory and the Development Division laboratory at Pantex for analysis; however, such samples were not collected during 1989.

Analysis of vegetation is used to determine whether unusual uptake of uranium-234, uranium-238, and tritium occurs from the soil or air. As with soil, there are no standards for uranium or tritium in vegetation, although DCGs for water are sometimes used for comparison. Table 3.10 lists the annual summary of the vegetation sampling program at Pantex.

In 1988, sample site OV-VS-04 had a high level of U-234 ($38 \times 10^{-7} \mu\text{Ci/g}$) in vegetation. However, for the 1989 sampling year the same site showed the radiation level to be within the same range (0 to $8 \times 10^{-7} \mu\text{Ci/g}$) as years prior to 1988. Three samples were collected from the 1988 sampling event and were checked by two independent laboratories. Two samples were found to be within guidelines, while the third sample was not. Data history has shown no high readings for this site. Taking the data history and recheck of the samples into consideration, the third sample is assumed to be an anomaly.

At sites FB-VS-02 and FB-VS-03, U-238 concentrations for sampling year 1988 was approximately ten times higher (approximately $85 \times 10^{-7} \mu\text{Ci/g}$) than those at other sampling locations, but the levels returned to the averages and remained in the historical range in 1989, except for site FB-VS-01, which had a high reading of $71 \times 10^{-7} \mu\text{Ci/g}$. The higher readings in 1988 are attributed to the use of depleted uranium during past test firings. The higher reading in 1989 at site FB-VS-01 is assumed to be an anomaly since the data history shows no incidence of higher readings in the past.

FAUNA SAMPLING PROGRAM

Since 1974, jack rabbits (*Lepus californicus gray*) have been used for analysis in the environmental monitoring program. Jack rabbits were collected within the controlled plant area and analyzed for the presence of uranium-234, uranium-238,

Table 3.9 1989 Radiological Vegetation Monitoring

Pantex Sample Location ID	Location/Description
Burning Ground	
BG-VS-01	Northeast of northwest pad
Firing Site 5	
FB-VS-01	300 feet northwest of site
FB-VS-02	250 feet north of site
FB-VS-03	400 feet south of site
Firing Site 10	
FC-VS-01	300 feet northeast of site
Offsite	
OV-VS-01	Intersection of FM 683 and FM 245
OV-VS-02	Northeast of intersection of FM 2373 and FM 293
OV-VS-03	1.6 miles west of intersection of FM 683 and FM 293
OV-VS-04	1 mile west of intersection of FM 683 and FM 293
OV-VS-05	Northeast of intersection of FM 683 and FM 293
OV-VS-06	Northeast of OV-VS-05
OV-VS-07	2.0 miles west of City of Amarillo well #616
OV-VS-08	3.4 miles east on FM 293
OV-VS-09	Southeast of intersection of FM 23e73 and FM 293
OV-VS-10	Northeast of intersection of FM 2373 and U.S. 60
OV-VS-11	2.6 miles south of intersection of U.S. 60 and FM 2161
OV-VS-12	2.8 miles south of intersection of U.S. 60 and FM 2373
OV-VS-13	Northeast of OV-VS-12
OV-VS-14	Intersection of U.S. 60 and FM 683
OV-VS-15	Northeast of City of Amarillo well #616
OV-VS-16	Adjacent to Plant's north fence
OV-VS-17	Bushland, Texas

Table 3.10 Pantex Vegetation Monitoring Radiological Data Summary for 1989

Location and Analysis	Number of Samples	Average Percent Moisture	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-7}$)
BG-VS-01						
Tritium	3	75.4	0.13 ± 0.14	11.00 ± 1.00	4.21 ± 0.45	-6
Uranium-234	3		0.40 ± 0.20	2.50 ± 0.80	1.17 ± 0.47	-7
Uranium-238	3		0.40 ± 0.30	2.90 ± 0.80	1.33 ± 0.43	-7
FB-VS-01						
Tritium	3	78.8	0.19 ± 0.19	2.90 ± 0.30	1.96 ± 0.23	-6
Uranium-234	3		0.20 ± 0.10	8.10 ± 0.90	2.87 ± 0.37	-7
Uranium-238	3		0.80 ± 0.20	71.00 ± 2.00	24.40 ± 0.83	-7
FB-VS-02						
Tritium	3	75.2	0.20 ± 0.14	1.20 ± 0.20	0.54 ± 0.16	-6
Uranium-234	3		0.20 ± 0.10	1.50 ± 0.30	0.73 ± 0.17	-7
Uranium-238	3		1.40 ± 0.30	11.80 ± 1.30	5.33 ± 0.63	-7
FB-VS-03						
Tritium	3	76.2	$<0.02 \pm 0.20$	1.60 ± 0.20	0.68 ± 0.20	-6
Uranium-234	3		0.20 ± 0.10	0.60 ± 0.20	$<0.40 \pm 0.20$	-7
Uranium-238	3		0.80 ± 0.20	2.90 ± 0.30	1.73 ± 0.40	-7
FC-VS-01						
Tritium	2	62.2	0.40 ± 0.14	1.40 ± 0.20	0.90 ± 0.17	-6
Uranium-234	2		0.10 ± 0.10	0.70 ± 0.20	0.40 ± 0.15	-7
Uranium-238	2		0.30 ± 0.10	3.60 ± 0.40	1.95 ± 0.25	-7
OV-VS-01						
Tritium	2	69.6	$<0.02 \pm 0.21$	0.00 ± 0.15	$<0.02 \pm 0.18$	-6
Uranium-234	2		0.40 ± 0.20	1.30 ± 0.50	0.85 ± 0.35	-7
Uranium-238	2		0.50 ± 0.20	1.20 ± 0.50	0.85 ± 0.35	-7

* Value $\pm$ counting error.

Table 3.10, continued

Location and Analysis	Number of Samples	Average Percent Moisture	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-}$)
OV-VS-02 Tritium	3	70.2	0.00 $\pm$ 0.14	0.08 $\pm$ 0.15	0.03 $\pm$ 0.17	-6
Uranium-234	3		2.90 $\pm$ 0.70	3.10 $\pm$ 0.70	2.97 $\pm$ 0.63	-7
Uranium-238	3		2.30 $\pm$ 0.60	2.70 $\pm$ 0.70	2.57 $\pm$ 0.60	-7
OV-VS-03 Tritium	2	71.2	0.01 $\pm$ 0.15	0.43 $\pm$ 0.22	0.22 $\pm$ 0.19	-6
Uranium-234	2		0.20 $\pm$ 0.10	0.20 $\pm$ 0.10	<0.40 $\pm$ 0.10	-7
Uranium-238	2		0.10 $\pm$ 0.10	0.20 $\pm$ 0.10	<0.40 $\pm$ 0.10	-7
OV-VS-04 Tritium	2	62.8	0.07 $\pm$ 0.15	0.11 $\pm$ 0.22	0.09 $\pm$ 0.19	-6
Uranium-234	2		0.20 $\pm$ 0.10	1.80 $\pm$ 0.40	1.00 $\pm$ 0.25	-7
Uranium-238	2		0.20 $\pm$ 0.10	2.10 $\pm$ 0.50	1.15 $\pm$ 0.30	-7
OV-VS-05 Tritium	1	59.5	0.06 $\pm$ 0.22	0.06 $\pm$ 0.22	0.06 $\pm$ 0.22	-6
Uranium-234	1		4.30 $\pm$ 0.90	4.30 $\pm$ 0.90	4.30 $\pm$ 0.90	-7
Uranium-238	1		3.00 $\pm$ 0.80	3.00 $\pm$ 0.80	3.00 $\pm$ 0.80	-7
OV-VS-06 Tritium	2	79.6	<0.02 $\pm$ 0.15	0.40 $\pm$ 0.22	0.18 $\pm$ 0.19	-6
Uranium-234	2		0.60 $\pm$ 0.20	4.00 $\pm$ 0.90	2.30 $\pm$ 0.55	-7
Uranium-238	2		0.50 $\pm$ 0.20	3.60 $\pm$ 0.80	2.05 $\pm$ 0.50	-7
OV-VS-07 Tritium	1	80.90	0.02 $\pm$ 0.21	0.02 $\pm$ 0.21	0.02 $\pm$ 0.21	-6
Uranium-234	1		2.00 $\pm$ 0.50	2.00 $\pm$ 0.50	2.00 $\pm$ 0.50	-7
Uranium-238	1		2.70 $\pm$ 0.60	2.70 $\pm$ 0.60	2.70 $\pm$ 0.60	-7
OV-VS-08 Tritium	2	69.1	0.09 $\pm$ 0.15	0.11 $\pm$ 0.22	0.10 $\pm$ 0.19	-6
Uranium-234	2		0.10 $\pm$ 0.10	0.80 $\pm$ 0.30	0.45 $\pm$ 0.20	-7
Uranium-238	2		0.20 $\pm$ 0.10	1.10 $\pm$ 0.40	0.65 $\pm$ 0.25	-7

* Value $\pm$ counting error.

Table 3.10, continued

Page 3

Location and Analysis	Number of Samples	Average Percent Moisture	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-6}$)
OV-VS-09						
Tritium	3	68.2	0.02 ± 0.15	0.15 ± 0.22	0.07 ± 0.17	-6
Uranium-234	3		1.80 ± 0.30	2.90 ± 1.00	2.47 ± 0.70	-7
Uranium-238	3		2.00 ± 0.40	3.50 ± 1.00	2.77 ± 0.80	-7
OV-VS-10						
Tritium	2	74.8	0.01 ± 0.22	0.06 ± 0.15	0.04 ± 0.19	-6
Uranium-234	2		0.60 ± 0.20	1.60 ± 0.20	1.10 ± 0.20	-7
Uranium-238	2		0.50 ± 0.20	1.70 ± 0.20	1.10 ± 0.20	-7
OV-VS-11						
Tritium	1	65.8	0.11 ± 0.22	0.11 ± 0.22	0.11 ± 0.22	-6
Uranium-234	1		0.70 ± 0.20	0.70 ± 0.20	0.70 ± 0.20	-7
Uranium-238	1		0.80 ± 0.20	0.80 ± 0.20	0.80 ± 0.20	-7
OV-VS-12						
Tritium	2	68.7	0.05 ± 0.15	0.10 ± 0.22	0.08 ± 0.19	-6
Uranium-234	2		0.40 ± 0.30	2.50 ± 0.60	1.45 ± 0.45	-7
Uranium-238	2		0.40 ± 0.20	2.70 ± 0.70	1.55 ± 0.45	-7
OV-VS-13						
Tritium	3	53.9	0.07 ± 0.15	0.13 ± 0.22	0.10 ± 0.17	-6
Uranium-234	3		2.00 ± 0.50	3.10 ± 0.50	2.37 ± 0.53	-7
Uranium-238	3		1.40 ± 0.50	2.70 ± 0.40	2.17 ± 0.50	-7
OV-VS-14						
Tritium	1	64.9	0.72 ± 0.22	0.72 ± 0.22	0.72 ± 0.22	-6
Uranium-234	1		2.50 ± 0.30	2.50 ± 0.30	2.50 ± 0.30	-7
Uranium-238	1		2.30 ± 0.30	2.30 ± 0.30	2.30 ± 0.30	-7
OV-VS-15						
Tritium	1	65.7	0.06 ± 0.22	0.06 ± 0.22	0.06 ± 0.22	-6
Uranium-234	1		0.10 ± 0.10	0.10 ± 0.10	$< 0.40 \pm 0.10$	-7
Uranium-238	1		0.80 ± 0.40	0.80 ± 0.40	0.80 ± 0.40	-7

* Value $\pm$ counting error.

Table 3.10, continued

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Location and Analysis	Number of Samples	Average Percent Moisture	Minimum* ($\mu\text{Ci/g}$)	Maximum* ($\mu\text{Ci/g}$)	Mean* ($\mu\text{Ci/g}$)	Magnitude ($\times 10^{-7}$)
OV-VS-16						
Tritium	3	53.4	$<0.02 \pm 0.14$	0.02 ± 0.21	$<0.02 \pm 0.17$	-6
Uranium-234	3		1.80 ± 0.30	5.00 ± 1.50	3.20 ± 0.83	-7
Uranium-238	3		1.40 ± 0.30	5.00 ± 1.50	3.10 ± 0.83	-7
OV-VS-17						
Tritium	5	66.4	0.07 ± 0.14	4.80 ± 0.30	1.07 ± 0.18	-6
Uranium-234	5		0.80 ± 0.30	2.90 ± 0.90	1.58 ± 0.48	-7
Uranium-238	5		0.50 ± 0.30	2.90 ± 0.90	1.56 ± 0.48	-7

* Value $\pm$ counting error.

Dry weight obtained by oven drying.

Minimum detectable levels:

Tritium $0.02 \times 10^{-6} \mu\text{Ci/g}$
 Uranium-234 $4.0 \times 10^{-8} \mu\text{Ci/g}$
 Uranium-238 $4.0 \times 10^{-8} \mu\text{Ci/g}$

* Value $\pm$ counting error.

plutonium-239, and tritium during previous years. However, due to the extremely low population of jack rabbits on the Pantex plant during 1989, specimens were not collected for analysis. In review of the data for previous years, there does not appear to be any indication of an upward trend in radionuclides in the samples.

MILK SAMPLING PROGRAM

Pantex has not established a sampling program for milk since the nuclides normally of concern (strontium, cesium, and iodine) are not produced at the site. However, this pathway is being evaluated for future monitoring activities.

POTENTIAL RADIATION DOSE ESTIMATES

The EPA has published regulations which limit the amount of airborne radionuclides released from DOE facilities. The EPA has specified that the EPA-AIRDOS/RADRISK computer program be used to demonstrate compliance unless an alternative model has been approved by the EPA (40 CFR 61).

For Pantex operations, estimates of radiation air pathway dose for the maximally exposed individual (1,900 meters east of zone 12), and the 80-kilometer (50-mile) population dose were calculated using the EPA-AIRDOS/RADRISK computer program code. The EPA-AIRDOS/RADRISK program computes air concentrations, ground surface deposition, and intake rates for the inhalation and ingestion pathways. The program uses a modified Gaussian plume equation to estimate both horizontal and vertical dispersion of radionuclides released from stacks or area sources. Dose estimates are expressed in rem or person-rem. The term person-rem refers to the product of dose equivalent times population for the various receptor groups.

Population estimates were based on figures presented in the "Final Environmental Impact Statement, Pantex Plant Site, 1983" for projected 1990 population. Meteorological data for 1989 were obtained from NOAA. Total radionuclides released to the air for 1989 amounted to an accidental release conservatively estimated to be approximately 40,000 curies of tritium. Total radionuclides released to the air from normal operations was 0.12 Ci of tritium and 21 μ Ci of uranium-238 from burning ground operations. The population estimates, meteorological data, and radionuclides released were used as input parameters for EPA-AIRDOS/RADRISK.

For 1989, dose calculations were performed for tritium and uranium-238 using both the normal operational releases and the accidental release in May 1989. Meteorological data (wind speed and direction) used for dose calculations are shown in figure 1.3. The dominant contributor to the doses received by the maximally exposed individual and the population dose is the tritium release during the May incident. The tritium accounts for greater than 99 percent of the offsite dose.

The annual individual and population dose calculations for 1989, taking into account the 40,000-Ci tritium release, are presented in tables 3.11 and 3.12. The annual population and individual dose calculations for 1989, considering radionuclide releases during normal operations, are presented in tables 3.13 and 3.14.

Table 3.11 Annual Dose to Individual Due to Accidental Release
of 40,000 Ci of Tritium

Nuclide	Organ	Dose (rem)
Tritium	Whole body	0.143×10^{-2}
Tritium	R mar	0.143×10^{-2}
Tritium	Endost	0.134×10^{-2}
Tritium	Thyroid	0.143×10^{-2}
Tritium	Breast	0.143×10^{-2}
Tritium	Pulmonary	0.143×10^{-2}
Tritium	Stomach wall	0.149×10^{-2}
Tritium	Internal wall	0.146×10^{-2}
Tritium	Liver	0.143×10^{-2}
Tritium	Pancreas	0.142×10^{-2}
Tritium	Kidneys	0.145×10^{-2}

Data generated using EPA AIRDOS/RAD RISK computer program.

Comparison of the annual dose to individuals and the standards under which DOE must operate shows that exposure to the public was below the limits of 25 mrem dose equivalent to whole body and 75 mrem dose equivalent to any organ.

The following assumptions were made to make a worst-case evaluation of the tritium release:

1. The entire 40,000 Ci release of tritium was released to the environment during the accidental incident.
2. None of the tritium had decayed to helium prior to the release.
3. All of the material which was released was tritium oxide.

