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1994 ENVIRONMENTAL REPORT FOR PANTEX PLANT

June 1995

Prepared by
Environmental Protection Department
Environment, Safety & Health Division

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Mason & Hanger-Silas Mason Co., Inc.
Pantex Plant

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Work Performed Under Contract No. DE-AC04-91AL65030

Prepared for
U.S. Department of Energy
Albuquerque Operations Office
Amarillo Area Office

Prepared by
Environmental Protection Department
Environment, Safety & Health Division
Battelle Pantex
Mason & Hanger-Silas Mason Co., Inc.
Amarillo, Texas 79177

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EXECUTIVE SUMMARY

Residents

The U.S. Department of Energy (DOE) oversees operation of Pantex Plant through the Amarillo Area Office, which reports to the Albuquerque Operations Office. Residents of Pantex Plant include (a) Mason & Hanger-Silas Mason Co., Inc. (Mason & Hanger) as the management and operations contractor; (b) Battelle Memorial Institute (Battelle Pantex) as subcontractor to Mason & Hanger for its waste management/environmental restoration and environment, safety, and health divisions; (c) Sandia National Laboratories for selected testing and evaluation activities; (d) DOE Transportation Safeguards Division; (e) U.S. Army Corps of Engineers for management of construction projects and performance of the environmental restoration program; (f) Tri-Labs (Sandia, Los Alamos, and Lawrence Livermore national laboratories) for programmatic support of dismantlement activities; and (g) Texas Tech University for management of its farming operations.

Report Contents

This report summarizes and interprets environmental monitoring data for Pantex Plant, outlines site environmental management performance, summarizes compliance with applicable environmental regulations, and describes significant programs and achievements during 1994. Detailed information on waste minimization activities and cultural and natural resources is also presented. The report was prepared in accordance with DOE Order 5400.1, "General Environmental Protection Program."

Monitoring and Results

Environmental monitoring involves two principal collection and analysis activities for radiological and nonradiological constituents: (a) monitoring liquid and airborne effluents to characterize and quantify releases and (b) environmental surveillance of air, water, soil, and vegetation and measurement of external radiation to characterize the environmental impacts of Pantex Plant operations. Data are used to assess impacts of operations on the public and the environment and to demonstrate compliance with applicable standards and permits for both radiological and nonradiological contaminants. In 1994, more than 270 onsite and offsite locations were monitored regularly and 99,808 analyses were performed. Sixteen new air monitoring stations were established around the Plant perimeter in 1994. Data from a location at the U.S. Department of Agriculture Agricultural Research Service's Conservation and Production Research Laboratory at Bushland, Texas, and historical data are also presented for reference.

Individual data from the monitoring program are published in the *Pantex Plant Environmental Monitoring 1994 Data Compilation*. The data are summarized in the body of this report. In addition to summaries of sampling results, the report includes radiation doses to the public calculated according to U.S. Environmental Protection Agency (EPA) requirements. The dose to a hypothetical maximally exposed individual at the Plant boundary was 0.000058 millirem (equaling 0.00000058 millisievert), well below the EPA's limit of 10 millirem per year from the air pathway. All 1994 radiological monitoring results were consistent with previous years' results and well below the DOE's derived concentration guides. Doses from external penetrating radiation for the Plant area averaged 95.4 millirem (0.95 millisievert), attributed to natural background terrestrial and cosmic radiation.

Pantex Plant and nearby areas are relatively free of nonradiological contaminants. No contamination from DOE operations was found in the

Ogallala aquifer in 1994. Investigation and remediation of Plant areas suspected of having contamination is required by corrective action provisions of the Resource Conservation and Recovery Act (RCRA) Part B Permit. In general, monitoring results are similar to historical results for all media sampled. As of December 1994, no contamination from Pantex Plant operations was found in samples from offsite locations. No new locations or contaminants were observed by the environmental monitoring program during 1994. Some contamination has been found in the perched groundwater under Zone 12 (explosives, chromium, and solvents), in the soil near operations areas (solvents, fuels, explosives, metals, and trace uranium-238), and in the playas and ditches that form the drainage system (explosives and metals). Results from the surface water and groundwater monitoring programs are included in this report and indicate contaminant levels.

The final section of this report describes the quality assurance program that supports the environmental monitoring program. Quality assurance was incorporated into all aspects of the monitoring program and included performance checks, rigorous quality control checks, and intensive data management. A data validation review was performed for all samples and indicated that 97.02% of all analyses were valid according to requirements determined in advance.

State of Texas Activities

Oversight of Pantex Plant is performed by the State of Texas through an Agreement in Principle (AIP) grant from DOE. The AIP addresses waste management, environmental monitoring, and emergency preparedness. The Texas Natural Resource Conservation Commission (TNRCC) operates five stations that monitor ambient air onsite. However, only thermoluminescent dosimetry results from the Texas Department of Health—Bureau of Radiation Control co-sampling activities are included in this report; these results indicate that environmental radiation levels at Pantex Plant correspond to regional levels.

Under an additional DOE Grant in Aid, continuing research activities titled "Geologic and Hydrologic Site Characterization of the Pantex Plant" were conducted by the University of Texas at Austin Bureau of Economic Geology. Support for these efforts was provided by the Water Resources Center at Texas Tech University and the Department of Geological Sciences at the University of Texas at Austin. Initiatives included seismic surveys, drilling at offsite locations, sampling, and installing hydrologic equipment.

Compliance

The TNRCC conducted a drinking water inspection in October 1994 and confirmed that the system was being operated and maintained in compliance with Texas regulations. The 1994 RCRA inspection reported two alleged violations that involved drum labeling discrepancies and unlisted sites for less-than-90-day accumulation of materials. Activities continued in support of modifications of the RCRA and wastewater permits and obtaining a National Pollutant Discharge Elimination System permit. A major activity involved efforts to prepare a site-wide Environmental Impact Statement.

Restoration

Work plans for all RCRA Facility Investigations have been approved by the TNRCC. Field investigations have been initiated at 12 of 14 sites. Pantex Plant was listed on the National Priority List (Superfund) by the EPA in May 1994. Argonne National Laboratory initiated activities for expedited site characterization of the perched aquifer beneath Zone 12.

Conclusion

Overall, Pantex Plant is currently in compliance with the major environmental laws and regulations, with no regulatory enforcement actions or lawsuits pending.

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Chapter 1

INTRODUCTION

This report summarizes data resulting from the environmental protection program conducted at Pantex Plant in 1994. Data from the environmental protection program in past years have been summarized in previous annual environmental reports. This report discusses the Plant's compliance with environmental statutes, regulations, and permit provisions, and highlights other significant environmental programs and efforts at the Plant in 1994. The report is provided to regulatory agencies and the public so that they can review and assess how well Pantex Plant is protecting the environment while fulfilling the Plant mission.

The report is organized into 15 chapters:

Chapter 1 is an introduction to and general description of Pantex Plant. Included within this chapter are brief discussions of the climate, geology, hydrology, seismology, population, and land and water uses of the area around Pantex Plant.

Chapter 2 discusses regulatory requirements for environmental compliance during 1994 and describes the Plant's compliance-related issues and activities. It presents results of various regulatory inspections and environmental activities during 1994 and lists the environmental permits issued to the Plant.

Chapter 3 describes the overall Environmental Protection Program. Overviews are provided for six program elements: public communication, oversight, quality assurance, compliance, pollution prevention, and environmental monitoring.

Chapter 4 describes the Plant's Cultural Resource Management Program. When fully implemented, this program will provide systematic, comprehensive, and long-term compliance with all cultural resource laws and regulations. Included in this chapter are summaries of activities through 1994, as well as current management strategies.

Chapter 5 describes the natural resource conservation program. Specifically covered under the program are land-use management, control of playas and wetlands, management of species of concern (including endangered and threatened species), and support of the ecological risk assessment program.

Chapter 6 describes the scope and mission of the Environmental Restoration (ER) program at Pantex Plant and delineates ER activities in 1994. Program elements include assessment of solid waste management units, expedited site characterization, underground storage tank management, technical development, and integration of efforts under the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act. Closures under RCRA are also described.

Chapter 7 describes the environmental radiological monitoring program, which deals with the potential exposure of the public and the environment to radiation resulting from Plant operations. Also discussed are results of the environmental thermoluminescent dosimetry program and other radiological monitoring programs that are not specific to individual environmental media (that is, air, groundwater, surface water, soil, and flora).

Chapters 8 through 13 discuss radiological and nonradiological monitoring and surveillance programs for individual environmental

media. Chapter 8 discusses the air monitoring program. The groundwater, drinking water, and surface water monitoring programs are discussed in Chapters 9, 10, and 11, respectively. Chapter 12 describes the soil monitoring program, and flora are discussed in Chapter 13. Each of these chapters includes a description of the monitoring program for that medium and an analysis of radiological and nonradiological data for samples collected during 1994.

Chapter 14 reviews Pantex Plant's quality assurance program for the environmental monitoring program, as initiated in response to U.S. Department of Energy (DOE) Order 5700.6C, "Quality Assurance." The chapter also includes an analysis of quality control samples collected during 1994 and a data validation summary.

Chapter 15 lists documents referenced in the report.

An appendix defines acronyms and abbreviations, and the external distribution of this report is tabulated at the end of the report.

1.1 General

The ongoing Environmental Protection Program at Pantex Plant is implemented by Mason & Hanger—Silas Mason Co., Inc. (Mason & Hanger) through its contract with DOE, administered by the Amarillo Area Office. Day-to-day operations are carried out by Mason & Hanger's subcontractor, Battelle Memorial Institute.

1.2 Site Location

Pantex Plant is located in the Texas Panhandle in Carson County along U.S. Highway 60. The Plant lies about 27 kilometers (17 miles) northeast of downtown Amarillo (Figure 1.1), at 101°34' west longitude and 35°19' north latitude. The Pantex Plant facility consists of 4,119 hectares (10,177.1 acres) owned by DOE, including 3,683 hectares (9,100 acres) in the main Plant area and 436 hectares (1,077.1 acres) around Pantex Lake approximately 4 kilometers (2.4 miles) northeast of the main Plant area. An additional 2,347 hectares (5,800.2 acres) of land immediately south of the main Plant area is leased from Texas Tech University for use as a safety and security buffer zone.

Pantex Plant lies on the Llano Estacado (staked plains) portion of the Great Plains. The topography at Pantex Plant is relatively flat, characterized by rolling grassy plains and numerous natural playa basins. The term "playa" is used to describe the more than 17,000 ephemeral lakes in the Texas Panhandle, mostly less than 1 kilometer (0.6 mile) in diameter, that receive water runoff from the surrounding area. The region is a semiarid farming and ranching area. Pantex Plant is surrounded by agricultural land, but several significant industrial facilities are also located nearby.

1.3 Facility History and Mission

Pantex Plant is a government-owned, contractor-operated facility. Mason & Hanger has been the operating contractor since 1956. Since 1991, the environmental, health, and safety programs have been subcontracted to Battelle Memorial Institute.

Pantex Plant was first used by the U.S. Army, for loading conventional ammunition shells and bombs from 1942 to 1945. In 1951, the Atomic Energy Commission arranged to begin rehabilitating portions of the original Plant and constructing new facilities for nuclear weapons operations. In 1974, the Energy Research and Development Administration superseded the Atomic Energy Commission and took responsibility for operation of Pantex Plant, and in 1977 the Energy Research and Development Administration was superseded by the Cabinet level DOE.

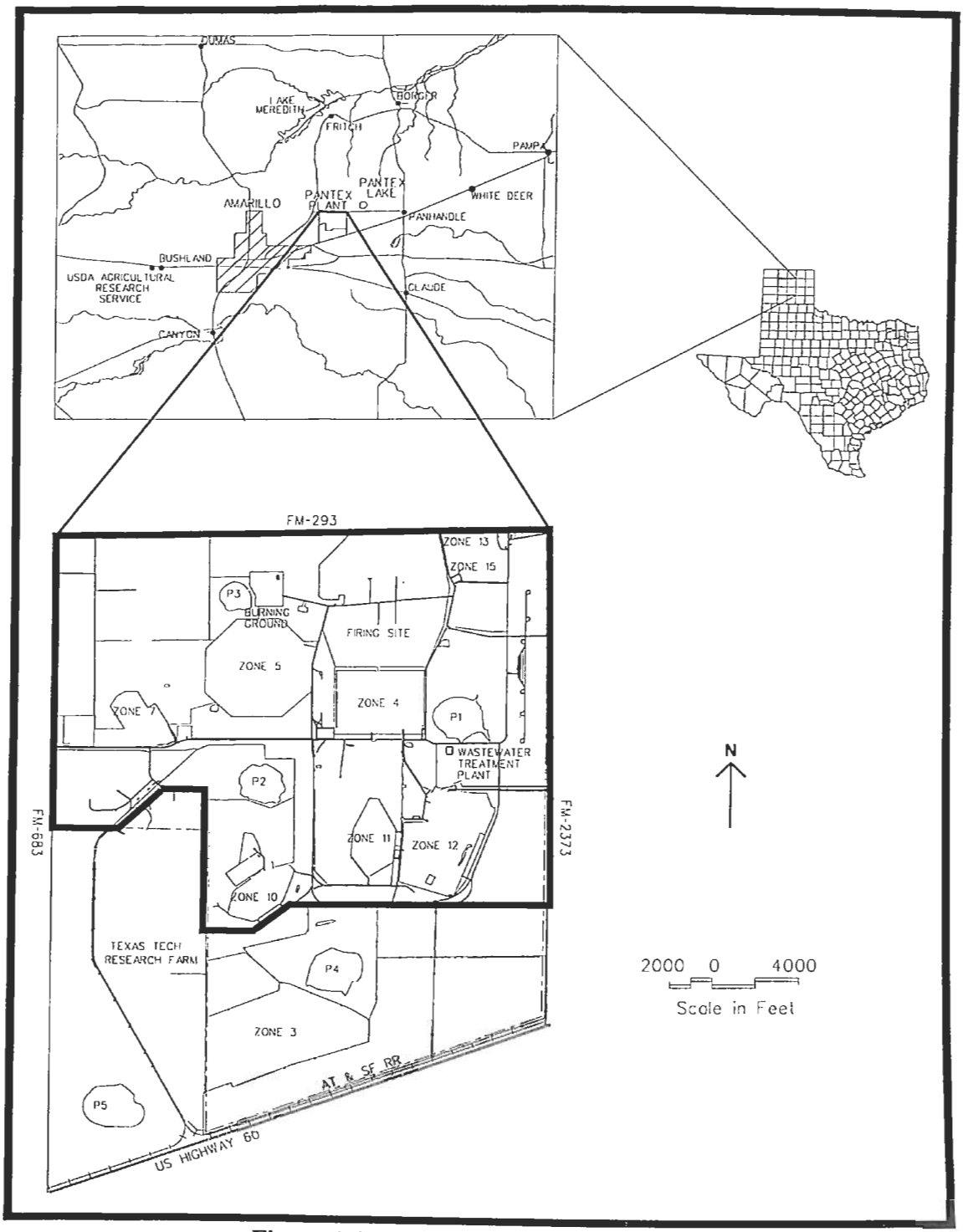


Figure 1.1: Location of Pantex Plant

The Plant missions are the fabrication of chemical explosives for nuclear weapons, assembly of nuclear weapons for the nation's stockpile, maintenance and evaluation of nuclear weapons in the stockpile, disassembly of nuclear weapons being retired from the stockpile, and interim storage of plutonium components from retired weapons. Weapons assembly, disassembly, and stockpile surveillance activities involve short-term handling (but not processing) of encapsulated uranium, plutonium, and tritium, as well as a variety of nonradioactive hazardous or toxic chemicals. Environmental restoration of the facility is a recent addition to operations at the Plant.

1.4 Facility Description

The facility is composed of several functional areas, commonly referred to as numbered zones (Figure 1.1). These zones include a weapons assembly/disassembly area (Zone 12), a weapons staging area (Zone 4), an area for experimental explosive development (Zone 11), a drinking water treatment plant (Zone 15), a sanitary wastewater treatment facility (WWTF) (Zone 13), and vehicle maintenance and administrative areas (Zone 16). Other functional areas include an explosive test-firing facility, a burning ground for burning explosive materials, and an area of landfills north of Zone 10. Zone 10 is currently used only for storage. Overall, there are more than 400 buildings at the Plant.

The weapons assembly area (Zone 12) covers approximately 80 hectares (200 acres) and contains more than 100 buildings. Nuclear components and other items received from other DOE plants, and explosive and metal parts fabricated at Pantex Plant, are assembled into nuclear weapons that are also disassembled at this zone. Nuclear weapons are also disassembled at this zone.

In 1993, Zone 4 was used for general warehousing and temporary holding (or staging) of weapons and weapons components awaiting movement to the assembly area for modification, repair, or disassembly; shipment to other DOE facilities for reworking or disposal; or shipment to the military. Interim storage of plutonium components, or pits, also takes place in Zone 4.

The explosive development area (Zone 11) consists of facilities for synthesizing, formulating, and characterizing experimental explosives.

The drinking water treatment facility (Zone 15) consists of production wells, chlorination/pumping facilities, storage tanks, and associated distribution lines. Zone 15 also supplies non-drinking water to the high-pressure fire protection system.

Sanitary wastewater generated at Pantex Plant is routed through a sewer system to a WWTF in Zone 13. The present WWTF came into service in 1988, replacing an older facility built in 1942. Effluent from the WWTF is discharged to Playa #1. Two explosive-processing operations discharge wastewater, which is first processed through particulate filters and activated carbon filters to remove residual explosive material, into ditches that drain into onsite playas.

The explosive test-firing facility (the firing sites) includes several test-shot stands and small-quantity test-firing chambers for measuring detonation properties of explosive components. The firing sites also include supporting facilities for setting up test shots and interpreting the results.

The Burning Ground is used for processing explosives, explosive components, and explosive-contaminated materials and waste by means of controlled open burning. Until 1980, waste solvents were disposed of in a chemical burn pit at the Burning Ground. From 1980 to 1989, such solvents were placed in open metal tanks at the Burning Ground and allowed to evaporate. Currently, these chemicals are sent offsite for disposal in accordance with applicable regulations at a permitted disposal facility.

The land disposal area, north of Zone 10, is divided into two landfill sites, one of which is currently used for Class 3 nonhazardous wastes (primarily construction debris). Before 1989, the Plant's domestic solid waste was sent to one onsite sanitary landfill for disposal. Since late 1989, such waste has been processed to remove recyclable materials, after which the nonrecyclable component is sent to an offsite landfill for burial. Current practices preclude disposal of hazardous materials in onsite landfills, and therefore hazardous materials are transported offsite for disposal in accordance with applicable regulations.

1.5 Climatology

The climate in the Texas Panhandle is mainly semiarid with mild winters and hot, dry summers. To illustrate the change in temperature with respect to seasons, a bar chart of the maximum, minimum, and average temperatures for each month of 1994 is presented in Figure 1.2. The climate is characterized by large variations in daily temperature extremes, low relative humidity, and irregularly spaced rainfall of moderate amounts. Rainfall averages approximately 50 centimeters (20 inches) per year. A breakdown of precipitation by month for 1994 is presented in Figure 1.3. These data were collected from a site at the southeast corner of Playa #1. For comparison, a 54-year average of monthly precipitation data from the National Weather Service is also presented. The average gross lake-surface evaporation rate averages approximately 185 centimeters (73 inches) per year (as measured from 1950 through 1975). Thunderstorms occur about 49 days per year and can produce tornados. Pantex Plant is located in a moderate to high hazard zone for tornados (Texas Tech University 1974).

Table 1.1 presents precipitation, temperature, and wind speed data collected at the Plant during 1994. Wind speed and temperature data came from the Plant meteorological tower, located at the northeast corner of the Plant. Precipitation data came from a rain gauge located at the southeast corner of Playa #1.

Table 1.1 Meteorological Data for 1994

Precipitation	44.2 cm	17.41 in.
Average Temperature	13.9°C	57.0°F
Average Wind Speed	5.5 m/sec	12.2 mph

The Panhandle is a windy area, with the prevailing wind direction being from the south-southeast to southwest. Figure 1.4 shows the annual average wind speed and direction for the local area for 1994. This figure, known as a wind rose, is based on data from the Plant's meteorological tower. On the wind rose, the total length of each spoke is proportional to the frequency of the wind's coming from that direction. The distribution of wind speeds within each direction is indicated by the length of the individual thickness segments of each spoke. Thus, local winds for 1994 were predominantly from the southeast through south-southwest directions approximately 33% of the time. The overall distributions of wind speeds and directions for 1994 were slightly different from those of previous years, in that winds from the north were slightly less common, and winds from the southeast and south-southeast were slightly more common.

1.6 Geology

The primary surface deposits at Pantex Plant 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 6-meter- (20-foot-) thick lower unit of silty sand with caliche.

The Ogallala Formation consists of sand, silt, clay, gravel, and some caliche and underlies the Blackwater Draw Formation. The base of the

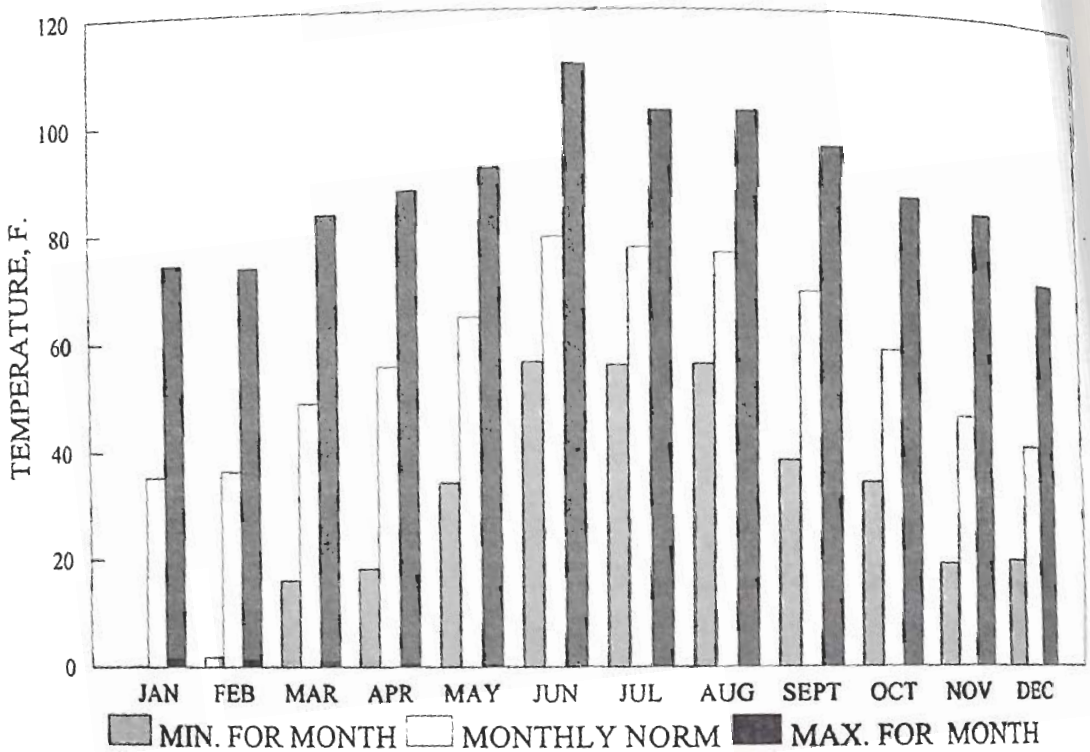


Figure 1.2 Maximum, minimum, and average temperatures by month for 1994

Ogallala Formation is an irregular surface that represents the pre-Ogallala topography. As a result, depths to the base of the Ogallala vary. At Pantex Plant, the vertical distance to the base of the Ogallala varies from 90 meters (300 feet) at the southwest corner to 220 meters (720 feet) at the northeast corner of the Plant (Purtymun and Becker 1982).

Underlying the Ogallala Formation is sedimentary rock of the Lower Dockum Group, consisting of shale, clayey siltstone, and sandstone. The Lower Dockum Group is less than 30 meters (100 feet) thick beneath Pantex Plant and is underlain by Permian rock.

1.7 Hydrology

The principal surface water feature on the Southern High Plains is the Canadian River, which runs southwest to northeast approximately 35 kilometers (20 miles) north of the Plant. Plant surface waters do not drain into this system, but rather discharge into onsite playas. From the playas, water either evaporates or infiltrates into the soil.

Two principal subsurface water-bearing units exist beneath Pantex Plant and adjacent areas: the Ogallala aquifer and the underlying Dockum Group aquifer. The vadose, or unsaturated, zone above the Ogallala aquifer consists of as much as 140 meters (460 feet) of sediments that lie between the land surface and the Ogallala aquifer.

1.7.1 Ogallala Aquifer

Two water-bearing units are present in the Ogallala Formation beneath Pantex Plant. Up to four discontinuous perched aquifers are present above the main zone of saturation. Perched

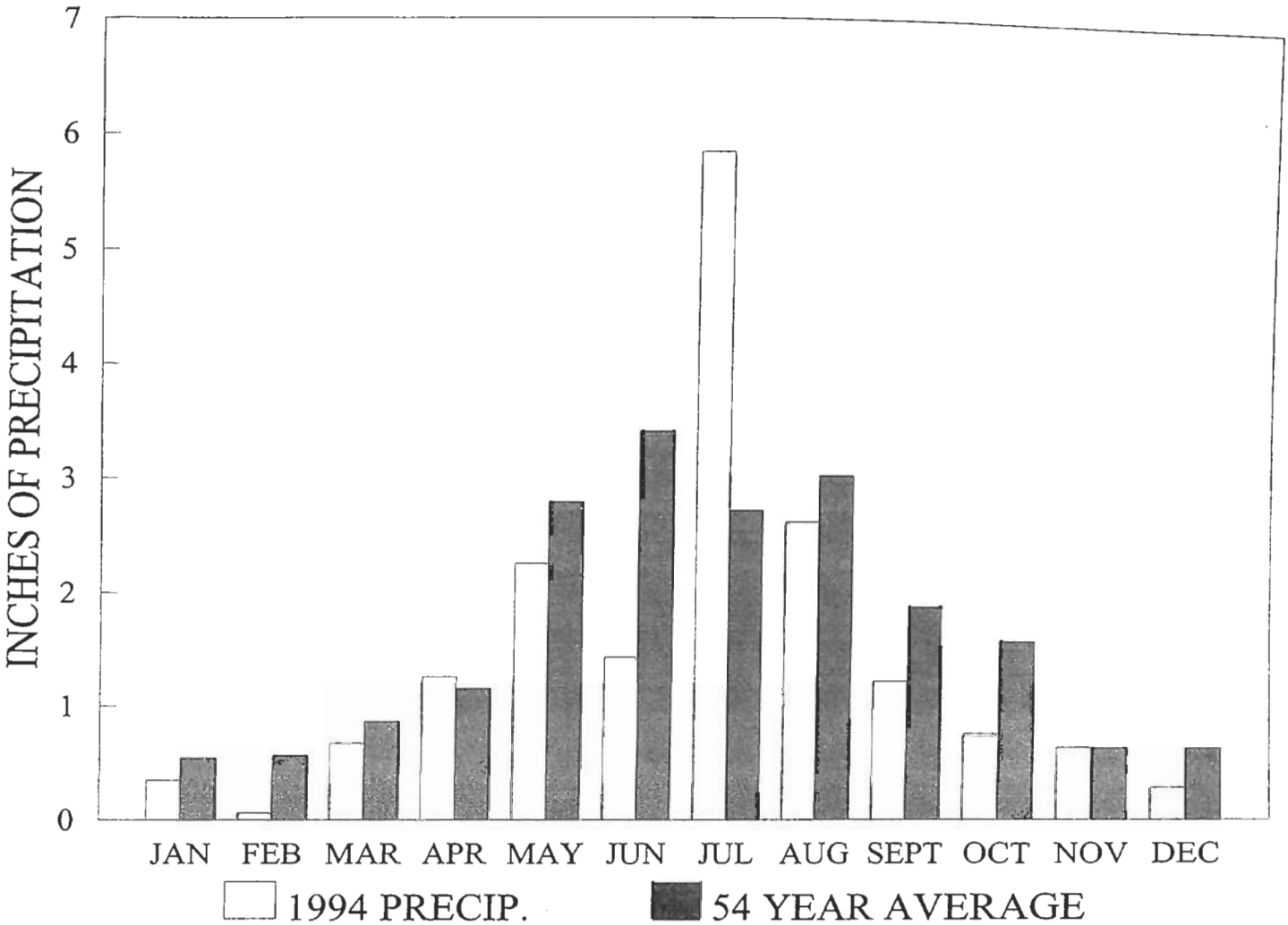


Figure 1.3: Precipitation by month for 1994

aquifers or water zones form above clayey layers that have lower permeability. Data collected from wells at Pantex Plant indicate that the zone of saturation in the perched aquifers varies in thickness up to 30 meters (100 feet). Depths from the surface to the perched aquifers range from 64 to 85 meters (209 to 280 feet). The lateral extent of these perched aquifers has not been completely defined, but it is currently being characterized (Gustavson et al. 1993).