Table 3.12 Annual 80 km Dose to Population Due to
Accidental Release of 40,000 Ci of Tritium

Nuclide	Organ	Dose (person-rem)
Tritium	Whole body	0.2074×10^1
Tritium	R mar	0.2071×10^1
Tritium	Endost	0.1742×10^1
Tritium	Thyroid	0.2071×10^1
Tritium	Breast	0.2084×10^1
Tritium	Pulmonary	0.2084×10^1
Tritium	Stomach wall	0.2084×10^1
Tritium	Internal wall	0.2200×10^1
Tritium	Liver	0.2071×10^1
Tritium	Pancreas	0.2032×10^1
Tritium	Kidneys	0.2135×10^1

Data generated using EPA AIRDOS/RADRISK computer program.

Table 3.13 Annual 80 km Collective Doses Due to Release of
0.12 Ci of Tritium and 21 μ Ci of Uranium During Normal Operations

Nuclide	Organ	Dose (person-rems)
Tritium	Whole body	0.6221×10^{-5}
Tritium	R mar	0.6213×10^{-5}
Tritium	Endost	0.5227×10^{-5}
Tritium	Thyroid	0.6213×10^{-5}
Tritium	Breast	0.6252×10^{-5}
Tritium	Pulmonary	0.6252×10^{-5}
Tritium	Stomach wall	0.6252×10^{-5}
Tritium	Internal wall	0.6600×10^{-5}
Tritium	Liver	0.6213×10^{-5}
Tritium	Pancreas	0.6097×10^{-5}
Tritium	Kidneys	0.6406×10^{-5}
Uranium-238	Whole body	0.9888×10^{-3}
Uranium-238	R mar	0.1781×10^{-5}
Uranium-238	Endost	0.2183×10^{-4}
Uranium-238	Thyroid	0.6326×10^{-7}
Uranium-238	Breast	0.7359×10^{-7}
Uranium-238	Pulmonary	0.4762×10^{-2}
Uranium-238	Stomach wall	0.1103×10^{-6}
Uranium-238	Internal wall	0.1043×10^{-5}
Uranium-238	Liver	0.7551×10^{-7}
Uranium-238	Pancreas	0.7136×10^{-7}
Uranium-238	Kidneys	0.8704×10^{-5}

Data generated using EPA AIRDOS/RAD RISK computer program.

Table 3.14 Annual Dose to Individuals Due to Release of
0.12 Ci of Tritium and 21 μ Ci of Uranium During Normal Operations

Nuclide	Organ	Dose (rems)
Tritium	Whole body	0.2804×10^{-7}
Tritium	R mar	0.2802×10^{-7}
Tritium	Endost	0.2588×10^{-7}
Tritium	Thyroid	0.2802×10^{-7}
Tritium	Breast	0.2811×10^{-7}
Tritium	Pulmonary	0.2811×10^{-7}
Tritium	Stomach wall	0.2811×10^{-7}
Tritium	Internal wall	0.2887×10^{-7}
Tritium	Liver	0.2802×10^{-7}
Tritium	Pancreas	0.2777×10^{-7}
Tritium	Kidneys	0.2845×10^{-7}
Uranium-238	Whole body	0.2546×10^{-5}
Uranium-238	R mar	0.4619×10^{-8}
Uranium-238	Endost	0.5667×10^{-7}
Uranium-238	Thyroid	0.1624×10^{-9}
Uranium-238	Breast	0.1843×10^{-9}
Uranium-238	Pulmonary	0.1226×10^{-4}
Uranium-238	Stomach wall	0.2954×10^{-9}
Uranium-238	Internal wall	0.2965×10^{-8}
Uranium-238	Liver	0.1945×10^{-9}
Uranium-238	Pancreas	0.1842×10^{-9}
Uranium-238	Kidneys	0.2259×10^{-7}

Data generated using EPA AIRDOS/RAD RISK computer program.

SECTION 4

ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

The environmental nonradiological program at Pantex consists of the collection and evaluation of soil, surface water, and vegetation samples in and around the Pantex site to determine the concentration of various nonradiological pollutants. The nonradiological pollutants for surface water are heavy metals, organics, associated products of high explosives, nitrates, phosphates, and oils and greases. Non-radiological pollutants for soil and vegetation are beryllium and fluoride, respectively.

Data from the analyses were recorded, and from these data the statistical mean, standard deviation, and variance were calculated. In cases where no evidence of a substance was detected in the sample, the concentration of that substance was recorded as being equal to the detection limit. The detection limit was then used in the calculation of the statistical parameters.

The remainder of section 5 discusses the nonradiological testing program and any apparent trends in the test data.

SANITARY WASTEWATER TREATMENT PLANT

The Pantex Plant operates a sanitary wastewater treatment facility located on site. This facility treats primarily sanitary wastes from various buildings at the plant. The treatment facility consists of a facultative lagoon system. Effluent from the wastewater treatment facility flows into Playa 1.

The wastewater discharge permit, TWC Permit 02296, requires sampling and testing of the wastewater treatment facility effluent for compliance with the permitted water quality limits. The samples are tested in accordance with *Standard Methods for the Examination of Water and Wastewater*. The effluent from the treatment facility is sampled and tested for 5-day biochemical oxygen demand (BOD₅), measured in milligrams per liter (mg/L), and for pH. Samples are collected and tested approximately seven or eight times per month. The results of the tests are then recorded and submitted to the Texas Water Commission during TWC's annual wastewater compliance inspection of the Pantex Plant. Any exceptions to the permitted limits are required to be reported in writing to the TWC within 5 days. Table 4.1 shows the average monthly BOD₅ and pH for calendar year 1989. The values shown were averaged from approximately seven to eight samples taken per month. The average value for January 1989 was 61.9 mg/L, which exceeded the

50-mg/L limit. This exception to compliance with plant effluent requirements was not reported to the TWC within 5 days. Pantex has added administrative controls so that any future exceptions will be reported to the TWC in a timely manner. All pH tests produced values within effluent requirements.

Since the wastewater treatment facility effluent not evaporated from the playa is used by Texas Tech University for irrigation and is not discharged to any streams or rivers, no permit has been issued under the NPDES permitting process. However, as a result of the 1989 Tiger Team assessment, Pantex has requested that EPA Region 6 determine whether an NPDES permit is applicable to Pantex operations.

AIR

The Texas Air Control Board administers standards for the prevention and control of air emissions. Several facilities at the Pantex Plant have been granted air permit exemptions by the TACB or EPA Region 6. The site has a "Written Grant of Authority" from the TACB for open burning of high-explosive materials at the Pantex burning grounds. In addition to the existing permit exemptions, Pantex has applied for an operating permit for the new steam plant. The Pantex Plant currently has a "grandfathered registration" for three nonradiological operations. These operations are:

1. Evaporation of HE-contaminated solvents in open pans
2. Open burning of HE-contaminated materials in burning cages at the burning grounds
3. The boiler house at the existing steam plant.

Additionally, Pantex follows NESHAP notification procedures for asbestos. Since Pantex has fluoride emissions associated with various operations, the TCAA (TAC 31 chapter 113, subchapter A, paragraph 113.3) requires that ambient air be monitored for fluoride emissions by suitable sampling and analysis or by approved alternative methods. Ambient air monitoring for fluorides has not been conducted in the past; however, a fluoride sampling program is being initiated.

The Pantex Plant releases volatile organic compounds from the synthesis and formulation of HE, as well as from painting operations. The 1989 Tiger Team assessment noted that virtually none of Pantex's VOC emissions had been inventoried, except for those from the evaporation pans at the burning grounds. The VOC evaporation process was terminated at the plant in late 1989. A contractor is currently performing an inventory of VOC emissions at the plant.

The Pantex Plant also conducts test fires with quantities of excess explosives. The plant conducted about 485 test fires in 1989, consuming approximately 400 pounds of high explosives. The Pantex Plant currently has an environmental consulting firm under contract to develop a comprehensive air emissions inventory. This project should be completed in mid-1990. The purpose of this contract is to identify emission sources and determine their associated emissions. Using the results of the inventory, Pantex will be able to determine which sources will have to be permitted or can be exempted. At this time, three sources are possible

candidates for air permits based on estimated releases of volatile organic compounds (VOCs): (1) building 16-4 (paint spray booth), (2) building 12-19 (HE formulation), and (3) building 11-36 (HE synthesis). Pantex is also in the process of obtaining an operating permit for the boilers at the new steam plant.

The most significant emission source on the plant facility is the boiler house for the steam plant. Pantex operates two natural-gas-fired boilers for steam production. Estimated emissions for the two boilers are listed in table 4.2. This outdated source will be replaced in the near future by the new steam plant containing four natural-gas/fuel-oil-fired boilers. Estimated emissions for these new boilers are presented in table 4.3. Emissions for the new plant will be higher than emissions for the old plant because of the number and size of the new boilers; however, permit requirements should still be met.

SOIL

Samples were collected monthly from nineteen onsite sampling locations and from one offsite location (at the control site in Bushland). Table 4.4 lists the sampling site ID numbers and locations. The samples consisted of a plug out from the surface via a soil sampler. The sampler is 3.5 inches in diameter and 3 inches in depth.

Beryllium was the only nonradiological contaminant for which soil samples were analyzed. Beryllium is used in the fabrication of components for nuclear weapons at Pantex Plant. Destructive testing conducted at FS-23 is another possible source of beryllium in soil. The results of the analyses are given in table 4.5.

Concentrations of beryllium detected in soil samples collected at Pantex ranged from 0.56 to 1.40 ppm by weight. These levels are below applicable regulatory guidelines. The common range of beryllium concentrations in soil is 0.1 to 40.0 ppm by weight. Fifty ppm is the suggested maximum concentration of beryllium that can be left in place at closure of a hazardous waste land treatment facility (EPA, 1983).

VEGETATION

TACB regulation III, chapter 113, subchapter A, article 113.3, paragraphs (a)(1) and (a)(2)(B) require that operators with fluoride emissions monitor forage vegetation for fluorides by suitable tests, for up to 12 consecutive months, in affected bovine grazing lands. Land within the plant boundaries, as well as adjacent land, is used for grazing of cattle. It has been established that various types of vegetation absorb inorganic fluoride compounds, especially during the growing season, and particularly when fluorides are in the gaseous form. Fluorides can become concentrated in a plant to such a degree that they become toxic to the plant and/or cause fluorosis in certain animals (particularly the bovine species) which eat vegetation containing high levels of fluoride. Fluoride concentrations in air which adversely affect human beings appear to be higher than those which adversely affect vegetation and foraging animals. Therefore, standards for inorganic fluoride compounds are directed to the protection of vegetation and animal life, which in turn will help to ensure that human beings are adequately protected.

Pantex has established six onsite vegetation sampling sites. Table 4.6 lists the sampling site ID numbers and locations. Samples are collected monthly and analyzed for fluoride. The samples consist primarily of native and domestic grasses; other vascular plants may be included. No vegetation samples were collected at the USDA Bushland site.

The presence of any fluoride in the vegetation is measured in parts per million (ppm). The limits are specified in TACB regulation III as 40 ppm by weight on samples taken once a month over a period of 12 consecutive months, or an average of 60 ppm by weight on samples taken once a month over a period of 3 months, or an average of 80 ppm by weight on samples taken once a month over a period of 2 months.

Samples were collected and tested for fluoride at the six locations shown on table 4.6. Results of the tests are given on table 4.7. Of the sample sets reported on table 4.7, only the data on samples collected at BG-VS-01 meet the duration requirements given in TACB regulations. These data show fluoride in vegetation to exceed regulatory limits during the period from April through June and to be below the limits for the period from July through September. The same trend, high fluoride concentrations during the spring, can also be seen in the analytical data for samples collected at OV-VS-17; however, samples collected at OV-VS-17 did not meet regulatory duration requirements.

The 1989 Tiger Team assessment found that the results of the data sets are scattered and do not meet the monitoring duration requirements of the TACB regulation. This discrepancy in the vegetation monitoring is being corrected to address the Tiger Team finding and to ensure compliance with TACB regulations.

SURFACE WATER

Surface water samples were collected at eleven locations at Pantex. These samples were analyzed for heavy metals, explosives, organics, and certain inorganic water quality parameters. The sampling site ID numbers and locations are listed in table 4.8. Figure 3.3 shows the onsite sampling locations for surface water. Surface water samples were analyzed for the constituents listed in table 4.9. Results of the analyses are given in table 4.10. Water quality regulatory criteria are listed on table 5.3.

Surface water was sampled in accordance with internal operating procedures (Mason and Hanger-Silas Mason Co., Inc.). Results of analyses are discussed below.

Heavy Metals

The following constituents were detected in surface waters. Barium was detected in every sample collected at concentrations below EPA drinking water criteria. Barium appears to be a naturally occurring metal in surface waters at Pantex. Total chromium and lead were each detected in one sample collected at 36 at concentrations slightly above EPA drinking water standards. Cyanide was detected at four of eleven sample locations in concentrations ranging from 0.06 to 0.55 mg/L. Iron was detected in samples collected from locations OW-WR-01, OW-

WR-08, OW-WR-24, OW-WR-25, and OW-WR-27 at concentrations exceeding irrigation water criteria. All other heavy metals listed on table 4.9 were not detected or were not found to exceed water quality criteria listed on table 5.3.

Explosives

HMX was detected in samples collected from OW-WR-08, OW-WR-09, OW-WR-13, OW-WR-15, OW-WR-27, and OW-WR-31 in average concentrations ranging from 0.037 mg/L at OW-WR-27 to 81.56 mg/L at OW-WR-13. PETN was detected at a concentration of 4.0 mg/L in one sample collected from both OW-WR-13 and OW-WR-25. Explosives were not detected in other surface water samples collected.

Detection of chromium and lead at OW-WR-36 indicates that these constituents may enter playa 3 via runoff from the burning grounds. Detection of HMX and PETN at OW-WR-13 indicates that effluent from the 12-43 HE filter building sometimes contains these constituents.

Nitrates, Phosphates, and Sulfate

Nitrates were not detected in samples collected at concentrations above the EPA drinking water criteria. Phosphates were detected in samples collected at nine locations. Average concentrations of phosphates detected ranged from 0.06 mg/L at OW-WR-09 and 1.178 mg/L at OW-WR-17. No phosphates were detected in samples collected from OW-WR-25 and OW-WR-27. Sulfates were detected in samples of industrial waters, wastewater, and waters of the north retention basin playa. Average concentrations of sulfate in samples collected from these seven locations ranged from 28 mg/L at OW-WR-08 to 130.5 mg/L at OW-WR-17.

Organics

Organics were not detected above detection limits in any samples collected.

Oil and Grease

Oil and grease were detected in samples collected at OW-WR-01, OW-WR-08, OW-WR-09, OW-WR-13, OW-WR-15, OW-WR-17, and OW-WR-31. Average concentrations detected in these samples ranged from 1.000 mg/L at OW-WR-01 and OW-WR-09 to 2.500 mg/L at OW-WR-15.

Table 4.1 Pantex Wastewater Treatment Facility
Average Effluent BOD₅ and pH

Month	1989 Average BOD ₅ (mg/L)	1989 Average pH
January	61.9	7.6
February	30.2	7.1
March	41.8	7.5
April	23.2	7.5
May	34.1	7.7
June	18.9	8.0
July	25.0	8.1
August	48.4	8.5
September	34.5	7.6
October	17.6	8.0
November	20.7	8.3
December	6.8	7.9

Table 4.2 Estimated Emissions from Operating Steam Plant Fueled by Natural Gas

Unit	Fuel	Particulate Matter (tons/yr)	Oxides of Nitrogen (tons/yr)	Sulfur Dioxide (tons/yr)	Carbon Monoxide (tons/yr)	Volatiles Organic Compounds (nonmethane) (tons/yr)	Volatiles Organic Compounds (methane) (tons/yr)
Boiler 6800491	Natural gas	0.44	24.78	0.11	6.20	0.50	0.53
Boiler 6800492	Natural gas	0.04	2.03	0.01	0.51	0.04	0.04
Totals		0.48	26.81	0.12	6.71	0.54	0.57

Table 4.3 Estimated Emissions from New Steam Plant

Unit	Fuel	Particulate Matter (tons/year)	Oxides of Nitrogen (tons/year)	Sulfur Dioxide (tons/year)	Carbon Monoxide (tons/year)	Volatile Organic Compounds (tons/year)
Boiler 1	Natural gas	1.3	31.80	0.16	5.30	0.74
Boiler 2	Natural gas	1.3	31.80	0.16	5.30	0.74
Boiler 3	Natural gas	0.64	15.90	0.08	2.70	0.37
Boiler 4	Natural gas	0.64	15.90	0.08	2.70	0.37
Totals		3.88	95.40	0.48	16.00	2.22
Boiler 1	No. 2 fuel oil	0.30	3.10	4.00	0.73	0.03
Boiler 2	No. 2 fuel oil	0.30	3.10	4.00	0.73	0.03
Boiler 3	No. 2 fuel oil	0.15	1.60	2.00	0.37	0.02
Boiler 4	No. 2 fuel oil	0.15	1.60	2.00	0.37	0.02
Totals		0.90	9.40	12.00	2.20	0.10

Table 4.4 1989 Nonradiological Soil Monitoring

Pantex Sample Location ID	Location/Description
Burning Ground	
BG-SS-01	North of northwest pad
BG-SS-02	Northeast of northwest pad
BG-SS-03	South of southwest pad
BG-SS-04	South of southwest pad
Firing Site 4	
FA-SS-01	Bunker area
Firing Site 5	
FB-SS-01	200 feet north of site
FB-SS-02	300 feet north of site
FB-SS-03	400 feet north of site
FB-SS-04	500 feet north of site
FB-SS-05	200 feet northeast of site
FB-SS-06	300 feet northeast of site
FB-SS-07	400 feet northeast of site
FB-SS-08	500 feet northeast of site
FB-SS-09	100 feet south of site
Firing Site 5	
FC-SS-01	100 feet north of site
FC-SS-02	250 feet north of site
FC-SS-03	400 feet north of site
FC-SS-04	100 feet northeast of site
FC-SS-05	250 feet northeast of site
Offsite	
OS-SS-32	Bushland, Texas

Table 4.5 Pantex Soil Monitoring Nonradiological Data Summary for 1989

Location	Number of Samples	Minimum (µg/g)	Maximum (µg/g)	Mean (µg/g)	Standard Deviation
Beryllium					
BG-SS-01	1	0.8400	0.8400	0.8400	NA
BG-SS-02	1	0.9700	0.9700	0.9700	NA
BG-SS-03	1	1.2000	1.2000	1.2000	NA
BG-SS-04	1	1.0000	1.0000	1.0000	NA
FA-SS-01	10	0.8200	1.3000	1.1460	0.1608
FB-SS-01	10	0.5600	1.2000	0.9960	0.2010
FB-SS-02	10	0.7900	1.4000	1.1690	0.1727
FB-SS-03	10	0.7100	1.2000	1.0710	0.1389
FB-SS-04	10	0.7000	1.2000	1.0590	0.1435
FB-SS-05	10	0.9300	1.3000	1.0970	0.1352
FB-SS-06	10	0.9900	1.4000	1.1290	0.1172
FB-SS-07	10	0.9200	1.3000	1.0720	0.1128
FB-SS-08	10	0.9200	1.3000	1.0580	0.1077
FB-SS-09	10	1.0000	1.4000	1.1500	0.1179
FC-SS-01	10	0.8000	1.1000	0.9590	0.0976
FC-SS-02	10	0.7000	1.2000	0.9110	0.1301
FC-SS-03	10	0.8400	1.2000	0.9640	0.1086
FC-SS-04	10	0.8000	1.2000	0.9590	0.1062
FC-SS-05	10	0.8000	1.2000	0.9640	0.1166
OS-SS-32	8	0.7500	1.2000	0.9313	0.1565

NA = Not applicable. Standard deviation cannot be calculated for a data set consisting of one number.

Table 4.6 1989 Nonradiological Vegetation Monitoring

Pantex Sample Location ID	Location/Description
Burning Ground	
BG-VS-01	Northeast of northwest pad
Offsite	
OV-VS-02	Northeast of intersection of FM 2373 and FM 293
OV-VS-06	Northeast of OV-VS-05
OV-VS-10	Northeast of intersection of FM 2373 and U.S. 60
OV-VS-14	Intersection of U.S. 60 and FM 683
OV-VS-17	Bushland, Texas

Table 4.7 Pantex Vegetation Monitoring Results of Fluoride Analyses

Sample Location	Date Sampled	Concentration (ppm)
BG-VS-01	04/21/89	130.00
BG-VS-01	05/15/89	180.00
BG-VS-01	06/19/89	34.00
BG-VS-01	07/21/89	< 10.00
BG-VS-01	08/18/89	61.00
BG-VS-01	09/29/89	10.00
OV-VS-02	01/09/89	14.00
OV-VS-02	04/07/89	53.00
OV-VS-02	07/14/89	110.00
OV-VS-06	04/07/89	110.00
OV-VS-06	07/14/89	19.00
OV-VS-06	10/16/89	17.00
OV-VS-10	04/07/89	< 10.00
OV-VS-10	10/18/89	37.00
OV-VS-14	10/18/89	58.00
OV-VS-17	02/01/89	14.00
OV-VS-17	03/27/89	180.00
OV-VS-17	05/03/89	100.00
OV-VS-17	06/05/89	160.00
OV-VS-17	06/19/89	82.00
OV-VS-17	08/02/89	35.00
OV-VS-17	08/21/89	81.00
OV-VS-17	11/01/89	68.00

Note: Detection limit = 10 ppm.

Table 4.8 1989 Non-Radiological Surface Water Monitoring

Pantex Sample Location ID	Location/Description
Playas	
OW-WR-01	Pantex Playa Lake
OW-WR-08	East bank of north retention basin playa
OW-WR-24	South playa, due south of zone 12
OW-WR-27	West playa near sanitary landfill
OW-WR-36	Burning ground playa lake
Industrial waters	
OW-WR-09	Main drainage ditch (east side of zone 12)
OW-WR-13	Building 12-43 HE filter building effluent
OW-WR-15	Building 11-44 HE filter building effluent
OW-WR-25	Drainage from building 12-04 to south playa
Wastewater	
OW-WR-17	Sewage treatment discharge
OW-WR-31	Effluent pond, zone 11 east

Table 4.9 Nonradiological Surface Water Analytes in 1989

Silver
Arsenic
Barium
Cadmium
Cyanide
Chromium (total)
Chromium (hexavalent)
Copper
Fluoride
Iron
Mercury
Lead
Selenium
Zinc
Nitrate (as N)
Phosphates
Total suspended solids
Phenol
Lindane
HMX
PETN
RDX
TNT

Table 4.10 Pantex Surface Water Monitoring Nonradiological Data Summary for 1989

Page 1

Location and Analysis	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-01					
Silver	5	<0.0050	0.0100	0.0060	0.0022
Arsenic	5	<0.0050	0.0100	0.0066	0.0023
Barium	5	0.1300	0.4300	0.2200	0.1249
Chromium (total)	5	<0.0050	0.0410	0.0144	0.0156
Copper	5	<0.0050	0.0220	0.0110	0.0070
Iron	5	2.7000	38.0000	12.2600	15.1456
Mercury	5	<0.0001	0.0001	0.0001	0.0000
Nitrate (as N)	5	<0.0500	1.6000	0.5540	0.6784
Oil and grease	5	<1.0000	1.0000	1.0000	0.0000
Lead	5	<0.0050	0.0250	0.0104	0.0087
Phosphate	5	0.0600	0.2800	0.1640	0.0856
Zinc	5	<0.0050	0.1400	0.0442	0.0585
OW-WR-08					
Arsenic	6	<0.0050	0.0100	0.0065	0.0021
Barium	6	0.1500	0.3300	0.2250	0.0666
Chromium (hexavalent)	6	<0.0200	0.0300	0.0217	0.0041
Chromium (total)	6	<0.0050	0.0200	0.0077	0.0061
Copper	6	<0.0050	0.0200	0.0082	0.0058
Fluoride	6	0.7000	0.9000	0.8000	0.0632
Iron	6	1.4000	16.0000	5.0667	5.4873
HMX	6	<0.0200	0.6900	0.1317	0.2735
Nitrate (as N)	6	<0.0500	1.3000	0.2733	0.5037
Oil and grease	6	<1.0000	4.0000	1.6667	1.2111
Lead	6	<0.0050	0.0100	0.0060	0.0020
PETN	6	<0.4000	0.4000	0.4000	0.0000
Phosphate	6	0.0400	0.6700	0.1533	0.2532
RDX	6	<0.0200	0.6800	0.1310	0.2690
Sulfate	1	28.0000	28.0000	28.0000	NA
Total dissolved solids	3	280.000	1400.00	690.000	617.333
Total suspended solids	2	<5.0000	770.000	387.500	540.937
Zinc	6	0.0090	0.0700	0.0237	0.0242

Table 4.10, continued

Page 2

Location and Analysis	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-09					
Silver	4	<0.0050	0.0210	0.0090	0.0080
Barium	4	0.1500	0.3000	0.2450	0.0666
Chromium (total)	4	<0.0050	0.0050	0.0050	0.0000
Copper	4	<0.0050	0.0210	0.0090	0.0080
Iron	4	0.1600	2.8000	0.9875	1.2236
HMX	4	<0.0200	2.0000	2.0000	0.9461
Nitrate (as N)	4	<0.0500	0.8300	0.2750	0.3733
Oil and grease	4	<1.0000	1.0000	1.0000	0.0000
PHEN	2	0.0020	0.0020	0.0020	0.0000
Phosphate	3	0.0200	0.0900	0.0633	0.0379
RDX	4	<0.0200	0.2000	0.2000	0.0862
Sulfate	4	16.0000	39.0000	32.0000	10.7393
Total dissolved solids	4	180.000	290.000	252.500	51.8813
Total suspended solids	4	<5.0000	40.0000	20.7500	15.5216
Zinc	4	<0.0050	0.0130	0.0095	0.0033
OW-WR-13					
Arsenic	9	<0.0050	0.0050	0.0050	0.0000
Barium	9	0.2100	3.0000	0.8122	0.9616
Cyanide	8	<0.0050	0.0550	0.0174	0.0161
Copper	9	<0.0050	0.0160	0.0086	0.0040
Iron	9	0.0200	0.1000	0.0533	0.0308
Mercury	9	<0.0001	0.0004	0.0001	0.0001
HMX	9	<0.0200	730.000	81.5656	243.163
Nitrate (as N)	9	0.8500	2.2000	1.2400	0.4111
Oil and grease	9	1.0000	2.0000	1.1111	0.3333
PETN	9	<0.4000	4.0000	4.0000	1.7714
PHEN	4	<0.0020	0.0040	0.0027	0.0010
Phosphate	9	<0.0200	0.6000	0.1911	0.1971
RDX	9	<0.0200	0.4000	0.4000	0.1310
Sulfate	9	<0.0200	30.0000	19.7356	9.8510
Total dissolved solids	9	230.000	1600.00	422.222	442.232
Total suspended solids	9	<5.0000	15.0000	6.1111	3.3334
Zinc	9	0.0060	0.0610	0.0251	0.0161

Table 4.10, continued

Page 3

Location and Analysis	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-15					
Arsenic	6	<0.0050	0.0070	0.0053	0.0008
Barium	6	0.1500	0.2600	0.1883	0.0462
Cyanide	5	<0.0050	0.0060	0.0052	0.0004
Chromium (total)	6	<0.0050	0.0070	0.0053	0.0008
Copper	6	<0.0050	0.0090	0.0067	0.0016
Iron	6	0.0800	1.1000	0.5550	0.4710
Mercury	6	<0.0001	0.0002	0.0001	0.0000
HMX	5	<0.0200	0.8700	0.2164	0.3679
Nitrate (as N)	6	0.0800	1.2000	0.8017	0.4038
Oil and grease	6	<1.0000	8.0000	2.5000	2.7386
Phenol	3	<0.0020	0.0040	0.0027	0.0012
Sulfate	6	18.0000	27.0000	22.8334	3.3117
Total dissolved solids	6	260.000	310.000	275.000	18.7082
Total suspended solids	6	<5.0000	15.0000	8.5000	5.0498
Zinc	6	0.0070	0.0250	0.0180	0.0061
OW-WR-17					
Silver	8	<0.0050	0.0180	0.3082	0.0060
Barium	8	0.1000	0.1600	0.1312	0.0173
Cyanide	6	<0.0050	0.0120	0.0082	0.0035
Copper	8	0.0150	0.0460	0.0244	0.0100
Iron	8	0.1500	0.4200	0.2687	0.0901
Nitrate (as N)	8	<0.0500	1.2000	0.6025	0.4153
Oil and grease	8	<1.0000	7.0000	2.3750	2.3261
Phenol	2	0.0030	0.0160	0.0095	0.0092
Phosphate	8	0.0130	2.2000	1.1779	0.6207
Sulfate	8	53.0000	170.000	130.500	41.4871
Total dissolved solids	8	310.000	610.000	508.750	110.769
Total suspended solids	8	16.0000	220.000	52.4999	68.2745
Zinc	8	0.0140	0.4200	0.0782	0.1388

Table 4.10, continued

Page 4

Location and Analysis	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-24					
Silver	1	0.0060	0.0060	0.0060	NA
Arsenic	1	0.0110	0.0110	0.0110	NA
Barium	1	0.3000	0.3000	0.3000	NA
Chromium (total)	1	0.0260	0.0260	0.0260	NA
Copper	1	0.0140	0.0140	0.0140	NA
Fluoride	1	0.6000	0.6000	0.6000	NA
Iron	1	22.0000	22.0000	22.0000	NA
Lead	1	0.0160	0.0160	0.0160	NA
Phosphate	1	0.2600	0.2600	0.2600	NA
Zinc	1	0.1000	0.1000	0.1000	NA
OW-WR-25					
Arsenic	1	0.0100	0.0100	0.0100	NA
Barium	1	0.5100	0.5100	0.5100	NA
Chromium (total)	1	0.0000	0.0000	0.0000	NA
Copper	1	0.0400	0.0400	0.0400	NA
Iron	1	13.0000	13.0000	13.0000	NA
Nitrate (as N)	1	0.9600	0.9600	0.9600	NA
Lead	1	0.0100	0.0100	0.0100	NA
PETN	1	4.0000	4.0000	4.0000	NA
Sulfate	1	28.0000	28.0000	28.0000	NA
Total dissolved solids	1	280.000	280.000	280.000	NA
Total suspended solids	1	770.000	770.000	770.000	NA
Zinc	1	0.0700	0.0700	0.0700	NA

Table 4.10, continued

Page 5

Location and Analysis	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-27					
Silver	2	<0.0050	0.0060	0.0055	0.0007
Arsenic	2	<0.0050	0.0100	0.0075	0.0035
Barium	2	0.1800	0.2600	0.2200	0.0566
Chromium (total)	2	<0.0050	0.0270	0.0160	0.0156
Copper	2	0.0060	0.0130	0.0095	0.0049
Iron	2	5.0000	25.0000	15.0000	14.1421
Mercury	2	<0.0001	0.0001	0.0001	0.0000
HMX	2	<0.0200	0.0540	0.0370	0.0240
Nitrate (as N)	2	0.0800	0.1700	0.1250	0.0636
Lead	2	<0.0050	0.0160	0.0105	0.0078
Phosphate	2	0.0900	0.5400	0.3150	0.3182
Zinc	2	0.0100	0.0810	0.0455	0.0502
OW-WR-31					
Arsenic	8	<0.0050	0.0110	0.0072	0.0023
Barium	8	0.1500	0.4000	0.2575	0.0945
Cyanide	7	<0.0050	0.0110	0.0066	0.0027
Copper	8	<0.0050	0.0100	0.0057	0.0018
Iron	8	0.1500	0.5900	0.2912	0.1806
HMX	8	<0.0200	2.0000	2.0000	0.6977
Nitrate (as N)	8	<0.0500	0.1300	0.0600	0.0283
Oil and grease	7	1.0000	4.0000	1.4286	1.1339
Phosphate	8	<0.0200	0.0500	0.0237	0.0106
RDX	8	<0.0200	0.2000	0.2000	0.0633
Sulfate	8	22.0000	50.0001	35.8750	10.6696
Total dissolved solids	8	200.000	1800.00	1035.00	691.644
Total suspended solids	8	<5.0000	39.9999	16.8750	12.4262
Zinc	8	<0.0050	0.0100	<0.0057	0.0018

Table 4.10, continued

Page 6

Location and Analysis	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-36					
Silver	4	<0.0050	0.0240	0.0097	0.0095
Arsenic	4	<0.0050	0.0170	0.0097	0.0053
Barium	4	0.2300	0.9700	0.6000	0.4048
Chromium (total)	4	<0.0050	0.0880	0.0462	0.0476
Copper	4	0.0100	0.0390	0.0245	0.0167
Iron	4	3.8000	88.0000	44.3750	46.4219
Nitrate (as N)	4	<0.0500	3.3000	1.2400	1.4390
Lead	4	<0.0050	0.0520	0.0277	0.0237
Phosphate	4	0.0700	0.4000	0.2375	0.1434
Zinc	4	0.0200	0.3700	0.1950	0.1964

NA = Not applicable. Standard deviation cannot be calculated for a data set consisting of one number.