The main Ogallala aquifer lies below these perched water zones. Depth to the main Ogallala aquifer ranges from 107 to 168 meters (350 to 550 feet) below ground surface. The shallower depths are to the southwest; the deeper, to the northeast. The saturated thickness varies from 12 to 98 meters (40 to 320 feet; PGWCD 1980). The aquifer is defined as the basal water-saturated portion of the Ogallala Formation and is a principal water supply on the High Plains. This unconfined aquifer is capable of

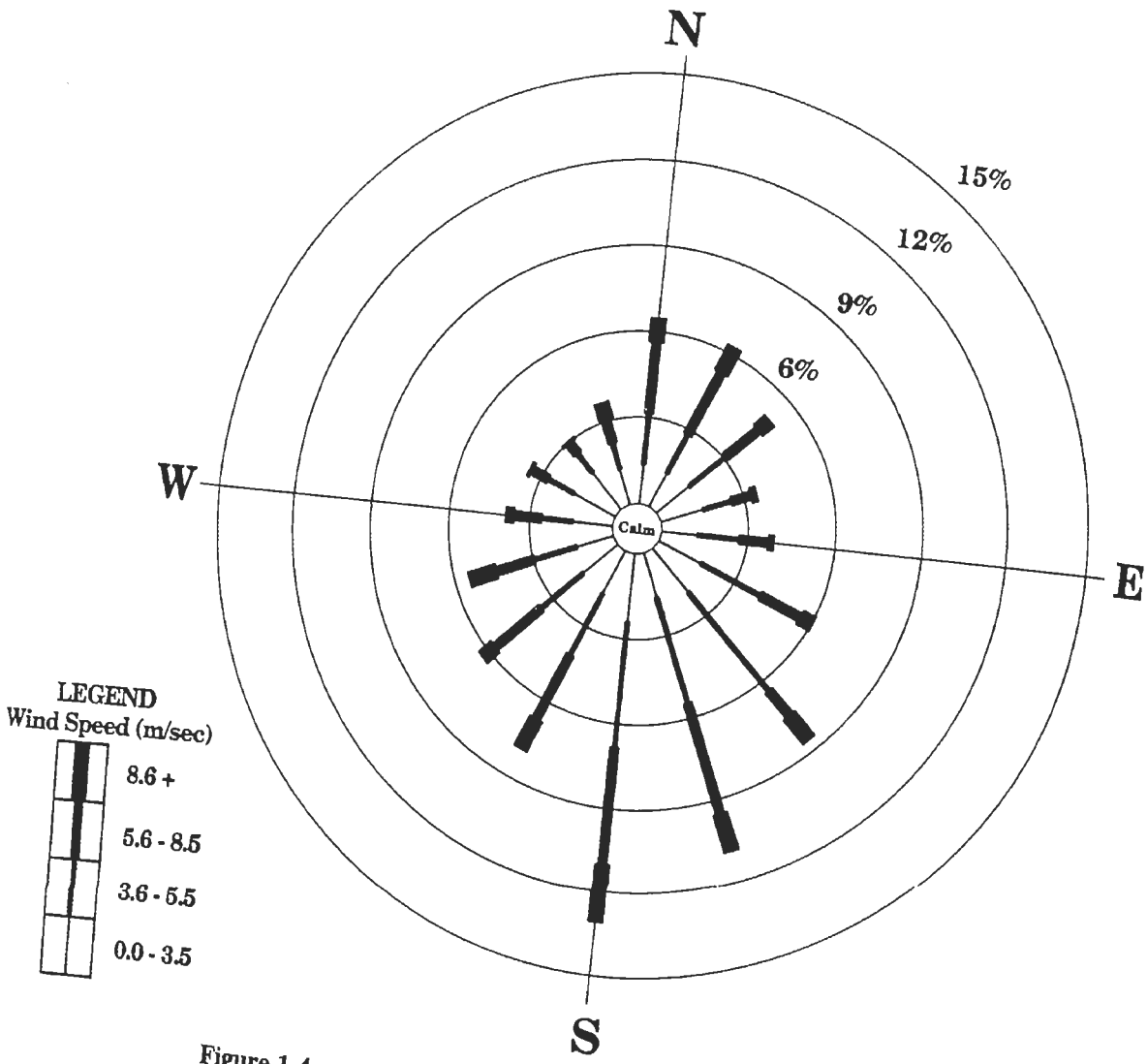


Figure 1.4: Distribution of wind speed and direction in 1994

yielding 2,500 to 4,500 liters per minute [700 to 1,200 gallons per minute (gpm)] of high-quality water to wells in the Plant vicinity. The gradient of the Ogallala aquifer beneath Pantex Plant trends from the southwest to the northeast, where the zone of saturation is thickest and where the Plant's five production wells are located. The City of Amarillo's Carson County Well Field is located north and northeast of Pantex Plant's well field.

1.7.2 Dockum Group Aquifer

The Dockum Group aquifer lies under the Ogallala Formation at Pantex Plant. Water contained in sandstone layers within the Lower

Dockum Group supplies domestic and livestock wells south and southeast of Pantex Plant. Other wells reaching the Dockum Group aquifer are located 16 kilometers (10 miles) south and west of the Plant. The aquifer may be semiconfined with respect to the overlying Ogallala aquifer because of lateral variations in the Ogallala and shale layers within the Dockum Group. Regionally, Dockum Group aquifer wells yield an average of 400 liters per minute (105 gpm), and water quality is typically poor. However, water quality is better near Pantex Plant. No detailed information is available on the potentiometric surface of the Dockum Group aquifer under the Pantex Plant (Knowles et al. 1982).

1.8 Seismology

Pantex Plant and the surrounding area are relatively free of earthquakes. The Uniform Building Code places the area around Pantex Plant in Earthquake Zone 1, which rates second lowest in earthquake occurrence (the scale runs from 0 to 4). Since local records began in 1882, four earthquakes have been recorded in the Plant area. These 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-northeast of the Plant, and all were estimated to have intensities of V or VI on the modified Mercalli intensity scale (URS/Blume 1976).

1.9 Land Use

The area around Pantex Plant is semiarid. Land is used mainly for farming and ranching. Although dryland farming is dominant, some fields are irrigated from the Ogallala aquifer or, less commonly, from local playas. Ranching in the region is primarily cow-calf operations. Several significant industrial facilities are located in the general area, including two electric power plants, a copper refinery, a beef packing plant, and the Amarillo International Airport and associated industries (Burns & McDonnell 1991).

1.10 Population

A land-use census of the residential population surrounding Pantex Plant showed that most of the population is located west-southwest of Pantex Plant in the Amarillo metropolitan area (Burns & McDonnell 1991). Figure 1.5 shows the population distribution. The total population within an 8-kilometer (5-mile) radius of Pantex Plant was 181; the total population within 80 kilometers (50 miles) of the Plant was 269,928. Amarillo has about 156,000 residents. Pampa, Texas, located about 64 kilometers (40 miles) east-northeast of the Plant, is the second largest population concentration, with about 21,000 residents. The remaining population within the 80-kilometer (50-mile) circle is fairly evenly distributed at a density of about three people per square mile.

1.11 Water Use

The major surface water source near Pantex Plant is the Canadian River, which flows into Lake Meredith approximately 40 kilometers (25 miles) north of the Plant. Many local communities use this artificial lake for domestic purposes. The major groundwater source in the vicinity of the Plant is the Ogallala aquifer, which is used as a domestic source by numerous municipalities and industries in the High Plains.

The water table of the Ogallala aquifer in the vicinity of Pantex Plant is believed to be declining at a rate of approximately 0.6 to 1.5 meters (2 to 5 feet) per year (Knowles et al. 1982).

The City of Amarillo, which is the largest user of water from the aquifer, pumps water for domestic use from the Carson County Well Field north and northeast of the Plant. From October 1993 through September 1994, the City of Amarillo produced 23.9 billion liters (6.32 billion gallons) of drinkable water from this well field. In the same period, the City pumped 4.58 billion liters (1.21 billion gallons) from its Southwest

Field and processed 31.3 billion liters (8.27 billion gallons) from Lake Meredith. Total water production by the City of Amarillo during this period was 59.8 billion liters (15.8 billion gallons), an increase from 57.9 billion liters (15.3 billion gallons) in 1993 (Battelle 1994b).

Pantex Plant obtains water from five wells in the northeast corner of the site. During 1994, Pantex Plant obtained 840 million liters (221 million gallons) of water from the Ogallala aquifer. Pantex Plant provided 133 million liters (35 million gallons) of this water to Texas Tech University for irrigation and domestic consumption. The remaining water, approximately 707 million liters (186 million gallons), was used for industrial and domestic purposes at the Plant. The 1994 Plant consumption was an increase over the 1993 consumption, which was 684 million liters (181 million gallons).

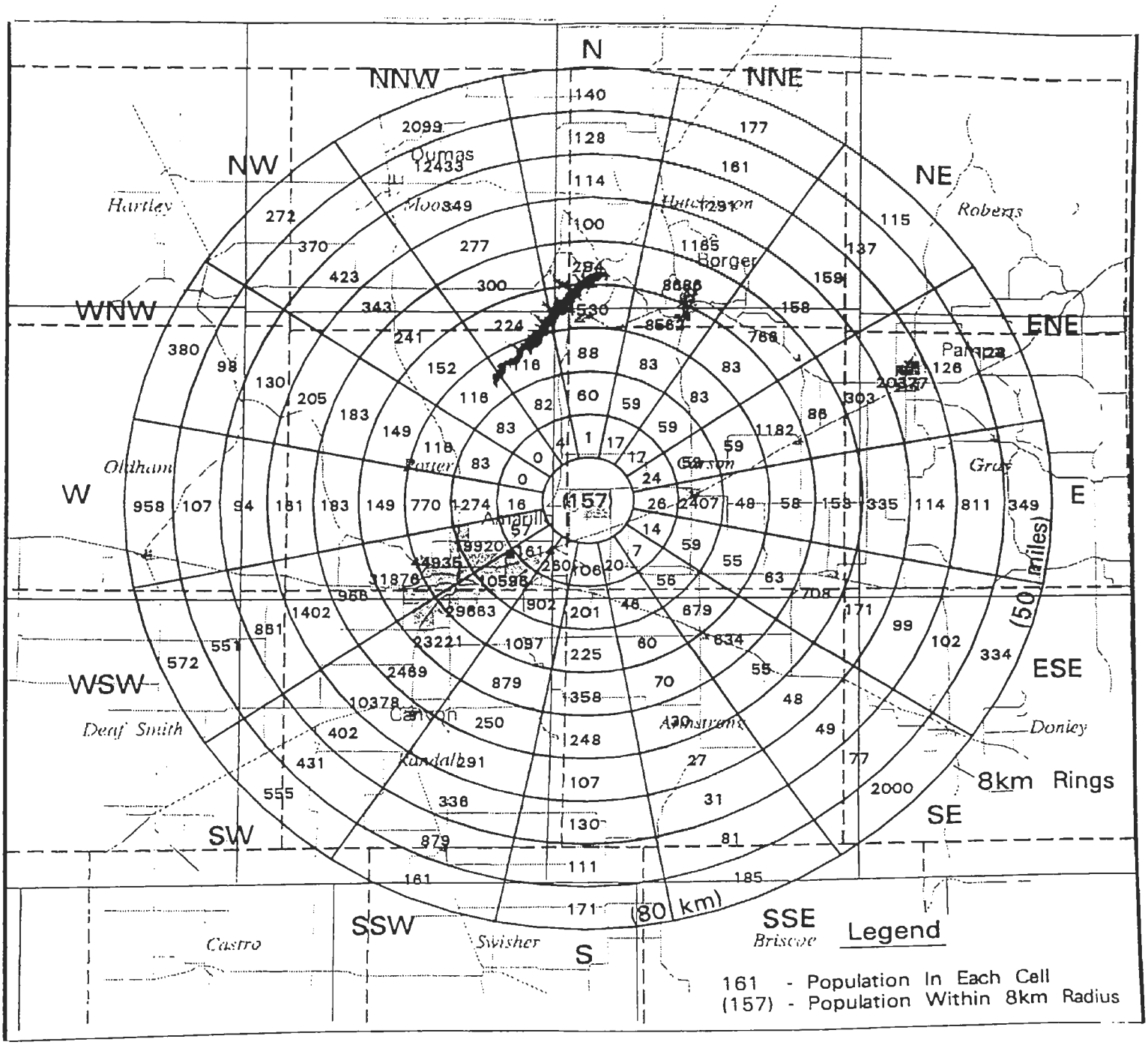


Figure 1.5: Population in the 80-kilometer (50-mile) area around Pantex Plant

Barrel cactus (*Coryphantha* sp.)

Chapter 2

COMPLIANCE ISSUES AND ACTIVITIES

The policy of Pantex Plant is to conduct operations in compliance with all applicable environmental regulations and statutes and with the requirements of the various permits issued to the Plant. Table 2.1 summarizes the major applicable regulations, and Table 2.2 summarizes the permits issued to Pantex Plant. The remainder of the chapter is a review of the current issues and actions related to these requirements. Overall, Pantex Plant is currently in compliance with the major environmental laws and regulations, with no regulatory enforcement actions or lawsuits pending.

In 1993, the Texas legislature created the Texas Natural Resource Conservation Commission (TNRCC), which has the responsibilities of the former Texas Water Commission and Texas Air Control Board. The TNRCC now includes the Office of Water Resource Management, Office of Air Quality, and Office of Waste Management.

2.1 Comprehensive Environmental Response, Compensation, and Liability Act

After sites have been evaluated and ranked by U.S. Environmental Protection Agency (EPA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides for listing of certain sites as candidates for the National Priorities List (sites on the list are commonly referred to as "Superfund sites"). The listing of Pantex Plant was proposed in July 1991. In May 1994, Pantex Plant was added to the National Priorities List. In August 1994, the U.S. Department of Energy (DOE) began discussions with EPA Region 6 and the TNRCC to reach agreement on a Federal Facility Agreement to perform response and remediation activities, pursuant to CERCLA National Contingency Plan requirements and consistent with corrective actions currently being performed under Resource Conservation and Recovery Act (RCRA) requirements.

Section 107 of CERCLA provides for the designation of federal and state trustees, who are responsible for assessing damages for injury to, destruction of, and loss of natural resources. As primary Federal Natural Resource Trustee [via Article 300.600(b)(3) of the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR 300)], DOE is responsible for encouraging the involvement of designated federal and state trustees.

To meet this responsibility, DOE convened a meeting of state and federal agencies on December 14, 1994, at Pantex Plant. Federal agencies represented at the meeting included the U.S. Department of Agriculture (USDA) through its Natural Resources Conservation Service and the U.S. Department of the Interior through its U.S. Fish and Wildlife Service (USFWS) and U.S. Geological Survey (USGS).. The State of Texas participated through the TNRCC and the Texas General Land Office. The Texas Parks and Wildlife Department was represented by the TNRCC and is expected to participate in future meetings. EPA, which is not a designated trustee, also participated in the meeting.

The Emergency Planning and Community Right-to-Know Act was enacted as part of the Superfund Amendments and Reauthorization Act of 1986 (SARA). The Emergency Planning and Community Right-to-Know Act requires that the public be provided with information about hazardous chemicals in the community and establishes emergency planning and notification procedures to protect the public in the event of a release. To accomplish these goals, the Emergency Planning and Community Right-to-

Table 2.1 Review of Major Environmental Regulations Applicable to Pantex Plant

Authority	Codification	Regulatory Description	Status
Federal: Advisory Council on Historic Preservation State: State Historic Preservation Office	Federal: Code of Federal Regulations, 36 CFR 79, 43 CFR 7	ARCHEOLOGICAL RESOURCES PROTECTION ACT (ARPA) ARPA provides for the protection of archeological resources and sites located on public and Native American lands.	All archeological surveys and testing at Pantex Plant conformed to ARPA standards.
Federal: U.S. Environmental Protection Agency State: Texas Natural Resource Conservation Commission	Federal: Code of Federal Regulations, 40 CFR 50-80 State: Texas Administrative Code, 30 TAC 101-125 & 305	CLEAN AIR ACT (CAA) The CAA and the Texas Clean Air Act (TCAA), through their implementing regulations, regulate the release of air pollutants through the use of permits and standard exemptions.	Pantex Plant has permits and standard exemptions issued by the U.S. Environmental Protection Agency and the Texas Natural Resource Conservation Commission.
Federal: U.S. Environmental Protection Agency State: Texas Natural Resource Conservation Commission	Federal: Code of Federal Regulations, 40 CFR 109-140, 230, 231, 401, 403 State: Texas Administrative Code, 30 TAC 305 & 308-325	CLEAN WATER ACT (CWA), or FEDERAL WATER POLLUTION CONTROL ACT The CWA and the Texas Water Code, through their implementing regulations, regulate the quantity and quality of industrial water discharges to waters of the United States and State of Texas.	Pantex Plant has submitted Wastewater and Stormwater National Pollutant Discharge Elimination System Permit applications to U.S. Environmental Protection Agency Region 6. Those applications are pending. Pantex Plant has a wastewater no-discharge permit. A wastewater discharge amendment application was submitted April 1992 and is pending.
Federal: U.S. Environmental Protection Agency State: Texas Natural Resource Conservation Commission	Federal: Code of Federal Regulations, 40 CFR 300, 302, 355, & 370 State: Texas Administrative Code, 30 TAC 265-275	COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA) CERCLA provides the regulatory framework for the remediation of releases of hazardous substances and cleanup of inactive hazardous substance disposal sites. Section 107 provides for the protection of natural resources on publicly owned property through designation of Natural Resource Trustees.	In 1994, Pantex Plant was added to the National Priorities List (NPL) by U.S. Environmental Protection Agency Region 6. Notifications have been submitted to potential co-trustees. Co-trustees are formulating plans to participate in the Natural Resource Damage Assessment process.
Federal: U.S. Fish and Wildlife Service State: Texas Parks and Wildlife Department	Federal: Code of Federal Regulations, 50 CFR 11 et seq. State: Texas Parks and Wildlife Code, 68.0001-68.021.	ENDANGERED SPECIES ACT (ESA) The ESA regulates human and industrial activities in such a manner as not to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of a critical habitat.	Ongoing and proposed actions will be assessed as to the adverse effects on threatened and endangered species.
Federal: U.S. Environmental Protection Agency State: Texas Department of Agriculture	Federal: Code of Federal Regulations, 40 CFR 162-171 State: Texas Administrative Code, 4 TAC 7.1-7.40	FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA) FIFRA governs the manufacture and use of biocides, specifically the use, storage, and disposal of all pesticides and pesticide containers and residues. Applications of agricultural chemicals at Pantex Plant are regulated by the Texas Department of Agriculture, as per the Texas Pesticide Control Act, the Texas Herbicide Law, and the Texas Structural Pest Control Act.	Pesticides are applied in accordance with regulations by state-licensed personnel.

Table 2.1 Review of Major Environmental Regulations Applicable to Pantex Plant (cont'd)

Authority	Codification	Regulatory Description	Status
Federal: U.S. Department of Energy Council for Environmental Quality	Federal: Code of Federal Regulations, 10 CFR 1021, 40 CFR 1500-1508	NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) NEPA establishes a broad national policy to conduct federal activities in ways that promote the general welfare and are in harmony with the environment. NEPA procedures must ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken.	Pantex Plant submitted one reference document in 1994, originally an environmental assessment (EA), to be incorporated into the ongoing Site-Wide Environmental Impact Statement. Also, one EA was approved in 1994. For minor projects, 17 environmental checklists and 44 NEPA-Related Documents were submitted in 1994.
Federal: Advisory Council on Historic Preservation State: State Historic Preservation Office	Federal: Code of Federal Regulations, 36 CFR 60, 63, 79, & 800 State: Texas Natural Resources Code, 191.001-.174	NATIONAL HISTORIC PRESERVATION ACT (NHPA) NHPA identifies, evaluates, and protects historic properties eligible for listing in the National Register of Historic Places. Historic properties can be archeological sites, historic structures, or historic documents, records, or objects.	Archeology: Sixty-nine prehistoric Native American and historic Euroamerican sites have been identified but not evaluated. Historic Buildings: All World War II-era buildings, structures, and associated properties have been surveyed and recorded but not evaluated. Surveys are planned or in progress to complete the identification and evaluation of historic Cold War-era properties. Historic Documents: Efforts are under way to coordinate identification and evaluation of potentially historic documents with other Plant offices.
Federal: Advisory Council on Historic Preservation State: State Historic Preservation Office	Federal: Code of Federal Regulations, 40 CFR 10 (proposed, pending final revision)	THE NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT (NAGPRA) NAGPRA requires the identification, protection, and repatriation of Native American grave remains and associated objects.	No Native American mortuary remains or funerary artifacts have been located at Pantex Plant.
Federal: U.S. Environmental Protection Agency State: Texas Natural Resource Conservation Commission	Federal: Code of Federal Regulations, 40 CFR 260-280 State: Texas Administrative Code, 30 TAC 305, 334, & 335	RESOURCE CONSERVATION & RECOVERY ACT (RCRA) RCRA and the Texas Solid Waste Disposal Act govern the generation, storage, handling, treatment, and disposal of hazardous waste. Underground storage tanks and spill release cleanup are also regulated by these statutes and regulations.	Pantex Plant is defined as a large-quantity generator and has both permitted and interim-status storage and treatment facilities. The Hazardous Waste Permit issued to the Plant includes a corrective action section.
Federal: U.S. Environmental Protection Agency State: Texas Natural Resource Conservation Commission	Federal: Code of Federal Regulations, 40 CFR 141-149 State: Texas Administrative Code, 30 TAC 290	SAFE DRINKING WATER ACT (SDWA) SDWA and the Texas Water Code govern public water supplies. Pantex Plant is classified as a non-transient, non-community, public water supply system.	The Plant water supply meets all required primary and secondary drinking water standards and operational and maintenance regulations.
Federal: U.S. Environmental Protection Agency	Federal: Code of Federal Regulations, 40 CFR 700-766	TOXIC SUBSTANCES CONTROL ACT (TSCA) TSCA requires the characterization of toxicity and other harmful properties of manufactured substances and regulates the manufacture, distribution, and use of regulated materials.	The Plant is managing polychlorinated biphenyls (PCBs), asbestos, and chemicals in compliance with applicable regulations.

Table 2.2 Major Permits Issued to Pantex Plant

Building or Activity	Permit Number	Issuing Agency	Effective Date	Expiration Date
Medium: Air				
Building 16-13 Steam Plant	C-18379	TNRCC	07-21-1988	07-21-2003
Burning Ground	Written Grant of Authority	TNRCC	Reissued 05-29-1991	None
Building 11-36	21233	TNRCC	03-11-1993	03-11-1998
Building 12-19	21233	TNRCC	03-11-1993	03-11-1998
High Explosives Synthesis Building (11-55)	21233	TNRCC	03-11-1993	03-11-1998
Medium: Solid Waste				
Solid Waste Registration No.	TX-4890110527, 30459	EPA TNRCC	10-30-1980	None
Hazardous Waste Permit	TX-4890110527, HW-50284	EPA TNRCC	04-25-1991	04-25-2001
Hazardous Waste Permit	Class III Modification	EPA TNRCC	Application under review	
Medium: Water				
Wastewater No-Discharge Permit	02296	TNRCC	05-19-1980; 05-17-1988	05-03-1993
Wastewater Discharge Permit	—	TNRCC	Amendment under review	
NPDES[1] Permit	TX-0107107	EPA	Application under review	
NPDES[1] Stormwater Discharge Permit	TX-0107107	EPA	Application under review	
Clean Water Act Section 404 Dredge and Fill Permit	Nationwide Permit for Survey Activities	Corps of Engineers	06-16-1994	06-16-1996

[1] National Pollutant Discharge Elimination System.

Know Act requires that Pantex Plant file several reports with EPA annually and participate in Local Emergency Planning Committee activities.

The report information required under SARA Title III, Sections 311 and 312, for 1993 was submitted in March 1994. No Toxic Chemical Release Inventory Form (Form R) for 1993 was required under SARA Title III, Section 313, because no reportable substances were released at levels above threshold values. The information required for 1994 will be reported in 1995. The Pantex Plant's operating contractor, Mason & Hanger, is a member of the Carson County Local Emergency Planning Committee, and the DOE/Amarillo Area Office (DOE/AAO) serves as a member of the Potter/Randall Counties Local Emergency Planning Committee.

2.2 Resource Conservation and Recovery Act

Section 3006 of RCRA authorizes states to assume responsibility for carrying out the RCRA program. The State of Texas has taken partial authority for the RCRA program and exercises its authority through regulations promulgated under the Texas Solid Waste Disposal Act. The TNRCC administers the Texas Solid Waste Disposal Act, and facilities that store, treat, or dispose of hazardous waste must comply with the regulations of both the TNRCC and EPA.

Pantex Plant manages some solid wastes under Texas Solid Waste Disposal Act Hazardous Waste Permit Number HW-50284, and the Plant has been assigned TNRCC Solid Waste Registration Number 30459. EPA has assigned Identification Number TX-4890110527 to this permit and registration. Under interim permit status, Pantex Plant also operates thermal treatment units for processing explosives. Actions under these permits are described below; those corrective actions required under RCRA for the identified Solid Waste Management Units at Pantex Plant are described in Chapter 6. Closures of RCRA units and management of underground storage tanks are also discussed in Chapter 6.

2.2.1 Active Waste Management

All wastes generated from routine operations onsite in 1994 are summarized in Table 2.3. An overall reduction of more than 50% compared to 1993 was achieved.

Management of solid waste is regulated by the TNRCC. Some solid waste (inert and insoluble materials like scrap metals, paper, cardboard, bricks, glass, dirt, and certain plastics and rubber items that are not readily degradable) is designated as Class 3 Nonhazardous Waste and is disposed of onsite. A total of 4,664 cubic meters of solid waste was generated in 1994, a 57% reduction from 1993 amounts. The remainder of the nonhazardous solid waste generated at Pantex Plant is sanitary waste, such as cafeteria and lunchroom waste, paper towels, and usual office waste. This waste is disposed of offsite at permitted landfills.[1] Waste generated from cafeteria operations at Pantex Plant is used as animal feed if possible, and otherwise disposed of in permitted facilities.

Hazardous wastes generated at Pantex Plant include, but are not limited to, solvent-contaminated wastewater, explosive-contaminated wastewater, and spent organic solvents that are contaminated with explosive. In 1994, these wastes were either managed onsite by storage and limited treatment, or shipped offsite for treatment and disposal at permitted treatment, storage, and disposal facilities. The amounts to be disposed of in 1994 were reduced by 48% as a result of aggressive programs for pollution prevention and waste minimization (these programs are described in Chapter 3). A total of 192.7 cubic meters of hazardous waste was generated in 1994. With respect to the Toxic Substances Control Act, a total of 7.6 cubic meters of toxic waste governed by the act was generated in 1994, a 93% reduction from 1993.

All of the routinely generated radioactive waste from Pantex Plant operations in 1994 was low-level radioactive waste, regulated under the Atomic Energy Act. This waste was generated in small quantities from the assembly and disassembly of weapons and consisted primarily of materials contaminated with depleted uranium or tritium. Some low-level waste generated at Pantex Plant may also contain thorium, plutonium, and cesium. Low-level radioactive waste is temporarily stored onsite until it is shipped to the Nevada Test Site. During 1994, Pantex Plant shipped 157.2 cubic meters of low-level radioactive material to the Nevada Test Site.

Table 2.3 Waste Volumes from Routine Operations, in cubic meters

Waste Type[1]	1992	1993	1994	Percentage Change 1993–1994
Low-Level Waste	178	130	157.2	+21%
Mixed Waste[2]	50.5	37.5	25.4	-32%
Solid Waste (Non-Hazardous)	6,489	10,885	4,664	-57%
Hazardous Waste	589	369.6	192.7	-48%
TSCA Waste	95	112.9	7.6[3]	-93%
Sanitary Waste	494	612	835.2	+36%
TOTAL	7,896	12,147	5882	-51%

[1] Conversions of different waste types from weight to volume were made using a conversion factor of 0.72 kg of waste per liter (6 lb waste per gallon).
[2] Mixed waste contains both radioactive and hazardous waste components.
[3] Generation of asbestos waste decreased in 1994.

Assembly and disassembly of weapons also result in some waste that includes both radioactive and hazardous constituents; such waste is termed "mixed waste." The hazardous portion of the mixed waste is regulated by TNRCC pursuant to RCRA. The radioactive portion is regulated under the Atomic Energy Act. Most mixed waste consists of paper products contaminated with organic solvents and low-level radionuclides. A total of 25.4 cubic meters of mixed waste was generated in 1994, a 32% reduction from 1993 amounts.

Pursuant to the requirements of the Federal Facility Compliance Act of 1992, DOE prepared an inventory of all mixed waste stored at Pantex Plant and submitted it to EPA and the TNRCC on April 23, 1993. Pantex Plant submitted its Draft Site Treatment Plan for mixed waste to the TNRCC in October 1994. The proposed Site Treatment Plan will be submitted to the TNRCC by April 6, 1995. The TNRCC has six months from the date of submittal to approve the plan, approve it with modification, or disapprove it. It is expected that, following review, the TNRCC will issue an agreed order on compliance.

2.2.2 Permit Modifications

In April 1991, the State of Texas and EPA issued a permit to allow Pantex Plant to store hazardous waste in containers and tanks and to treat hazardous waste in tanks. When issued, the permit specifically excluded the 17 thermal treatment units at the Burning Ground, but operation of these units was allowed to continue under RCRA interim status. In November 1991, DOE formally requested a Class III Modification to add the units at the Burning Ground to the existing RCRA permit, and DOE added 10 more storage units to the modification request in October 1992. Pursuant to a public notice published on October 31, 1991, interested parties requested a hearing on the permit before a hearing examiner. As of December 31, 1994, the hearing process was continuing. A closure plan was submitted for five of the 17 thermal treatment units. As of December 31, 1994, it was awaiting approval.

2.2.3 Annual Inspection

On January 11, 1994, the TNRCC conducted a multi-medium inspection of Pantex Plant. The TNRCC notified DOE of two areas of alleged noncompliance, which are described in Table 2.4. Pantex Plant submitted a response to the alleged noncompliance issues on March 9, 1994, and corrective actions were completed in May 1994.

Both corrective actions required for areas of alleged noncompliance issued in 1993 were completed before the end of 1994. Corrective actions for four of the five areas of concern identified in 1993 were also completed in 1994. Actions are continuing for Area of Concern 3, relating to the prairie dog population at the Burning Ground. Evidence was submitted to the TNRCC that the prairie dog burrows at the Burning Ground were improbable pathways for contamination to reach the Ogallala aquifer. However, as a good management practice, Pantex Plant plans to curb the population of prairie dogs at the Burning Ground in early 1995 by removing animals and increasing vegetation cover for predators.