SECTION 5

GROUNDWATER PROTECTION

The current network of groundwater wells consists of seven monitoring wells (two Ogallala and five perched) and five industrial water supply wells on site, and four offsite water supplies. In addition, three onsite drinking water locations were sampled in 1989 as part of the groundwater monitoring program. There are additional monitoring wells located at the Pantex Plant, but they were not sampled as part of the monitoring program in 1989.

Table 5.1 is a summary of data for each of the sample locations in the current groundwater monitoring program. Figure 5.1 shows the sample locations. Sample locations correspond to those used in the past "Annual Pantex Plant Environmental Monitoring Reports" (DOE, 1989).

The wells were sampled seven to ten times for radiological and nonradiological analyses. Table 5.2 lists constituents analyzed for in 1989.

There are no regulatory requirements specifically for groundwater monitoring at nonmunicipal, nonhazardous waste units. The TWC set guidelines for groundwater monitoring at these facilities that basically mirror those specified for hazardous waste units. Hazardous waste unit requirements are described in 40 CFR 264 Subpart F and 265 Subpart F. Groundwater monitoring associated with RCRA Facility Investigations generally follows the requirements established for hazardous waste facilities. Additionally, DOE Order 5400.1 requires that groundwater monitoring be conducted on site in the vicinity of DOE facilities; where appropriate, the program must be at least as stringent as the programs described in 40 CFR 264 Subpart F or 265 Subpart F.

Pantex is considered a noncommunity, nontransient public water supply system. "Noncommunity nontransient" is a definition recently created by EPA (EPA, 1989a) to identify private systems which supply water to a relatively small group of people on a continual basis (for example, in schools and factories). Similar to community water systems, water supplied by nontransient systems is consumed by basically the same group of people daily over a long period of time.

Current EPA monitoring requirements for water supply systems address twenty inorganic parameters, fourteen organic parameters, three radiological parameters, and one microbiological parameter (25 TAC 337.3, 337.14). These parameters and their respective MCLs are listed in table 5.3. Texas Department of Health

performed sampling for regulatory requirements for the drinking water supply and found no contamination.

Radioactive measurements are subject to the statistical nature of radioactive decay and are presented in conjunction with an associated statistical error. All errors presented represent counting errors at the 95-percent confidence level only; no attempt has been made to quantify systematic errors. The minimum detection limits of the radioactive parameters were calculated based on Nuclear Regulatory Commission (NRC) regulatory guide 4.14. Negative numbers can arise when the radioactivity of the sample is less than the background of the counting device. Detection limits for each radioactive constituent are shown on the same tables as the results of the sampling analyses.

During 1989 three monitoring wells were constructed in the Ogallala aquifer at the Burning Grounds as part of the ongoing Environmental Restoration Program at Pantex. These wells were subsequently sampled twice by two separate sampling crews and no contaminants were detected.

Water levels were also measured in some of the wells in 1989. Table 5.4 lists the water level measurements. Exact locations and elevations have not been surveyed, therefore, results can not be shown graphically.

Tables 5.5 through 5.19 summarize the 1989 data analysis results, as follows:

Table Number	Type	Analyte
5.5	Ogallala monitoring	Radiological
5.6	Perched monitoring	Radiological
5.7	Industrial/water supply	Radiological
5.8	Drinking water stations	Radiological
5.9	Offsite water supplies	Radiological
5.10	Ogallala monitoring	Inorganics
5.11	Perched monitoring	Inorganics
5.12	Industrial/water supply	Inorganics
5.13	Drinking water stations	Inorganics
5.14	Offsite water supplies	Inorganics
5.15	Ogallala monitoring	Detected organics
5.16	Perched monitoring	Detected organics
5.17	Industrial/water supply	Detected organics
5.18	Drinking water stations	Detected organics
5.19	Offsite water supplies	Detected organics

For each sample location, only those nonradiological constituents which showed some appreciable concentrations are listed in the tables. The constituents that are not listed were detected at levels below the detection limit.

At the time of this report, portions of the radiological data for 1989 had not been received from the laboratory. As a result, the number of samples listed in the tables may be fewer than the total number collected by the monitoring program.

Prior to October 1989, water samples were collected from the Ogallala and perched wells without purging the well first. Beginning in October, each monitoring well was purged approximately three well volumes prior to sampling. The purging removes stagnant water that may be present in the well and allows sampling of water that is more characteristic of the aquifer. Since the results of the analyses may differ between the purged and nonpurged samples, the results of the sampling events for October and December are listed separately from those for January through September.

The summary of the results of the radiological analyses (tables 5.5 through 5.9) indicate that all measurements are well within the EPA drinking water standards (table 5.3). These results are similar to previous years, which are well below any applicable standards.

Tables 5.10 through 5.14 present the results of the detected nonradiological inorganic constituents. These results indicate that all constituents are well within the EPA drinking water standards (table 5.3) and below any applicable standards, with the exception of chromium in the perched groundwater. Two samples collected from OW-WR-45 on June 29 and October 19, 1989, contained concentrations of total chromium at 0.18 mg/L and 0.059 mg/L, respectively. Two samples collected from OW-WR-20 on October and December 1989, contained concentrations of total chromium at 0.064 mg/L and 0.099 mg/L, respectively. In addition, one sample collected from OW-WR-38 on May 4, 1989, contained a concentration of total chromium at 0.073 mg/L. The EPA drinking water standard for total chromium is 0.05 mg/L. However, the average of the results for the total chromium analyses of all of the samples taken from these two wells in 1989, as shown in table 5.11, is well below the drinking water standard.

The results for the organics constituents that were detected at or above their respective detection limits are presented in table 5.15 through 5.19. Well OW-WR-20 (perched groundwater) contained 1,2-Dichloroethane at a concentration of 0.011 mg/L in the sample collected on December 7, 1989. The sample collected in October showed no concentrations above the detection limit. Past samples indicate that the concentration of 1,2-dichloroethane in OW-WR-20 has fluctuated from nothing detected above the detection limit to showing low concentrations. Also, the sample collected on October 18, 1989, showed concentrations of two high explosives, RDX and HMX. The concentrations detected were 0.52 and 0.026 mg/L for RDX and HMX, respectively. The TWC was notified of these readings following their detection. These HE readings, however, may be a result of a laboratory artifact and subsequently not representative of the aquifer. Additional samples are presently being collected to confirm or deny the presence of these high explosives. Samples collected from OW-WR-45 (perched groundwater) on October 19 and December 7, 1989, contained concentrations of trichloroethene at concentrations of 0.011 mg/L and 0.006 mg/L, respectively. Samples collected in the past have shown similar concentrations of trichloroethene.

Some samples collected from the drinking water stations and offsite water supplies showed low concentrations of bromoform, chlorodibromomethane, dichlorobromomethane, and chloroform. Since none of these constituents were

detected in the well samples, they are probably a result of disinfectants used in the water treatment process.

Bis(2-ethylhexyl)phthalate was detected in low concentrations in almost all of the samples collected in 1989. Bis(2-ethylhexyl)phthalate, which can be readily leached from certain plastics, is a common laboratory/sampling contaminant. The low concentrations detected in the samples and its wide spread occurrence in samples taken throughout the plant and offsite suggests that the bis(2-ethylhexyl)phthalate was introduced to the sample sometime during its sampling, transportation, or analysis and is not representative of the aquifer. The constituent levels discussed above are well within the EPA drinking water standards and well below any other applicable standard (table 5.3).

Table 5.1 1989 Groundwater Monitoring

Pantex Sample Location ID	Date Constructed	Location/Description	Total Depth (feet)
Ogallala monitoring wells:			
OW-WR-39	10-7-85	NW of playa 1	707.4
OW-WR-40	10-17-85	SW of playa 1	683.77
Perched zone monitoring wells:			
OW-WR-19	1-30-75	Playa 1 test well 1	350
OW-WR-20	2-3-75	Zone 12 test well 2	350
OW-WR-38	1-88	NE of playa 1	230
OW-WR-44	7-13-88	UST test well, NW of zone 11	298
OW-WR-45	7-1-88	UST test well, N of zone 12	275
Industrial/water supply wells:			
OW-WR-02	3/70	Production well 15-17	847
OW-WR-06	1942	Production well 15-6	653
OW-WR-16	11-30-70	Production well 15-20	740
OW-WR-18	6/66	Production well 15-16	727
OW-WR-41	10-22-85	Production well 15-26	763
Drinking water:			
OW-WR-23		Drinking water from building 12-2	
OW-WR-28		Drinking water from 12-6 cafeteria	
OW-WR-43		Drinking water from firing site	
Offsite water supplies:			
OW-WR-33		Bunland	
OW-WR-37		Jack Anthony private well	
OW-WR-49		Lee Cockrell private well	
OW-WR-50		Mark Hodges private well

Table 5.2 Constituents in 1989 Groundwater Analytical Program

VOLATILES

Acetone	Methylene chloride
Bromoform	Hexane
Benzene	N-Butyl alcohol
Dichlorobromomethane	4-Methyl-2-pentanone
Chlorodibromomethane	Di-isobutyl ketone
Chloroform	Chloromethane
Dimethylformamide	Bromomethane
Ethylbenzene	Vinyl chloride
Methyl ethyl ketone	Chloroethane
Methyl alcohol	Carbon disulfide
Tetrahydrofuran	1,1-Dichloroethene
Toluene	1,1-Dichloroethane
Xylene	trans-1,2-Dichloroethene
Isopropyl alcohol	1,2-Dichloroethane
Carbon tetrachloride	1,1,1-Trichloroethane
Bromodichloromethane	Vinyl acetate
1,2-Dichloropropane	1,1,2,2-Tetrachloroethane
Trichloroethene	trans-1,3-Dichloropropane
cis-1,3-Dichloropropene	1,1,2-Trichloroethane
2-Hexanone	2-Chloroethyl vinyl ether
Chlorobenzene	Tetrachloroethene
1,4-Dichlorobenzene	Styrene

SEMIVOLATILES

Bis(2-chloroethyl)ether	Benzyl alcohol
Bis(2-chloroisopropyl)ether	Hexachloroethane
Nitrobenzene	Isophorone
Bis(2-chloroethoxy)methane	1,2,4-Trichlorobenzene
Naphthalene	4-Chloroaniline
Hexachlorobutadiene	2-Methylnaphthalene
Hexachlorocyclopentadiene	2-Chloronaphthalene
2-Nitroaniline	Dimethyl phthalate
Acenaphthylene	2,6-Dinitrotoluene
3-Nitroaniline	Acenaphthene
Dibenzofuran	2,4-Dinitrotoluene
Diethyl phthalate	4-Chlorophenyl phenyl ether
Fluorene	4-Nitroaniline
N-nitrosodiphenylamine	4-Bromophenyl phenyl ether
Bis(2-ethylhexyl)phthalate	Hexachlorobenzene
Phenanthrene	Anthracene
Di-n-butyl phthalate	Fluoranthene
Pyrene	Butyl benzyl phthalate
3,3-Dichlorobenzidine	Benzo(a)anthracene
Chrysene	Di-n-octyl phthalate

Table 5.2, continued

Benzo(b)fluoranthene
 Indeno(1,2,3-cd)pyrene
 Benzo(g,h,i)perylene
 2-Methylphenol
 Benzoic acid
 4-Nitrophenol
 Phenol
 2,4-Dinitrophenol
 4-Chloro-3-methylphenol
 2,4,6-Trichlorophenol
 2-Chlorophenol

Benzo(k)fluoranthene
 Dibenzo(a,h)anthracene
 N-nitrosodi-n-propylamine
 4-Methylphenol
 2,4,5-Trichlorophenol
 2,4-Dimethylphenol
 2,4-Dichlorophenol
 2-Methyl-4,6-dinitrophenol
 Pentachlorophenol
 2-Nitrophenol
 Benzo(a)pyrene

PESTICIDES AND HERBICIDES

2,4,5-T
 Endrin
 Toxaphene
 Heptachlor epoxide
 Aldrin
 beta-BHC
 Endosulfan II
 Chlordane
 4,4-DDD
 Endrin aldehyde
 Endosulfan I

2,4-D
 Lindane
 Methoxychlor
 Endosulfan sulfate
 alpha-BHC
 delta-BHC
 4,4-DDT
 Dieldrin
 4,4-DDE
 Heptachlor

HIGH EXPLOSIVES

HMX
 RDX

PETN
 TNT

PCB's

Aroclor 1260
 Aroclor 1221
 Aroclor 1248
 Aroclor 1242

Aroclor 1254
 Aroclor 1232
 Aroclor 1016

METALS

Silver
 Barium
 Chromium
 Iron
 Lead
 Zinc

Arsenic
 Cadmium
 Copper
 Mercury
 Selenium

Table 5.2, continued

RADIOACTIVE

Gross alpha dissolved
Gross alpha suspended
Plutonium-239
Radium-228
Uranium-238

Gross beta dissolved
Gross beta suspended
Tritium
Radium-226
Uranium-234

MISCELLANEOUS

Cyanide
Hardness
pH
Sulfate
Total suspended solids

Fluoride
Nitrate (as N)
Phosphate
Total dissolved solids
Oil and grease

Table 5.3 Water Quality Criteria

	EPA Drinking Water Regulations (mg/L)	Desired Maximum of Elements for Irrigation Waters (mg/L)	Texas Water Development Board Water Quality Levels, Inland Waters (mg/L)	TWC Permit To Dispose of Waste Permit 02296
Arsenic (As)	0.05	0.1	0.1	-
Barium (Ba)	1.0	1.0	1.0	-
Cadmium (Cd)	0.010	0.005	0.05	-
Chromium (total)	0.05	-	-	-
Chromium (+6)	-	1.0	-	-
Copper	-	0.2	0.5	-
Cyanide	-	-	-	-
Fluoride	2.2*	10	-	-
Iron	-	5.0	-	-
Lead	0.05	-	-	-
Mercury	0.002	-	0.005	-
Nitrate (as N)	10	-	-	-
Phenol	-	-	-	-
Phosphate	-	-	-	-
Silver	0.05	200	-	-
Sulfate	-	0.02	0.05	-
Selenium	0.01	0.02	0.05	-
Total dissolved solids	-	-	-	-
Suspended solids	-	5.0	1.0	-
Zinc	-	-	-	-
Lindane	0.004	-	-	-
COD	-	-	-	50, 30-day avg 150, grab 300, grab
Radiological:				
Radium 226 + 228	5**			
Gross alpha	15**			
Gross beta	50**			
Tritium	20,000**			
Organics:				
Benzene	0.005			
Carbon tetrachloride	0.005			
1,2-Dichloroethane	0.005			
Trichloroethylene	0.005			
1,4-Dichlorobenzene	0.075			
1,1-Dichloroethylene	0.007			
1,1,1-Trichloroethane	0.20			
Vinyl chloride	0.002			

* This value for fluoride is based upon an annual average daily air temperature between 12.1 and 14.6°C.

** Units expressed in pCi/L.

Table 5.4 1989 Water Level Data (feet)

Number	Location	Jan 89	Feb 89	Mar 89	Apr 89	May 89	Jun 89	Jul 89	Sep 89	Oct 89	Nov 89	Dec 89
Industrial/water supply wells												
OW-WR-16							461					463
OW-WR-18							460					460
OW-WR-41							462					465
Ogallala monitoring wells												
OW-WR-39	NW playa 1	428	426	425	428	425	426	426	425.5	442.79**		426.6
OW-WR-40	SW playa 1	*	392	393	392	393	393	392	394.4	395.2		394.5
Perched zone monitoring wells												
OW-WR-19	N playa 1	225	223	223	223	224	224	222	222.9	222.7		225.35
OW-WR-20	Zone 12 south	*	260	263	260	260	262	261	259.7	260.4		261.7
OW-WR-38	NE playa 1	197	198	199	199	200	199	199	198.7	199.25		200.25
OW-WR-44	Bldg 16-1	275	271	270	271	270	270	271	270.2	271.5		271.2
OW-WR-45	SE bldg 12-2	248	249	247	249	248	248	248	246.9	248.6		249.6

* Instrumentation or logistic problem.