2.3 National Environmental Policy Act

On December 1, 1992, DOE published revised DOE Order 5440.1E to establish internal responsibilities and procedures to implement National Environmental Policy Act (NEPA) requirements. In June 1994, DOE published "Secretarial Policy on the National Environmental Policy Act." This policy is designed to ensure the excellence of the NEPA compliance process by streamlining the process, minimizing its cost, emphasizing teamwork, and enhancing public involvement. In 1994 Pantex Plant submitted a reference document (*Waste Streams and Disposition Activities Associated with Weapons Assembly and Dismantlement Operations*) to be incorporated into the ongoing site-wide environmental impact statement (EIS). Also in 1994, an environmental assessment for Pantex Plant, *Interim Storage of Plutonium Components at Pantex Plant*, was approved (Table 2.5). In addition, for minor projects, Pantex Plant submitted 17 environmental checklists and 44 NEPA-Related Documents (abbreviated checklists based on previously approved NEPA documents) in 1994. Of the 61 documents, 57 were approved, and one was found not to be required. Resolution of the three remaining environmental checklists was pending as of December 31, 1994.

In January 1994, DOE finalized the *Environmental Assessment for the Interim Storage of Plutonium Components* and issued a Finding of No Significant Impact. The environmental assessment analyzed the impacts of storage of up to 20,000 pits at Pantex Plant. In its Finding of No Significant Impact, DOE decided to store no more than 12,000 plutonium pits at Pantex Plant until the storage issue is fully addressed in a site-wide EIS.

In May 1994, DOE published a Notice of Intent to prepare a new site-wide EIS concerning the impacts of current operations at Pantex Plant and the associated additional storage of components of nuclear weapons. Public scoping meetings were held in Amarillo and in communities near other potentially affected DOE sites to invite public input and identify significant issues. To support preparation of the EIS, a draft environmental information document was prepared (available in 1995) to describe the environmental conditions at and surrounding Pantex Plant. The environmental information document will summarize the geohydrological, meteorological, biological, socioeconomic, cultural, land use, natural resource, waste management, and radiological and chemical environmental conditions at Pantex Plant.

2.4 Clean Air Act

Most federal Clean Air Act requirements are implemented in Texas under the Texas Clean Air Act, which is administered by the TNRCC.

Under the Clean Air Act, toxic materials in air are regulated by the National Emission Standards for Hazardous Air Pollutants, or NESHAPs, given in the subparts of 40 CFR 61; these regulations will be replaced in time by 40 CFR 63 subparts. The three subparts most important to Pantex Plant are Subpart A (General Provisions); Subpart H (Emissions of Radionuclides Other than Radon from Department of Energy Facilities); and Subpart M (Asbestos). In 1994, the Plant reviewed activities conducted in all buildings to determine their compliance with 40 CFR 61 Subparts A and H. All buildings were in compliance.

Subpart H is administered by EPA Region 6. Under Subpart H, the allowable emissions limit is that level of radionuclides that would cause any member of the public to receive an effective dose equivalent of no more than 10 millirem (mrem) in one year. The minimum emissions standard

Table 2.4 1994 Annual RCRA Inspection

	Areas of Alleged Noncompliance	Corrective Action
1	Two drums with no labels other than "analysis pending" on the 11-7A container storage area pad, NOR #3 Permit No. 1. The drums have been on the pad for more than one year (31 TAC 335.62 and 40 CFR 262.11).	Pantex Plant placed non-hazardous waste labels on the two drums and removed the drums from the 11-7A storage pad.
2	Less-than-90-day waste accumulation sites are not listed on the Notice of Registration.	Pantex Plant revised the Notice of Registration to include the less-than-90-day waste accumulation sites. Pantex Plant prepared closure documentation for those less-than-90-day sites that were designated as 55-gallon sites or whose use was discontinued.

Table 2.5 Environmental Assessments for 1994

Project Title	Date Submitted or Resubmitted	Date Approved
Hazardous Treatment and Processing Facility	1-24-91, 7-8-91, 9-27-93	(will be revised or incorporated into site-wide EIS)
Pit Reuse Project	1-6-92, 9-27-93, 3-10-94	(will be incorporated into site-wide EIS)
ES&H Analytical Laboratory	6-29-92, 1-25-93	--
Interim Storage of Plutonium Components at Pantex Plant	12-1-92, 11-11-93, 2-17-94	1-18-94
Reference Document for Waste Streams and Disposition Activities Associated with Weapons Assembly and Dismantlement Operations	12-22-94	--

for monthly reporting is 1% of 10 mrem, or 0.1 mrem. In 1994, the maximum effective dose equivalent to any member of the public from emission of radionuclides from Pantex Plant was 0.000058 mrem/year, much less than the minimum reporting standard. To further demonstrate its compliance with 40 CFR 61 Subpart H, Pantex Plant performed periodic confirmatory monitoring as prescribed in 40 CFR 61.93 for DOE facilities that emit less than 1% of the allowable limit.

Also in 1994, Pantex Plant prepared an Asbestos Management Plan in accordance with Subpart M. The Plant performed all notifications required by the Clean Air Act for asbestos removal and building demolition. On September 22, 1994, the Texas Department of Health adopted regulations and assumed notification, inspection, and enforcement oversight of Subpart M, except for those regulations dealing with licensing and inspection of asbestos waste disposal sites, which are overseen by the TNRCC. The two state agencies have a Memorandum of Understanding delineating their responsibilities. Renovation and demolition are the only activities conducted at Pantex Plant that are subject to these regulations.

At the Burning Ground, explosive weapons components, explosive-contaminated materials, and explosive waste are thermally treated (that is, burned). The Burning Ground operates under a written Grant of Authority from the State of Texas for its air emissions and under RCRA interim status for its waste management activities. In 1990, Pantex Plant applied to the TNRCC to modify its Permit for Industrial Solid Waste Management Site, jointly issued by EPA and the TNRCC (TNRCC Permit No. HW-50284; EPA Permit No. TX-4890110527), to include the Burning Ground. As of December 31, 1994, the hearing process on the permit modification was continuing.

Pantex Plant also synthesizes and processes explosives in Buildings 11-36 and 12-19. The Plant has submitted a permit application to the TNRCC to construct a new Explosives Synthesis and Processing Facility (Building 11-55) combined with an operating permit application for operations not authorized under standard exemptions currently on file. On March 11, 1993, the TNRCC issued a combined permit to construct Building 11-55 and for operations in Buildings 11-36, 11-55, and 12-19. Construction of Building 11-55 began during 1994, and completion is scheduled for mid-1996.

Pantex Plant operates four steam boilers under Permit Number C-18379. These boilers are gas-fired but can be switched to diesel fuel if the gas fuel supply is interrupted. In 1994, Pantex Plant determined that it might be possible and desirable to further limit permitted pollutant emissions. A study was initiated to assess the requirements of federally enforceable limits on fuel consumption. Action to modify the permit is scheduled for 1995.

Pantex Plant also has several other operations that are performed at various locations under air emissions standard exemptions, as allowed by the TNRCC's New Source Review/Air Permitting regulations. As new or modified activities are considered, they are evaluated for their emission potential and the new source authorization requirements that may apply.

2.5 Federal Clean Water Act (or Federal Water Pollution Control Act)

The National Pollutant Discharge Elimination System (NPDES) mandated by the Clean Water Act is administered by EPA in the State of Texas. An NPDES permit application for Pantex Plant was submitted in November 1990 and resubmitted in February 1991 and August 1994. On December 31, 1994, EPA issued a draft NPDES permit.

DOE submitted an application for an NPDES stormwater discharge permit on October 14, 1991. In response to EPA comments, Pantex

Plant resubmitted its permit application on August 24, 1994, and submitted a Notice of Intent on September 29, 1994.

Texas Water Code. Since 1980, pursuant to the Texas Water Code, the State of Texas has permitted Pantex Plant to discharge its wastewater into onsite playas under a Wastewater No-Discharge Permit (Number 02296). On December 26, 1990, DOE filed an application to renew and amend its permit. At the request of the State of Texas, an application to change the permit from a no-discharge to a discharge permit was submitted in May 1992. On April 1, 1993, the TNRCC issued a draft permit based on DOE's May 1992 application. (Subsequent revised draft permits were issued on June 11 and November 22, 1993.) At the direction of the TNRCC, on May 3, 1993, Pantex Plant published a public announcement that the Plant had applied for a modification to its permit, that a draft permit was prepared, and that affected persons could request a hearing. Pursuant to this notice, interested parties requested that the TNRCC hold a public hearing on the application. As of December 31, 1994, the hearing process was continuing.

The TNRCC performed an official inspection for Wastewater No-Discharge Permit Number 02296 in January 1994 and issued no findings. During June 1994, Pantex Plant reported one "excursion" of the water level in Playa #1 as defined in the 1988 permit, meaning that the water level had risen above the permitted level.

2.6 Safe Drinking Water Act

The TNRCC has responsibility and authority for regulation of public water supplies in the State of Texas. The Plant draws its drinking water from the Ogallala aquifer via five groundwater wells located at the northeast corner of the Plant. The water is treated onsite and tested in accordance with requirements for public drinking water systems; Chapter 10 details the Plant's activities to ensure compliance with the requirements of the TNRCC and the Safe Drinking Water Act.

On October 4, 1994, TNRCC representatives inspected the drinking water supply system at Pantex Plant. The inspection confirmed that the system is being operated and maintained in compliance with Texas statutes and regulations.

2.7 Toxic Substances Control Act

The major objective of the Toxic Substances Control Act is to characterize and understand the risk that a chemical poses to humans and the environment before it is introduced into commerce. The goal of the Toxic Substances Control Act is not to regulate all chemicals that present a risk, but to regulate only those that present "unreasonable" risk of harm to human health or the environment.

Toxic waste, as defined by the Toxic Substances Control Act, at Pantex Plant consists of asbestos and materials contaminated with polychlorinated biphenyls (usually referred to as PCBs). Such wastes are shipped offsite to permitted facilities for treatment and disposal. As of December 31, 1994, all equipment and parts used at Pantex Plant that contain PCBs have concentrations of less than 50 parts per million. Maintenance and demolition generated some waste containing asbestos. This waste was disposed of in accordance with regulations.

Pantex Plant, as a user of chemical substances, 1) complies with regulations issued under the Act; 2) refrains from using PCBs except as permitted by EPA; 3) refrains from using any chemical substance that Plant personnel know or have reason to believe has been manufactured, produced, or distributed in violation of the Act; and 4) submits to EPA inspections and subpoenas as authorized by the Act.

2.8 Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act governs the manufacture and use of biocides. EPA has federal jurisdiction for the Federal Insecticide, Fungicide, and Rodenticide Act; the Texas Department of Agriculture has the state jurisdiction described below. Regulations promulgated under this act govern the use, storage, and disposal of all pesticides and pesticide containers and residues. In 1994, Pantex Plant initiated actions to comply with the January 1995 worker protection standards published in 40 CFR 170. Those pesticides needed for Pantex Plant operations are applied by state-licensed personnel in accordance with federal and state regulations.

Applications of agricultural chemicals at Pantex Plant are regulated by the Texas Pesticide Control Act, the Texas Herbicide Law, and the Texas Structural Pest Control Act, all of which are administered by the Texas Department of Agriculture. The Federal Insecticide, Fungicide, and Rodenticide Act governs the chemicals that may lawfully be used at the Plant. These acts are designed to establish standards for application of pesticides and fungicides to prevent unreasonable risk to human health and to protect workers and others during the production of agricultural field crops. Compliance with these acts at Pantex Plant allows agricultural production on the arable land surrounding the Plant while ensuring the health and safety of workers and protecting the integrity of the environment from potential adverse impacts of wrongfully applied agricultural chemicals.

2.9 National Historic Preservation Act, Archeological Resources Protection Act, and Native American Graves Protection and Repatriation Act

DOE is committed to managing cultural resources at Pantex Plant in compliance with all applicable cultural resource management (CRM) laws and regulations. Pantex Plant is currently operating under interim management procedures developed and initiated in 1994. A management agreement between DOE and the Texas State Historic Preservation Office (SHPO) provides for the case-by-case evaluation of Plant undertakings that might impact cultural resources. Pantex Plant cultural resources related to three periods (prehistoric, World War II era, and Cold War era) are managed under this arrangement.

In compliance with Section 110 of the National Historic Preservation Act, Pantex Plant initiated the development of a programmatic agreement and a comprehensive CRM plan in 1994 (see Chapter 4 for detailed discussion of both). Preparations included two archeological surveys covering 2,640 hectares (6,600 acres) of land, completion of the World War II-era historic buildings survey, development of a list of interested parties, initiation of a search for relevant Native American treaty obligations, initiation of an archeological context statement, initiation of a World War II-era national-level context statement, separate meetings with representatives of eight Native American Tribes, and three meetings with the Texas SHPO to review status and strategy.

Fulfilling its CRM compliance obligations under the interim management procedures, Pantex Plant CRM staff evaluated 25 Plant undertakings (as defined by 36 CFR 800) in 1994. Of these, 23 evaluations were handled internally and two were forwarded to the Texas SHPO for review and comment. The Texas SHPO agreed with DOE's determination that both undertakings had no effect on properties potentially eligible for the National Register of Historic Places. To date, no Native American mortuary remains or funerary artifacts have been located at Pantex Plant; consequently, no compliance issues related to the Native American Graves Protection and Repatriation Act have been raised. In 1994, Pantex Plant initiated a strategy for compliance with curatorial requirements set out in the Archeological Resources Protection Act.

2.10 Endangered Species Act

Pantex Plant provides habitat for several species protected by the federal and state Endangered Species Acts. The current status of endangered or threatened species known or expected to reside at Pantex Plant — permanently, seasonally, or periodically — are summarized in Table 2.6. In 1992, Pantex Plant began a program to assess its natural resources; this program was expanded in 1993 and 1994 and has confirmed the presence of several species of concern, as well as the potential for others. See Chapter 5 for more information on natural resources.

Federal actions being considered at Pantex Plant are reviewed through the NEPA process, which covers consideration of impacts to species of concern. In a letter dated December 1993, the USFWS deferred its concurrence on a general conclusion by DOE that current Plant activities are not adversely affecting federally listed, threatened, or endangered species. As of December 31, 1994, this concurrence was still deferred and additional information was being gathered.

2.11 Executive Orders 11988 "Floodplain Management" and 11990 "Protection of Wetlands"

In response to a 1989 Tiger Team finding, Pantex Plant wetlands were evaluated, and the data were forwarded to the Corps of Engineers. In December 1991, the Corps of Engineers issued a letter concurring that Pantex Plant's playas are jurisdictional wetlands and regulated by 10 CFR 1022. This determination required DOE to enhance and protect its wetlands and floodplains.

In February 1992, the Corps of Engineers determined that the Nation-Wide Permit for Survey Activities applied to investigatory activities proposed in the Ditches and Playas RCRA Facility Investigation (RFI) Work Plan. The Corps of Engineers approved a two-year extension of the permit in June 1994. Pantex Plant is in compliance with the provisions of this permit.

A report on the assessment of wetlands and floodplains associated with Playa #5 and Pantex Lake (Battelle 1994a) was completed in 1994. This report describes potential impacts to Playa #5 and Pantex Lake.

2.12 Summary of DOE Headquarters Tiger Team Assessment

A DOE Headquarters Tiger Team Assessment was conducted at Pantex Plant October 2–31, 1989. The final action plan, approved August 13, 1990, included 72 findings. In 1994, six findings were closed, including the last three environmental findings. As of December 31, 1994, 70 of the 72 findings were closed; the two open findings do not pertain to environmental affairs and are on schedule to be completed in late 1995.

2.13 Permitted Facilities

Table 2.2 lists, by medium, the permits issued to Pantex Plant. Table 2.2 also lists the permit applications submitted by Pantex Plant to various regulatory agencies. The permitting agencies involved are the TNRCC for air, the TNRCC and EPA for solid waste and water, and the Corps of Engineers for wetlands.

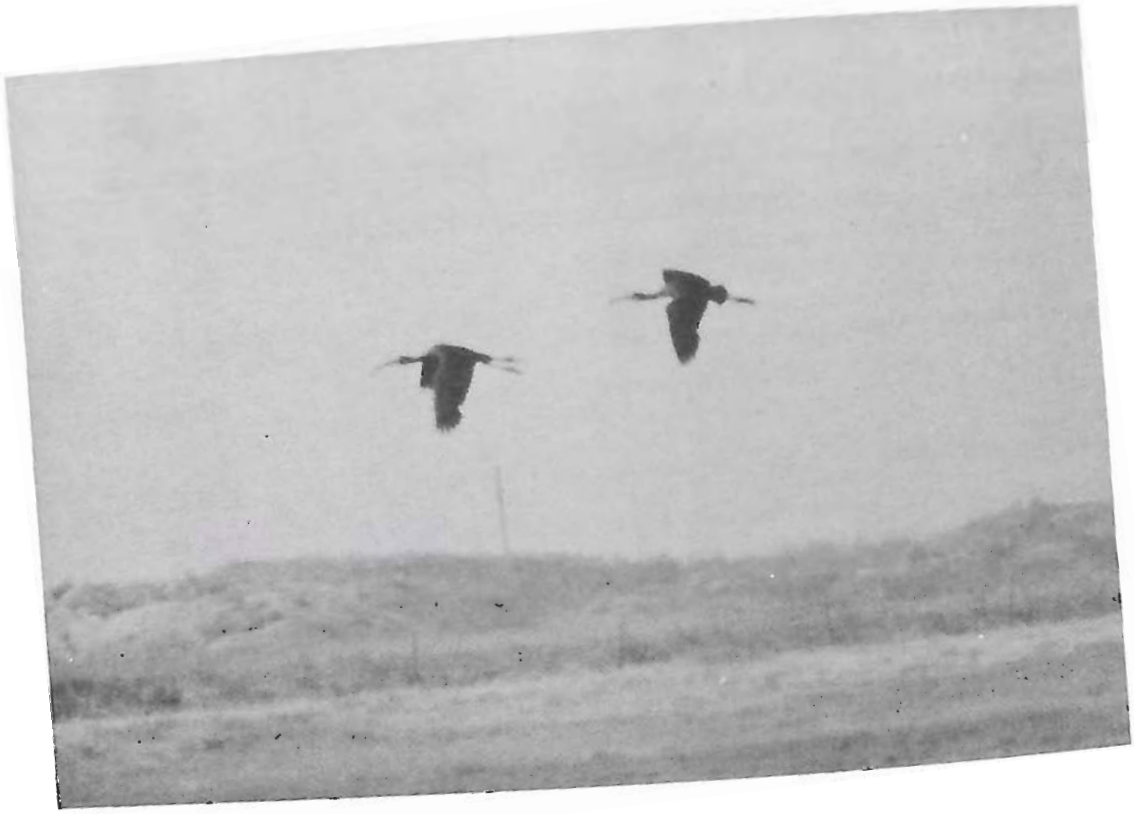
Notes for Chapter 2

1. Some Class 1 nonhazardous waste goes to incinerators.

Table 2.6 Threatened, Endangered, or Candidate Species Observed or Potentially Occurring at Pantex Plant

Common Name	Scientific Name	Federal Status[1]	State Status
Species Observed at Pantex Plant			
Bald eagle	*Haliaeetus leucocephalus*	Endangered	Endangered
Black tern	*Chlidonias niger*	Candidate - C2	Not listed
Ferruginous hawk	*Buteo regalis*	Candidate - C2	Not listed
Loggerhead shrike	*Lanius ludovicianus*	Candidate - C2	Not listed
White-faced ibis	*Plegadis chihi*	Candidate - C2	Threatened
Whooping crane	*Grus americana*	Endangered	Endangered
Swift fox	*Vulpes velox*	Candidate - C2	Not listed
Texas horned lizard	*Phrynosoma cornutum*	Candidate - C2	Threatened
Species Potentially Occurring at Pantex Plant			
American peregrine falcon	*Falco peregrinus anatum*	Endangered	Endangered
Arctic peregrine falcon	*Falco peregrinus tundrius*	Threatened	Threatened
Baird's sparrow	*Ammodramus bairdii*	Candidate - C2	Not listed
Interior least tern	*Sterna antillarum athalassos*	Endangered	Endangered
Mountain plover	*Charadrius montanus*	Candidate - C1	Not listed
Snowy plover	*Charadrius alexandrinus*	Candidate - C2	Not listed
Plains spotted skunk	*Spilogale putorius interrupta*	Candidate - C2	Not listed
Texas garter snake	*Thamnophis sirtalis annectans*	Candidate - C2	Not listed
Western smooth green snake	*Opheodrys vernalis blanchardi*	Not listed	Endangered

[1] C1 = Category 1 candidate species. USFWS has substantial information on biological vulnerability and threats to support proposing to list as endangered or threatened. Data are being gathered on habitat needs and/or critical habitat designations.
C2 = Category 2 candidate species. Information indicates that it may be appropriate to propose to list as endangered or threatened, but current data on biological vulnerability and threats are not sufficiently substantial to support the listing. Further biological research and field study will be necessary to ascertain the status and/or taxonomic validity of the taxa in Category 2.



White-faced ibises (*Plegadis chihi*)

Chapter 3

ENVIRONMENTAL PROTECTION PROGRAM

The Environmental Protection Program is continuously improving its ability to ensure that Pantex Plant performs its mission in a safe and environmentally protective manner. Currently, the program consists of nine program elements: public communication, oversight, quality assurance, compliance, pollution prevention and waste minimization, environmental monitoring, cultural resources, natural resources, and environmental restoration (Figure 3.1). An overview of the first six of these program elements is given here. The cultural resources, natural resources, and environmental restoration program elements are described in Chapters 4, 5, and 6, respectively.

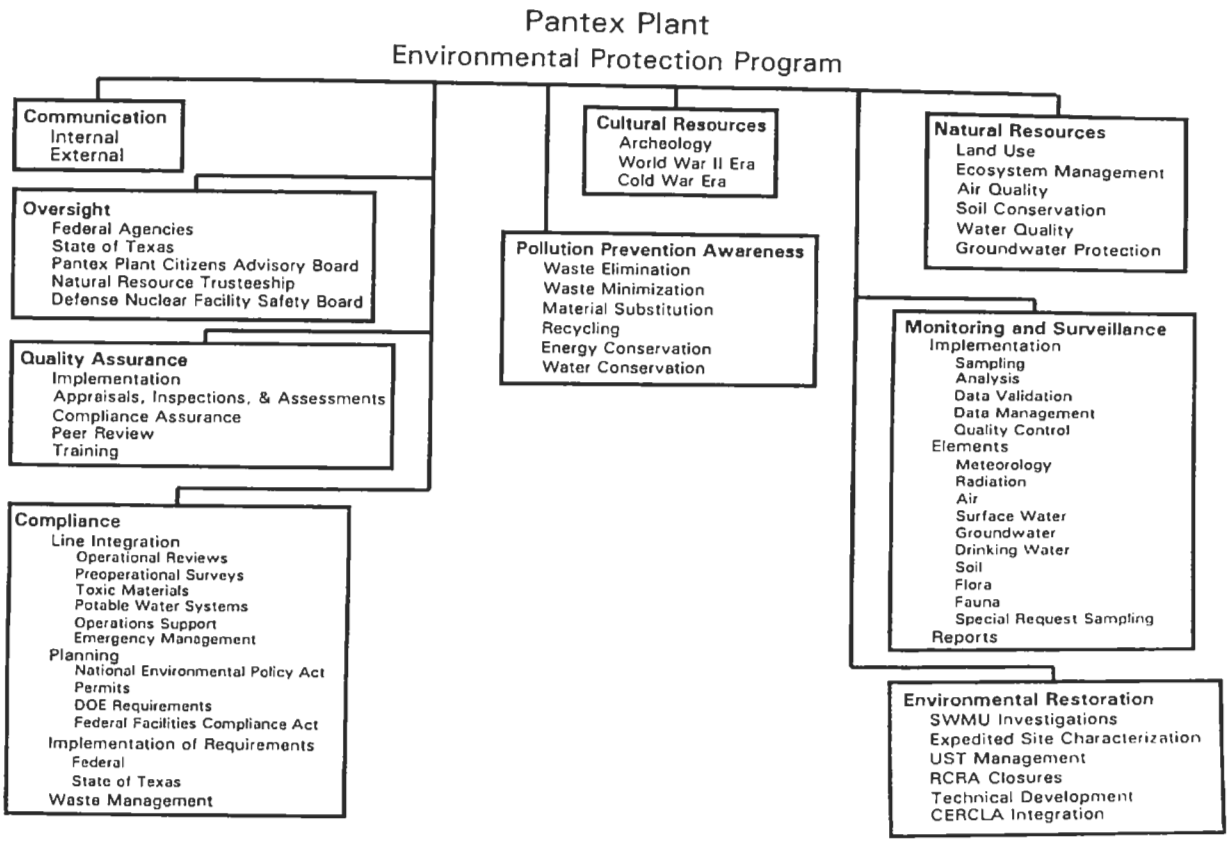


Figure 3.1: Elements of the Pantex Plant Environmental Protection Program

3.1 Public Communication

One of the greatest challenges in environmental protection is communicating with 3,500 Pantex Plant employees, federal and Texas regulators and legislators, and the public. For example, Pantex Plant must communicate with the Pantex Plant Citizens' Advisory Board, special interest groups, and the public at large.

To inform and involve stakeholders on issues of concern, the Pantex Plant External Affairs and Communication Division has established a public outreach project that

- Facilitates public input and involvement in major decisions concerning past, present, and future operations at Pantex Plant that could impact the local community
- Provides information on such topics as radiation, waste management, environmental monitoring, environmental clean-up, and related topics of interest
- Serves as a liaison between the public and other departments at Pantex Plant
- Communicates the Plant's mission — especially in the areas of environment, safety, and health — to both employees and the public

Communication vehicles include a weekly in-Plant newsletter (*Cracker Barrel*); a monthly magazine sent to employees and members of the public (*The Pantexan*); informational brochures and fact sheets; a wide variety of reports that are placed in public reading rooms in Amarillo and Panhandle; presentations at monthly public meetings; mailing of announcements and information documents; a speakers bureau; public information fairs; and tours of Pantex Plant for the public and the news media.

3.2 Oversight

3.2.1 State of Texas Activities

In 1989, the Secretary of Energy invited the host state of each U.S. Department of Energy (DOE) facility to verify impacts of facility operations to the environment, if any. In response to this initiative at Pantex Plant, DOE entered into a five-year Agreement in Principle (AIP) with the State of Texas in August 1990. Negotiations to extend the AIP for another five years were initiated in December 1994. The AIP focuses on three activities: waste management, emergency response, and environmental monitoring. Four state agencies are involved: the Governor's Office, the Texas Natural Resource Conservation Commission (TNRCC), the Texas Department of Public Safety Division of Emergency Management, and the Texas Department of Health—Bureau of Radiation Control. The State of Texas has extended the emergency response activities to include Carson County and the City of Amarillo. A number of meetings were held in 1994 between DOE and these agencies; in addition, DOE provided required information to the State of Texas, and the State conducted its own sampling and research activities.

Concurrent with the AIP, in September 1990 DOE authorized a Grant in Aid (GIA) for hydrogeologic characterization at the Plant. The University of Texas at Austin Bureau of Economic Geology is the lead agency, and the Geosciences Department of the University of Texas at Austin and the Water Resources Center at Texas Tech University are supporting agencies. The studies, which will conclude in 1995, have produced a detailed understanding of the hydrogeologic conditions in the vicinity of Pantex Plant. Results of these investigations are being published in the open literature.

The Amarillo National Resource Center for Plutonium of the Texas Higher Education Consortium was established in October 1994 to

support issues critical to Pantex Plant. The Center includes scientists and engineers from Texas Tech University, schools in the University of Texas and Texas A&M systems, Amarillo College, and Texas State Technical College. The Center's proposed research to support the Environmental Protection Program includes validation of the environmental monitoring program element and assessment of available and practicable remediation technologies.

3.2.2 Site-Specific Advisory Board

The Pantex Plant Citizens' Advisory Board is an independent body representing a balance of diverse interests affected by Pantex Plant activities. The Board's primary mission is to provide informed recommendations and advice to DOE concerning health, safety, environmental, and waste management aspects of all past, present, and future Plant activities, including the associated costs and benefits. The Board consists of 20 members and is chartered under the Federal Advisory Committee Act. The Board's monthly meeting is open to the public; the date, place, and time are announced in the *Federal Register* two weeks before the meeting and also reported by the local news media.

3.2.3 Natural Resource Trustee Council

Following Pantex Plant's listing on the National Priorities List in May 1994, DOE developed plans for the establishment of a trustee council of representatives from federal and Texas natural resource trustee agencies. This trustee council will review environmental restoration investigations and remediation strategies to minimize future natural resource liabilities, as well as assessing potential damages to natural resources that may have resulted from Pantex Plant operations.

3.3 Quality Assurance

3.3.1 Program Description

DOE Order 5700.6C, "Quality Assurance," requires all DOE operations to integrate quality assurance practices into the work process. To comply with the Order, Pantex Plant has included the requirements of the Order in its procedural documents, which are strictly followed by all Plant personnel. Training of personnel is another element of the quality assurance program. In addition, a program-specific quality assurance manual (Mason & Hanger 1994d) has been prepared as a supporting document to the Environmental Monitoring Plan (Mason & Hanger 1992a). Quality assurance activities to support the environmental monitoring program element are discussed in detail in Chapter 14.

3.3.2 Appraisals, Inspections, and Assessments

The Environmental Protection Program underwent seven reviews in 1994. These reviews included a multi-medium inspection by the TNRCC, an Operational Readiness Review for Stage Right Operations in Zone 4, an assessment by the Defense Nuclear Facility Safety Board, an internal audit of the waste tracking database, a Mason & Hanger corporate assessment, three visits by staff from DOE/Albuquerque Operations Office (DOE/AL), and a drinking water inspection by the TNRCC.

TNRCC conducted its first multi-medium (waste, air, water) inspection of Pantex Plant in January 1994. The two Resource Conservation and Recovery Act (RCRA)-related findings are discussed in Chapter 2.

The Operational Readiness Review for Stage Right Operations in Zone 4 was performed by DOE/Headquarters in February 1994 to determine whether modified stacking of plutonium components in Zone 4 could be allowed. No environmental findings were issued.

The Defense Nuclear Facility Safety Board performed a comprehensive assessment of the Environmental Protection Program in March 1994 to evaluate progress made since its visit in August 1992. No findings were issued.

The Pantex Plant Quality Division audited the waste tracking database in July 1994. No findings were issued.

An assessment of environmental and waste practices by staff from Mason & Hanger's corporate headquarters in Lexington, Kentucky, in June 1994 resulted in three findings, one observation, and eight recommendations for changes to incorporate "best management practices."

Three DOE/AL visits, each one week long, occurred in August-September 1994. Air, water, and radiological aspects of the Environmental Protection Program were reviewed. Five observations were made with respect to the air program.[1]

TNRCC performed a drinking water inspection in October 1994, issuing a statement of general compliance with rules and regulations; no findings were issued.

Actions undertaken in response to a number of findings from previous appraisals, inspections, and assessments were completed in 1994. Responses to five open "recommendations" by the Technical Safety Appraisal (January-February 1992) were completed. Responses to four findings and two observations from the Waste Management Appraisal by DOE/AL (August 24-28, 1992) were completed. Responses to four open findings from the Monitoring and Air Programs-Radiation Appraisal by DOE/AL (September 14-18, 1992) were also completed.

3.4 Compliance

A major function of the Environmental Protection Program is to support the overall Pantex Plant mission by ensuring that compliance is achieved with all environmental requirements. Chapter 2 of this report summarizes compliance status by requirement, including an extensive discussion of waste management activities. This section describes how compliance is integrated into the activities of the production line and the associated planning.

3.4.1 Line Integration

To ensure that environmental compliance is integrated into production line activities, the Environmental Protection Program conducts operational reviews (reviewing documents and checking their accuracy in person) and preoperational surveys and provides *ad hoc* support to resolve issues when they arise. An additional environmental protection activity involves participation in the Emergency Management Program: providing environmental and waste management staff to the Emergency Operation Center; maintaining the meteorological program, which is a critical component of the Atmospheric Release Advisory Capability system; implementing the spill prevention control and countermeasures plan (Mason & Hanger 1993c); and reporting occurrences that affect the environment. DOE Order 5480.19, "Conduct of Operations Requirements for DOE Facilities," requires that all "events" be reported by the process described in DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information." This process ensures prompt, uniform reporting to DOE and regulators. Eleven occurrence reports of an environmental nature were filed in 1994 (Table 3.1).

3.4.2 Planning

Various planning activities were performed in anticipation of new and changing regulations. As such regulations become available, they are reviewed in the light of information generated by the Environmental Monitoring Program and a detailed knowledge of operations conducted at

Table 3.1 Occurrence Reports of an Environmental Nature Filed in 1994

Number	Name	Date Reported	Status[1]
0013	Tritium Contamination Discovered at Building 12-95	2/3/94	In validation
0038	Onsite Transportation Event Involving Tritiated Water	3/22/94	Closed
0048	Sewage Leak West of 12-42	3/25/94	Cancelled
0056	Halon 1301 Actuation in Building 12-86	4/14/94	Closed
0090	Concerns Regarding Classification of Hazardous Materials Shipped Offsite	6/15/94	Closed
0112	Improper Packaging and Labeling of Regulated Materials for Transport	7/18/94	Closed
0114	Hazardous Substance Discovered in Sewer System in Building 12-110	7/21/94	Closed
0116	Wastewater Discharge Permit Exceedance	7/28/94	Closed
0118	Tritium Contamination Identified in Building 12-64 HVAC Drain Pipe	8/3/94	Closed
0145	Contamination Detected in Conex Trailers	9/17/94	In validation
0161	Contamination Identified in Building 12-21, Bay 6 - - Loss of Accountability of Sealed Source per DOE N5400.9	10/14/94	Open

[1] Closed = corrective actions are complete. Open = corrective actions are ongoing. Cancelled = the occurrence was found not to be a real issue.

the Plant. Those planning activities required by the National Environmental Policy Act and by various regulations with respect to permitting are discussed in Chapter 2. Other planning activities are performed as required by DOE Order 5400.1, "General Environmental Protection Program," and have resulted in the preparation of the environmental protection implementation plan (Mason & Hanger 1993a), environmental monitoring plan (Mason & Hanger 1992a), groundwater protection management program plan (Mason & Hanger 1993b), and pollution prevention and waste minimization plan (Mason & Hanger 1994c).

3.5 Pollution Prevention and Waste Minimization

Activities in support of the Pollution Prevention/Waste Minimization program are waste elimination, waste minimization, air emission reduction, material substitution, recycling, energy conservation, and water conservation. Pollution Prevention/Waste Mini-

mization personnel have been working with Pantex Plant's Assembly Engineering Department to review all weapons assembly and disassembly procedures. Over 400 procedures have been reviewed.

All waste codes[2] were reviewed to check their accuracy and to determine whether procedures could be modified to use chemicals that would not generate hazardous waste. Most mixed hazardous and radioactive waste at the Plant comes from activities governed by these procedures. Chemical substitutions can be made if the design specifications allow for the use of nonhazardous chemicals. Over 100 Pollution Prevention Opportunity Assessments have been performed for Plant waste streams. A ranking system was developed to prioritize the waste streams to be studied. In addition, goals for affirmative procurement (that is, purchasing from environmentally conscious manufacturers) were outlined in a 1994 plan that will be sent to other DOE facilities as a guide. Pantex Plant expects to be a leader in the area of affirmative procurement and the use of recycled materials.

Pollution Prevention/Waste Minimization activities are promoted and communicated in the quarterly *Minimizer* newsletter, in articles in the *Cracker Barrel* newsletter, in the *Pollution Prevention Advisor* (a DOE-wide monthly publication), and by an employee incentive program. A training program was developed to instruct all Plant employees on Pollution Prevention/Waste Minimization activities, and the goal of training 80% of the Plant staff by the end of September 1994 was met. In fact, the entire staff had been trained by June 1994. This training has increased employee awareness of the opportunities to reduce waste that they themselves generate. Members of the Pollution Prevention/Waste Minimization program also volunteered to teach college-bound high school students about waste management. A 3-kilometer (2-mile) section of U.S. Highway 60 immediately south of the Plant was adopted through the Texas "Adopt-A-Highway" program. Under this program, volunteers from the Pollution Prevention/Waste Minimization staff keep the section of highway clean (Figure 3.2). The first cleanup day was covered by three local television stations.

Efforts to reduce and eliminate waste at Pantex Plant have greatly reduced waste generation. In 1994, Pantex Plant reduced the generation of hazardous waste by 48%, that of low-level waste by 21%, and that of mixed (hazardous and radioactive) waste by 32%. These reductions have meant significant savings on the cost of waste disposal, as well as benefiting the environment. Disposal costs in 1994 were less than a third of those in 1992, and more than $2 million was saved. This decrease was even better than expected; the amount spent for disposal in 1994 was half the amount budgeted. In response to a cost-saving initiative from DOE/AL, Pantex Plant initiated seven Pollution Prevention/Waste Minimization activities that had a total start-up cost of $67,475 and a projected annual savings of $196,036 per year.

From 1987 to 1994, the Plant's generation of hazardous waste decreased by more than 96%. In contrast to the reductions at other facilities in the DOE weapons complex, this is not a reflection of a reduced workload. While the production workload at Pantex Plant has decreased, the dismantlement mission has actually increased, which might be expected to increase the amount of waste. Thus, the 96% decrease is indicative of real reductions and improved processes.

Pantex Plant has continued waste minimization activities started in previous years. Recharging laser printer cartridges has saved over $110,000 since 1992. Freon recycling has saved 225 kilograms (500 pounds) of Freon since 1991. Antifreeze recycling has saved $30,000 since 1990. Blending used motor oil with diesel fuel has saved $25,000 since 1990. The Plant also reuses or recycles lead-acid batteries, gold, tantalum-plated parts, aluminum, copper wiring,

Figure 3.2 **Pantex Plant employees volunteer their time to keep U.S. 60 clean as part of the Adopt-a-Highway Program**

explosive machining scrap, mock-explosive machining scrap, titanium, lead, DMSO (an organic solvent), scrap metal, X-ray films, plastic bottles, explosive-contaminated machining wastewater, photoprocessing rinse water, and wood. Listed below are several of the initiatives undertaken in 1994:

The GREEN Contest: Pantex Plant's GREEN (Globally Reduce Environmental Emissions Now) Contest is unique in the DOE complex. The contest was designed to encourage employees to identify projects that will reduce waste. In June 1994, the contest generated more suggestions (23) in one month than had normally been received in two years. Eight of these suggestions have been implemented, and others are still being considered.

Source Reduction of Explosive-Contaminated Waste: Previously, all waste collected in certain designated areas of the Plant was assumed to be explosive-contaminated. Thus coffee cups, calendars, and many other items that did not have any explosive contamination were nevertheless burned as explosive-contaminated waste. More definitive characterization of explosive-contaminated waste and new procedures decreased the amount of explosive-contaminated waste by 99%. This decrease has resulted in the use of fewer active thermal treatment units and reduced air emissions at the Burning Ground.

Explosives Reuse/Recycling: In 1994, 18,000 kilograms (40,000 pounds) of virgin explosives no longer needed at Pantex Plant were sold (in accordance with federal requirements) to a commercial company.

Used Tire Recycling: All used tires from Plant vehicles are now being reused or recycled. Those tires that can be recapped and reused (primarily truck tires) are sold at auction. The remaining tires are sent to an offsite recycler.

Rechargeable Battery Program: One-time-use batteries have been replaced by rechargeable alkaline batteries. The new batteries can be recharged and reused up to 25 times. This activity was suggested by an employee. The activity will save the Plant over $10,000 each year, and the return on investment for the project was 430%. The activity is also reducing the number of batteries requiring disposal, and unlike many of the old batteries, which became hazardous waste, the rechargeable batteries do not contain hazardous materials and will not require special treatment.

Fluorescent Light Tube Recycling: This activity manufactures new tubes out of the old, reducing hazardous waste. Six thousand tubes were processed by a subcontractor in 1994.

Office Paper Recycling: By recycling paper, most employees become involved in Pollution Prevention/Waste Minimization efforts. Saving office paper is a constant reminder to employees that the Plant is committed to minimizing waste. Between 10 and 50 tons of paper are recycled each week, the equivalent of 10,000 trees per year. The Panhandle Environmental Partnership has recognized Pantex Plant's paper recycling effort as one of the top recycling programs in the Texas Panhandle and invited representatives from the Plant to speak at the "Texas Recycles Day" celebration.

Aluminum Can Recycling: Containers with an integral smasher were deployed around the Plant for the collection of aluminum cans.

Freon Reuse: Four drums of Freon no longer needed at Pantex Plant and planned for disposal were shipped to DOE's Kansas City Plant. Sending the Freon to the Kansas City Plant not only saved Pantex Plant the cost of disposal, but also saved the Kansas City Plant the cost of purchasing the Freon.

Weapons Cleaning Reductions: Pantex Plant's Security Division has substituted a nonhazardous citrus-based solvent for a hazardous solvent previously used to clean weapons. The Security Division is now using reusable rags instead of disposable wipes. These changes have reduced associated waste generation by approximately 90%.

Finally, a systems approach has been applied to pollution prevention, resulting in the conclusion that both energy and water conservation measures are environmentally protective. Energy conservation results in less use of natural resources and less generation of waste in producing the energy. Energy conservation activities carried out at Pantex Plant in 1994 include use of alternatively fueled vehicles, replacement of incandescent light bulbs with fluorescent bulbs, and increased use of automated heating-ventilation-air conditioning (HVAC) controls. Water conservation reduces both the amount of water used (which for Pantex Plant is water extracted from the Ogallala aquifer) and the volume of wastewater for disposal. A water balance study identified alternatives for wastewater reuse (Jacobs Engineering Group 1994), such as in steam plant make-up water. These alternatives will be further investigated.

3.6 Environmental Monitoring Program

An environmental monitoring plan required by DOE Order 5400.1, "General Environmental Protection Program," was prepared in November 1991 (Mason & Hanger 1992a), updated in July 1993, and revised in 1994 (it is scheduled for release in early 1995). The revised environmental monitoring plan implements changes required by environmental regulations and advances in industry practices as cost efficiently as is practicable.

Elements of the Environmental Monitoring Program include

- Establishing sampling criteria and guidelines for monitoring the environment at and around Pantex Plant
- Collecting, analyzing, and documenting routine and special environmental samples and measurements
- Conducting radiological and nonradiological monitoring and surveillance in accordance with applicable regulations
- Evaluating and reporting environmental data
- Applying appropriate quality assurance and quality control measures to environmental monitoring activities
- Estimating the amounts of radionuclides released to air, water, and soil from routine Plant operations and using computer modeling to evaluate the effective dose equivalent to the public from such releases
- Publishing the Pantex Plant Annual Site Environmental Report and other required documents
- Ensuring compliance with applicable DOE Orders.

3.6.1 Routine Activities

Environmental monitoring consists of effluent monitoring and environmental surveillance. Effluents are monitored for both radiological and nonradiological constituents to comply with applicable effluent regulations and DOE Orders and to provide representative measurements of the quantities and concentrations of pollutants in liquid and airborne discharges. Environmental surveillance both verifies compliance with applicable federal, state, and local environmental laws and regulations and monitors the effects of Pantex Plant activities onsite and offsite. The current environmental monitoring program was designed based on regulatory requirements, potential for release, exposure pathways, and management directives. The active monitoring programs include air, soil, flora, meteorological, surface water, groundwater, and drinking water sampling activities. In addition, control samples are collected at the U.S. Department of Agriculture (USDA) Agricultural Research Service's Conservation and Production Research Laboratory at Bushland, Texas.

Ambient air monitoring is designed to determine concentrations of pollutants in the vicinity of the Plant and at areas unaffected by Plant operations (measurements there are referred to as background or reference concentrations) and to evaluate the effect of Plant emissions. Possible pollutants derived from Plant operations include volatile organic compounds, explosives (and their degradation products), metals, and radiological materials. Monitoring results are presented in Chapters 7 and 8. Confirmatory measurements are achieved by sampling soil and flora, as discussed in Chapters 12 and 13. As described in Chapter 1, meteorological data are collected to support environmental monitoring and surveillance and for use in calculations of the atmospheric transport and diffusion calculations of pollutants.

Water monitoring has been conducted at Pantex Plant for 20 years. Surface water, groundwater, and drinking water are monitored to verify compliance with applicable regulations. Both surface water and groundwater are monitored to determine and document possible effects of Plant operations on water quality and quantity. Groundwater, drinking water, and surface water samples are analyzed for a wide range of organic and inorganic chemicals and radioactive materials, as described in Chapters 9, 10, and 11.

3.6.2 Special Request Sampling

The special request sampling program has grown from 85 requests in 1992 to 101 requests in 1993 and 192 in 1994. Collection of these samples is requested to check for regulatory compliance or in response to a special event or investigation. In 1994, 134 of the requests were in support of Environmental Restoration and Waste Management activities. Activities included co-sampling with the Environmental Restoration program, underground storage tank sampling, effluent monitoring, and sampling for waste characterization. In addition, the AIP and GIA were supported with eight co-sampling requests. Three requests were for sampling to support a base hydrolysis demonstration project. Eight requests were for sampling to identify necessary changes to the environmental monitoring plan.

Five special requests were for quality control samples. These samples were assigned sample numbers and analyzed in the same manner as routine environmental samples. Results of quality control analyses are discussed in Chapter 14.

Thirty-four special requests were from the Environmental Monitoring Program to obtain additional information. Soil, water, and vegetation were sampled, and those results are presented with the results of routine monitoring.

Notes for Chapter 3

1. Memo from S.N. Goel, Environmental Protection Division, DOE/AL, to D.L. Heim, DOE/AAO, dated September 20, 1994.

2. A waste code is a number assigned by the Plant to identify wastes produced by a specific process. This process waste is also referred to as a waste stream.

Chapter 4

CULTURAL RESOURCES

Numerous cultural resources have been identified at Pantex Plant on land owned by the U.S. Department of Energy (DOE) and land leased by DOE from Texas Tech University. These resources include 69 archeological sites indicating prehistoric Native American and historic-period Euroamerican occupation and use of Plant land. They also include standing structures, foundations, and other features that were once part of the Pantex Ordnance Plant (1942-1945), the World War II predecessor of Pantex Plant. In addition, many structures and features associated with Cold War (1951-1991) operations at the Plant are included in the cultural resource inventory. Valuable historical documents and artifacts also present onsite can aid in the interpretation of prehistoric and historic human activities at the Plant. Some of the cultural resources that have been identified are potentially eligible for the National Register of Historic Places (National Register) and consequently require protection and preservation under the National Historic Preservation Act (NHPA) and related cultural resource management (CRM) laws and regulations.

4.1 Archeological Resources

Large tracts of DOE-owned and -leased land at Pantex Plant have been surveyed for archeological resources (see Figure 4.1). The archeological resources identified at Pantex Plant are primarily prehistoric Native American sites but also include several Euroamerican sites, mainly farmsteads. The original structures at these farmsteads have been largely destroyed. Consequently, apart from existing documentary information, much knowledge relating to these sites can be collected only by archeological methods. The sites are therefore discussed as archeological rather than historical resources.

4.1.1 CRM Activities Before 1994

The first professional archeological study at Pantex Plant was conducted by West Texas State University (WTSU), now West Texas A&M University, during the spring of 1981 (Hughes and Speer 1981). This study was an archeological survey primarily of the playas of the main Plant site [approximately 3,600 hectares (9,000 acres)] and Pantex Lake [approximately 444 hectares (1,100 acres)]. The southern portion of the Plant, currently leased by DOE from Texas Tech University, was not included in this survey. Forty-five archeological sites were discovered; three of the sites were historical farmsteads, and the remaining 42 were prehistoric Native American sites. All but one of the sites, a farmstead, were located near Playas #1, #2, and #3 and Pantex Lake.

The next archeological survey at the Plant was conducted in 1992 by Mariah Associates. The purpose of this survey was to locate archeological sites so that they could be avoided by activities related to the Ditches and Playas Resource Conservation and Recovery Act Facility Investigation study. Objectives of this survey were to 1) confirm the location of 17 archeological sites identified by Hughes and Speer (1981) as having medium-high significance at Pantex Lake and Playas #1, #2, and #3; 2) make an archeological inventory of possible borehole locations, water well locations, and vehicle access routes around these playas; and 3) conduct the first archeological survey of 80 hectares (200 acres) near Playa #4, on the Texas Tech University-owned portion of the Plant (Acklen 1992: 1-2). This survey resulted in confirmation of 15 site locations (two were omitted as outside the project scope), discovery of 14 isolated occurrences[1] (IOs) of artifacts, identification of three new sites at Playa #2, and identification of two new sites

and 25 IOs at Playa #4. Although the Mariah Associates survey partially confirmed the results of the WTSU survey and added new sites to the Pantex Plant inventory, its scope of effort was restricted. In addition, the report contained unsupported recommendations of eligibility for the National Register that contradicted the recommendations of Hughes and Speer (1981) for some Plant sites.

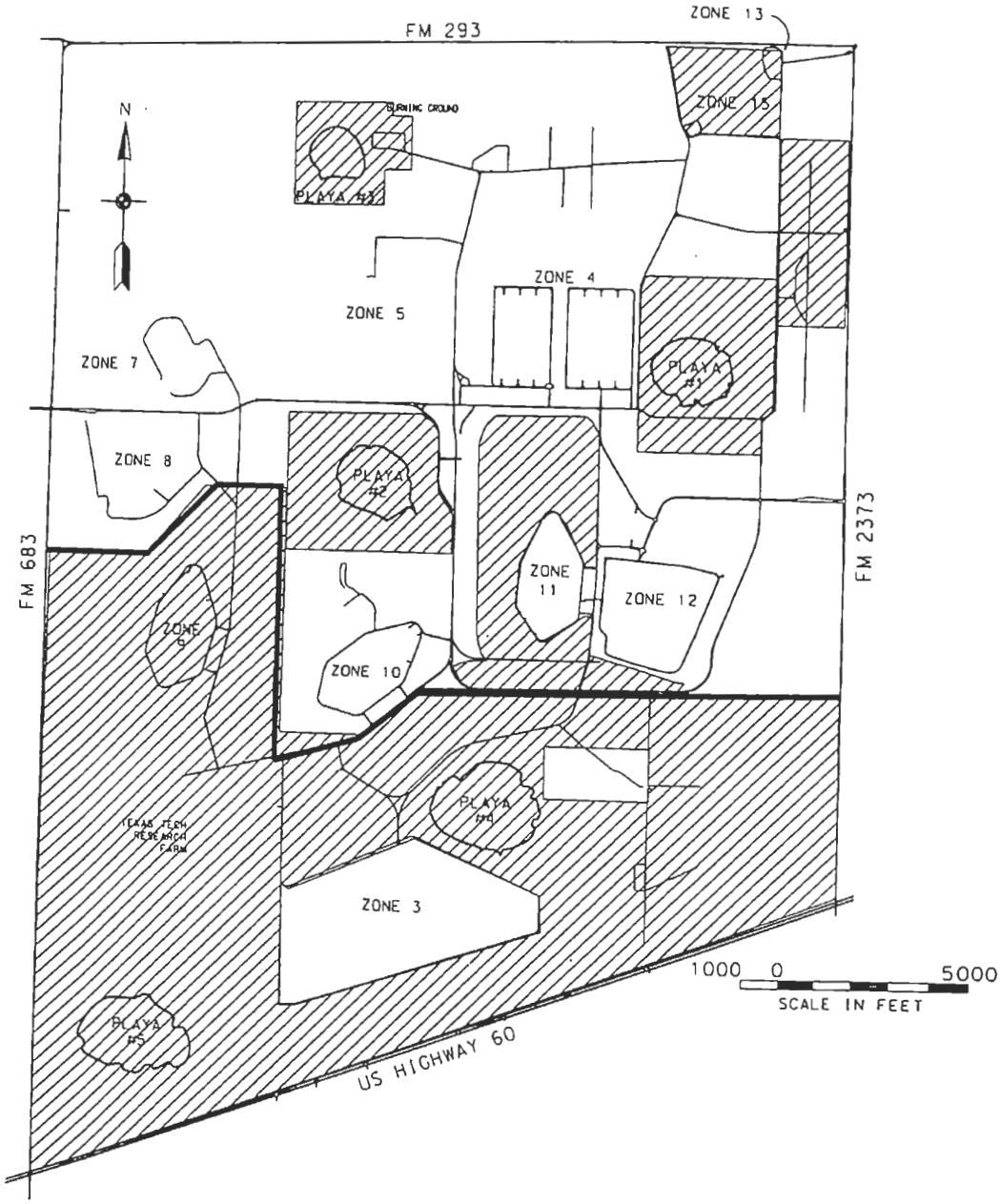


Figure 4.1: **Areas of DOE-owned and -leased land that have been surveyed for archeological resources**

In 1993 a Cultural Resource Management Program was established at Pantex Plant. Establishment of the program marked the beginning of a more systematic and comprehensive approach to cultural resource studies at Pantex Plant.

The first archeological excavations at Pantex Plant were conducted at 23 sites by Geo-Marine, Inc., between April 1993 and March 1994. These test excavations were performed at the 17 medium-high significance sites identified by Hughes and Speer (1981), all five new sites located by the Mariah Associates survey, and site 41CZ66, which was discovered and recorded during the Geo-Marine, Inc. testing project (Winchell and Largent 1994). These test excavations were designed to collect information needed for future determinations of eligibility for the National Register.

A major focus of the Cultural Resource Management Program has been systematic survey coverage of all areas surrounding the playas and of a substantial sample of non-playa areas (Figure 4.1). The systematic survey process begun by Mariah Associates at Playa #4 continued with a 200-hectare (500-acre) survey by Geo-Marine, Inc. around Playa 5, on Texas Tech University land, in November 1993 (Largent and Winchell 1994b). Six archeological sites were discovered: five prehistoric Native American sites and one Euroamerican farmstead site. In addition, seven IOs — three Native American and four historical — were identified (Largent and Winchell 1994b).

4.1.2 1994 CRM Activities

A second systematic survey on Texas Tech University land was conducted in February-March 1994 by Geo-Marine, Inc. (Largent and Winchell 1994a), covering a previously unsurveyed area of 1,680 hectares (4,200 acres), mostly interplaya uplands. Eight new archeological sites were discovered. Six of these were Native American sites near playas and two were predominantly historical sites. Thirteen prehistoric and four historical IOs were identified. With the completion of this survey, most of the Texas Tech University-owned portion of Pantex Plant has been surveyed.

Systematic resurveys of all DOE-owned playa areas, including approximately 0.4-kilometer (1/4-mile) bands surrounding Playas #1, #2, and #3 and Pantex Lake, were completed by Geo-Marine, Inc., in October 1994, along with surveys of interplaya areas near Plant Zones 11, 13, and 15 (Largent 1994). These recent surveys ensure a current, comprehensive, and consistently recorded archeological data set for future resource management consultations and determinations of eligibility for the National Register. In addition, these surveys included large interplaya tracts on both Texas Tech University and DOE land, making it possible to test the adequacy of a proposed archeological site location model for the Plant and to identify possible sites in Plant areas designated for future development. According to the archeological site location model tested, prehistoric archeological sites at Pantex Plant lie only within approximately 0.4 kilometer (1/4 mile) of playas or their drainages. Conversely, such sites do not lie in interplaya upland areas. An archeological context statement is currently being developed to evaluate the eligibility of Pantex Plant archeological sites for the National Register.

Although no Native American burial sites or funerary objects have been found at Pantex Plant, any such remains or objects that may be discovered will be managed in compliance with the Native American Graves Protection and Repatriation Act and the Archeological Resources Protection Act.

4.1.3 Management

To manage all National Register-eligible archeological sites and historical resources at Pantex Plant, a comprehensive cultural resource management plan (CRMP) is being developed according to DOE guidelines (DOE 1994). Prior to implementation of the CRMP, management of

archeological resources is focused on 1) archeological surveys and test excavations to meet requirements under Section 110 of the NHPA and 2) avoidance of impact to archeological sites by Plant activities.

The eligibility of known archeological sites at Pantex Plant for the National Register has not been determined and formal consultation with the State Historic Preservation Office (SHPO) and the President's Advisory Council on Historic Preservation (Advisory Council) has not occurred. Until such consultations and determinations are completed, all archeological sites are being managed as though they are eligible, as required by NHPA. Potential adverse impacts to archeological sites are currently being managed case by case, to ensure that proposed ground-disturbing projects avoid known or possible site locations. Such case-by-case management has been effective and will be continued until it can be replaced by a programmatic and comprehensive management agreement among DOE, the SHPO, and the Advisory Council.

4.2 Historical World War II-Era Resources

Pantex Ordnance Plant was designed and built in 1942, less than nine months after its authorization. By the time it closed in August 1945, Pantex Ordnance Plant covered 6,413 hectares (16,032 acres) with three bomb-loading lines (a fourth was completed just before the war ended and never used during the war), an ammonium nitrate line, a bomb fuse and booster line (see Figure 4.2), three large complexes for explosives/ammunition storage, a shop and maintenance area, a cafeteria, a hospital, two large dormitories, a sewage treatment plant, and a water-softening plant, as well as Pantex Village, which consisted of 69 residences, a community center, a store, and a movie theater (Carr 1992). Today the World War II-era historical resources of Pantex Plant consist of 165 standing buildings and structures, as well as various building remains and designed landscapes located on both DOE-owned and DOE-leased land.

4.2.1 CRM Activities Before 1994

A comprehensive survey of the historical resources at Pantex Plant began in 1992, when DOE authorized an inventory of buildings constructed between 1942 and 1945. This research, conducted by DOE's Pacific Northwest Laboratory and Legacy Research Associates, Inc., was divided into three "packets" (Stricker and Poet 1994a). Packet 1 consisted of developing a local-level World War II historic context statement for the Plant and surveying the World War II-era standing structures in the currently active zones of the Plant: Zones 4, 10, 11, and 12. Work began on Packet 1 in July 1992, and the final report was completed in May 1994 (Stricker and Poet 1994a).

Packets 2 and 3 consisted of the survey and evaluation of all World War II-era historical resources not covered by Packet 1. Packet 2 was an inventory of 29 standing structures in Zones 1, 2, 3, 5, 8, 9, 13, and 15 and in the General Area. Packet 3 documented all World War II-era foundations and ruins inside the historical boundaries of Pantex Ordnance Plant (all zones). Eighty-two foundations and partial structures were documented. Work on Packets 2 and 3 began in 1993, and a combined final report was completed in May 1994 (Stricker and Poet 1994b).

4.2.2 1994 CRM Activities

Two subcontracts involving World War II-era cultural resources were initiated in 1994. A subcontract for a national-level World War II historic context statement is ongoing, with a draft expected in 1995. In addition, a subcontract has been negotiated to develop a second local-level World War II-era historic context statement based primarily on oral histories. Together these reports will provide a complete World War II-era

historic context statement that will be used to evaluate the eligibility of the Plant's World War II-era buildings, structures, ruins, and landscapes for the National Register.

Pantex Plant CRM staff and DOE/AAO held three meetings with the SHPO at the Texas Historical Commission in Austin, Texas, in 1994. These meetings indicated SHPO approval of the direction and overall strategy of Pantex Plant's Cultural Resource Management Program. In 1994, the CRM staff also reviewed and commented on 23 Plant projects or "undertakings" that might affect archeological or historical resources. Two additional undertakings required DOE/AAO and Plant CRM staff consultation with the SHPO, whose review resulted in determinations of "No Effect," allowing Plant projects to proceed without delay.