** Exact depth; all other values have a systematic error in measurement of 3 feet per 100 feet.

Table 5.5 Pantex Groundwater Radiological Data Summary for Ogallala Monitoring Wells in 1989

Page 1

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-9}$)
OW-WR-39					
Gross alpha (dissolved)	7	0.00 ± 0.00	6.00 ± 16.00	3.57 ± 5.43	-9
Gross alpha (suspended)	7	-1.00 ± 1.00	1.00 ± 1.00	$< 1.00 \pm 0.86$	-9
Gross beta (dissolved)	7	-5.00 ± 38.00	7.00 ± 3.00	3.00 ± 7.71	-9
Gross beta (suspended)	7	-1.00 ± 2.00	2.00 ± 2.00	$< 1.00 \pm 1.71$	-9
Tritium	7	-0.08 ± 0.19	0.13 ± 0.22	$< 0.20 \pm 0.14$	-6
Plutonium-239	7	0.00 ± 0.00	0.30 ± 0.20	$< 0.20 \pm 0.19$	-10
Uranium-234	7	0.00 ± 0.00	3.40 ± 0.60	1.91 ± 0.37	-9
Uranium-238	7	0.00 ± 0.00	1.40 ± 0.40	0.90 ± 0.26	-9
OW-WR-40					
Gross alpha (dissolved)	6	-1.00 ± 6.00	3.00 ± 3.00	1.00 ± 3.33	-9
Gross alpha (suspended)	6	-1.00 ± 1.00	1.00 ± 1.00	$< 1.00 \pm 0.83$	-9
Gross beta (dissolved)	6	0.00 ± 0.00	8.00 ± 3.00	6.00 ± 2.50	-9
Gross beta (suspended)	6	0.00 ± 0.00	1.00 ± 2.00	$< 1.00 \pm 1.67$	-9
Tritium	6	-0.10 ± 0.14	0.19 ± 0.17	$< 0.20 \pm 0.16$	-6
Plutonium-239	6	0.00 ± 0.00	0.20 ± 0.20	$< 0.20 \pm 0.20$	-10
Uranium-234	6	0.00 ± 0.00	1.40 ± 0.30	0.60 ± 0.17	-9
Uranium-238	6	0.00 ± 0.00	0.70 ± 0.20	$< 0.30 \pm 0.13$	-9

* Value $\pm$ counting error.

Minimum detectable levels:

Tritium $2 \times 10^{-7} \mu\text{Ci/mL}$
 Plutonium-239 $2 \times 10^{-11} \mu\text{Ci/mL}$
 Uranium-234 $3 \times 10^{-10} \mu\text{Ci/mL}$
 Uranium-238 $3 \times 10^{-10} \mu\text{Ci/mL}$

Table 5.6 Pantex Groundwater Radiological Data Summary for Perched Monitoring Wells in 1989

Page 1

Number of Location and Analysis	Minimum* Samples	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\mu\text{Ci/mL}$)	($\times 10^{-9}$)
OW-WR-19					
Gross alpha (dissolved)	7	-1.00 $\pm$ 4.00	7.90 $\pm$ 4.00	<1.00 $\pm$ 3.00	-9
Gross alpha (suspended)	7	-1.00 $\pm$ 1.00	2.00 $\pm$ 1.00	<1.00 $\pm$ 1.14	-9
Gross beta (dissolved)	7	0.00 $\pm$ 0.00	7.00 $\pm$ 3.00	4.00 $\pm$ 2.43	-9
Gross beta (suspended)	7	0.00 $\pm$ 0.00	2.00 $\pm$ 2.00	<1.00 $\pm$ 1.71	-9
Tritium	7	-0.01 $\pm$ 0.16	0.27 $\pm$ 0.17	<0.20 $\pm$ 0.14	-6
Plutonium-239	7	-0.10 $\pm$ 0.20	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.19	-10
Uranium-234	7	-0.10 $\pm$ 0.10	1.70 $\pm$ 0.40	<0.30 $\pm$ 0.14	-9
Uranium-238	7	-0.10 $\pm$ 0.10	0.70 $\pm$ 0.30	<0.30 $\pm$ 0.14	-9
OW-WR-20					
Gross alpha (dissolved)	6	0.00 $\pm$ 5.00	2.00 $\pm$ 4.00	1.17 $\pm$ 3.17	-9
Gross alpha (suspended)	6	-1.00 $\pm$ 1.00	1.00 $\pm$ 1.00	<1.00 $\pm$ 0.83	-9
Gross beta (dissolved)	6	0.00 $\pm$ 0.00	9.00 $\pm$ 3.00	4.67 $\pm$ 2.67	-9
Gross beta (suspended)	6	0.00 $\pm$ 2.00	1.00 $\pm$ 2.00	<1.00 $\pm$ 1.67	-9
Tritium	6	-0.01 $\pm$ 0.16	0.60 $\pm$ 0.21	<0.20 $\pm$ 0.17	-6
Plutonium-239	6	0.00 $\pm$ 0.00	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.17	-10
Uranium-234	6	0.00 $\pm$ 0.10	1.10 $\pm$ 0.50	<0.30 $\pm$ 0.17	-9
Uranium-238	6	-0.10 $\pm$ 0.10	0.60 $\pm$ 0.30	<0.30 $\pm$ 0.13	-9
OW-WR-38					
Gross alpha (dissolved)	7	-3.00 $\pm$ 7.00	11.00 $\pm$ 9.00	4.43 $\pm$ 6.00	-9
Gross alpha (suspended)	7	-1.00 $\pm$ 1.00	2.00 $\pm$ 1.00	<1.00 $\pm$ 0.86	-9
Gross beta (dissolved)	7	0.00 $\pm$ 0.00	13.00 $\pm$ 4.00	8.43 $\pm$ 3.71	-9
Gross beta (suspended)	7	-1.00 $\pm$ 2.00	5.00 $\pm$ 2.00	<1.00 $\pm$ 1.71	-9
Tritium	7	-0.08 $\pm$ 0.21	0.17 $\pm$ 0.16	<0.20 $\pm$ 0.13	-6
Plutonium-239	7	-0.10 $\pm$ 0.20	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.17	-10
Uranium-234	7	0.00 $\pm$ 0.00	3.50 $\pm$ 0.50	1.93 $\pm$ 0.37	-9
Uranium-238	7	0.90 $\pm$ 0.00	2.00 $\pm$ 0.40	1.06 $\pm$ 0.30	-9

* Value $\pm$ counting error.

Table 5.6, continued

Page 2

Number of Location and Analysis	Minimum* Samples	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\mu\text{Ci/mL}$)	($\times 10^{-}$)
OW-WR-44					
Gross alpha (dissolved)	7	-1.00 $\pm$ 3.00	7.00 $\pm$ 4.00	3.14 $\pm$ 3.00	-9
Gross alpha (suspended)	7	-1.00 $\pm$ 1.00	1.00 $\pm$ 1.00	<1.00 $\pm$ 0.86	-9
Gross beta (dissolved)	7	0.00 $\pm$ 0.00	9.00 $\pm$ 3.00	5.57 $\pm$ 2.57	-9
Gross beta (suspended)	7	-2.00 $\pm$ 2.00	1.00 $\pm$ 2.00	<1.00 $\pm$ 1.71	-9
Tritium	7	-0.03 $\pm$ 0.16	0.18 $\pm$ 0.16	<0.20 $\pm$ 0.13	-6
Plutonium-239	7	-0.10 $\pm$ 0.20	0.30 $\pm$ 0.20	<0.20 $\pm$ 0.19	-10
Uranium-234	7	0.00 $\pm$ 0.00	2.90 $\pm$ 0.60	2.01 $\pm$ 0.34	-9
Uranium-238	7	0.00 $\pm$ 0.00	1.40 $\pm$ 0.30	0.94 $\pm$ 0.26	-9
OW-WR-45					
Gross alpha (dissolved)	7	0.00 $\pm$ 0.00	12.00 $\pm$ 9.00	7.00 $\pm$ 5.29	-9
Gross alpha (suspended)	7	0.00 $\pm$ 1.00	1.00 $\pm$ 1.00	<1.00 $\pm$ 0.86	-9
Gross beta (dissolved)	7	0.00 $\pm$ 0.00	13.00 $\pm$ 3.00	8.00 $\pm$ 2.71	-9
Gross beta (suspended)	7	0.00 $\pm$ 0.00	3.00 $\pm$ 2.00	<1.00 $\pm$ 1.71	-9
Tritium	7	-0.04 $\pm$ 0.25	0.06 $\pm$ 0.16	<0.20 $\pm$ 0.13	-6
Plutonium-239	7	0.00 $\pm$ 0.00	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.19	-10
Uranium-234	7	0.00 $\pm$ 0.00	5.00 $\pm$ 0.50	3.04 $\pm$ 0.39	-9
Uranium-238	7	0.00 $\pm$ 0.00	2.60 $\pm$ 0.40	1.64 $\pm$ 0.31	-9

* Value $\pm$ counting error.

Minimum detectable levels:

Tritium $2 \times 10^{-7} \mu\text{Ci/mL}$
 Plutonium-239 $2 \times 10^{-11} \mu\text{Ci/mL}$
 Uranium-234 $3 \times 10^{-10} \mu\text{Ci/mL}$
 Uranium-238 $3 \times 10^{-10} \mu\text{Ci/mL}$

Table 5.7 Pantex Groundwater Radiological Data Summary for Industrial/Water Supply Wells in 1989

Page 1

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-9}$)
OW-WR-02					
Gross alpha (dissolved)	4	0.00 $\pm$ 1.00	5.00 $\pm$ 4.00	3.00 $\pm$ 3.50	-9
Gross alpha (suspended)	4	0.00 $\pm$ 1.00	0.00 $\pm$ 1.00	<1.00 $\pm$ 1.00	-9
Gross beta (dissolved)	4	6.00 $\pm$ 3.00	8.00 $\pm$ 3.00	7.50 $\pm$ 3.00	-9
Gross beta (suspended)	4	-1.00 $\pm$ 2.00	3.00 $\pm$ 2.00	<1.00 $\pm$ 2.00	-9
Tritium	4	-0.01 $\pm$ 0.25	0.04 $\pm$ 0.16	<0.20 $\pm$ 0.14	-6
Plutonium-239	4	0.00 $\pm$ 0.00	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.10	-10
Radium-226	2	0.10 $\pm$ 0.20	0.40 $\pm$ 0.20	<0.60 $\pm$ 0.20	-9
Radium-228	2	-0.50 $\pm$ 2.00	0.50 $\pm$ 0.90	<1.00 $\pm$ 1.45	-9
Uranium-234	4	3.50 $\pm$ 0.50	4.20 $\pm$ 0.30	3.87 $\pm$ 0.55	-9
Uranium-238	4	1.70 $\pm$ 0.30	2.60 $\pm$ 0.80	2.07 $\pm$ 0.43	-9
W-WR-06					
Gross alpha (dissolved)	4	-2.00 $\pm$ 3.00	12.00 $\pm$ 5.00	4.25 $\pm$ 3.00	-9
Gross alpha (suspended)	4	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	<1.00 $\pm$ 0.75	-9
Gross beta (dissolved)	4	0.00 $\pm$ 0.00	8.00 $\pm$ 4.00	4.75 $\pm$ 2.50	-9
Gross beta (suspended)	4	0.00 $\pm$ 0.00	4.00 $\pm$ 2.00	1.50 $\pm$ 1.50	-9
Tritium	4	-0.14 $\pm$ 0.16	0.05 $\pm$ 0.16	<0.20 $\pm$ 0.08	-6
Plutonium-239	4	0.00 $\pm$ 0.00	0.10 $\pm$ 0.10	<0.20 $\pm$ 0.08	-10
Radium-226	2	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	<0.60 $\pm$ 0.10	-9
Radium-228	2	0.00 $\pm$ 0.00	2.50 $\pm$ 1.30	1.25 $\pm$ 0.65	-9
Uranium-234	4	0.00 $\pm$ 0.00	3.70 $\pm$ 0.70	2.45 $\pm$ 0.40	-9
Uranium-238	4	0.00 $\pm$ 0.00	1.60 $\pm$ 0.30	1.18 $\pm$ 0.27	-9
OW-WR-16					
Gross alpha (dissolved)	3	4.00 $\pm$ 5.00	14.00 $\pm$ 8.00	8.00 $\pm$ 6.67	-9
Gross alpha (suspended)	3	0.00 $\pm$ 1.00	0.00 $\pm$ 1.00	<1.00 $\pm$ 1.00	-9
Gross beta (dissolved)	3	8.00 $\pm$ 3.00	10.00 $\pm$ 3.00	8.67 $\pm$ 3.00	-9
Gross beta (suspended)	3	0.00 $\pm$ 2.00	2.00 $\pm$ 2.00	1.00 $\pm$ 2.00	-9
Tritium	3	0.02 $\pm$ 0.15	0.07 $\pm$ 0.21	<0.20 $\pm$ 0.20	-6
Plutonium-239	3	0.00 $\pm$ 0.20	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.20	-10
Radium-226	2	0.10 $\pm$ 0.20	0.10 $\pm$ 0.20	<0.60 $\pm$ 0.20	-9
Radium-228	2	0.30 $\pm$ 0.80	1.40 $\pm$ 0.80	<1.00 $\pm$ 0.80	-9
Uranium-234	3	4.60 $\pm$ 0.50	5.30 $\pm$ 0.70	4.93 $\pm$ 0.60	-9
Uranium-238	3	2.60 $\pm$ 0.50	2.80 $\pm$ 0.40	2.73 $\pm$ 0.43	-9

* Value $\pm$ counting error.

Table 5.7, continued

Page 2

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{\sim}$)
OW-WR-41					
Gross alpha (dissolved)	2	4.00 $\pm$ 4.00	10.00 $\pm$ 4.00	7.00 $\pm$ 4.00	-9
Gross alpha (suspended)	2	0.00 $\pm$ 1.00	7.00 $\pm$ 2.00	3.50 $\pm$ 1.50	-9
Gross beta (dissolved)	2	7.00 $\pm$ 3.00	7.00 $\pm$ 3.00	7.00 $\pm$ 3.00	-9
Gross beta (suspended)	2	-1.00 $\pm$ 2.00	11.00 $\pm$ 2.00	5.00 $\pm$ 2.00	-9
Tritium	2	0.04 $\pm$ 0.15	0.10 $\pm$ 0.21	<0.20 $\pm$ 0.18	-6
Plutonium-239	2	0.00 $\pm$ 0.30	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.25	-10
Radium-226	1	0.40 $\pm$ 0.20	0.40 $\pm$ 0.20	<0.60 $\pm$ 0.20	-9
Radium-228	1	-0.10 $\pm$ 1.10	-0.10 $\pm$ 1.10	<1.00 $\pm$ 1.10	-9
Uranium-234	2	3.30 $\pm$ 0.50	3.80 $\pm$ 0.70	3.55 $\pm$ 0.60	-9
Uranium-238	2	1.80 $\pm$ 0.30	2.00 $\pm$ 0.50	1.90 $\pm$ 0.40	-9

* Value $\pm$ counting error.

Minimum detectable levels:

Tritium	2x10 ⁻⁷ $\mu\text{Ci/mL}$
Plutonium-239	2x10 ⁻¹¹ $\mu\text{Ci/mL}$
Radium-226	6x10 ⁻¹⁰ $\mu\text{Ci/mL}$
Radium-228	1x10 ⁻⁹ $\mu\text{Ci/mL}$
Uranium-234	3x10 ⁻¹⁰ $\mu\text{Ci/mL}$
Uranium-238	3x10 ⁻¹⁰ $\mu\text{Ci/mL}$

Table 5.8 Pantex Groundwater Radiological Data Summary for Drinking Water Stations in 1989

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/mL}$)	Maximum* ($\mu\text{Ci/mL}$)	Mean* ($\mu\text{Ci/mL}$)	Magnitude ($\times 10^{-9}$)
OW-WR-23					
Gross alpha (dissolved)	3	2.00 $\pm$ 6.00	12.00 $\pm$ 5.00	6.33 $\pm$ 5.33	-9
Gross alpha (suspended)	3	0.00 $\pm$ 1.00	0.00 $\pm$ 1.00	<1.00 $\pm$ 1.00	-9
Gross beta (dissolved)	3	5.00 $\pm$ 3.00	10.00 $\pm$ 3.00	8.00 $\pm$ 3.00	-9
Gross beta (suspended)	3	0.00 $\pm$ 2.00	1.00 $\pm$ 2.00	<1.00 $\pm$ 2.00	-9
Tritium	3	0.00 $\pm$ 0.00	0.04 $\pm$ 0.21	<0.20 $\pm$ 0.15	-6
Plutonium-239	3	0.10 $\pm$ 0.10	0.70 $\pm$ 1.00	0.33 $\pm$ 0.43	-10
Uranium-234	3	1.00 $\pm$ 0.30	5.50 $\pm$ 0.60	3.63 $\pm$ 0.57	-9
Uranium-238	3	0.30 $\pm$ 0.20	3.10 $\pm$ 0.50	1.83 $\pm$ 0.43	-9
OW-WR-28					
Gross alpha (dissolved)	2	6.00 $\pm$ 4.00	12.00 $\pm$ 7.00	9.00 $\pm$ 5.50	-9
Gross alpha (suspended)	2	0.00 $\pm$ 1.00	1.00 $\pm$ 1.00	<1.00 $\pm$ 1.00	-9
Gross beta (dissolved)	2	9.00 $\pm$ 3.00	11.00 $\pm$ 3.00	10.00 $\pm$ 3.00	-9
Gross beta (suspended)	2	0.00 $\pm$ 2.00	1.00 $\pm$ 2.00	<1.00 $\pm$ 2.00	-9
Tritium	2	-0.07 $\pm$ 0.21	0.00 $\pm$ 0.00	<0.20 $\pm$ 0.11	-6
Plutonium-239	2	0.00 $\pm$ 0.10	0.20 $\pm$ 0.20	<0.20 $\pm$ 0.15	-10
Uranium-234	2	1.90 $\pm$ 0.70	4.70 $\pm$ 0.60	3.30 $\pm$ 0.65	-9
Uranium-238	2	1.40 $\pm$ 0.60	2.20 $\pm$ 0.40	1.80 $\pm$ 0.50	-9
OW-WR-43					
Gross alpha (dissolved)	6	2.00 $\pm$ 4.00	14.00 $\pm$ 5.00	8.33 $\pm$ 4.83	-9
Gross alpha (suspended)	6	-1.00 $\pm$ 1.00	2.00 $\pm$ 1.00	<1.00 $\pm$ 1.00	-9
Gross beta (dissolved)	6	5.00 $\pm$ 3.00	11.00 $\pm$ 3.00	7.67 $\pm$ 3.17	-9
Gross beta (suspended)	6	-1.00 $\pm$ 2.00	2.00 $\pm$ 2.00	<1.00 $\pm$ 2.00	-9
Tritium	6	-0.01 $\pm$ 0.16	0.31 $\pm$ 0.16	<0.20 $\pm$ 0.14	-6
Plutonium-239	6	0.00 $\pm$ 0.10	0.30 $\pm$ 0.40	<0.20 $\pm$ 0.23	-10
Uranium-234	6	2.60 $\pm$ 0.40	5.20 $\pm$ 0.60	4.43 $\pm$ 0.48	-9
Uranium-238	6	1.70 $\pm$ 0.20	2.70 $\pm$ 0.40	2.15 $\pm$ 0.35	-9

* Value $\pm$ counting error.