4.2.3 Management

Prior to implementation of the CRMP in late 1997, management of historical resources involves evaluation of Plant undertakings case by case. Undertakings that involve potentially eligible historical properties are identified through the Plant's National Environmental Policy Act (NEPA) compliance process and the centralized Environment, Safety, and Health (ES&H) review. The CRM staff then assist other Plant departments in determining which projects require NHPA Section 106 review and coordinate consultation between DOE and the SHPO when appropriate. When potentially eligible properties are identified, management efforts focus on reducing or minimizing "adverse effect" to the properties' historic character, adaptive reuse of properties when feasible (see Figures 4.3 and

U. S. ENGINEER OFFICE — WAR DEPARTMENT — DENISON, TEXAS
Amarillo, Texas — PANTEX ORDNANCE PLANT — Industrial Inventory.
Fuze and Booster Assembly Building 10-14. Zone 10.
348-130 — January 26, 1944.

Figure 4.2: Pantex Ordnance Plant fuse and booster line, January 1944. During World War II, approximately 60% of production line employees at Pantex Ordnance Plant were female. Employment levels during World War II peaked in 1942 at 5,254 employees.

4.4), and preservation either in place or through documentation.

Although the Plant's World War II-era resources have been surveyed and national- and local-level historic contexts are being developed, the process of consultation with the SHPO and the Advisory Council to determine the eligibility of these resources for the National Register has not been completed. The Plant's CRM staff are now developing a programmatic approach for managing those historic World War II-era resources that are determined to be eligible for the National Register.

4.3 Historical Cold War-Era Resources

The NHPA typically applies only to historical properties that are 50 years old or older, unless those properties are associated with events that have made a significant contribution to the broad patterns of our history (36 CFR 60.4). The Cold War is one such event. Pantex Plant operations were associated with the Cold War from 1951 through 1991. As the final assembly, maintenance, distribution, and disassembly facility for the nation's nuclear weapons arsenal, Pantex Plant lies at the heart of Cold War history. The historical resources of this period, such as the

Figure 4.3: **This photograph taken January 26, 1944, depicts the interior of Building 10-9 used in the production of 105-mm artillery shells**

Figure 4.4: **This photograph taken January 26, 1995, shows the same building 51 years later, now used for storage of excess Plant equipment.** The important character-defining features related to industrial architecture, generous floor-to-ceiling height and exposed truss system, have been retained.

"Gravel Gerties" (Figure 4.5), are among the Plant's most significant and offer a potential contribution to the nation's cultural heritage. A Cold War-era historic context statement and historical resource surveys pertinent to this period will be completed by 1997.

4.3.1 CRM Activities

The history of the Cold War, as a single event, is a relatively new topic for Pantex Plant and for historians as a profession. The end of the Cold War initiated the study of CRM issues at Pantex Plant surrounding this topic. The study began in 1994 and is in the strategic planning stages.

4.3.2 Management

Cold War-era resources are being treated as though they are eligible for the National Register and managed case by case until the CRMP is implemented. In line with published Advisory Council guidance, management is based on a philosophy of coexistence between the Plant mission and preservation.

4.4 Historical Documents and Artifacts

Many documents, photographs, maps, drawings, records, and artifacts pertinent to interpretation of prehistoric and historic activities exist at

Pantex Plant. However, their identification and evaluation is potentially more complex than the identification and evaluation of archeological sites and historical structures. In addition, the regulations for protection of these resources are less explicit. At present, various offices at the Plant have responsibility for these resources, but the responsibilities are now being coordinated to effect NHPA compliance.

Contacts with various Plant organizations have been initiated with the goal of coordinating the protection and compliance efforts for these historical properties. The Records Management Department has completed a Plant-wide inventory of official documents. This information has been organized into a database that distinguishes between documents older and newer than 30 years, in accordance with National Archives and Records Administration regulations.

Figure 4.5: The "Gravel Gertie," designed and tested at Pantex Plant, is one example of a Cold War-era structure

Notes for Chapter 4

1. The term *isolated occurrence*, or IO, is used to refer to a location where one or a few similar artifacts are found but where too little evidence is present for the location to be considered an archeological site.

Chapter 5

NATURAL RESOURCES

A variety of natural resources have been identified at Pantex Plant, both on U.S. Department of Energy (DOE)-owned land, including Pantex Lake, and on DOE-leased land. These natural resources include the Plant's surface waters and playa wetlands, groundwater, soils, air, flora, and fauna, as well as the complex ecosystems of which they are part.

A continuous improvement team representing different operational divisions of the Plant was established in March 1994 to identify ways to address natural resource needs. The team presented its recommendations to Plant management in November 1994. These recommendations focused on the creation of a Natural Resource Council to consider Plant-wide issues and to review and recommend actions necessary to protect natural resources and to ensure that the Plant complies with federal, state, and local statutes and regulations.

5.1 Land Use

The Southern High Plains in which Pantex Plant lies offers only slight relief expressed as playa basins. In this semiarid region, playa lakes are typically ephemeral, yet highly productive. Topography has determined land use, influencing where industrial facilities are sited on the uplands and leaving the remainder to be used by Texas Tech University for agriculture. Under Texas Tech University management, the nonindustrial uplands have been cultivated in a cropping/fallow rotation, and the playas and their floodplains have been used as rangeland.

Pantex Plant includes short-grass prairie, farmland, and four playas on the 4,119 hectares (10,177.1 acres) of DOE-owned land including Pantex Lake, and two playas on the 2,370 hectares (5,800.2 acres) of land leased from Texas Tech University. The DOE-owned land includes approximately 1,216 hectares (3,004 acres) dedicated to industrial operations (e.g., buildings, roads, parking areas, and mowed grass areas); 1,747 hectares (4,317 acres) under cultivation; and 720 hectares (1,779 acres) used for domestic livestock grazing. The 436 hectares (1,077 acres) at Pantex Lake are used for domestic livestock grazing and farming. Land uses are shown in Figure 5.1.

Future Pantex Plant mission-related requirements for facilities and land are identified in the Pantex Plant site development plan (Mason & Hanger 1994b) and the capital asset management process report (Mason & Hanger 1994a). Potential impacts on the Plant's natural resources have been considered in the planning process.

Most of Pantex Plant's nonindustrial areas are under cultivation by Texas Tech University or by farmers leasing from Texas Tech University. Because farming practices often involve routine use of pesticides and fertilizers, pesticide drift and stormwater runoff that carries pesticides and sediment load are concerns in protecting surface waters, especially the playa areas. A plan that establishes guidelines for use of those chemicals currently applied to Pantex Plant land is being developed.

5.2 Surface Waters and Playa Wetlands

The six playas at Pantex Plant are the site's surface water resources (Figure 1.1). Four of these playas (Playas #1, #2, and #3, and Pantex Lake) are DOE-owned. Playas #4 and #5 are on Texas Tech University property leased by DOE. Playa #1 receives continuous wastewater effluents from the Wastewater Treatment Facility; it is the only playa that contains water permanently. Playas #1, #2, and #4 receive

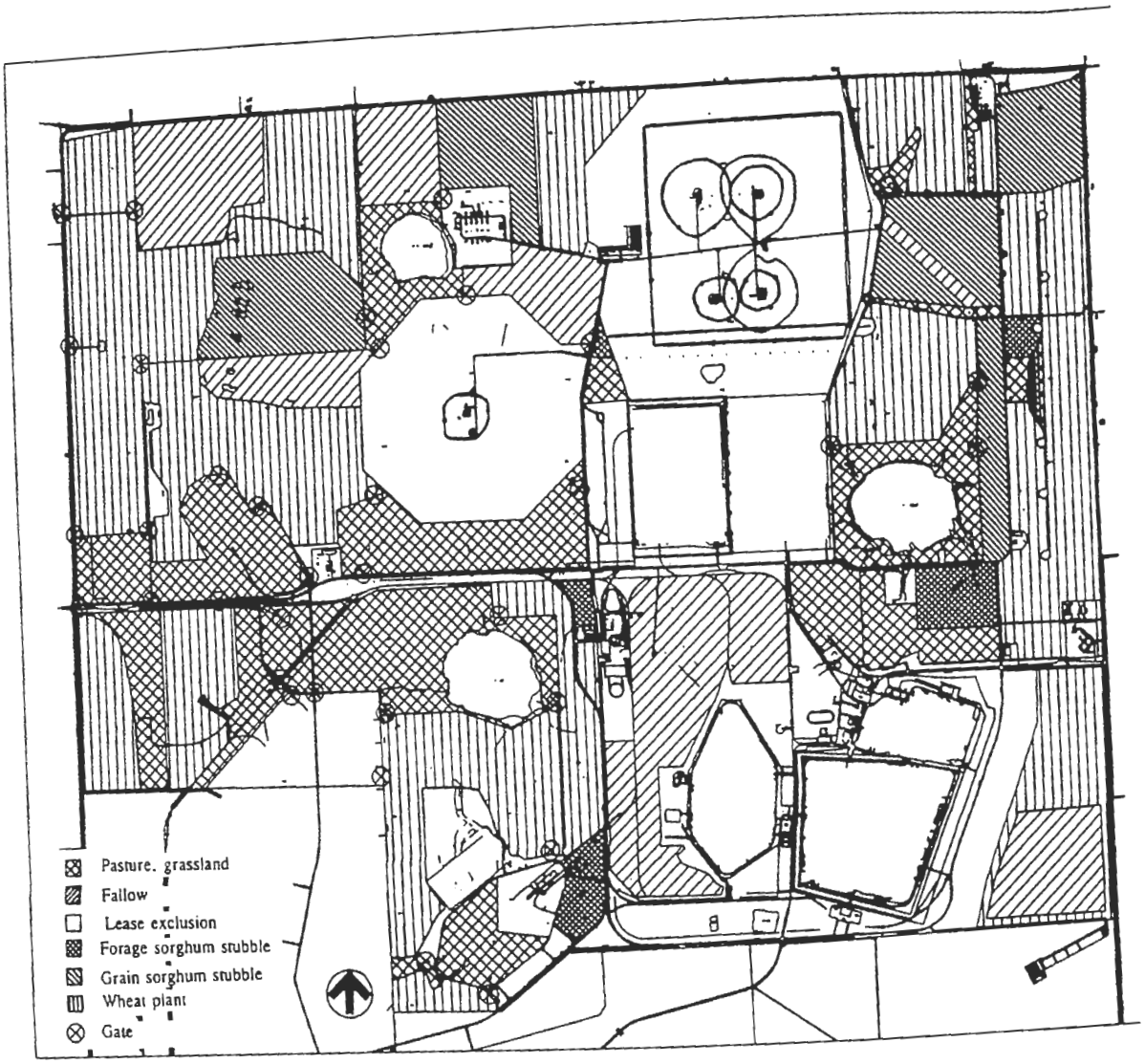


Figure 5.1: Land use at Pantex Plant

occasional industrial and stormwater effluents from Pantex Plant's industrial areas. Playa #3 receives stormwater from the Burning Ground. All six playas receive stormwater runoff from Texas Tech University agricultural areas. The water quality of Playas #1, #2, #3, #4, and Pantex Lake is discussed in Chapter 11. Site characterization studies at Pantex Plant have documented recharge from the surface to groundwater; therefore, maintaining the quality of surface water is critical to protecting groundwater.

Because water quality in the playas is important to waterfowl, shorebirds, and marshbirds, as well as other wildlife, actions that may impact wetlands and floodplains are evaluated through a process that includes public involvement (10 CFR 1022). In 1994, wetlands assessments were performed at Playa #5 and Pantex Lake (Battelle 1994a).

Texas Tech University returned management of the DOE-owned Playa #2 to DOE in October 1994. At that time, grazing at the playa was discontinued and a plan for managing the playa was developed. Management is intended to increase biological diversity, control erosion, protect cultural resources, and provide habitat for migratory birds and wildlife, as well as for those species designated as federal or state threatened or endangered species.

Guidance for playa management was finalized in the *Interim Guidance Document for Pantex Plant Playas* (Triebel et al. 1994) following public review and comment. The guidance identifies issues involving Pantex Plant wetlands and floodplains and recommends specific management actions.

5.3 Groundwater

The Ogallala aquifer, which is also known as the High Plains aquifer, lies below the perched aquifers and underlies the Plant. The Ogallala aquifer provides water for Plant operations, irrigation, and drinking. Conserving and protecting the water quality of this regionally important aquifer is an important focus of the groundwater protection management program plan (Mason & Hanger 1993b). Groundwater monitoring and surveillance data are discussed in Chapter 9; those specific to drinking water are discussed in Chapter 10.

5.4 Soils

Surface soils at Pantex Plant consist mainly of Randall clay and Pullman clay loam, with areas of Estacado, Lofton, and Pep clay loams. Subsurface soils are considered part of the Ogallala and Blackwater Draw Formations. The Pullman clay loam series dominates uplands and Randall clay dominates the playa bottoms. Areas of Estacado, Lofton, and Pep clay loams are found in sloping areas surrounding playa bottoms. Environmental surveillance and monitoring results for soil are described in Chapter 12.

5.5 Air

Pantex Plant is located within Air Quality Control Region No. 211, a 39-county area. The region has been classified by the U.S. Environmental Protection Agency (EPA) as attaining all national air quality standards for which the area could be evaluated (EPA 1991a). Current emissions from the Plant are below levels that would classify it as a "major" source of air pollution. Pantex Plant activities that result in air emissions are subject to emission limits specified in state permits and permit exemptions, as described in Chapter 2. Radionuclide emissions are regulated as hazardous air pollutants by EPA. Pantex Plant operations routinely release less than 1% of the emission level allowed by the regulations (see Chapter 7 for details for 1994). Air monitoring results are presented in Chapter 8.

5.6 Flora and Fauna

As has happened across most of the Southern High Plains, agricultural and industrial activities have reduced biological diversity at Pantex Plant. The only remaining areas of native habitat are small and primarily centered on the Pantex Plant playas, as an aquatic habitat at Playa #1 and as wetlands and short-grass prairie upland in and around all six playas. The playa areas managed by Texas Tech University have been intensively grazed. Plant operations in several industrial areas, such as the Burning Ground and firing sites, have precluded agricultural activities and therefore provide some protection for native habitat. As a result, species of barrel cactus and

the Texas horned lizard have been found in localized areas.

This section provides descriptions of the floral and faunal species found at Pantex Plant. Results of floral sampling are discussed in Chapter 13. No faunal samples were analyzed for environmental contaminants in 1994.

5.6.1 Floral Species

During field surveys at Pantex Plant in May, July, and September 1993, 230 floral species were identified (Johnston and Williams 1993). Because the surveys focused on natural areas of the Plant, the playas were strongly represented. However, historical areas such as Pantex Village and the Zone 3 bunkers were also surveyed. Many of the species found were non-native, weedy species, and many native species were represented by only a few individuals.

No floral species protected by the federal or state Endangered Species Acts were found. However, several species of barrel cactus were noted. Because of their rarity and the continuing loss of habitat throughout their range, a management strategy of protecting these cactuses and their habitats has been adopted at Pantex Plant. The green-flowered barrel cactus *Echinocereus viridiflorus* var. *viridiflorus* is the rarest species at Pantex Plant, represented by a single population at Playa #1. A variety of the species is protected by the federal and state Endangered Species Acts.

Another barrel cactus, the more common cerise-flowered *Coryphantha vivipara*, grows on the slopes and short-grass prairie uplands at all six Pantex Plant playas, the Burning Ground, and the firing sites. This cactus is found throughout the rangeland of the Canadian River breaks.

5.6.2 Faunal Species

Several animal field surveys were initiated during 1994. A general animal survey by Rylander (1994) in 1993-1994 provided an initial species listing of animals at Pantex Plant. The report lists a total of 65 species, including protistans and invertebrates, amphibians, reptiles, birds, and mammals.

Mazeroll et al. (1994) conducted field surveys to identify amphibians and reptiles during the summer of 1994; few amphibian species were found, in part due to the lack of precipitation during the survey period. One Texas horned lizard (*Phrynosoma cornutum*), a state-listed threatened species, was encountered.

To evaluate effects of land-use practices on invertebrates in the playa wetlands and to obtain information for future land-use management decisions, an aquatic invertebrate study was initiated in 1994. Zooplankton, insects, and other macro- and micro-invertebrates were identified. Because of inadequate rainfall in some of the playa basins in 1994, the project will continue in 1995.

Migratory birds are an important part of Pantex Plant natural resources. Bird migrations vary from year to year, especially with changing environmental conditions. A bird checklist for Pantex Plant has been compiled by Seyffert (1994). The checklist provides a listing of species and their expected abundances at Pantex Plant during various seasons of the year, based on habitat types and knowledge of migrations through the local area.

Species listed as threatened or endangered, or those identified as candidates for listing, under the federal and state Endangered Species Acts and that are known or expected to reside at the Pantex Plant are listed in Table 2.6. Species of concern include migratory birds protected by the federal and state Migratory Bird Treaty Acts. Although some species of concern occasionally occur in the industrial and cultivated areas, they generally concentrate in the natural areas.

The largest concentrations of waterfowl occur at Playa #1. Hundreds of mallards (*Anas platyrhynchos*) and widgeons (*Anas americana*) and lesser numbers of Canada geese (*Branta canadensis*) winter on the water and in the cattail cover at Playa #1. Playa #1 is used seasonally by many other species, the most notable being the bald eagle (*Haliaeetus leucocephalus*), red-tailed hawk (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*), white-faced ibis (*Plegadis chihi*), black-crowned night heron (*Nycticorax nycticorax*), yellow-crowned night heron (*Nyctanassa violacea*), eared grebe (*Podiceps nigricollis*), canvasback duck (*Aythya valisineria*), and Wilson's phalarope (*Phalaropus tricolor*).

Depending on precipitation and quality of habitat, different playas provide different habitat to various species. Playas #2, #3, #4, and Pantex Lake supported greater numbers of small rodent species than did Playa #1, which contains permanent water, during the 1994 animal surveys. Birds of prey are also commonly seen in those playas that contain water only seasonally. Although white-faced ibises are occasionally seen at Playa #1, they are most common during spring and fall migrations at Playas #2 and #4. Black terns (*Chlodonias niger*) have been seen only at Playa #4.

The short-grass prairie uplands surrounding Playas #2, #3, #4, and #5 support prairie dogs (*Cynomys ludovicianus*). Prairie dog towns at Pantex Plant (Figure 5.2) make up an important ecological community and form part of the wintering habitat for bald eagle, golden eagle (*Aquila chrysaetos*), ferruginous hawk (*Buteo regalis*), and rough-legged hawk (*Buteo lagopus*). In summer, prairie dog towns provide nesting sites for burrowing owls (*Athene cunicularia*). Swift foxes (*Vulpes velox*) are known to den near prairie dog towns, although none have been seen at Pantex Plant since 1970. Migrating mountain plovers (*Charadrius montanus*) and other grassland birds also use prairie dog towns as seasonal habitats.

The Texas horned lizard is also found in the short-grass prairie uplands surrounding all playas. Few individuals are seen at Pantex Plant, but they do occur in the firing site area west of Zone 4 and in the playa areas. Conversion of native grassland to improved pasture or cropland and use of insecticides are reported to hurt Texas horned lizard populations (Stone 1993).

Occasionally wildlife is trapped and removed from industrial areas. During 1994, two striped skunks (*Mephitis mephitis*) and one badger (*Taxidea taxus*) were live-trapped in industrial areas and released at Playa #1. The relocations were in accordance with a letter of authority issued to Pantex Plant by the Texas Parks and Wildlife Department.

Two injured American kestrels (*Falco sparverius*) were found in 1994. On September 19, an injured kestrel was found near the Old Sewage Treatment Plant at the northeast corner of the Plant. An injured wing was repaired at Timbercreek Veterinary Clinic, and the bird was released a few weeks later. The injured wing of another kestrel found at Building 11-5 on December 6 was unrepairable and the bird was euthanized at the clinic.

Diagnostic investigations are sometimes used to determine causes of animal deaths. These investigations are to determine whether operations are impacting certain animals or to identify any epidemics early so that actions can be taken to protect the rest of the population. An American widgeon was found dying at Playa #1 on February 20, 1994. The bird was taken to Texas A&M Diagnostic Laboratory to determine the cause of death, which was *Pasteurella multocida* septicemia/bacteremia. The disease is not uncommon and at times can reach epidemic proportions. Because the disease was observed in only one bird, it was not considered a problem this time.

On November 9, 1994, a dead spotted skunk was found alongside a road adjacent to the Pantex

Plant Zone 12 industrial area. Although the specimen looked like a western spotted skunk (*Spilogale gracilis*), Pantex Plant is outside its known range. The range of the closely related eastern spotted skunk (*Spilogale putorius*) includes Pantex Plant. Species/subspecies identification of the skunk is in progress at Texas A&M University in College Station, Texas.

5.7 Ecological Risk Assessment

Data on Pantex Plant's natural resources will be used to assess ecological risks and to select environmentally acceptable restoration strategies.

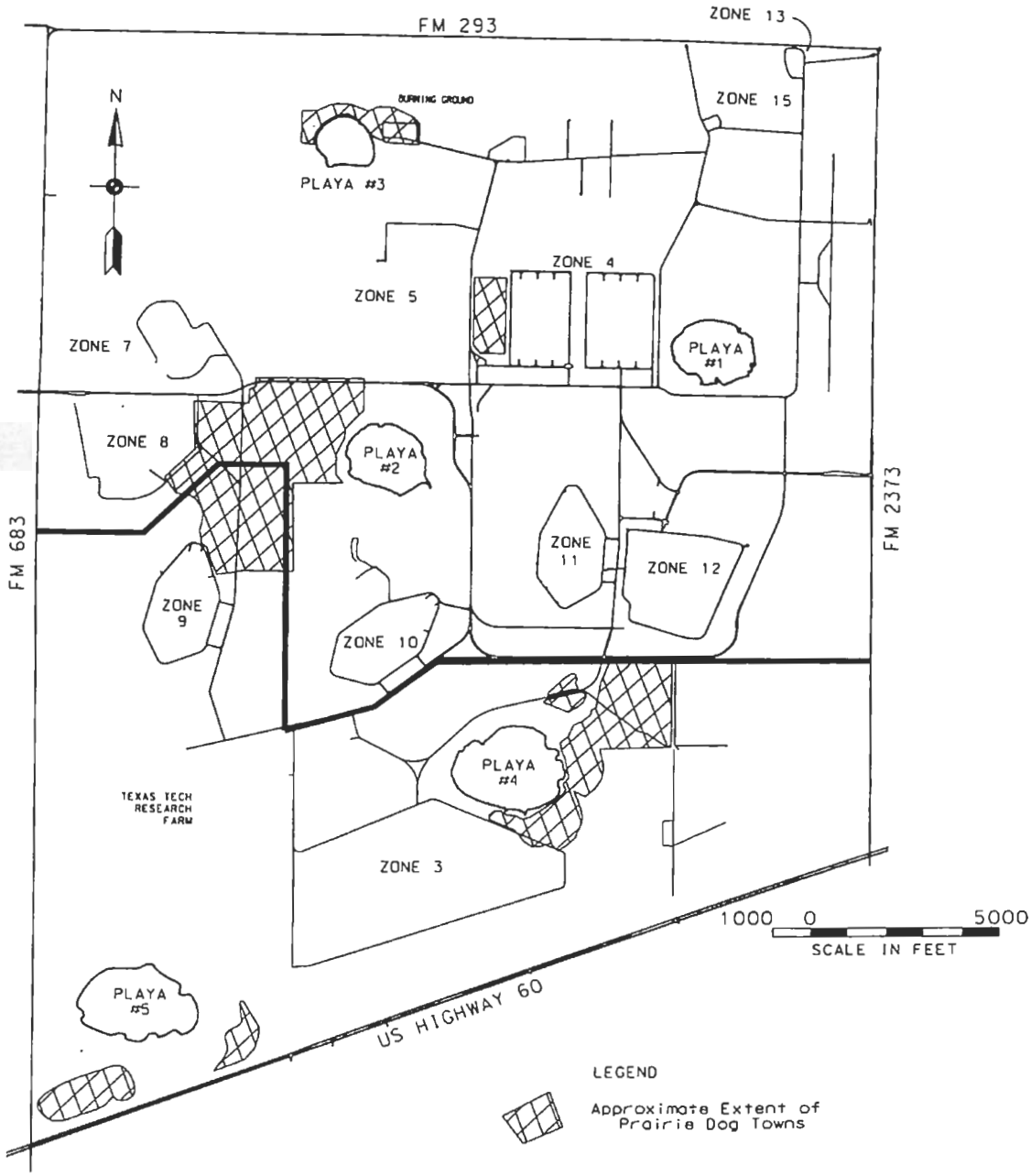


Figure 5.2: Prairie dog towns at Pantex Plant

Prairie dog (*Cynomys ludovicianus*)

Chapter 6

ENVIRONMENTAL RESTORATION

The scope and mission of the Pantex Plant Environmental Restoration (ER) program are to assess all inactive sites, determine the nature and extent of contamination, and perform remediation to eliminate any present or future threat to human health and the environment. The ER program is conducted in compliance with all regulatory requirements, with the goal of gaining acceptance by the public, regulatory agencies, and natural resource trustees. The ER program is detailed in the Pantex Plant Environmental Restoration Facility Action Plan (Mason & Hanger 1995b). The plan establishes aggressive remediation schedules, with a goal of initiating remediation at all sites by the year 2000, meeting the State of Texas' "Clean Texas 2000" initiative.

This chapter summarizes activities conducted in 1994 for the investigation of Resource Conservation and Recovery Act (RCRA) Solid Waste Management Units (SWMUs), expedited site characterization, management of underground storage tanks, technical development, and integration of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) efforts into existing activities. Closure activities for operating RCRA units are also described. The U.S. Army Corps of Engineers, Tulsa District, under an Interagency Agreement with the U.S. Department of Energy (DOE), provides technical support and carries out fieldwork in the SWMU investigations. Mason & Hanger provides oversight support to the DOE/Amarillo Area Office (DOE/AAO) for the SWMU investigations and has the lead for the other activities described below. Administration of the ER program is described in detail in Pantex Plant's five-year plan (Mason & Hanger 1994e) and the Environmental Restoration and Waste Management site-specific plan (Mason & Hanger 1992b).

In May 1994, Pantex Plant was added to the National Priorities List under CERCLA. Activities related to CERCLA are administered by the U.S. Environmental Protection Agency (EPA), and future restoration activities at Pantex Plant will be administered jointly by the Texas Natural Resource Conservation Commission (TNRCC) and EPA, which have signed a memorandum of understanding for activities at federal facilities. Pantex Plant is working with both agencies to develop a Federal Facility Agreement.

6.1 CERCLA Integration

In 1991, EPA conducted a Hazard Ranking System scoring of Pantex Plant, and in May 1994 EPA published formal notification in the *Federal Register* that Pantex Plant had been added to the National Priorities List. A tri-party Federal Facility Agreement is currently being negotiated by EPA, TNRCC, and DOE to outline the reporting requirements, schedules, and funding for the ER program under CERCLA.

6.2 SWMU Investigations

In January 1989, the EPA conducted a RCRA facility assessment to identify SWMUs (defined as any unit from which hazardous constituents may migrate) that might require investigation and/or corrective action under the 1984 Hazardous and Solid Waste Amendments to RCRA. In September 1989, a draft Administrative Order on Consent, pursuant to Section 3008(h) of RCRA, was issued. The Order was issued as final in December 1990. However, the Corrective Action section of the Order was incorporated into a RCRA permit (TX-4890110527; HW-50284) issued jointly by EPA and the TNRCC in April 1991.

The Order identified 144 SWMUs and areas of concern. Based on their sources of contamination, 113 of the 144 original SWMUs and areas of concern were combined into 14 SWMU groupings, to which underground storage tanks were added. These groupings are undergoing investigation on independent schedules.[1] The RFIs determine the nature and extent of any releases and provide data that will be used during corrective measures studies. The corrective measures studies evaluate the potential options for remediation and recommend an option. If required, a design phase is conducted, and ultimately the corrective measures are implemented.

The primary contaminants of concern resulting from the formulation and processing of explosives are organic solvents and explosive compounds. Additional contaminants detected are those typically found at manufacturing facilities, such as those generated by vehicle maintenance, photographic and chemistry laboratories, machine shops, metal plating operations, and painting operations. Testing of explosives and explosive components has also resulted in the potential for radiological contamination at some SWMUs.

Past Plant activities have resulted in some contamination of surface and subsurface soils and of the perched aquifers that underlie portions of the Plant. Contaminated areas range in size from several cubic meters of soil to hectare-meter (acre-feet) volumes in the perched aquifers. Although the perched aquifers under Pantex Plant have some contamination, they are not used for either agricultural or domestic purposes. The perched aquifers are separated from the Ogallala aquifer by a zone of fine-grained sediments that forms a vertical barrier to downward migration of the contaminants. To date, no contamination of the Ogallala aquifer from DOE operations has been detected at Pantex Plant.

Work plans for all RFIs have been approved by the TNRCC. Field investigations have been initiated at 13 of the 14 sites. Data already collected on many of the SWMUs are sufficient to allow recommendation of either no further action or interim corrective action. An initial review of the current data by the TNRCC indicates that most sites can be remediated to Risk Reduction Level 1 or 2.[2] The current status of each SWMU grouping is summarized below. All wells constructed in support of the ER program are shown in Figure 6.1.

6.2.1 AL-PX-1 — Burning Ground

The SWMUs at this site include the former chemical burn/solvent evaporation pit, burning pads for explosives, and Burning Ground landfills. The Phase I RFI fieldwork has been completed. Contamination has been found to be limited to the top 6 meters (20 feet) of soil. The highest concentrations of contaminants were found in the landfills; contaminants have not migrated past the landfill boundaries. Phase II fieldwork, which included one additional soil boring to complete the characterization of the chemical burn pit and additional water sampling, has been completed. However, data from the Phase II fieldwork were not submitted in 1994.