Minimum detectable levels:

Tritium $2 \times 10^{-7} \mu\text{Ci/mL}$
 Plutonium-239 $2 \times 10^{-11} \mu\text{Ci/mL}$
 Uranium-234 $3 \times 10^{-10} \mu\text{Ci/mL}$
 Uranium-238 $3 \times 10^{-10} \mu\text{Ci/mL}$

Table 5.9 Pantex Groundwater Radiological Data Summary for Offsite Water Supplies in 1989

Page 1

Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/ml}$)	Maximum* ($\mu\text{Ci/ml}$)	Mean* ($\mu\text{Ci/ml}$)	Magnitude ($\times 10^{-9}$)
OW-WR-33					
Gross alpha (dissolved)	8	0.00 $\pm$ 0.00	14.00 $\pm$ 8.00	6.38 $\pm$ 5.12	-9
Gross alpha (suspended)	8	-1.00 $\pm$ 1.00	1.00 $\pm$ 1.00	< 1.00 $\pm$ 0.88	-9
Gross beta (dissolved)	8	0.00 $\pm$ 0.00	10.00 $\pm$ 3.00	6.75 $\pm$ 2.75	-9
Gross beta (suspended)	8	-1.00 $\pm$ 2.00	2.00 $\pm$ 2.00	< 1.00 $\pm$ 1.75	-9
Tritium	8	-0.09 $\pm$ 0.16	0.18 $\pm$ 0.26	< 0.20 $\pm$ 0.14	-6
Plutonium-239	8	0.00 $\pm$ 0.00	0.40 $\pm$ 0.50	< 0.20 $\pm$ 0.20	-10
Radium-226	3	0.00 $\pm$ 0.00	0.20 $\pm$ 0.20	< 0.60 $\pm$ 0.13	-9
Radium-228	3	0.00 $\pm$ 0.00	0.20 $\pm$ 5.90	< 1.00 $\pm$ 2.40	-9
Uranium-234	8	0.00 $\pm$ 0.00	3.80 $\pm$ 0.50	2.64 $\pm$ 0.45	-9
Uranium-238	8	0.00 $\pm$ 0.00	2.60 $\pm$ 0.40	1.59 $\pm$ 0.34	-9
OW-WR-37					
Gross alpha (dissolved)	8	0.00 $\pm$ 0.00	9.00 $\pm$ 4.00	5.63 $\pm$ 4.63	-9
Gross alpha (suspended)	8	-1.00 $\pm$ 1.00	0.00 $\pm$ 0.00	< 1.00 $\pm$ 0.88	-9
Gross beta (dissolved)	8	0.00 $\pm$ 0.00	10.00 $\pm$ 3.00	7.00 $\pm$ 2.75	-9
Gross beta (suspended)	8	0.00 $\pm$ 0.00	3.00 $\pm$ 2.00	1.00 $\pm$ 1.75	-9
Tritium	8	-0.11 $\pm$ 0.16	0.05 $\pm$ 0.16	< 0.20 $\pm$ 0.14	-6
Plutonium-239	8	-0.10 $\pm$ 0.20	0.30 $\pm$ 0.20	< 0.20 $\pm$ 0.36	-10
Radium-226	2	0.00 $\pm$ 0.00	0.30 $\pm$ 0.20	< 0.60 $\pm$ 0.10	-9
Radium-228	2	0.00 $\pm$ 0.00	1.60 $\pm$ 1.30	< 1.00 $\pm$ 0.65	-9
Uranium-234	8	0.00 $\pm$ 0.00	6.30 $\pm$ 0.80	3.10 $\pm$ 0.49	-9
Uranium-238	8	0.00 $\pm$ 0.00	3.40 $\pm$ 0.60	1.83 $\pm$ 0.36	-9
OW-WR-49					
Gross alpha (dissolved)	1	-2.00 $\pm$ 4.00	-2.00 $\pm$ 4.00	-2.00 $\pm$ 4.00	-9
Gross alpha (suspended)	1	-1.00 $\pm$ 1.00	-1.00 $\pm$ 1.00	-1.00 $\pm$ 1.00	-9
Gross beta (dissolved)	1	7.00 $\pm$ 3.00	7.00 $\pm$ 3.00	7.00 $\pm$ 3.00	-9
Gross beta (suspended)	1	1.00 $\pm$ 2.00	1.00 $\pm$ 2.00	1.00 $\pm$ 2.00	-9
Tritium	1	0.09 $\pm$ 0.25	0.09 $\pm$ 0.25	< 0.20 $\pm$ 0.25	-6
Plutonium-239	1	0.20 $\pm$ 0.20	0.20 $\pm$ 0.20	0.20 $\pm$ 0.20	-10
Radium-226	1	0.10 $\pm$ 0.20	0.10 $\pm$ 0.20	< 0.60 $\pm$ 0.20	-9
Radium-228	1	0.20 $\pm$ 0.90	0.20 $\pm$ 0.90	< 1.00 $\pm$ 0.90	-9
Uranium-234	1	2.30 $\pm$ 0.40	2.30 $\pm$ 0.40	2.30 $\pm$ 0.40	-9
Uranium-238	1	0.80 $\pm$ 0.20	0.80 $\pm$ 0.20	0.80 $\pm$ 0.20	-9

* Value $\pm$ counting error.

Table 5.9, continued

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Location and Analysis	Number of Samples	Minimum* ($\mu\text{Ci/ml}$)	Maximum* ($\mu\text{Ci/ml}$)	Mean* ($\mu\text{Ci/ml}$)	Magnitude ($\times 10^{\wedge}$)
00W-WR-50					
Gross alpha (dissolved)	1	8.00 $\pm$ 7.00	8.00 $\pm$ 7.00	8.00 $\pm$ 7.00	-9
Gross alpha (suspended)	1	0.00 $\pm$ 1.00	0.00 $\pm$ 1.00	<1.00 $\pm$ 1.00	-9
Gross beta (dissolved)	1	8.00 $\pm$ 3.00	8.00 $\pm$ 3.00	8.00 $\pm$ 3.00	-9
Gross beta (suspended)	1	2.00 $\pm$ 2.00	2.00 $\pm$ 2.00	2.00 $\pm$ 2.00	-9
Tritium	1	0.00 $\pm$ 0.25	0.00 $\pm$ 0.25	<0.20 $\pm$ 0.25	-6
Plutonium-239	1	0.20 $\pm$ 0.20	0.20 $\pm$ 0.20	0.20 $\pm$ 0.20	-10
Radium-226	1	0.30 $\pm$ 0.20	0.30 $\pm$ 0.20	<0.60 $\pm$ 0.20	-9
Radium-228	1	-0.20 $\pm$ 0.90	-0.20 $\pm$ 0.90	<1.00 $\pm$ 0.90	-9
Uranium-234	1	3.80 $\pm$ 0.50	3.80 $\pm$ 0.50	3.80 $\pm$ 0.50	-9
Uranium-238	1	2.10 $\pm$ 0.40	2.10 $\pm$ 0.40	2.10 $\pm$ 0.40	-9

* Value $\pm$ counting error.

Minimum detectable levels:

Tritium	$2 \times 10^{-7} \mu\text{Ci/mL}$
Plutonium-239	$2 \times 10^{-11} \mu\text{Ci/mL}$
Uranium-234	$3 \times 10^{-10} \mu\text{Ci/mL}$
Uranium-238	$3 \times 10^{-10} \mu\text{Ci/mL}$

Table 5.10 Pantex Groundwater Inorganic Data Summary for Ogallala Monitoring Wells in 1989

Page 1

Location and Analysis*	Number of Samples	January through September				Standard Deviation	October (mg/L)	December (mg/L)
		Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)				
OW-WR-39								
Silver	7	<0.0050	0.0410	<0.0101	0.0136			<0.0050
Arsenic	7	<0.0050	0.0060	<0.0051	0.0004			0.0080
Barium	7	0.1200	0.1300	0.1257	0.0053			0.1800
Iron	7	0.5500	9.7000	4.6214	3.5142			10.0000
Nitrogen	7	0.3400	1.2000	0.8057	0.3682			1.2000
Lead	7	0.0050	0.0500	0.0311	0.0170			0.0390
Sulfate	7	11.0000	26.0000	18.1429	4.9474			26.0000
Total dissolved solids	7	220.000	300.000	264.286	25.0714			300.000
Zinc	7	1.0000	4.2000	2.7143	1.1611			3.1000
OW-WR-40								
Barium	6	0.1100	0.1400	0.1217	0.0133		0.1600	0.1600
Iron	6	0.0300	0.6000	0.1683	0.2140		3.1000	1.1000
Nitrogen	6	<0.0500	0.3600	<0.1700	0.1495		1.0000	1.3000
Lead	6	<0.0050	0.0080	<0.0060	0.0013		0.0290	0.0080
Sulfate	6	7.0000	21.0000	17.0000	5.1769		24.0000	22.0000
Total dissolved solids	6	260.000	300.001	273.334	13.6629		290.000	290.000
Zinc	6	0.8700	2.0000	1.4117	0.4517		2.9000	0.6300

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

Table 5.11 Pantex Groundwater Investigation Data Summary for Perched Monitoring Wells in 1989

Location and Analysis*	Number of Samples	January through September				Standard Deviation	October (mg/L)	December (mg/L)
		Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)				
OW-WR-19								
Arsenic	7	<0.0050	0.0130	<0.0079	0.0033	<0.0050	<0.0050	<0.0050
Barium	7	0.0700	0.1400	0.1057	0.0299	0.1900	0.1900	0.1900
Chromium	7	<0.005	<0.005	<0.005	0.000	<0.005	<0.005	0.008
Iron	7	3.6000	41.9998	21.5000	14.3725	4.4000	4.4000	16.0000
Lead	7	<0.0050	0.0110	<0.0074	0.0025	<0.0050	<0.0050	<0.0050
Sulfate	7	<5.0000	6.0000	<5.1429	0.3781	39.0001	39.0001	<5.0000
Total dissolved solids	7	200.000	310.000	250.000	43.2049	510.001	510.001	360.000
Total suspended solids	1	55.0000	55.0000	55.0000	0.000			
Zinc	7	0.1000	1.2000	0.5586	0.3831	0.1300	0.1300	0.1300
OW-WR-20								
Barium	6	0.0800	0.1200	0.0983	0.0147	0.1500	0.1500	0.1800
Cyanide	5	<0.0050	0.0050	<0.0050	NA	<0.0050	<0.0050	<0.0050
Chromium	6	<0.005	<0.005	<0.005	0.000	0.064	0.064	0.099
Iron	6	1.1000	3.3000	2.3500	0.8666	6.0000	6.0000	5.7000
Nitrogen	6	<0.0500	0.0600	<0.0533	0.0052	1.6000	1.6000	2.0000
Sulfate	6	28.0000	32.0001	29.5000	1.7607	29.0000	29.0000	29.0000
Total dissolved solids	6	240.000	270.001	260.000	12.6513	310.000	310.000	210.000
Zinc	6	<0.0050	0.1300	<0.0320	0.0484	<0.0050	<0.0050	0.0500
OW-WR-38								
Arsenic	7	<0.0050	0.0050	<0.0050	0.0000	<0.0050	<0.0050	<0.0050
Barium	7	0.1300	0.1900	0.1500	0.0208	0.1500	0.1500	0.1700
Cyanide	6	<0.0050	0.0070	<0.0053	0.0008	<0.0050	<0.0050	<0.0050
Chromium (total)	7	0.0130	0.0730	0.0326	0.0208	0.0340	0.0340	0.0170
Iron	7	0.4600	1.6000	0.8743	0.3590	0.3800	0.3800	0.1900
Nitrogen	7	1.3000	1.7000	1.4857	0.1345	1.4000	1.4000	2.0000
Sulfate	7	78.0000	120.000	90.2857	13.7447	96.0002	96.0002	83.0000
Total dissolved solids	7	550.001	640.000	587.143	28.1208	610.001	610.001	580.000
Zinc	7	0.0350	0.0900	0.0577	0.0231	0.0160	0.0160	0.0400

Table 5.11, continued

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Location and Analysis*	Number of Samples	January through September			Standard Deviation	October (mg/L)	December (mg/L)
		Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)			
OW-WR-44							
Arsenic	8	<0.0050	0.0050	<0.0050	0.0000	<0.0050	<0.0050
Barium	7	0.1200	0.1600	0.1429	0.0138	0.1600	0.1600
Chromium (total)	8	<0.0050	0.0050	<0.0050	0.0000	<0.0050	<0.0050
Iron	8	0.0400	2.5000	0.4612	0.8306	0.0400	0.0500
Nitrogen	8	0.0600	1.1000	0.2950	0.3467	0.9600	0.9500
Sulfate	8	10.0000	32.0000	16.1250	7.0191	16.0000	14.0000
Total dissolved solids	8	210.000	250.000	227.500	16.6928	220.000	220.000
Zinc	8	0.0200	0.1300	0.0689	0.0377	0.0420	0.0600
OW-WR-45							
Arsenic	7	<0.0050	0.0050	<0.0050	0.0000	<0.0050	<0.0050
Barium	7	0.1500	0.2200	0.1957	0.0223	0.2000	0.2400
Chromium (total)	7	0.0140	0.1800	0.0509	0.0575	0.0590	0.0290
Copper	7	<0.0050	0.0060	<0.0051	0.0004	<0.0050	<0.0050
Iron	7	0.2000	1.3000	0.6429	0.4302	0.7400	0.4800
Nitrogen	7	1.2000	1.8000	1.4714	0.2138	1.1000	0.4800
Sulfate	7	22.0000	26.0001	23.7143	1.2541	25.0000	27.0000
Total dissolved solids	7	330.000	450.000	410.000	38.2972	370.000	430.000
Zinc	7	0.0290	0.0920	0.0460	0.0222	0.0200	0.0700

NA = Not applicable. Standard deviation cannot be calculated for a data set consisting of one number.