6.2.2 AL-PX-2 — High-Priority Potential Release Sites

This grouping of industrial sites consists of five SWMUs, an area of concern, and three firing sites. Two separate phases of investigation were completed, and a draft RFI report was prepared for eight of the nine sites in 1994. No further action was recommended for six sites, and interim corrective actions were recommended for the Building FS-16 Surface Impoundment and Sump and for the FS-22 Container. It is expected that interim corrective action will also be recommended for the Building 12-68 Concrete Sump.

6.2.3 AL-PX-3 — Former Cooling Tower

The former cooling tower was used in the water cooling of machining operations of explosives

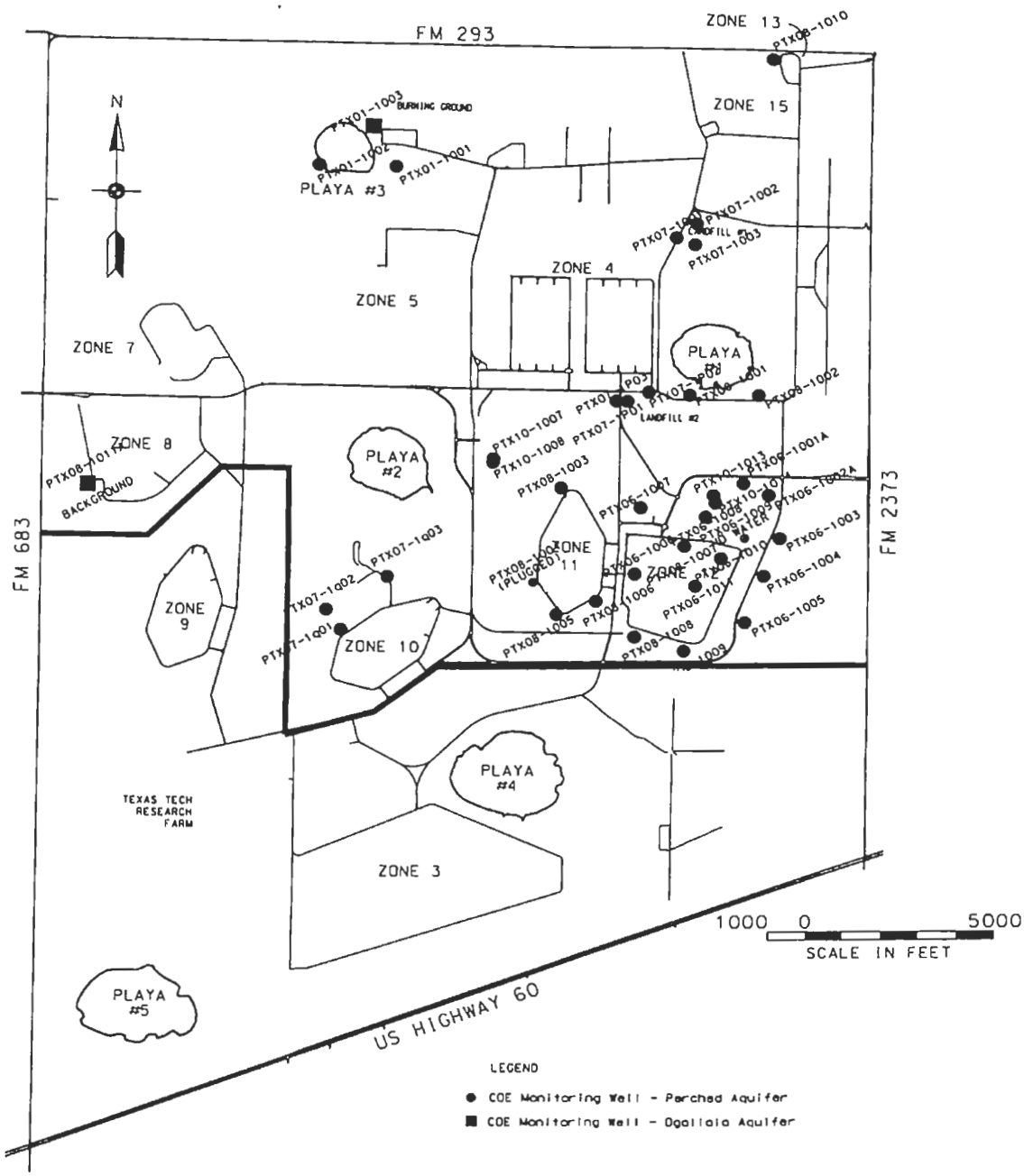


Figure 6.1: **Locations of monitoring wells constructed in support of the Environmental Restoration program**

from 1950 to 1964. The unit was dismantled in the early 1970s and only a concrete slab remains. Phase I fieldwork was completed in 1993. Contamination did not exceed Risk Reduction Level 2. An RFI report recommending no further action was prepared and submitted to the TNRCC. Regulatory approval is pending. Additional sampling in March 1995 will address the ancillary underground piping that connected the cooling tower and Buildings 12-17E and 12-19E.

6.2.4 AL-PX-4 — Old Sewage Treatment Plant Sludge Beds

The Old Sewage Treatment Plant operated from 1942 until 1987. The Old Sewage Treatment Plant received wastewater from the Amarillo Air Base and the Pantex Ordnance Plant during World War II and later from Pantex Plant. The Phase I fieldwork has been completed, and contamination did not exceed Risk Reduction Level 2. The draft final RFI report recommending no further action was submitted to the TNRCC in June 1994. Regulatory approval is pending.

6.2.5 AL-PX-5 — Fire Training Area Burn Pits

This site was used by the Pantex Plant Fire Department as a fire-extinguishing training area. Various solvents, chemicals, and fuels were ignited and extinguished in the training process. Phase I fieldwork was completed in 1993. Contamination was found to be localized and confined to the top 1.5 meters (5 feet) of soil. A risk assessment is expected to be performed, followed by a request for an interim corrective measure. The interim corrective measure would make it possible to attain Risk Reduction Level 1, and the results are expected to support a request for no further action.

6.2.6 AL-PX-6 — Zone 12 Groundwater

This SWMU comprises all contamination in the perched aquifer associated with Zones 11 and 12. The perched groundwater is 30-60 meters (100-200 feet) above the Ogallala aquifer. The contaminants detected in the perched groundwater, at concentrations above the decision criteria, include trichloroethene, benzene, dichloroethane, explosive compounds, total chromium, and hexavalent chromium. Phase I fieldwork was completed in early 1993. Phase II fieldwork is ongoing, and a study has been proposed to determine whether *in situ* bioremediation could be used for remediation of the groundwater and saturated and unsaturated soils.

6.2.7 AL-PX-7 — Landfills

Onsite landfills have been used to dispose of sanitary and industrial wastes at the Plant since 1942. Sixteen inactive landfills are located throughout the Plant, with a majority being located in Zones 11 and 12. Phase I fieldwork has been completed and the preliminary data have been validated and finalized. Phase II fieldwork will be conducted at several of the landfills to further determine the depth of contamination.

6.2.8 AL-PX-8 — Ditches and Playas

This SWMU grouping consists of a network of ditches that carry wastewater effluent and surface runoff from buildings in Zones 11 and 12, the Old Sewage Treatment Plant, and the Burning Ground to five playas. Phase I and Phase II fieldwork has been completed. Preliminary data from Phase I fieldwork have been validated and finalized. Data from Phase II fieldwork have not yet been submitted. It is anticipated that interim corrective measures will be required for two of the 12 SWMUs in this grouping.

6.2.9 AL-PX-9 — Firing Sites

This SWMU grouping consists of seven firing sites that have been in operation since 1952. The sites have been used for testing of explosives. Five of the firing sites are active and two are inactive. Phase I fieldwork is scheduled to start in April 1995.

6.2.10 AL-PX-10 — Leaking Underground Storage Tanks

This group comprises two sites where gasoline may have been released near Buildings 12-35 and 16-1. Underground storage tanks were used to store gasoline, diesel fuel, and used motor oil. Five underground storage tanks were removed from Building 12-35 in 1988, and two were removed from Building 16-1 in 1989. Phase I and II fieldwork has been completed. A draft final corrective action plan proposing no further action was submitted in October 1994. Although benzene concentrations below Building 12-35 in the perched aquifer exceed the Texas Risk Reduction Levels, that issue will be addressed as part of the Zone 12 Groundwater (AL-PX-6) assessment.

6.2.11 AL-PX-11 — Miscellaneous Explosive/Radiation Sites

This SWMU grouping consists of 12 sites, including a temporary burning site for explosives, radioactive residue storage, a subsurface leaching bed and settling pits for trinitrotoluene (TNT), two buildings where explosive-contaminated wastewater was filtered, and the soil surrounding a building where explosives were fabricated. Phase I fieldwork is ongoing.

6.2.12 AL-PX-12 — Miscellaneous Chemical Spills/Releases

This grouping includes 4 SWMUs, 17 areas of concern, and 4 other sites in Zones 4, 10, 11, and 12. No signs of contamination were found at Area of Concern 2, and TNRCC approved no further action on that site in September 1993. Phase I fieldwork for the remaining sites was completed in September 1994. Contamination at 15 of the sites falls below Risk Reduction Levels 1 and 2, and the sites are therefore being considered for no further action. Corrective actions for the remaining sites per Risk Reduction Level 1 or 2 are being considered through seven interim corrective measures and two treatability studies.

6.2.13 AL-PX-13 — Supplemental Verification Sites

This grouping originally consisted of eight SWMUs, including five landfills, a denuded area, parallel depressions, and the old pistol range. The pistol range is still in operation and was removed from the ER program. The abandoned landfill in Zone 10 was transferred from this grouping to the Landfills group (AL-PX-7) for investigation. Phase I fieldwork was completed in 1993. The option of no further action for these sites is being considered by the TNRCC.

6.2.14 AL-PX-14 — Underground Storage Tanks at Other Locations

This grouping consists of diesel storage tanks for emergency power generation and one waste oil tank. Phase I fieldwork has been completed, and no further action has been recommended for all but one underground storage tank (#9). Additional fieldwork has been conducted at this underground storage tank and a demonstration of *in situ* treatability has been proposed to the TNRCC.

6.3 Expedited Site Characterization

Argonne National Laboratory is performing an expedited site characterization of the perched groundwater beneath Zone 12. The goals of the expedited site characterization are to determine the extent and direction of flow, distribution of contaminants, recharge processes and migration pathways, and the potential for contamination of the underlying Ogallala aquifer. Fieldwork is ongoing and a final report outlining Argonne's findings is anticipated in April 1995. In its characterization work, Argonne is using various technologies, including resonant sonic drilling and cone-penetrometer technologies.

6.4 Underground Storage Tank Management

Underground storage tank management activities continued during 1994. Two underground storage tanks are registered with the TNRCC and comply with current regulations. No underground storage tanks were removed or installed during 1994. A detailed report of the Underground Storage Tank Borehole Drilling Program investigation was forwarded to the TNRCC in the first quarter of 1994. One of the 13 former underground storage tank locations is scheduled for further characterization in the third quarter of 1995.

6.5 Active RCRA Unit Closures

On July 6, 1994, DOE/AAO notified the TNRCC that it was implementing the closure plan for the Batchmaster, a treatment unit for metal ions, in Building 12-68. Closure activities were conducted during the fourth quarter of 1994. The Report of Closure and Certification will be submitted to the TNRCC during the first quarter of 1995.

Closure of tanks associated with Buildings 11-44 and 12-43 was not achieved in 1992 because residual contamination was found in the soils surrounding the tanks. The investigation and closure of these sites is included in the Explosive/Radiological Sites RFI approved by the TNRCC in August 1993. Fieldwork has begun and is currently ongoing. On September 8, 1994, the TNRCC accepted all scientific evidence submitted by DOE/AAO and Pantex Plant regarding closure pursuant to Risk Reduction Level 2. In response to a TNRCC request, a modified facility closure plan was submitted to the TNRCC for review on September 15, 1994. As of December 31, 1994, Pantex Plant was awaiting comment from the TNRCC.

6.6 Technical Development

The Pantex Plant ER team identified and implemented treatability studies on two contaminated sites in 1994. A study of biodegradation of explosive compounds is ongoing at Building 11-44. Injection and soil gas monitoring wells were installed at this site to determine whether *in situ* aerobic biodegradation of explosive compounds is a feasible remediation option at Pantex Plant.

One vapor extraction well and one soil gas monitoring well have been installed at a former underground storage tank site to determine whether total recoverable hydrocarbons can be extracted from the clayey near-surface soils at Pantex Plant. Installation of an extraction system at this site is planned for 1996.

Notes for Chapter 6

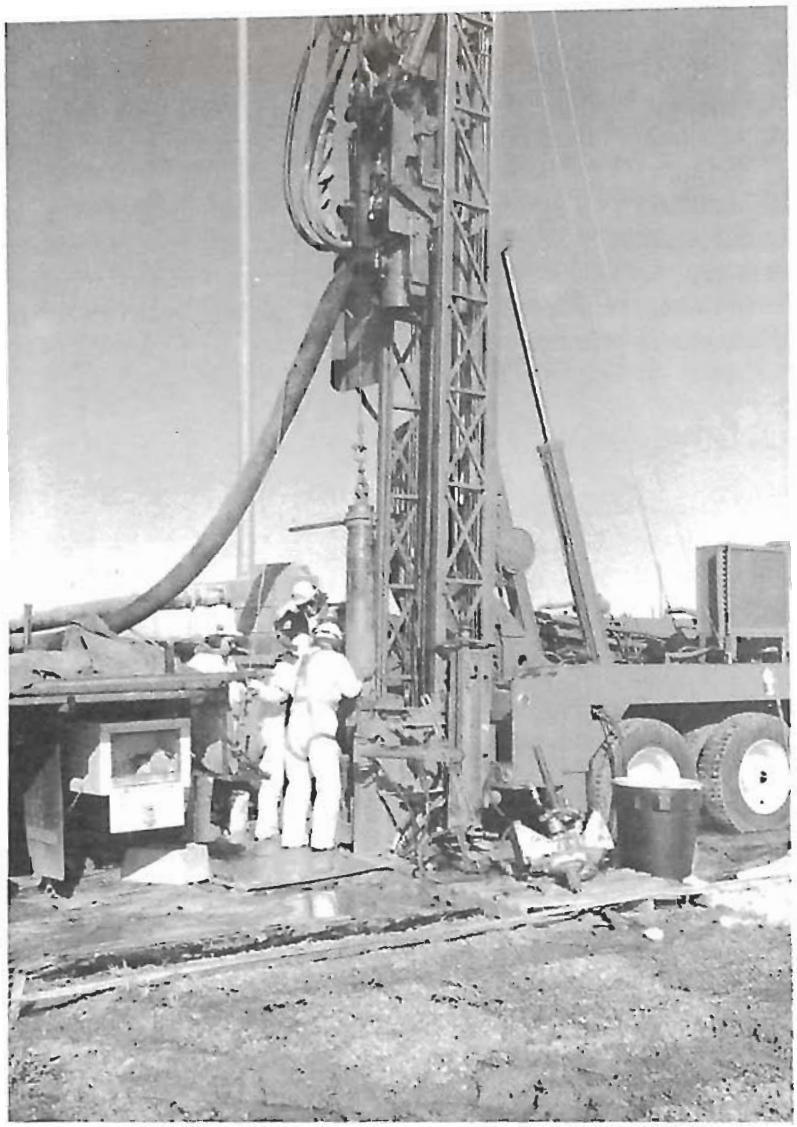
1. The remaining 31 sites were either active sites, non-RCRA sites, or sites that could not be located and verified in subsequent field surveys. These 31 SWMUs are being reviewed to verify that no contaminants are present at concentrations above action levels and then will undergo administrative closure.

2. The Texas Risk Reduction Rule, 31 TAC 335 Subchapter S, outlines three risk reduction levels to be considered relative to the corrective measures:

   Risk Reduction Level 1 — Closure/remediation to background — to remove and/or decontaminate all waste, waste residues, leachate, and contaminated media to background levels unaffected by waste management activities

Risk Reduction Level 2 — Closure/remediation to health-based standards and criteria — to remove and/or decontaminate all waste, waste residues, leachate, and contaminated media to meet standards and criteria such that any substantial present and future threat to human health and the environment is eliminated

Risk Reduction Level 3 — Closure/remediation with controls — to remove and/or decontaminate all waste, waste residues, leachate, and contaminated media to such levels and in such a manner that any substantial present or future threats to human health and the environment are eliminated or reduced to the maximum extent practicable.



Dual-walled air rotary percussion-hammer drilling rig, being used to install a monitoring well at Pantex Plant

Chapter 7

ENVIRONMENTAL RADIOLOGICAL MONITORING

Pantex Plant's environmental radiological monitoring program is conducted according to U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program." The program involves measuring radioactivity in environmental samples and then calculating the potential exposure or radiological dose to the offsite public. The program considers plutonium-239, uranium-234, uranium-238, and hydrogen-3 (tritium) in air, groundwater, surface water, soil, and flora samples. Plutonium-239, uranium-234, and uranium-238 emit primarily alpha particles, whereas tritium emits beta particles. Penetrating radiation from gamma radiation and X-rays are also evaluated. This chapter summarizes radiological emissions, unplanned releases, and potential associated doses to the public in 1994. Chapters 8 through 13 list the results of analyses for particular media. The full data are reported in a detailed compilation (Mason & Hanger 1995a). The results for offsite locations most probably reflect natural (background) conditions.

Radiological results are reported in customary units that are specific to different kinds of exposure and environmental media:

- Individual doses from airborne emissions of radionuclides are reported in millirem per year (mrem/year) or millisievert per year (mSv/year)
- Population dose is reported in person-rem per year or person-Sievert per year
- Penetrating radiation measurements are reported in mrem or mSv
- Exposures are reported in roentgen (R)
- Radioactivity measurements in air and water samples are reported in microcuries per milliliter (μCi/ml) or becquerels per milliliter (Bq/ml)
- Results for soil and flora are reported in microcuries per gram (μCi/g) or becquerels per gram (Bq/g).

Because radionuclides undergo radioactive decay randomly, measurements of a given sample will vary statistically. If the sample is measured repeatedly, even the same radiation detection instrument will register different results. The difference is quantified as the intrinsic counting error. The accuracy of measured environmental concentrations depends on the intrinsic counting error. At Pantex Plant, a 95% confidence level is used, meaning that 95% of the results are assumed to be within two standard deviations of the mean (presented as a "$\pm$" value in the tables).

7.1 Radiological Emissions and Doses

Figure 7.1 illustrates all possible environmental pathways for material released from Pantex Plant. No radioactive liquid effluents were released offsite by Plant operations. No Plant operations released radionuclides to the ground. Thus the only way radioactive material could reach beyond the Plant boundaries was through air (Table 7.1).

The U.S. Environmental Protection Agency (EPA) has published regulations relating to the air pathway in 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants" (NESHAP), Subpart H. Subpart H limits the radiological dose that can be received from DOE facilities to 10 mrem/year. The effective dose equivalent[1] was calculated using the EPA-approved CAP88-PC model (EPA 1992b). All calculations were performed for tritium, the only radionuclide that was released in 1994 (Table 7.1).

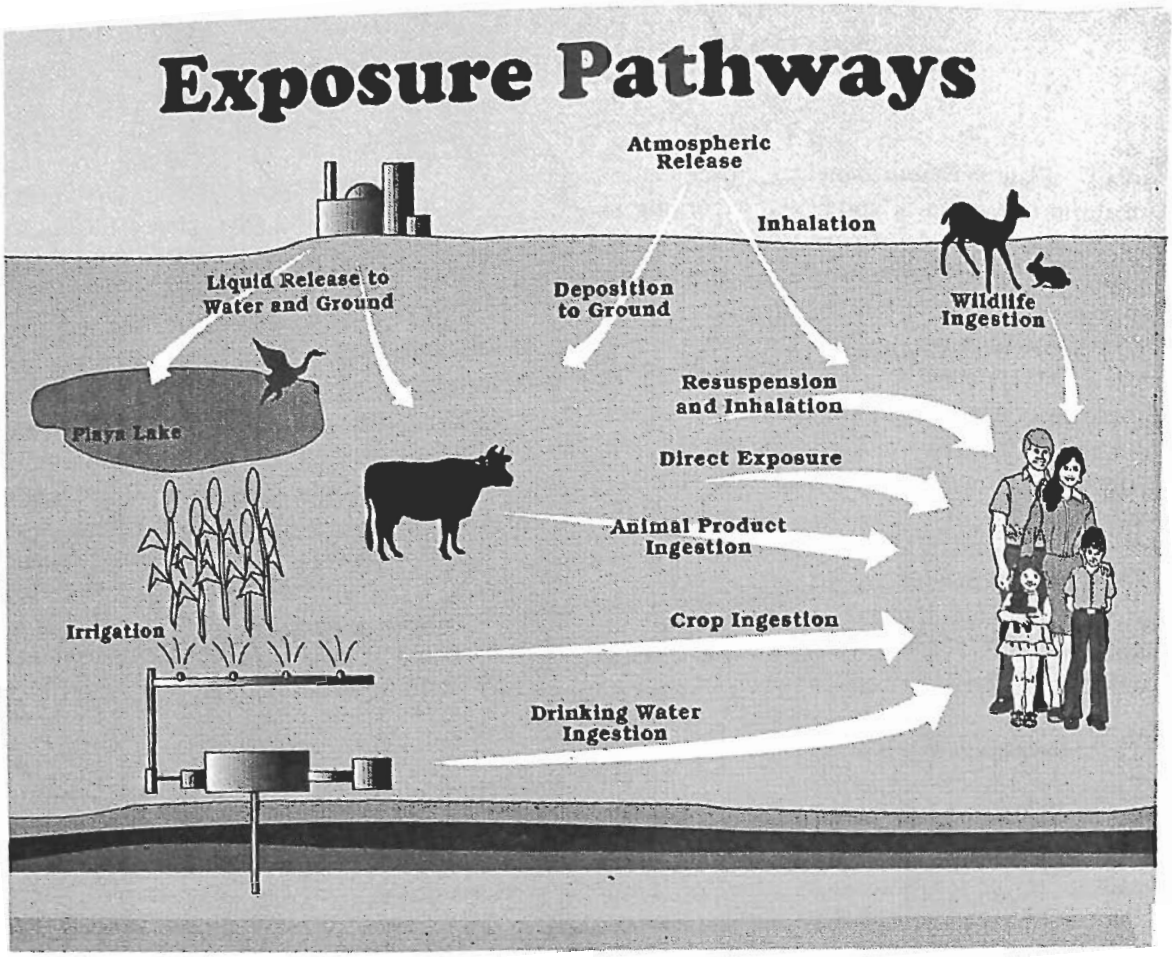


Figure 7.1: Possible pathways for environmental transport of radiation

Table 7.1 Releases to Environmental Pathways During 1994

Pathway	Radionuclide	Quantity Released	Maximum Individual Dose
Surface Water/ Groundwater	None	0	0
Ground	None	0	0
Air	Tritium[1]	4.46E-1 Ci (1.65E+10 Bq)	5.8E-5 mrem/year (5.8E-7 mSv/year)

[1] The half-life of tritium is 12.26 years.

In the past, meteorological data were obtained from the National Weather Service station at the Amarillo airport (Snyder 1993). In 1994, data came from a meteorological tower at Pantex Plant. Sensors at the tower automatically record average wind speed and direction every fifteen minutes. These data are incorporated into the CAP88-PC model.

The maximally exposed individual is a hypothetical person who would reside at the Plant's boundary and nearest the release point and who would therefore receive the highest effective dose equivalent from Plant operations. Distance affects the calculated effective dose equivalent; as distance increases, the effective dose decreases.

A 1,870-meter (6,233-foot) distance separates the closest release point in Zone 12 South from the nearest boundary fence. The nearest offsite neighbor's home actually lies 400 meters (1,300 feet) east-southeast beyond the fence. The shorter distance to the fence was used to obtain a conservative (worst-case) estimate. A maximally exposed individual who lived east-southeast of the Plant would have incurred an effective dose equivalent of 0.000013 mrem/year (0.00000013 mSv/year) in 1994.[2]

Similarly, an 800-meter (2,625-foot) distance separates the release point in the Burning Ground from the nearest boundary fence. Although the nearest offsite neighbor's home actually lies 100 meters (328 feet) northeast beyond the fence, the shorter distance to the fence was again used to obtain a conservative estimate. A maximally exposed individual who lived northeast of the Burning Ground would have incurred an effective dose equivalent of 0.000094 mrem/year (0.00000094 mSv/year) in 1994. If the effects of burning (the heat causing gases to rise) are specifically accounted for, the calculated effective dose equivalent for the maximally exposed individual in 1994 is 0.000058 mrem/year (0.00000058 mSv/year).

When Pantex personnel evaporated tritiated water jet fluid with the scrubbers in Zone 11, the evaporation caused an effective dose equivalent of 0.00000002 mrem/year (0.0000000002 mSv/year).

The effective dose equivalent that Pantex Plant is required to report to EPA is for the maximally exposed individual to the northeast of the Burning Ground, with the effects of burning accounted for. This value is substantially less than that permitted by 40 CFR 61, Subpart H. Air monitoring data (discussed in Chapter 8) substantiate the conclusion that the calculated dose at the locations assumed for the maximally exposed individual was not exceeded in 1994. Figure 7.2 compares the effective dose equivalent resulting from Pantex Plant operations to those from natural and artificial sources of radiation.

Table 7.2 lists the doses received by the population living within 80 kilometers (50 miles) of Pantex Plant. The value for the whole population is presented in units of person-rem, which refer to the product of the calculated dose equivalent for the maximally exposed individual in each compass sector multiplied by the number of people living in that sector. The population dose for the entire population within 80 kilometers of Pantex Plant totaled 0.000137 person-rem/year (0.00000137 person-Sv/year) in 1994.

During 1994, Pantex Plant operations released no radionuclides to surface water or groundwater. Tritium concentrations in surface water and groundwater at the Plant have historically averaged less than 0.00000005 μCi/ml (0.0019 Bq/ml), which is well below the limit of 0.0020 μCi/ml (74 Bq/ml) specified in DOE Order 5400.5, "Radiation Protection of the Public and the Environment." The historical average equals the concentrations found at the control location at Bushland, Texas.

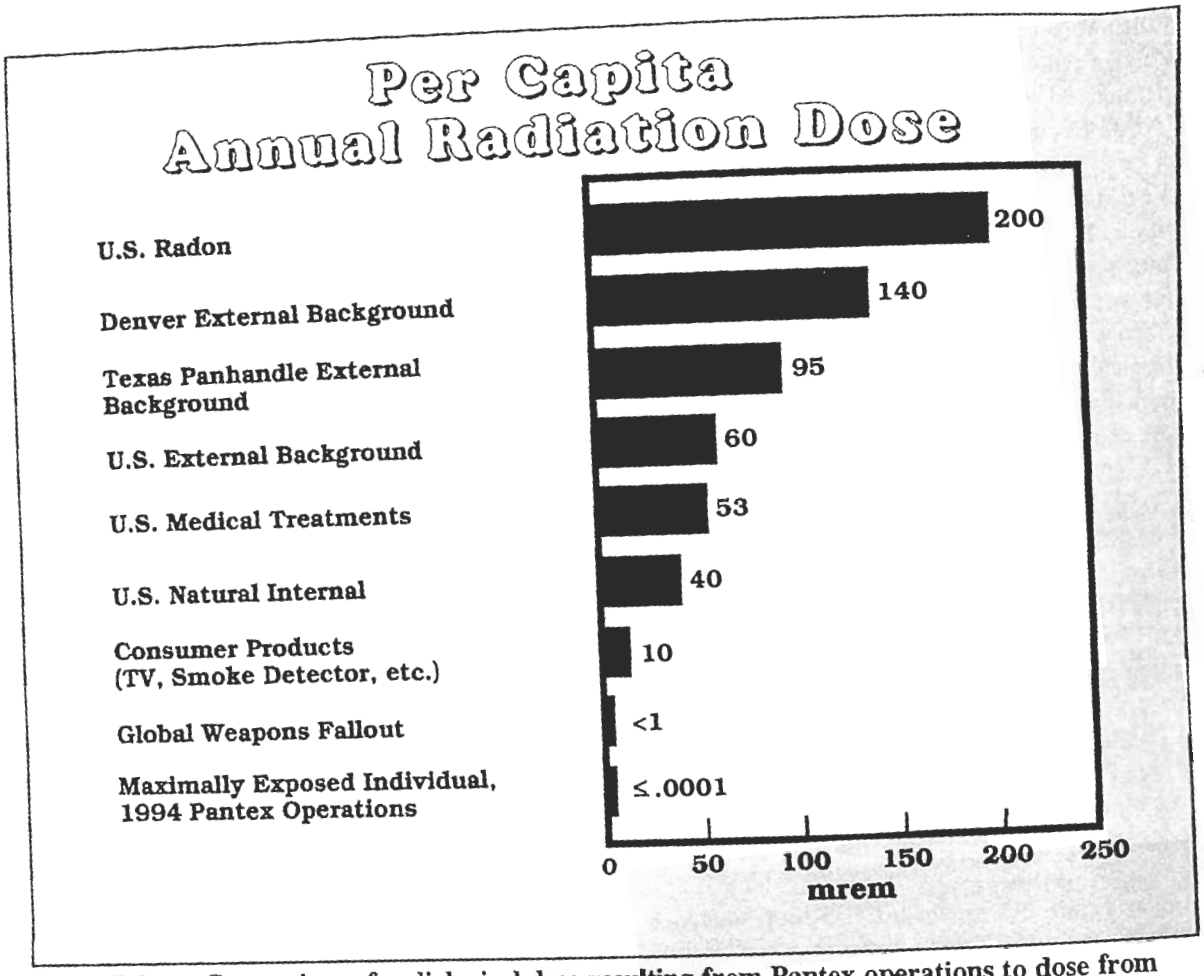


Figure 7.2: **Comparison of radiological dose resulting from Pantex operations to dose from other sources of radiation.** The sources shown are the average for radon in the United States, external background radiation, medical and internal doses, radiation from consumer products, and fallout from nuclear weapons (NCRP 1987a), as well as external background radiation in Denver (NCRP 1987b).