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

Table 5.12 Pantex Groundwater Inorganic Data Summary for Industrial/Water Supply Wells in 1989

Page 1

Location and Analysis*	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-02					
Barium	5	0.0800	0.1500	0.1240	0.0270
Chromium (total)	5	<0.0050	0.0090	<0.0058	0.0018
Fluoride	5	1.4000	1.8000	1.5600	0.1517
Iron	5	<0.0100	0.0400	<0.0220	0.0110
Nitrogen	5	1.2000	1.5000	1.3400	0.1517
Total dissolved solids	5	260.000	310.000	284.000	18.1659
Total suspended solids	5	<5.0000	20.0000	<9.4000	6.6559
Zinc	5	<0.0050	0.0100	<0.0062	0.0022
OW-WR-06					
Silver	6	<0.0050	0.0050	<0.0050	0.0000
Barium	6	0.0700	0.1200	0.1050	0.0176
Chromium (total)	6	<0.0050	0.0090	<0.0057	0.0016
Copper	6	<0.0050	0.0120	<0.0070	0.0032
Fluoride	6	1.9000	2.1000	1.9333	0.0816
Iron	6	0.0100	0.0400	0.0200	0.0126
Nitrogen	6	1.2000	1.3000	1.2667	0.0516
Lead	6	<0.0050	0.0400	<0.0108	0.0143
Total dissolved solids	6	260.000	310.000	288.333	19.4079
Total suspended solids	6	<5.0000	10.0000	<6.0000	2.0001
Zinc	6	<0.0050	0.0100	<0.0058	0.0020
OW-WR-16					
Barium	4	0.0500	0.0900	0.0750	0.0191
Chromium (total)	4	<0.0050	0.0100	<0.0062	0.0025
Copper	4	<0.0050	0.2700	<0.0752	0.1301
Fluoride	4	1.6000	1.9000	1.7250	0.1500
Iron	4	0.0200	0.1300	0.0550	0.0507
Nitrogen	4	1.4000	1.5000	1.4750	0.0500
Lead	4	<0.0050	0.0250	<0.0100	0.0100
Selenium	4	<0.0050	0.0050	<0.0050	0.0000
Total dissolved solids	4	290.000	340.000	310.000	21.6067
Total suspended solids	4	<5.0000	6.0000	<5.2500	0.5002
Zinc	4	<0.0050	0.1600	<0.0440	0.0773

Table 5.12, continued

Page 2

Location and Analysis*	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-18					
Barium	6	0.0800	0.1500	0.1283	0.0248
Chromium (total)	6	<0.0050	0.0110	<0.0060	0.0024
Copper	6	<0.0050	0.0120	<0.0070	0.0032
Fluoride	6	1.3000	1.5000	1.4167	0.0753
Iron	6	<0.0100	0.1000	<0.0350	0.0399
Nitrogen	6	1.3000	1.6000	1.4500	0.1225
Total dissolved solids	6	140.000	290.001	253.333	57.1548
Total suspended solids	5	<5.0000	10.0000	<6.6000	2.3022
Zinc	6	<0.0050	0.0180	<0.0075	0.0052
OW-WR-41					
Silver	3	<0.0050	0.0050	<0.0050	0.0000
Barium	3	0.0700	0.1300	0.1067	0.0321
Chromium (total)	3	<0.0050	0.0050	<0.0050	0.0000
Copper	3	<0.0050	0.0160	<0.0117	0.0059
Fluoride	3	1.5000	1.7000	1.6333	0.1155
Iron	3	0.0500	0.0700	0.0600	0.0100
Nitrogen	3	1.3000	1.5000	1.3667	0.1155
Lead	3	<0.0050	0.0080	<0.0060	0.0017
Total dissolved solids	3	200.000	300.001	266.667	57.7352
Total suspended solids	3	<5.0000	7.0000	<5.6667	1.1547
Zinc	3	0.0180	0.0200	0.0193	0.0012

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

Table 5.13 Pantex Groundwater Inorganic Data Summary for Drinking Water Stations in 1989

Page 1

Location and Analysis*	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-23					
Barium	4	0.1100	0.1400	0.1225	0.0126
Copper	4	0.0760	0.1800	0.1265	0.0427
Fluoride	4	1.5000	1.9000	1.7500	0.1732
Iron	4	0.0100	0.0200	<0.0150	0.0058
Nitrogen	4	1.3000	1.5000	1.4250	0.0957
Total dissolved solids	4	230.000	320.000	272.500	37.7511
Total suspended solids	4	<5.0000	9.0000	<6.0000	2.0000
Zinc	4	0.0490	0.1400	0.0947	0.0391
OW-WR-28					
Silver	3	<0.0050	0.0050	<0.0050	0.0000
Barium	3	0.1100	0.1300	0.1200	0.0100
Fluoride	3	1.5000	1.9000	1.7333	0.2082
Iron	3	<0.0100	0.0200	<0.0133	0.0058
Nitrogen	3	1.4000	1.4000	1.4000	0.0000
Total dissolved solids	3	260.000	290.000	276.667	15.2752
Total suspended solids	3	<5.0000	12.0000	<7.3333	4.0415
Zinc	3	0.0800	0.1300	0.1100	0.0265
OW-WR-43					
Barium	7	0.0900	0.1200	0.1057	0.0098
Cyanide	6	<0.0050	0.0070	<0.0053	0.0008
Copper	7	0.0060	0.0260	0.0121	0.0068
Fluoride	7	1.5000	1.9000	1.6143	0.1345
Iron	7	0.0700	0.4000	0.2386	0.1380
Mercury	7	<0.0001	0.0001	<0.0001	0.0000
Nitrogen	7	1.2000	1.5000	1.3143	0.1069
Total dissolved solids	7	270.000	310.000	287.143	12.5357
Zinc	7	0.0390	0.0930	0.0649	0.0228

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

Table 5.14 Pantex Groundwater Inorganic Data Summary for Offsite Water Supplies in 1989

Page 1

Location and Analysis*	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-33					
Barium	10	0.0600	0.1000	0.0780	0.0123
Chromium (total)	10	<0.0050	0.0050	<0.0050	0.0000
Copper	10	<0.0050	0.0100	<0.0055	0.0016
Fluoride	10	2.6000	4.5000	2.9800	0.5432
Iron	10	<0.0100	0.0200	<0.0130	0.0048
Mercury	10	<0.0001	0.0001	<0.0001	0.0000
Nitrogen	10	1.1000	1.5000	1.2600	0.1075
Phosphate	10	<0.0200	0.4600	<0.0660	0.1386
Sulfate	10	24.0000	50.0001	41.7000	7.3038
Total dissolved solids	10	320.000	380.000	343.000	17.6746
Total suspended solids	10	<5.0000	9.0000	<5.9000	1.5239
Zinc	10	0.0300	1.5000	0.2652	0.4383
OW-WR-37					
Barium	11	0.0500	0.1200	0.0991	0.0187
Chromium (total)	11	<0.0050	0.0060	<0.0051	0.0003
Copper	11	<0.0050	0.0476	<0.0186	0.0140
Fluoride	11	2.0000	2.4000	2.2000	0.1265
Iron	11	<0.0100	0.1000	<0.1000	0.0287
Nitrogen	11	1.2000	1.4000	1.2545	0.0688
Phosphate	11	<0.0200	0.3500	<0.0809	0.1331
Sulfate	11	30.0000	33.0001	31.0000	1.0961
Total dissolved solids	11	290.000	440.000	320.000	41.9534
Total suspended solids	11	<5.0000	6.0000	<5.2727	0.4672
Zinc	11	0.0500	1.8000	0.7373	0.5532

Table 5.14, continued

Location and Analysis*	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-49					
Barium	3	0.0500	0.0900	0.0733	0.0208
Cyanide	3	<0.0050	0.0080	<0.0060	0.0017
Chromium (total)	3	<0.0050	0.0060	<0.0053	0.0006
Copper	3	<0.0050	0.0070	<0.0057	0.0012
Fluoride	3	1.8000	2.1000	1.9333	0.1528
Iron	3	0.0200	0.3200	0.1667	0.1501
Nitrogen	3	1.2000	2.2000	1.7667	0.5132
Phosphate	3	<0.0200	0.3200	<0.1200	0.1732
Sulfate	3	37.0000	62.0000	53.0000	13.8928
Total dissolved solids	3	230.000	270.000	246.667	20.8199
Total suspended solids	3	6.0000	10.0000	7.3333	2.3095
Zinc	3	0.2600	0.5400	0.3700	0.1493
OW-WR-50					
Barium	3	0.0700	0.1500	0.1233	0.0462
Chromium (total)	3	<0.0050	0.0120	<0.0073	0.0040
Copper	3	<0.0050	0.0070	<0.0060	0.0010
Fluoride	3	1.6000	1.6000	1.6000	0.0000
Iron	3	0.0200	0.0900	0.0467	0.0379
Nitrogen	3	1.3000	1.4000	1.3333	0.0577
Phosphate	3	<0.0200	0.3300	<0.1233	0.1790
Sulfate	3	22.0000	24.0000	23.3333	1.1559
Total dissolved solids	3	260.000	320.000	286.667	30.5544
Total suspended solids	3	5.0000	10.0000	7.6667	2.5167
Zinc	3	0.3400	0.4500	0.4033	0.0569

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

Table 5.15 Pantex Groundwater Detected Organic Data Summary for Ogallala Monitoring Wells in 1989

Location and Analysis*	Number of Samples	January through September				Standard Deviation	October (mg/L)	December (mg/L)
		Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)				
OW-WR-39 Bis(2-ethylhexyl)phthalate	2	0.0100	0.0100	0.0100		0.0000	0.0100	
OW-WR-40 Bis(2-ethylhexyl)phthalate	2	0.0100	0.0100	0.0100		0.0000	0.0100	0.0100

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

Table 5.16 Pantex Groundwater Detected Organic Data Summary for Perched Monitoring Wells in 1989

Location and Analysis*	Number of Samples	January through September				October (mg/L)	December (mg/L)
		Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation		
OW-WR-19 Bis(2-ethylhexyl)phthalate RDX	2 7	0.0100 <0.0200	0.0100 0.0400	0.0100 <0.0229	0.0000 0.0076	0.0100 <0.0200	0.0100 <0.0200
OW-WR-20 Bis(2-ethylhexyl)phthalate RDX HMX 1,2-Dichloroethane	2 6 6 2	0.0100 <0.0200 <0.0200 <0.005	0.0100 0.0260 0.0200 <0.005	0.0100 <0.0217 <0.0200 <0.005	0.0000 0.0027 0.000 0.000	0.0100 0.52 0.026 <0.005	0.0100 <0.0200 <0.0200 0.011
OW-WR-38 Bis(2-ethylhexyl)phthalate RDX	2 7	0.0100 <0.0200	0.0100 0.0800	0.0100 <0.0286	0.0000 0.0227	0.0100 <0.0200	0.0100 <0.0200
OW-WR-44 Bis(2-ethylhexyl)phthalate	2	0.0100	0.0100	0.0100	0.0000	0.0100	0.0100
OW-WR-45 Bis(2-ethylhexyl)phthalate Trichloroethene	2 2	0.0100 <0.005	0.0100 <0.005	0.0100 <0.005	0.0000 0.000	0.0100 0.011	0.0100 0.006

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

Table 5.17 Pantex Groundwater Detected Organic Data Summary for Industrial/Water Supply Wells in 1989

Location and Analysis*	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-02 Bis(2-ethylhexyl)phthalate	2	0.0100	0.0100	0.0100	0.0000
OW-WR-06 Bis(2-ethylhexyl)phthalate	3	0.0100	0.0100	0.0100	0.0000
OW-WR-16 Bis(2-ethylhexyl)phthalate	2	0.0100	0.0100	0.0100	0.0000
Chloroform	2	0.0000	0.0050	<0.0050	0.0035
OW-WR-18 Bis(2-ethylhexyl)phthalate	3	0.0100	0.0100	0.0100	0.0000
OW-WR-41 Bis(2-ethylhexyl)phthalate	1	0.0100	0.0100	0.0100	NA

NA = Not applicable. Standard deviation cannot be calculated for a data set consisting of one number.

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

Table 5.18 Pantex Groundwater Detected Organic Data Summary for Drinking Water Stations in 1989

Location and Analysis*	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-23					
Bis(2-ethylhexyl)phthalate	2	0.0100	0.0100	0.0100	0.0000
Bromoform	4	<0.0050	0.0060	<0.0052	0.0005
Chlorodibromomethane	4	<0.0050	0.0060	<0.0052	0.0005
Chloroform	4	<0.0050	0.0080	<0.0057	0.0015
OW-WR-28					
Bis(2-ethylhexyl)phthalate	1	0.0100	0.0100	0.0100	NA
Bromoform	3	<0.0050	0.0080	<0.0060	0.0017
Dichlorobromomethane	3	<0.0050	0.0080	<0.0060	0.0017
OW-WR-43					
Bromoform	3	<0.0050	0.0050	<0.0050	0.0000
Dichlorobromomethane	3	<0.0050	0.0050	<0.0050	0.0000

NA = Not applicable. Standard deviation cannot be calculated for a data set consisting of one number.

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

Table 5.19 Pantex Groundwater Detected Organic Data Summary for Offsite Water Supplies in 1989

Location and Analysis*	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation
OW-WR-33					
Bis(2-ethylhexyl)phthalate	4	0.0100	0.0100	0.0100	0.0000
Chloroform	7	0.0000	0.0090	<0.0054	0.0030
Oil and grease	10	<1.0000	2.0000	<1.2000	0.4216
RDX	10	<0.0200	0.0210	<0.0201	0.0003
OW-WR-37					
Bis(2-ethylhexyl)phthalate	3	0.0100	0.0100	0.0100	0.0000
Chloroform	8	0.0000	0.0080	<0.0051	0.0025
Oil and grease	9	<1.0000	4.0000	<1.3333	1.0000
OW-WR-49					
Bis(2-ethylhexyl)phthalate	3	0.0100	0.0100	0.0100	0.0000
Chloroform	3	0.0000	0.0050	<0.0050	0.0029
Oil and grease	3	<1.0000	3.0000	<1.6667	1.1547
OW-WR-50					
Bis(2-ethylhexyl)phthalate	3	0.0100	0.0100	0.0100	0.0000
Chloroform	3	0.0000	0.0050	<0.0050	0.0029

* Only those constituents detected at levels equal to or exceeding their respective detection limits are included in this summary.

SECTION 6

NONRECURRING DATA

During 1989 there were many samples taken in addition to those collected as part of the various monitoring programs. These samples are considered to be non-recurring since they were taken as a proactive attempt to check for regulatory compliance or as a response to an event or investigation. Some examples of sampling events are miscellaneous spills, underground storage tank investigations, and any Environmental Restoration Program investigations. Table 6.1 lists constituents analyzed for in 1989. Samples were collected of water, soil, sludge, ash, and biota. Tables 6.2 through 6.4 list each sample type, the analyses performed, and the data summary. Only those constituents which were detected above their respective detection limits are listed in the tables.

Table 6.1 Target Constituents in 1989 Nonrecurring Samples

VOLATILES

Acetone	Methylene chloride
Bromoform	Hexane
Benzene	N-Butyl alcohol
Dichlorobromomethane	4-Methyl-2-pentanone
Chlorodibromomethane	Di-isobutyl ketone
Chloroform	Chloromethane
Dimethylformamide	Bromomethane
Ethylbenzene	Vinyl chloride
Methyl ethyl ketone	Chloroethane
Methyl alcohol	Carbon disulfide
Tetrahydrofuran	1,1-Dichloroethene
Toluene	1,1-Dichloroethane
Xylene	trans-1,2-Dichloroethene
Isopropyl alcohol	1,2-Dichloroethane
Carbon tetrachloride	1,1,1-Trichloroethane
Bromodichloromethane	Vinyl acetate
1,2-Dichloropropane	1,1,2,2-Tetrachloroethane
Trichloroethene	trans-1,3-Dichloropropane
cis-1,3-Dichloropropene	1,1,2-Trichloroethane
2-Hexanone	2-Chloroethyl vinyl ether
Chlorobenzene	Tetrachloroethene
1,4-Dichlorobenzene	Styrene

PESTICIDES AND HERBICIDES

2,4,5-T	2,4-D
Endrin	Lindane
Toxaphene	Methoxychlor

HIGH EXPLOSIVES

HMX	PETN
RDX	TNT

METALS

Silver	Arsenic
Barium	Cadmium
Chromium	Copper
Iron	Mercury
Lead	Selenium
Zinc	

MISCELLANEOUS

Cyanide	Total organic carbon
Total organic halogens	Parr bomb halides

Table 6.2 Summary of Nonrecurring Water Samples for 1989

Analysis	Number of Samples	Minimum	Maximum	Mean	Standard Deviation
Organics*					
Acetone, mg/L	40	0.140	600.00	27.33	100.66
Bromoform, mg/L	1	0.012	0.012	0.012	NA
Chloroform, mg/L	1	0.005	0.005	0.005	NA
Di-isobutyl ketone, mg/L	2	0.130	0.180	0.155	0.035
1,2-Dichloroethane, mg/L	1	0.021	0.021	0.021	NA
Ethyl benzene, mg/L	1	0.022	0.022	0.022	NA
Isopropyl alcohol	9	1.100	36.00	7.54	11.09
Methyl ethyl ketone, mg/L	18	0.700	200.00	16.74	46.18
Methylene chloride, mg/L	2	0.005	0.005	0.005	0
Methanol, mg/L	2	10.000	17.00	13.5	4.95
N-butyl alcohol, mg/L	1	8.300	8.30	8.30	NA
Styrene, mg/L	1	20.000	20.000	20.000	NA
Tetrahydrofuran, mg/L	1	0.013	0.013	0.013	NA
1,1,1-Trichloroethane, mg/L	1	0.820	0.820	0.820	NA
Trichloroethene, mg/L	1	0.960	0.960	0.960	NA
Toluene, mg/L	24	0.005	4.800	0.491	1.10
Total xylenes, mg/L	3	0.012	0.032	0.020	0.01
m/p-Xylenes, mg/L	6	0.010	2.500	0.456	1.00
o-Xylene, mg/L	4	0.007	0.23	0.013	4.95
Inorganics					
Arsenic, mg/L	26	0.005	0.029	0.0096	0.0045
Chromium (total), mg/L	10	<0.01	2.00	0.35	2.59
Iron, mg/L	10	<0.5	8.00	1.00	2.49
RDX, mg/L	42	<0.02	7.00	2.23	1.35

* Only those samples which contained concentrations higher than the detection limit are included in this summary.