7.2 Unplanned Releases

No unplanned releases of radioactive material occurred at Pantex Plant during 1994.

7.3 Environmental Dosimetry

The environmental dosimetry program uses thermoluminescent dosimeters (TLDs) to measure gamma radiation and X-ray levels in the vicinity of the Plant. This program has been conducted in conjunction with the Texas Department of Health—Bureau of Radiation Control (TDH—BRC) since the early 1980s. During 1994, Pantex Plant and TDH—BRC co-sampled at nine locations, including two offsite, one onsite, and six along the perimeter fence. Plant monitoring activities were also conducted independently at

Table 7.2 1994 Environmental Doses

Receptor	Dose	Comments
Maximally Exposed Individual	5.8E-5 mrem/year (5.8E-7 mSv/year)	Air path, 800 meters northeast of Burning Ground (reported in annual NESHAP report)
Collective Population Dose[1]	1.37E-4 person-rem (1.37E-6 person-Sv)	Population of 275,000 within 80-kilometer (50-mile) radius
1994 Natural Background	95.4 mrem/year (0.954 mSv/year) average from offsite TLDs	Penetrating radiation as measured by TLD

[1] For population within 80 kilometers (50 miles) of Pantex Plant.

eight other locations offsite and six onsite. Table 7.3 lists Pantex Plant's environmental dosimetry locations, many of which coincide with air monitors. Figure 7.3 shows where the Pantex Plant and TDH—BRC dosimeters are deployed.

The TLDs contain lithium borate and calcium sulfate crystals. Four separate crystal elements are secured next to various filters. A hard plastic shell protects the elements from the weather. A lead filter selectively attenuates different types of radiation. As radiation strikes the dosimeters, crystalline structure of the TLD changes, and the crystal contains more energy than it would in its normal state. The TLD is taken to the Pantex Plant Radiation Safety Department laboratory, where an electric lamp is used to anneal (or heat) the TLD crystals and free the energy, which emerges as light. A photomultiplier converts the light into an amplified electrical pulse, which corresponds to the amount of radiation to which the crystal was exposed. The digitized electrical pulse is then mathematically converted to a dose. Correction factors in the conversion equation adjust for various filters, TLD crystal elements, and incident radiation.

Pantex Plant's TLDs are changed and analyzed at the end of each calendar quarter. Table 7.4 lists results for 1994. These results combine the shallow beta and penetrating gamma doses to indicate the dose absorbed by tissues. This combined dose is what a person who stayed at the TLD station continuously for the full quarter might receive from all sources. The average dose at offsite locations was 95.4 mrem/year (0.954 mSv/year), which is equivalent to natural background radiation levels. The average dose measured at the control location at Bushland was 93 mrem/year (0.93 mSv/year).

Table 7.5 lists doses measured by Pantex Plant and TDH—BRC personnel at co-sampled locations in 1994. The results agree, within an acceptable statistical range.

7.4 Environmental Measurement of External Radiation

In late 1994, after it had been on display at the Tri-State Fair in Amarillo, a Neighborhood Environmental Watch Network (NEWNET) station developed by Los Alamos National Laboratory was set up to monitor environmental radiation east of the weapons storage area in Zone 4 and to complement the existing environmental TLDs located in that zone. The NEWNET station's gamma detection equipment consisted of a high-pressure ionization chamber

Table 7.3 Thermoluminescent Dosimetry Monitoring Locations

Location	Description
Onsite	
PD-01	West of water well 17
PD-02	West of old water treatment building
PD-03	Southwest of water well 6
PD-04	Adjacent to north fence of east side of Zone 4
PD-05	Adjacent to Plant north fence on FM 293
PD-06[1]	East of Building 12-42
PD-07	Northeast of Building 4-26, west side of Zone 4
Offsite	
OD-01	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 4.8 kilometers (3.0 miles) west, 0.3 kilometers (0.2 mile) north, 0.3 kilometers (0.2 mile) west
OD-02	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 3.2 kilometers (2.0 miles) west, 2.1 kilometers (1.3 miles) north
OD-03	3.7 kilometers (2.3 miles) north of intersection of FM 2373 and FM 293
OD-04[1]	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 3.2 kilometers (2.0 miles) east, 1.6 kilometer (1.0 mile) north, 0.5 kilometer (0.3 mile) west, southwest corner
OD-05	2.4 kilometers (1.5 miles) east of intersection of FM 293 and FM 2373, 0.6 kilometer (0.4 mile) north
OD-06	6.6 kilometers (4.1 miles) east of intersection of FM 2373 and US 60, south fenceline
OD-08	3.7 kilometers (2.3 miles) south of intersection of FM 2373 and US 60, southeast corner of intersection at fence
OD-09[1]	Intersection of FM 683 and US 60, northwest corner
OD-10	3.5 kilometers (2.2 miles) west of intersection of FM 683 and FM 245, north fence
OD-13	Bushland Station
Fenceline	
FD-14[1]	1.0 kilometer (0.6 mile) west of intersection of FM 2373 and FM 293
FD-16[1]	3.4 kilometers (2.1 miles) west of intersection of FM 2373 and FM 293
FD-17[1]	Pantex West Gate, barbed wire fence immediately south of large Plant sign
FD-19[1]	3.5 kilometers (2.2 miles) south of Pantex East Gate on FM 2373, immediately north of railroad tracks
FD-20[1]	1.3 kilometers (0.8 mile) south of Pantex East Gate on FM 2373
FD-21[1]	3.2 kilometers (2 miles) north of Pantex East Gate on FM 2373

[1] Co-sampling location with Texas Department of Health—Bureau of Radiation Control.

and associated electronic units. A radio transmitter on the station periodically broadcast data to an orbiting geosynchronous satellite. The satellite relayed the data to Los Alamos National Laboratory, where it was collected and stored. The results for approximately 2,000 measurements taken by the NEWNET station located east of Zone 4 between December 1 and December 28, 1994, are illustrated in Figure 7.4. The average measurement is 12 microroentgens per hour (μR/hr). Some measurements differ from the average, as indicated by the points on either side of the bar. However, these deviations are not statistically different from the average and are attributable to statistical variations in the detection and counting of radiation events that also vary statistically in their rate of occurrence.

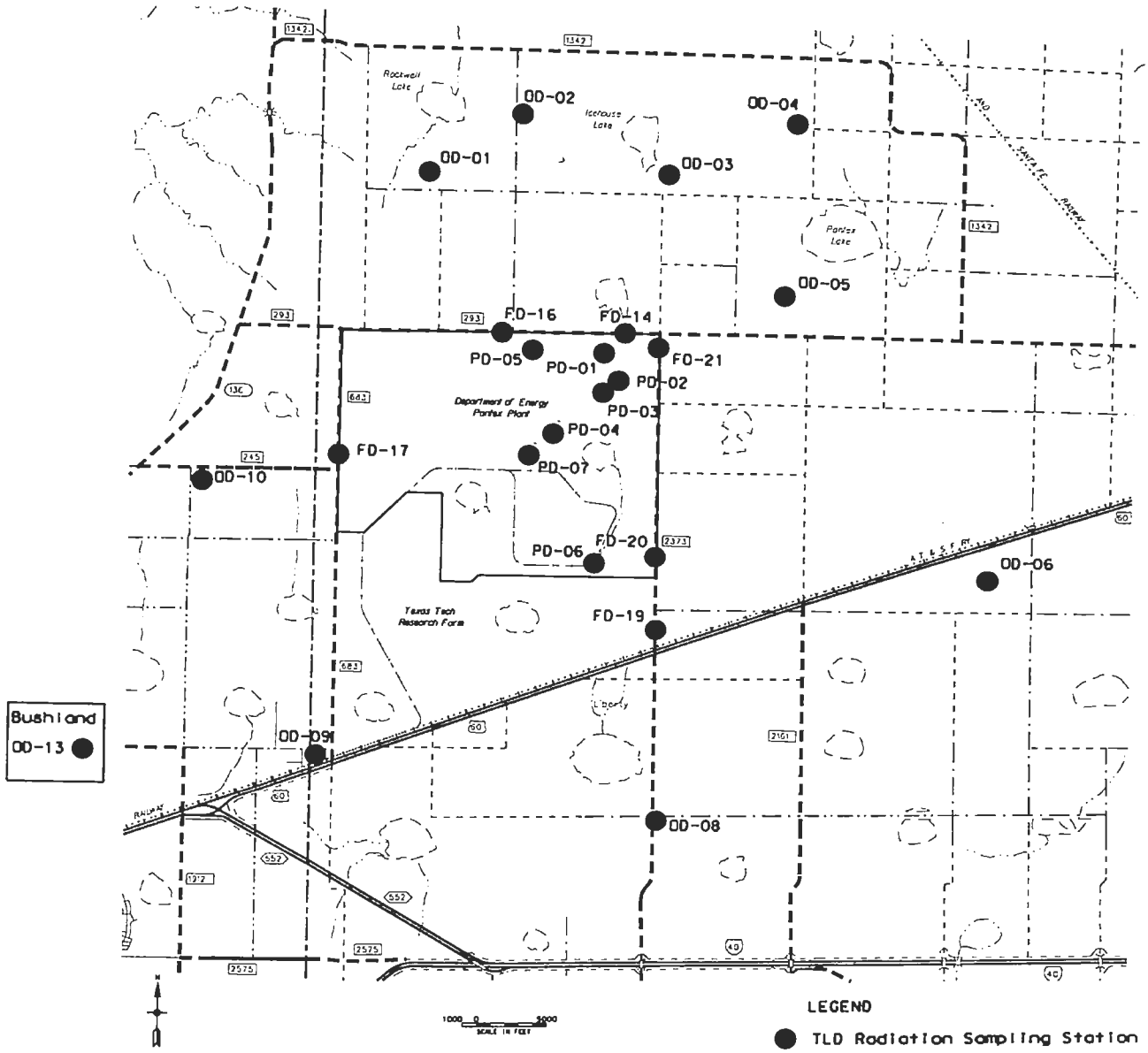


Figure 7.3: Locations of dosimeter stations

The average gamma radiation measurement when expressed on an annual basis is equivalent to 105 mrem/year[3]. This value is within an acceptable statistical range of the historical average annual natural background in the Texas Panhandle. The calculated value is slightly higher than the average radiation as measured by the TLDs located within Zone 4 (PD-04 and PD-07). Again, the variation is attributable to statistical variations in the detection and counting of radiation events.

In addition, a survey of Zone 4 involved the collection of soil samples and measuring existing radiation levels. Results of the survey are presented in Chapter 12.

Table 7.4 **Environmental Dose as Measured by Thermoluminescent Dosimeters, in millirem.** Locations marked with asterisks also had Texas Department of Health—Bureau of Radiation Control dosimeters.

Location	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total
Background					
OD-13	25	20	23	25	93
Onsite					
PD-01	24	21	23	29	97
PD-02	26	22	25	28	101
PD-03	21	21	23	28	93
PD-04	22	21	22	27	92
PD-05	33	21	24	28	106
PD-06*	29	20	21	23	93
PD-07	23	21	24	26	94
Offsite					
OD-01	23	20	23	--[1]	88
OD-02	28	21	22	26	97
OD-03	23	21	26	28	98
OD-04*	28	24	24	29	105
OD-05	27	21	23	27	98
OD-06	25	22	26	27	100
OD-08	24	19	23	25	91
OD-09*	23	19	21	24	87
OD-10	28	21	20	26	95
TDH—BRC Locations					
FD-14*	29	21	26	29	105
FD-16*	33	22	25	29	109
FD-17*	31	22	23	29	105
FD-19*	27	22	25	29	103
FD-20*	28	22	25	32	107
FD-21*	31	23	31	29	114

[1] Dosimeter was lost or damaged. In calculating the total, it was assumed that the average for the previous quarters was appropriate.

Table 7.5 **Environmental Doses Measured at Pantex and Texas Department of Health—Bureau of Radiation Control (TDH—BRC) Co-Sampling Locations, in millirem**

Location	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Mean
PD-06/29					
Pantex	29	20	21	23	23.3
TDH—BRC	29.0	20.8	25.7	27.9	25.9
OD-09/8					
Pantex	23	19	21	24	21.8
TDH—BRC	29.0	21.9	23.0	28.8	25.7
FD-16/16					
Pantex	33	22	25	29	27.3
TDH—BRC	31.0	21.9	26.7	28.8	27.1
FD-19/19					
Pantex	27	22	25	29	25.8
TDH—BRC	29.0	20.8	21.1	28.8	24.9
FD-21/21					
Pantex	31	23	31	29	28.5
TDH—BRC	30.0	21.9	25.7	31.6	27.3
OD-04/4					
Pantex	28	24	24	29	26.3
TDH—BRC	30.0	20.6	25.1	29.4	26.3
FD-14/14					
Pantex	29	21	26	29	26.3
TDH—BRC	30.0	21.9	24.8	29.7	26.6
FD-17/26					
Pantex	31	22	23	29	26.3
TDH—BRC	29.0	20.8	23.0	30.6	25.9
FD-20/20					
Pantex	28	22	25	32	26.8
TDH—BRC	29.0	20.8	23.9	30.6	26.1

	Qtr. Mean	Year Mean
Pantex	25.8	103.1
TDH—BRC	26.2	104.7

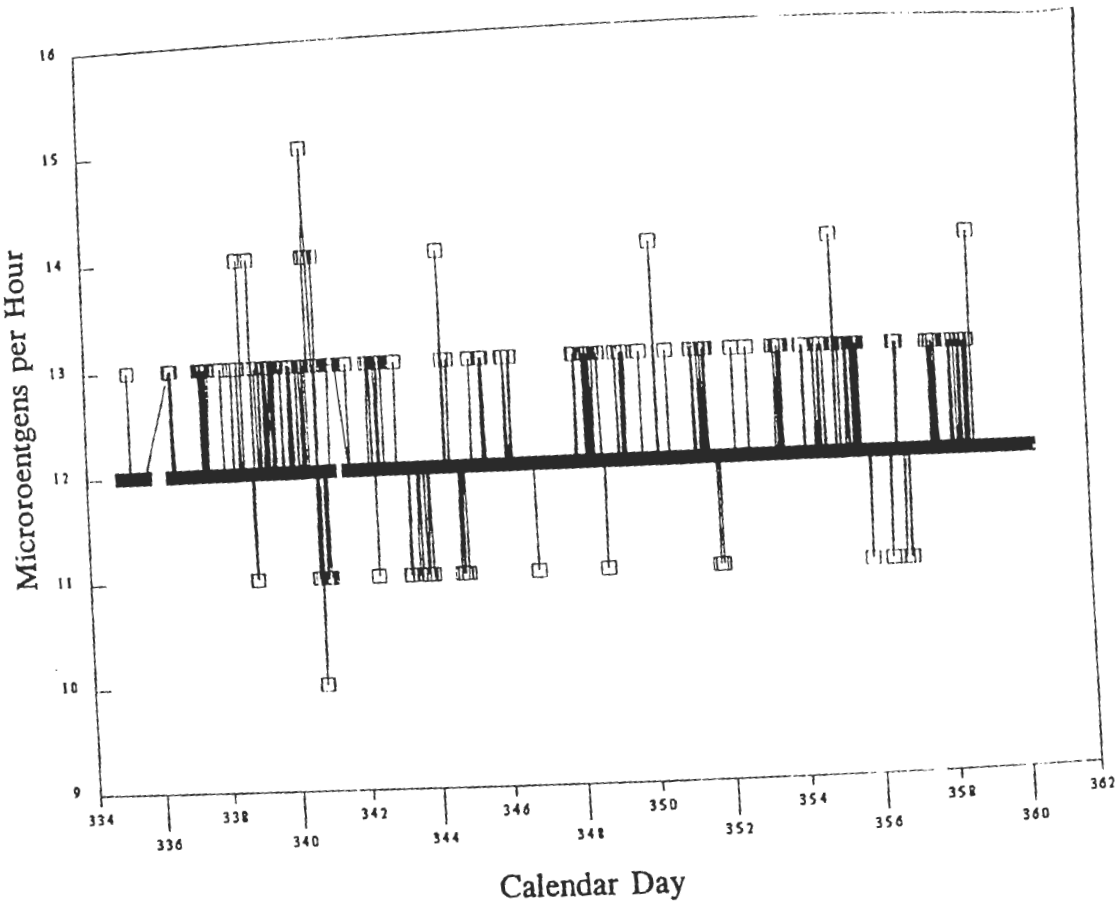


Figure 7.4: **Environmental gamma radiation results.** The graph represents 2,000 data points measured from December 1 through December 28, 1994.

Notes for Chapter 7

1. The effective dose equivalent (H_E) equals the sum of products of the dose equivalent received by specified tissues of the body (H_T) and appropriate weighting factors for each tissue (W_T); that is, $H_E = \Sigma W_T H_T$.

2. For very large and very small numbers, scientific notation is used to save space. In this notation, the number after the E is the number of places farther to the right (if the number is positive) or to the left (if the number is negative) that the decimal point belongs. Thus the number 1.1E-5 (which could also be written 1.1×10^{-5}) corresponds to 0.000011, and the number 1.1E+5 corresponds to 110,000.

3. To convert to a yearly value, multiply 12 μR/hour by the conversion factors 1 mR/1000 μR and 1 mrem/mR, and multiply that quantity by 24 hours/day and 365.25 days/year, to get the result 105.2 mrem/year.

Chapter 8

AIR MONITORING

This chapter discusses results for radiological monitoring of air at Pantex Plant and improvements made to the air sampling network during 1994.

8.1 Routine Radiological Air Monitoring

Both onsite and offsite sampling stations have been used for the routine monitoring of radiological materials in air for many years. During 1994, monitoring stations were added along the fenceline around the Plant perimeter. The fenceline stations include improvements in tritium sampling capabilities.

8.1.1 Onsite and Offsite Air Sampling Stations

Seven onsite and ten offsite air sampling stations were used to monitor for radionuclides in air in 1994 (Table 8.1, Figures 8.1 and 8.2). Nine of the ten offsite stations are located within 8 kilometers (5 miles) of Pantex Plant. The tenth station samples air at a control location in Bushland, Texas.

Table 8.1 Air Monitoring Locations

Location	Description
Onsite	
PA-AR-01	West of water well 17
PA-AR-02	West of old water treatment building
PA-AR-03	Southwest of water well 6
PA-AR-04	Adjacent to north fence of east side of Zone 4
PA-AR-05	Adjacent to Plant north fence on FM 293
PA-AR-06	East of Building 12-42
PA-AR-07	Northeast of Building 4-26, west side of Zone 4
Offsite	
OA-AR-01	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 4.8 kilometers (3.0 miles) west, 0.3 kilometer (0.2 mile) north, 0.3 kilometer (0.2 mile) west
OA-AR-02	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 3.2 kilometers (2.0 miles) west, 2.1 kilometer (1.3 mile) north
OA-AR-03	3.7 kilometers (2.3 miles) north of intersection of FM 2373 and FM 293
OA-AR-04	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 3.2 kilometers (2.0 miles) east, 1.6 kilometers (1.0 mile) north, 0.5 kilometer (0.3 mile) west, southwest corner
OA-AR-05	2.4 kilometers (1.5 miles) east of intersection of FM 2373 and FM 293, 0.6 kilometer (0.4 mile) north
OA-AR-06	6.6 kilometers (4.1 miles) east of intersection of FM 2373 and US 60, south fenceline
OA-AR-08	3.7 kilometers (2.3 miles) south of intersection of FM 2373 and US 60, southeast corner of intersection at fence
OA-AR-09	Intersection of FM 683 and US 60, northwest corner
OA-AR-10	3.5 kilometers (2.2 miles) west of intersection of FM 683 and FM 245, north fence
OA-AR-13	Bushland, Texas

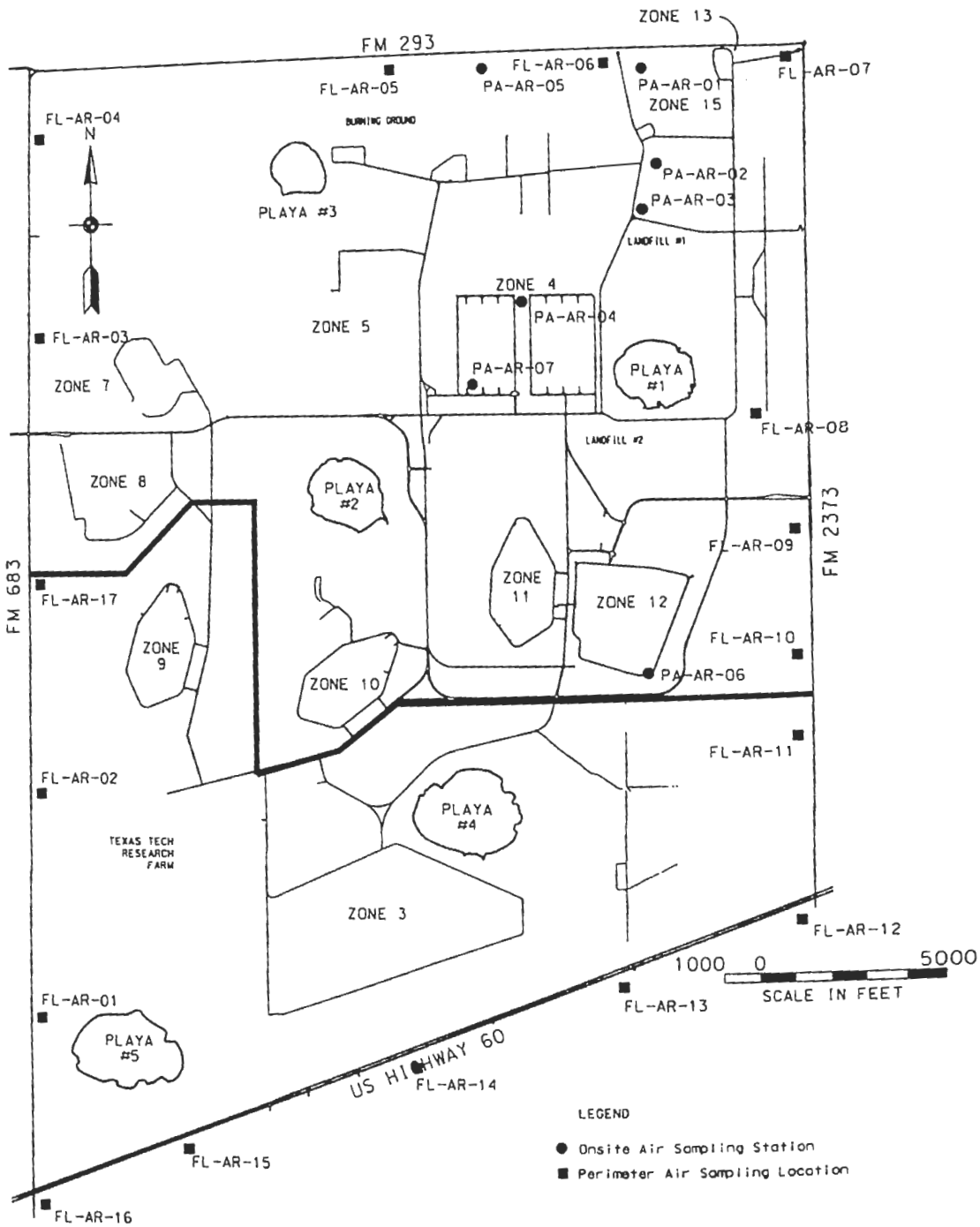


Figure 8.1: Locations of onsite and fenceline air monitoring stations

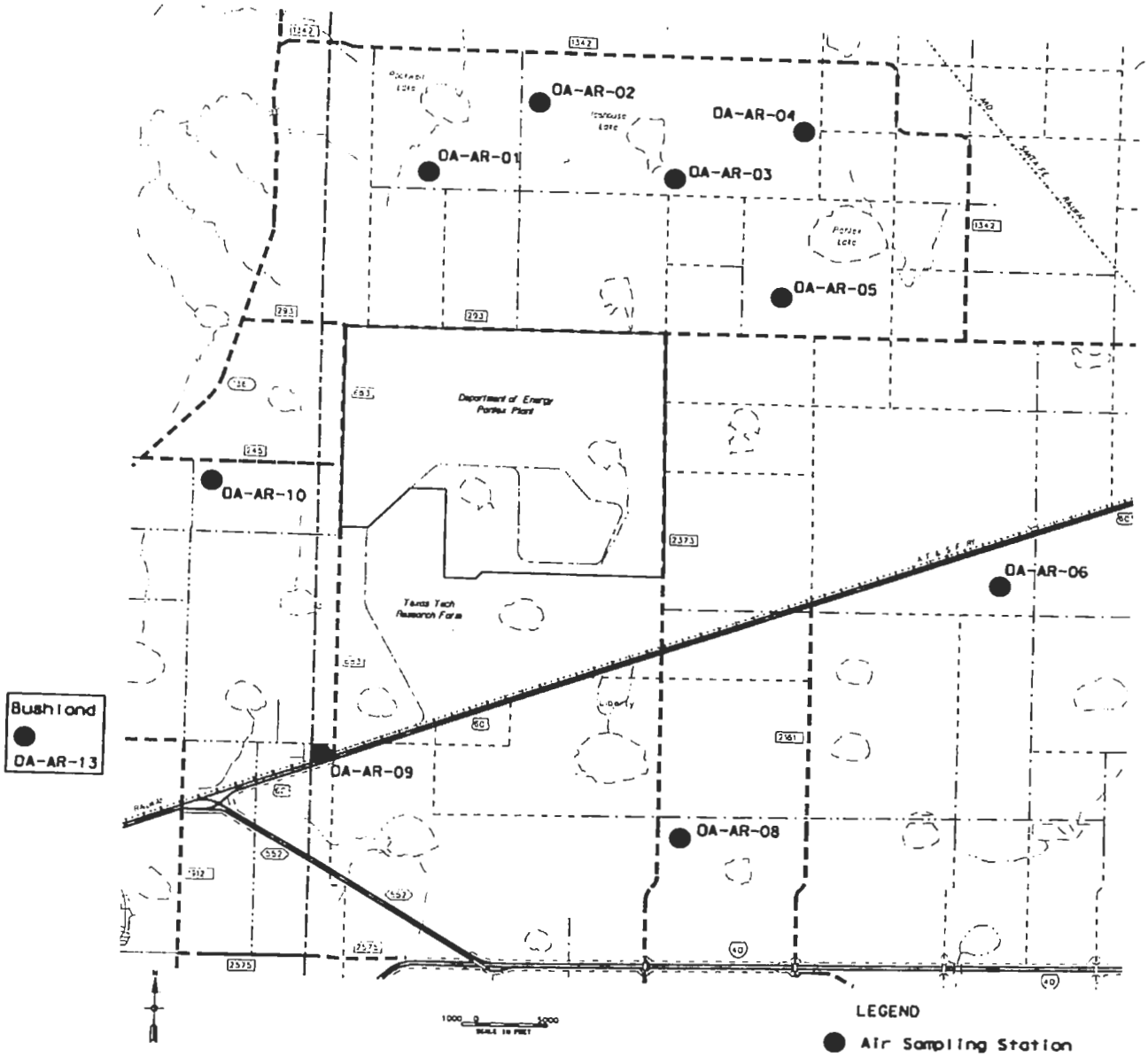


Figure 8.2: Locations of offsite air monitoring stations

Each monitoring station is equipped with a low- and a high-volume air sampler. Low-volume air samplers screen for gross alpha/beta and monitor for tritiated water vapor. The high-volume air samplers collect particulates that are later analyzed for uranium-234, uranium-238, and plutonium-239/240.[1] The samplers run continuously, and the filters (samples) are collected weekly. The equipment also records operational characteristics of the samplers, such as flow rate. The high-volume samplers operate at a flow rate of approximately 1.1 cubic meters per minute. During sampling, particles are collected on 20- × 25-centimeter (8- × 10-inch) filters. The

filters are changed weekly as weather permits. Each air sample includes particulate matter from about 11,400 cubic meters of air. Weekly samples for a given month are combined as one sample for analysis.

Nominal airflow through the low-volume air samplers is 42.5 liters per minute. Each low-volume sampler contains a prefilter for gross alpha/beta screening. The prefilter is placed before a silica gel column that collects water vapor. The silica gel acts as a desiccant, removing water vapor from air as it flows through the sampler. Water vapor in the sampled air is adsorbed and recovered during analysis for tritium. The low-volume prefilters are delivered to an onsite laboratory for determination of gross alpha/beta activity using a low-background proportional counting system. Silica gel samples are also collected weekly and analyzed for tritium by an offsite contract laboratory.

Analytical results are converted to concentrations in air by dividing the quantity of analyte collected by the volume of air sampled. Meteorological data used in performing calculations were obtained from the Pantex Plant meteorological tower, located at the northeast corner of Pantex Plant.

Results are compared to the derived concentration guide (DCG) for inhaled air listed in U.S. Department of Energy (DOE) Order 5400.5, "Radiation Protection of the Public and the Environment." Because there is no DCG for gross alpha/beta activity, gross alpha/beta measurements are compared to control limits based on historical data from all stations (Table 8.2). Both gross alpha and gross beta values must exceed the control limits to indicate an abnormal condition. All gross alpha/beta values in 1994 were below the historical averages.