NA — not applicable

Table 6.3 Summary of Nonrecurring Soil Samples for 1989

Analysis	Number of Samples	Minimum	Maximum	Mean	Standard Deviation
Organics					
Chloroform*, mg/kg	2	0.056	0.070	0.063	0.009
Methylene chloride*, mg/kg	1	0.008	0.008	0.008	NA
Tetrachloroethene*, mg/kg	1	0.074	0.074	0.074	NA
Toluene*, mg/kg	1	0.008	0.008	0.008	NA
Trichloroethene*, mg/kg	1	0.006	0.006	0.006	NA
2,4,-D, mg/kg	42	<1.0	5.00	1.88	1.78
Total petroleum hydrocarbons, mg/kg	4	160.0	220.0	197.5	28.72
Inorganics					
Arsenic, mg/kg	26	<2.0	7.00	3.5	1.66
Barium, mg/kg	26	<1.0	4.700	81.8	94.7
Cadmium, mg/kg	34	<1.1	6.00	1.500	1.38
Chromium (total), mg/kg	26	6.00	26.00	13.58	5.29
Lead, mg/kg	39	6.00	29.00	15.90	6.49
Silver, mg/kg	25	<1.0	12.00	2.64	2.29

* Only those samples which contained concentrations higher than the detection limit are included in this summary.

NA — not applicable

Table 6.4 Summary of Nonrecurring Sludge Samples for 1989

Analysis*	Number of Samples	Minimum	Maximum	Mean
Methyl ethyl ketone, mg/L	1	8.200	8.200	8.200
Toluene, mg/L	1	0.400	0.400	0.400

* Only those samples which contained concentrations higher than the detection limit are included in this summary.

Summary of Nonrecurring Ash Samples for 1989

Analysis*	Number of Samples	Minimum	Maximum	Mean	Standard Deviation
Acetone, $\mu\text{g/g}$	3	0.490	1.500	1.090	0.53
Benzene, $\mu\text{g/g}$	1	1.200	1.200	1.200	NA
Chloroform, $\mu\text{g/g}$	1	0.360	0.360	0.360	NA
Methylene chloride, $\mu\text{g/g}$	2	0.230	0.320	0.0275	0.06
Methyl ethyl ketone, $\mu\text{g/g}$	1	10.000	10.000	10.000	NA
Tetrachloroethene, $\mu\text{g/g}$	1	12.000	12.000	12.000	NA
Trichloroethene, $\mu\text{g/g}$	1	0.029	0.029	0.029	NA
Toluene, $\mu\text{g/g}$	2	0.860	62.000	31.43	43.2
Total xylenes, $\mu\text{g/g}$	1	1.500	1.500	1.500	NA

* Only those samples which contained concentrations higher than the detection limit are included in this summary.

Summary of Nonrecurring Frog Samples for 1989

Analysis	Number of Samples	Minimum	Maximum	Mean	Standard Deviation
HMX, mg/kg	2	8.7	10.00	9.35	0.92
TNT, mg/kg	2	<0.20	1.2	0.70	0.71

NA — not applicable

SECTION 7

QUALITY ASSURANCE

The basic objective of quality assurance (QA) for any data collection program is to ensure the accuracy, precision, and reliability of reported results. DOE Order 5400.1 requires that a quality assurance program consistent with the requirements of DOE Order 5700.6B be established for each element of the Pantex environmental monitoring and surveillance program. Requirements for quality assurance plans at Pantex are defined in the ES&H "Operations Quality Plan for Pantex Plant" (September 1989) and in the ES&H internal operating procedures (IOPs). Procedures for sampling and analysis of various environmental media at Pantex are set forth in the Environmental Protection Department's standard operating procedures.

Pantex personnel routinely collect samples of various environmental media for analysis. A limited amount of environmental sample analysis is done on site. Most samples collected for radiological and chemical analysis are analyzed off site by a contract laboratory.

BOD₅ AND COD ANALYSIS

Effluent from the Pantex wastewater treatment facility was analyzed to document compliance with TWC permit 02296. Tests for BOD₅ and COD were run in the Environmental Health Laboratory in accordance with *Standard Methods for the Examination of Water and Wastewater*, 15th edition. Fecal coliform samples were analyzed by the Amarillo Bi-City County Health Department, a state-certified laboratory.

RADIOACTIVE AND NONRADIOACTIVE

During 1989, radioactive and nonradioactive analyses were performed by a contract laboratory, Accu-Labs Research, Inc. (Accu-Labs) of Wheat Ridge, Colorado. The QA program at Accu-Labs is summarized as follows:

1. A major component of the QA program is the analysis of spiked and duplicate samples. The purpose of the spike analysis is to test the accuracy of the analysis and of the technician performing the analysis.

Accu-Labs routinely uses three kinds of spikes. An internal laboratory spike is prepared by the QA department and used by the laboratory technician to determine the accuracy of the analysis before a run is accepted. The technician knows the concentrations of these internal laboratory spikes. Internal laboratory spikes are analyzed at a frequency of 10 percent. The QA

department also introduces blind spikes for analysis as routine samples. These samples are assigned code numbers that are indistinguishable from those on routine samples, thereby preventing preferential treatment. These spikes test the proficiency of the technician in determining accurately the composition of the spike. The QA department prepares the blind spikes from concentrates provided by the EPA and Environmental Resource Associates.

In addition to the internal laboratory spikes and blind spikes, at least 10 percent of the samples are spiked with a known concentration of the element of interest prior to sample preparation and analysis. This procedure provides a measure of the chemical recovery of the sample preparation method as well as a verification of the analytical concentration in the sample.

Accu-Labs technicians also analyze duplicate samples to measure the precision of the analytical method. Duplicate analysis determines the reproducibility of the method when repeated on an identical sample. The precision is in the reproducibility, not in whether the observed values are the true values. The laboratory technician randomly selects duplicate samples to be analyzed. Duplicates are run on at least 10 percent of all samples.

Blank samples are also run at a frequency of 10 percent. Blanks consist of laboratory water and are used to determine any background levels of the parameters of interest.

2. Analysts, regardless of degree of experience, undergo a thorough, on-the-job training program. Each analyst observes an experienced chemist at work and studies the analytical procedures. Controlled copies of documents describing official analytical procedures are provided to each analyst. Once the technician is familiar with an analytical method, he or she is subjected to a procedure review to ascertain understanding and proficiency. Comprehensive training records for each technician are maintained by the QA department. Analytical results of all quality control samples are reviewed and compared by each analyst.
3. All reagents, carrier, and radioactive quality control solutions which are in regular use and critical to proper results are standardized monthly, or prior to use, as appropriate.
4. All instruments are maintained by the manufacturer through monthly preventive maintenance programs. Each instrument is calibrated weekly with sources traceable to the National Bureau of Standards (NBS). If the calibration detects any anomaly from the routine performance of the instruments, no analysis is allowed to be performed by that instrument until it is functioning properly.
5. Quality assurance audits are periodically performed on each department to evaluate adherence to the Accu-Labs QA plan. Results of these audits are provided to the area supervisors. Any observation reports or corrective

action reports must be reviewed and a response made to the quality control officer.

6. Interlaboratory comparisons are conducted with the U.S. Public Health Service, Environmental Protection Agency, U.S. Department of Energy (EML Quality Assurance Program Table A-II), Department of the Navy, and the American Industrial Hygiene Association. In addition, this laboratory is a member in good standing with the American Association for Laboratory Accreditation.
7. The Accu-Labs QA program is designed to comply with the requirements of the Nuclear Regulatory Commission specifications found in regulatory guide 4.15.

Independent data verification requirements for radionuclides were addressed by Pantex in 1989. Accu-Labs and EG&G Mound Applied Technologies (MAT) each analyzed the same vegetation, soil, air, and water samples. As this report was being prepared, a complete set of MAT's analytical results was not available for comparison with results of Accu-Labs' analyses. Table 7.1 is a comparison of the nine available matched sets of air analytical data.

The Tiger Team assessment of Pantex Plant found that the Pantex environmental monitoring program lacked quality assurance project plans and a written environmental monitoring plan, and that environmental sampling protocols and techniques were inadequate. Steps are being taken to correct these deficiencies.

A major chemical analytical problem involves the analysis of high explosives in various medias. Pantex is currently evaluating a number of methods for HE analysis.

The ES&H Division is currently preparing the Environmental Monitoring Quality Plan. This plan will fulfill the requirements of DOE Order 5700.6B, DOE Order 5400.1, DOE Order 5400.XY, ANSI/ASME NQA-1, and EPA guidance documents as they apply to Pantex Plant environmental monitoring and surveillance activities. The eleven elements of DOE Order 5400.1, chapter IV, section 10, will be addressed in the quality plan. This plan is scheduled for completion by September 1990. In addition, Pantex Plant internal operating procedures will be revised and extended to meet the requirements of DOE Order 5400.1, section 6.1.3B.

Table 7.1 Independent Data Verification,
Tritium in Water from Pantex Silica Gel Distilled

Pantex Sample Number	Accu-Labs Identification Number	Mound Identification Number	Accu-Labs Results Reported 12/11/89 (pCi/mL)	Mound Results Reported 2/90 (pCi/mL)
890829005349	31927-1	589-1698	0.16±0.22	<0.5
890829005350	31927-2	589-1699	0.31±0.22	<0.5
890829005351	31927-3	589-1700	0.12±0.21	<0.5
890829005352	31927-4	589-1701	0.03±0.21	<0.5
890829005353	31927-5	589-1702	0.05±0.21	<0.5
890829005354	31927-6	589-1703	0.27±0.22	<0.5
890829005355	31927-7	589-1704	0.16±0.22	<0.5
890829005356	31927-8	589-1705	0.15±0.22	<0.5
890829005357	31927-9	589-1706	0.16±0.22	<0.5

SECTION 8
SUMMARY ASSESSMENT
ENVIRONMENTAL COMPLIANCE ACTIVITY
JANUARY THROUGH OCTOBER 1990

BACKGROUND

The Pantex Plant is located in the Texas Panhandle in Carson County, on Highway 60, about 17 miles northeast of downtown Amarillo. The Pantex Plant is operated for the U.S. Department of Energy (DOE) by Mason & Hanger-Silas Mason Co., Inc. The Pantex facility consists of 10,080 acres of DOE-owned land and 5,856 acres of land leased from the Texas Tech University. The latter is used as a security buffer zone. Pantex was first used in 1942 by the Army Ordnance Corps for loading conventional ammunition shells and bombs. In 1949, the Atomic Energy Commission started rehabilitating portions of the original Pantex Plant and building new facilities for nuclear weapons operations. The principal operations performed at Pantex are the assembly of nuclear weapons from components received from other DOE plants; fabrication of chemical high explosive (HE) components for nuclear weapons; operation of the chemical HE Development Division; surveillance, testing, and disposal of chemical HE; disassembly of obsolete nuclear weapons for retirement; and maintenance, modification, repair, and nonexplosive testing of nuclear weapons components. Weapons assembly and stockpile surveillance activities involve handling significant quantities of uranium, plutonium, and tritium, as well as a variety of nonradioactive toxic chemicals.

It is the policy of Pantex to conduct its operations so as to comply with all applicable environmental laws and regulations. The following is a review of those environmental requirements that have undergone changes in the first half of 1990. In addition, the Pantex Plant maintains an active program for environmental protection as outlined in the accompanying Annual Environmental Monitoring Report.

CURRENT ISSUES AND ACTIONS

Resource Conservation and Recovery Act (RCRA)

Several activities relating to RCRA occurred during this period. These include:

- Part B Permit was resubmitted on April 19, 1990.

- Draft 3008(h) Administrative Order on Consent is being negotiated at headquarters level by DOE and the U.S. Environmental Protection Agency (EPA).
- One interim status location was removed from service in March 1990.
- On May 16-17, 1990, the Texas Water Commission (TWC) conducted its annual RCRA compliance inspection of the Pantex Plant. As a result of this inspection, on June 4, 1990, Pantex received a letter from the TWC identifying two alleged noncompliance issues regarding solid waste management regulations. Both noncompliance issues are administrative in nature and have been closed.
- Assessment via drilling at the 11-14 former surface impoundment to determine if hypalon liner had leaked was performed. A closure plan is currently waiting public notice.
- With respect to underground storage tanks (UST), thirteen were removed with consequent soil sampling. TWC inspected seven of the thirteen. Fifteen USTs remain in the ground, with removals scheduled.

Environmental Restoration Program

The U.S. Army Corps of Engineers, Tulsa District, was tasked by DOE to implement RCRA facility investigations as required by the Draft 3008(h) Order and anticipated corrective action section of the Hazardous Waste Permit. Preliminary draft work plans for studies to determine the extent of contamination within all relevant media were prepared for:

- playas and ditches
- further assessment of perched groundwater at two UST locations
- fire training area burn pits
- former cooling tower in zone 12
- old sewage treatment plant sludge beds.

Dedicated sampling pumps were installed at three Ogallala wells at the burning ground, which had been installed by the Environmental Restoration Program in 1989. Sampling was performed in September.

Clean Air Act (CAA)

The Amarillo area office and the operating contractor completed, or continued, work in several areas. These include:

- Operating permit application with emission testing results was submitted to the Texas Air Control Board (TACB) for the new boiler house.
- An assessment of emissions from all facilities is complete and have been transmitted to the Texas Air Control Board.
- Eight air permit exemptions were filed to TACB with at least twenty-five more Pending. Notice for two asbestos removal projects were also filed.

- A report on modeling of burning ground emissions is complete. Results have been transmitted to the TACB.
- A compliance strategy for 40 CFR 61 Subpart H was submitted to EPA Region 6 for review and concurrence.

National Environmental Policy Act (NEPA)

The requirements for NEPA compliance were significantly altered by the issuing of Secretary of Energy Notice, SEN-15-90, on February 5, 1990. The notice has the effect of a DOE Order and was made effective on the issue date. The new approach to NEPA will eliminate the use of the Memorandum to File by the end of Fiscal Year 1990, and will rely instead on categorical exclusions (CX), Environmental Assessments (EA), and Environmental Impact Statements (EIS). DOE's Albuquerque Operations Office (DOE/AL) has requested that the Pantex Plant submit a DOE environmental checklist (DEC) when required. These DEC's would become the basis for a DOE/AL recommendation to headquarters for a determination of a CX, EA, or EIS. The current estimate of the number of DEC's, which will be prepared during the next three years, under present guidelines, is at least 300. In addition, twenty EAs and two project specific EISs are anticipated.

In March, a CX was recommended approved by DOE/HQ and DOE/AL for maintenance work orders at Pantex. In 1989, approximately 39,000 work orders were processed. A CX was recommended based on the NEPA-specific preliminary hazard analysis process at the Pantex Plant.

One EA is currently being performed by Oak Ridge National Laboratory for a process activity, specifically W79 ALT-325. In addition, one EA has been completed and two more are being prepared.

Clean Water Act (CWA)

Regulatory agencies rendered important decisions in this area during this period. These were:

- EPA Region VI formally determined that the Pantex Plant does not require an NPDES permit in March 1990. In August 1990, the EPA requested more information on the original request.
- TWC formerly determined that water in playas are waters of the State.

With respect to industrial discharges from the Pantex Plant, pH conditions equalled or slightly exceeded the upper limit on occasion, and analytical problems were encountered with performing BOD and COD analyses with no exceedances measure.

Safe Drinking Water Act (SDWA)

Sampling of water supplies and reporting programs continued throughout the first five months of 1990. Pantex Plant is considered a noncommunity, nontransient water supply system. As a noncommunity, nontransient system, Pantex Plant is required to meet secondary drinking water standards, as well as interim primary

999/standards. All water supply samples collected and analyzed demonstrated compliance with EPA's drinking water standards.

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