Table 8.2 Results of Gross Alpha and Beta Screening, in disintegrations per minute (dpm)

	Gross Alpha[1]			Gross Beta[2]		
Site	Maximum	Minimum	Average	Maximum	Minimum	Average
Onsite						
PA-AR-01	7.08	0.32	2.02	37.36	0.43	23.11
PA-AR-02	5.37	0.24	2.07	42.85	5.54	24.66
PA-AR-03	4.86	0.58	2.15	46.73	7.20	25.11
PA-AR-04	5.03	0.41	1.89	38.76	1.58	22.26
PA-AR-05	4.35	0.50	1.94	34.86	3.24	22.11
PA-AR-06	3.91	1.01	2.01	41.06	7.33	24.50
PA-AR-07	5.51	0.84	2.32	46.16	9.63	27.90
Offsite						
OA-AR-01	5.20	1.01	2.23	40.41	8.35	23.50
OA-AR-02	4.15	0.41	2.05	45.20	2.03	24.85
OA-AR-03	4.35	0.84	2.08	42.93	9.12	22.78
OA-AR-04	4.86	0.24	1.94	38.24	0.43	22.07
OA-AR-05	5.20	0.84	2.18	44.00	7.20	24.54
OA-AR-06	5.03	0.32	2.02	41.19	0.30	23.35
OA-AR-08	4.52	0.58	2.04	43.66	2.29	23.54
OA-AR-09	3.66	0.50	2.07	42.38	5.04	23.78
OA-AR-10	5.89	0.15	1.87	40.80	0.05	22.63
OA-AR-13	5.46	1.01	2.76	48.84	7.07	24.53

1 Control limit for gross alpha is 9 dpm.
2 Control limit for gross beta is 40 dpm.

8.1.2 Fenceline Air Sampling Stations

During 1994, 16 new sampling stations were constructed along the fenceline around Pantex Plant. Each station is equipped with a high-volume sampler to collect particulates that are analyzed for uranium and plutonium isotopes in ambient air. These high-volume samplers are identical to those installed at stations discussed in Section 8.1.1. However, the tritium monitors at the fenceline stations differ from those at other sampling stations. The new monitors sample for both elemental and oxidized tritium (tritiated water vapor) that may be present in ambient air. Sampling at these stations began in October 1994. Data from the new fenceline stations are presented in Tables 8.3 through 8.7.

8.1.3 Data Interpretation

The raw data are reported in a detailed compilation (Mason & Hanger 1995a). Table 8.2 summarizes gross alpha/beta results for the low-volume prefilters. During 1994, no air monitoring stations had gross alpha/beta activities that exceeded the historical average at the Bushland control station. Results for tritiated water vapor and for uranium-234, uranium-238, and plutonium-239/240 are shown graphically in Figures 8.3 through 8.10. The figures show the average values plus or minus (±) the counting error. Because concentrations were low, the counting error (or uncertainty) as represented by error bars is relatively high.

As in the past, measured concentrations were less than the appropriate DCG by several orders of magnitude. Measured concentrations were also less than compliance levels (40 CFR 61 Table 2, Appendix E). Mean tritium concentrations were also below both the DCG [0.0000001 microcuries per milliliter (μCi/ml)] and the compliance level [0.0000000015 curies per cubic meter (Ci/m^3)].

Table 8.3 1994 Concentrations of Oxidized Tritium at Fenceline Sites, in μCi/ml

Location	Max	Min
FL-AR-01	20.59E-13 ± 8.42E-13	-2.68E-13 ± 6.29E-13
FL-AR-02	18.30E-13 ± 7.49E-13	-3.33E-13 ± 9.98E-13
FL-AR-03	12.51E-13 ± 5.80E-13	4.91E-13 ± 4.37E-13
FL-AR-04	20.65E-13 ± 8.45E-13	1.09E-13 ± 7.84E-13
FL-AR-05	15.96E-13 ± 8.26E-13	1.13E-13 ± 12.10E-13
FL-AR-06	8.74E-13 ± 4.75E-13	-0.53E-13 ± 11.22E-13
FL-AR-07	17.53E-13 ± 8.38E-13	-1.15E-13 ± 12.08E-13
FL-AR-08	17.76E-13 ± 9.06E-13	8.48E-13 ± 10.97E-13
FL-AR-09	14.33E-13 ± 6.45E-13	-3.72E-13 ± 11.15E-13
FL-AR-10	19.99E-13 ± 8.18E-13	6.17E-13 ± 6.57E-13
FL-AR-11	16.71E-13 ± 7.88E-13	9.83E-13 ± 9.83E-13
FL-AR-12	14.79E-13 ± 8.18E-13	5.62E-13 ± 10.03E-13
FL-AR-13	15.31E-13 ± 7.66E-13	1.90E-13 ± 9.52E-13
FL-AR-14	12.40E-13 ± 8.34E-13	0.92E-13 ± 43.17E-13
FL-AR-15	13.01E-13 ± 8.20E-13	5.25E-13 ± 5.47E-13
FL-AR-16	13.08E-13 ± 5.91E-13	4.99E-13 ± 0.85E-13

Table 8.4 1994 Concentrations of Elemental Tritium at Fenceline Sites, in μCi/ml

Location	Max	Min
FL-AR-01	59.58E-13 ± 6.34E-13	-1.53E-13 ± 11.48E-13
FL-AR-02	3.89E-13 ± 11.68E-13	-5.30E-13 ± 10.69E-13
FL-AR-03	10.85E-13 ± 10.50E-13	-7.74E-13 ± 8.25E-13
FL-AR-04	-5.01E-13 ± 8.61E-13	-9.94E-13 ± 9.51E-13
FL-AR-05	22.91E-13 ± 68.14E-13	2.62E-13 ± 15.38E-13
FL-AR-06	9.36E-13 ± 9.27E-13	1.44E-13 ± 8.32E-13
FL-AR-07	6.00E-13 ± 15.96E-13	-2.60E-13 ± 10.65E-13
FL-AR-08	6.42E-13 ± 10.54E-13	-7.56E-13 ± 13.49E-13
FL-AR-09	8.43E-13 ± 14.21E-13	4.07E-13 ± 10.76E-13
FL-AR-10	7.76E-13 ± 9.12E-13	-1.82E-13 ± 11.57E-13
FL-AR-11	4.98E-13 ± 10.66E-13	1.00E-13 ± 13.90E-13
FL-AR-12	7.80E-13 ± 11.08E-13	-3.55E-13 ± 14.41E-13
FL-AR-13	6.56E-13 ± 10.96E-13	-6.55E-13 ± 9.57E-13
FL-AR-14	65.21E-13 ± 59.76E-13	-4.30E-13 ± 9.43E-13
FL-AR-15	2.33E-13 ± 10.83E-13	-15.43E-13 ± 15.33E-13
FL-AR-16	5.48E-13 ± 8.89E-13	-8.37E-13 ± 10.43E-13

Table 8.5 1994 Concentrations of Uranium-234 at Fenceline Sites, in μCi/ml

Location	Max	Min
FL-AR-01	6.51E-17 ± 1.56E-17	9.83E-18 ± 5.90E-18
FL-AR-02	5.93E-17 ± 1.74E-17	1.08E-17 ± 5.90E-18
FL-AR-03	7.05E-17 ± 1.76E-17	1.96E-17 ± 1.05E-17
FL-AR-04	7.17E-17 ± 2.10E-17	1.18E-17 ± 5.92E-18
FL-AR-05	4.99E-17 ± 1.44E-17	2.07E-17 ± 2.76E-17
FL-AR-06	5.30E-16 ± 5.30E-16	6.52E-18 ± 7.83E-18
FL-AR-07	5.91E-17 ± 1.44E-17	1.19E-17 ± 5.93E-18
FL-AR-08	3.29E-17 ± 1.05E-17	7.90E-18 ± 4.94E-18
FL-AR-09	2.91E-17 ± 1.06E-17	1.56E-17 ± 2.18E-17
FL-AR-10	5.96E-16 ± 2.98E-16	1.32E-17 ± 6.61E-18
FL-AR-11	6.53E-17 ± 4.04E-17	2.65E-18 ± 5.29E-18
FL-AR-12	6.84E-17 ± 2.52E-17	1.58E-17 ± 5.92E-18
FL-AR-13	7.82E-17 ± 1.88E-17	7.94E-18 ± 5.29E-18
FL-AR-14	1.57E-16 ± 4.14E-17	9.73E-18 ± 6.95E-18
FL-AR-15	4.98E-17 ± 1.56E-17	1.04E-17 ± 5.19E-18
FL-AR-16	1.56E-16 ± 3.25E-17	1.10E-17 ± 4.99E-18

Table 8.6 1994 Concentrations of Uranium-238 at Fenceline Sites, in μCi/ml

Location	Max	Min
FL-AR-01	5.97E-17 ± 2.51E-17	1.28E-17 ± 6.88E-18
FL-AR-02	5.58E-17 ± 1.05E-17	1.08E-17 ± 4.92E-18
FL-AR-03	5.64E-17 ± 1.06E-17	2.10E-17 ± 9.17E-18
FL-AR-04	6.31E-17 ± 1.40E-17	1.18E-17 ± 5.92E-18
FL-AR-05	5.87E-17 ± 3.11E-17	2.07E-17 ± 7.25E-18
FL-AR-06	2.65E-16 ± 2.65E-16	6.52E-18 ± 5.22E-18
FL-AR-07	3.15E-17 ± 1.05E-17	1.19E-17 ± 5.93E-18
FL-AR-08	2.20E-17 ± 1.88E-17	1.28E-17 ± 5.93E-18
FL-AR-09	2.18E-17 ± 1.56E-17	1.37E-17 ± 6.34E-18
FL-AR-10	2.65E-16 ± 1.66E-16	1.16E-17 ± 5.26E-18
FL-AR-11	7.16E-17 ± 4.36E-17	9.86E-18 ± 1.97E-18
FL-AR-12	5.04E-17 ± 2.16E-17	2.07E-17 ± 6.90E-18
FL-AR-13	5.00E-17 ± 1.56E-17	1.41E-17 ± 7.06E-18
FL-AR-14	1.33E-16 ± 4.14E-17	8.34E-18 ± 5.56E-18
FL-AR-15	4.04E-17 ± 1.24E-17	9.26E-18 ± 6.61E-18
FL-AR-16	1.17E-16 ± 2.60E-17	1.20E-17 ± 5.99E-18

Table 8.7 1994 Concentrations of Plutonium at Fenceline Sites, in μCi/ml

Location	Max	Min
FL-AR-01	3.14E-18 ± 1.26E-17	-6.51E-18 ± 1.17E-17
FL-AR-02	6.54E-18 ± 6.54E-18	9.83E-19 ± 1.97E-18
FL-AR-03	3.53E-18 ± 1.41E-17	-1.31E-18 ± 3.93E-18
FL-AR-04	0.00 ± 9.86E-19	-7.01E-18 ± 1.05E-17
FL-AR-05	3.94E-18 ± 6.56E-18	1.04E-18 ± 2.07E-18
FL-AR-06	0.00 ± 2.65E-16	-1.30E-18 ± 3.91E-18
FL-AR-07	6.19E-18 ± 1.24E-17	0.00 ± 9.89E-18
FL-AR-08	9.42E-18 ± 1.26E-17	9.88E-19 ± 1.98E-18
FL-AR-09	5.29E-18 ± 6.61E-18	-3.11E-18 ± 9.33E-18
FL-AR-10	3.31E-17 ± 1.33E-16	-1.32E-18 ± 3.97E-18
FL-AR-11	1.56E-17 ± 1.87E-17	9.86E-19 ± 9.86E-19
FL-AR-12	3.98E-18 ± 5.30E-18	-3.60E-18 ± 1.08E-17
FL-AR-13	9.38E-18 ± 1.56E-17	0.00 ± 1.01E-18
FL-AR-14	1.39E-18 ± 2.78E-18	0.00 ± 1.03E-18
FL-AR-15	5.29E-18 ± 5.29E-18	1.04E-18 ± 2.07E-18
FL-AR-16	9.98E-18 ± 2.00E-18	0.00 ± 1.30E-17

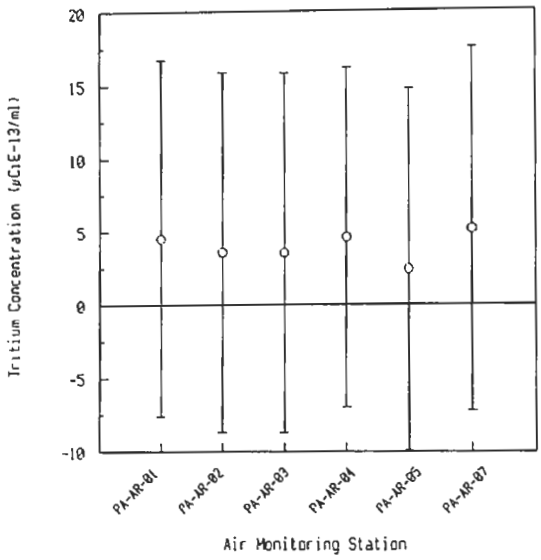


Figure 8.3: **Average onsite tritium concentrations in 1994.** Error bars around data points represent average counting error.

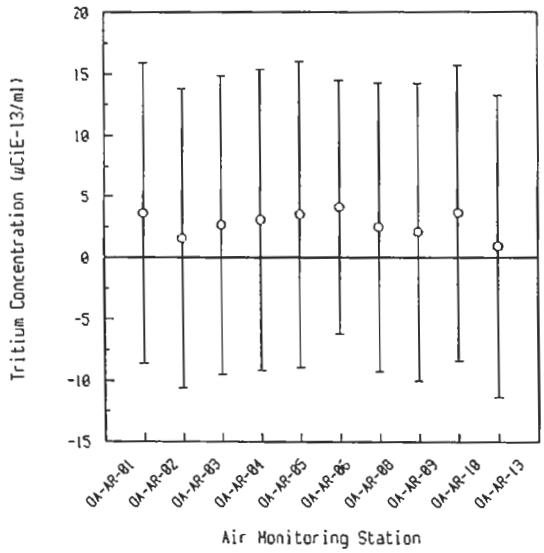


Figure 8.4: **Average offsite tritium concentrations in 1994.** Error bars around data points represent average counting error.

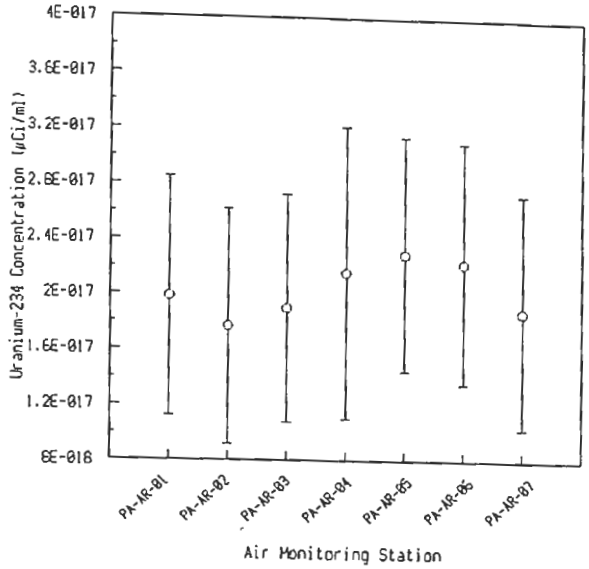


Figure 8.5: **Average onsite uranium-234 concentrations in 1994.** Error bars around data points represent average counting error.

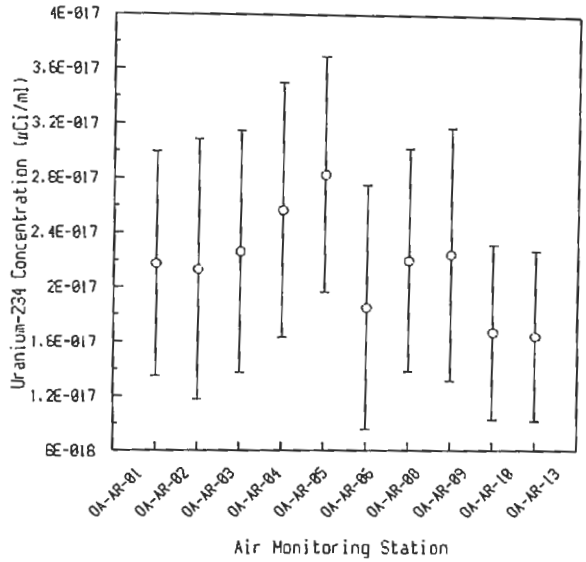


Figure 8.6: **Average offsite uranium-234 concentrations in 1994.** Error bars around data points represent average counting error.

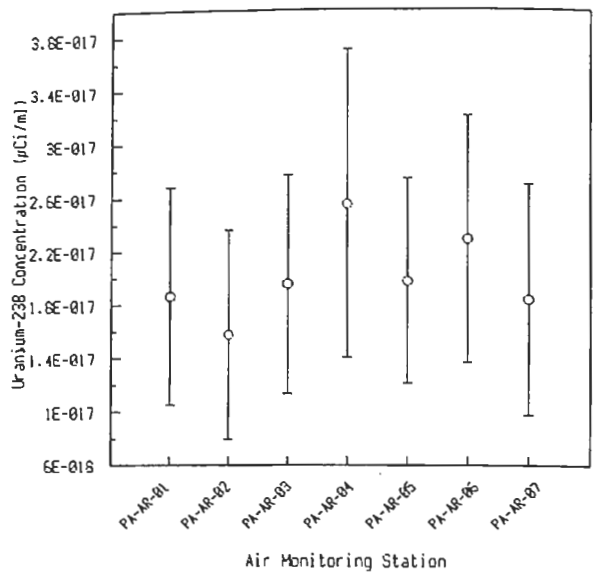


Figure 8.7: **Average onsite uranium-238 concentrations in 1994.** Error bars around data points represent average counting error.

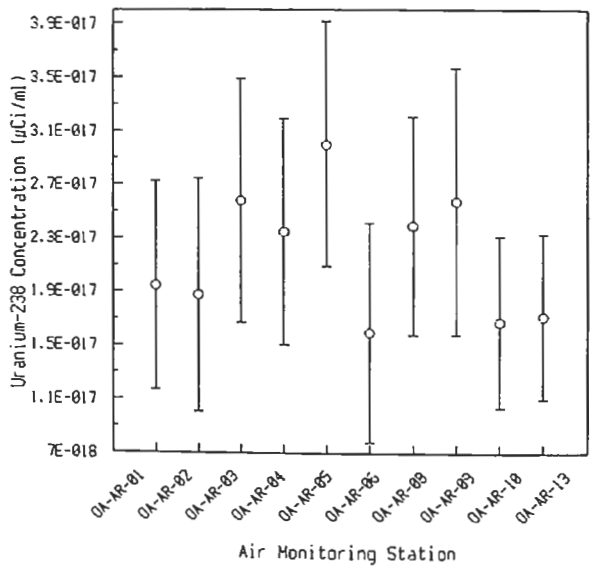


Figure 8.8: **Average offsite uranium-238 concentrations in 1994.** Error bars around data points represent average counting error.

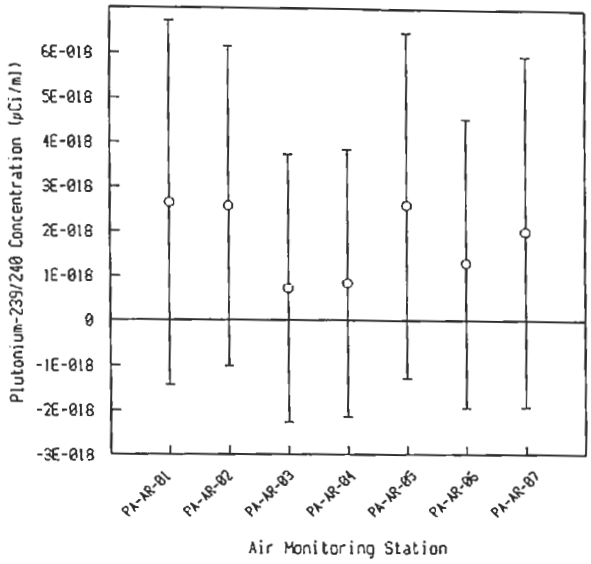


Figure 8.9: **Average onsite plutonium-239/240 concentrations in 1994**. Error bars around data points represent average counting error.

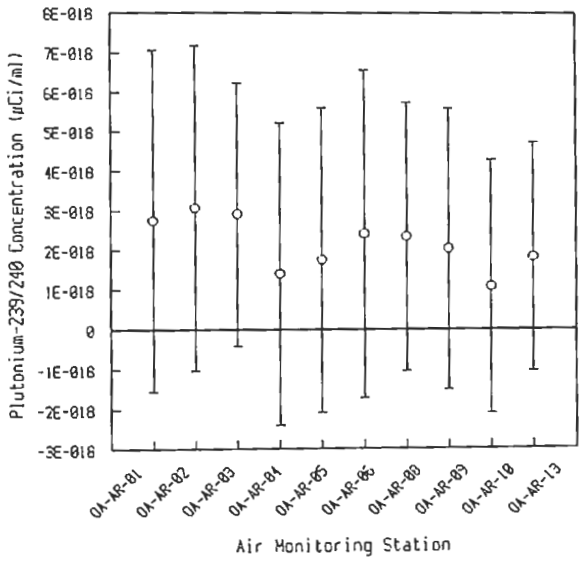


Figure 8.10: **Average offsite plutonium-239/240 concentrations in 1994**. Error bars around data points represent average counting error.

Zone 12 South Tritium Surveillance. Tritium concentrations in Zone 12 South exceeded levels seen at other onsite locations in 1994, but were still below the DCG. Station PA-AR-06, adjacent to Cell 12-44-1 (the structure contaminated during the unplanned release of tritium gas on May 17, 1989), recorded a maximum concentration of 0.00000000056 μCi/ml; this concentration is below compliance levels (DOE Order 5400.5; 40 CFR 61 Table 2, Appendix E). The tritium measured is believed to reflect fugitive emissions from residual contamination in the vicinity of Cell 12-44-1. The concentrations of tritium at station PA-AR-06 during 1994 (Figure 8.11) are similar to those measured in 1990, 1991, 1992, and 1993 (Mason & Hanger 1991; Battelle 1992, 1993, 1994b); tritium peaks have occurred during the same seasons each year and are believed to reflect meteorological factors.

8.2 TNRCC Air Monitoring Program

The Texas Natural Resource Conservation Commission (TNRCC) conducted routine nonradiological ambient air monitoring at Pantex Plant during 1994. Results of the sampling program were published in a series of quarterly reports (TNRCC 1994a,b, 1995a,b). Except for a few days when particulate matter was detected, generally low levels of pollutants have been found. Particulate matter is occasionally present in air around Pantex Plant as a result of high winds and agricultural activity. Pantex Plant and the surrounding Amarillo area are classified by the U.S. Environmental Protection Agency (EPA) as "Attainment" for all National Ambient Air Quality Standards (40 CFR 52.2279). This classification means that the area meets all existing air quality standards for which it could be evaluated.

8.3 Further Air Monitoring Planned

A seventeenth fenceline air monitoring station is due to be installed in 1995. The station will be located on the west fenceline, approximately due west of Zone 12. Equipment will be identical to that at present fenceline stations.

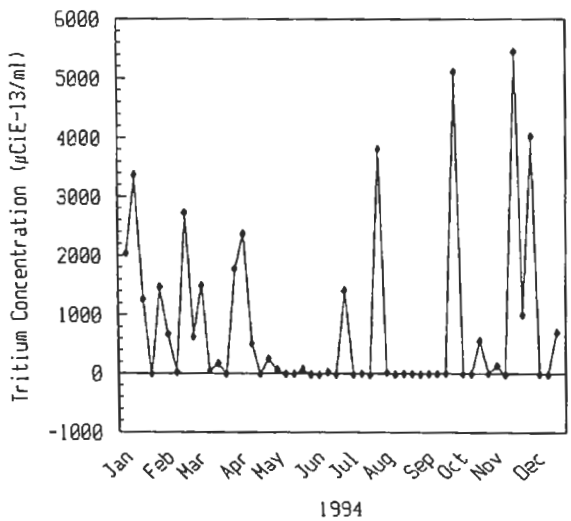
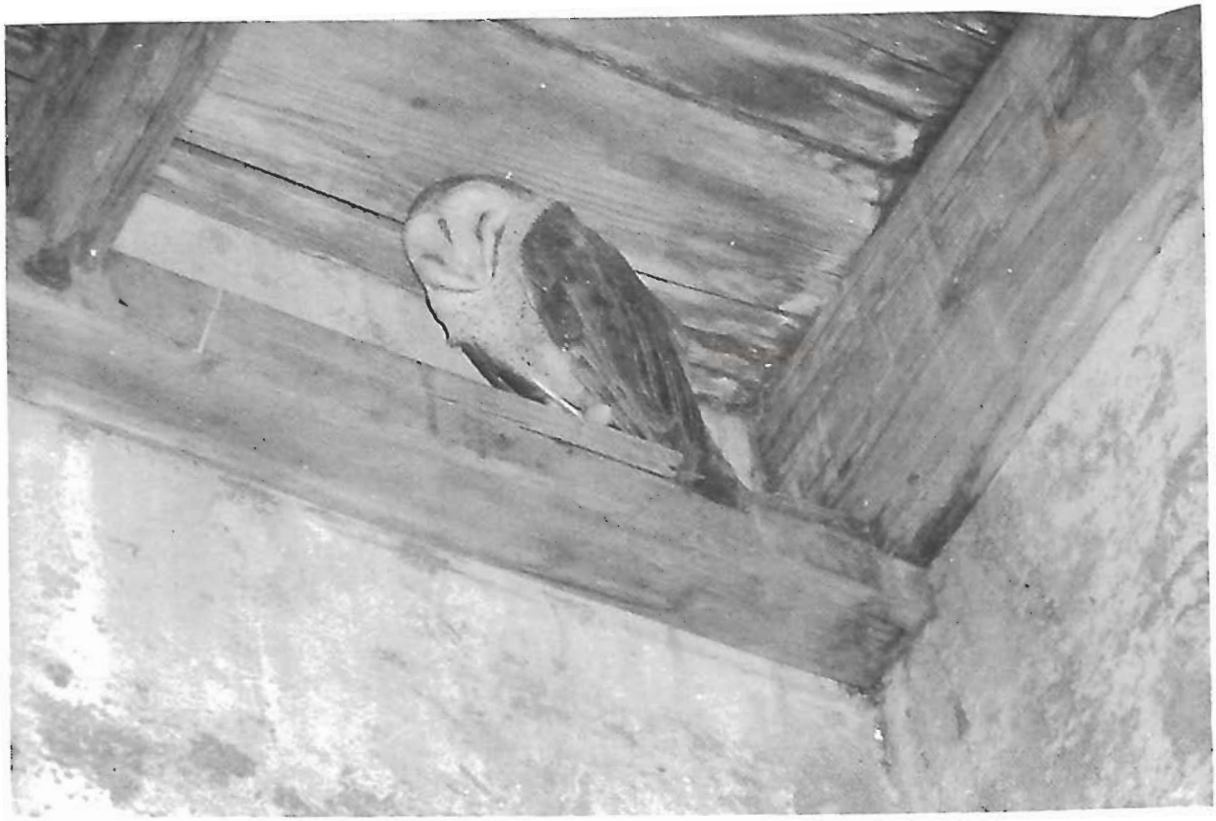


Figure 8.11 Tritium concentrations at station PA-AR-06 in 1994

Notes for Chapter 8

1. The alpha energies of plutonium-239 and plutonium-240 are very similar, and the alpha spectrophotometer is not sensitive enough to distinguish between these isotopes. Therefore the measurement is the sum of the activities resulting from both isotopes.



Barn owl (*Tyto alba*)

Chapter 9

GROUNDWATER MONITORING

Monitoring of groundwater to identify impacts of Pantex Plant operations is performed according to U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program." Because the City of Amarillo obtains 35% of its water supply from wells into the Ogallala aquifer north of the Plant, surveillance is aggressive. The monitoring program is designed to be at least as stringent as the programs described in 40 CFR 264 Subpart F for permitted treatment, storage, and disposal facilities. Pantex Plant is such a permitted facility under a Resource Conservation and Recovery Act (RCRA) permit. The permit, described in Chapter 2, requires investigation of past releases of hazardous wastes to the environment. The Environmental Restoration program implements these requirements, as described in Chapter 6. The Environmental Restoration program collects groundwater samples quarterly from 38 wells completed since 1992. Results are reported directly to regulatory agencies.

9.1 Hydrogeologic Characterization

The Ogallala Formation is the most important geological feature underlying Pantex Plant. The lower part of the formation is water saturated and is commonly known as the Ogallala aquifer. Perched groundwater occurs beneath parts of Pantex Plant and overlies the Ogallala aquifer in up to four discontinuous zones. Discharges and runoff from buildings, streets, parking lots, and fields at the Plant accumulate in playas. Water in playas that is not lost to evapotranspiration can infiltrate to the perched zone. Any contaminants transported from the surface by infiltrating waters will appear in the perched water, where it can be remediated before reaching the Ogallala aquifer.

The University of Texas at Austin Bureau of Economic Geology is currently concluding five years of geological characterization studies. These studies have been conducted onsite and off. Offsite studies provide background data for comparison with conditions at the Plant. The following major findings have been reported at quarterly status meetings:

- Preliminary maps of the top of the perched water table and a model simulating water flow from the playas to the perched zone have been developed. Preliminary interpretation indicates that perched groundwaters do not flow offsite to the north or west. Continuing field investigations are determining the extent of the perched aquifers to the east and south to determine whether contaminated perched groundwater has spread offsite.

- Estimated hydrologic conductivities of the aquitard (the less permeable layer on which the perched aquifers form) and overlying zones are being verified.

- Preferential flow paths in the vadose zone have been identified and continue to be studied.

- A preliminary recharge equation based on conductivity and flow path studies has been developed. The equation will help estimate the time required for surface contaminants to reach groundwater.

- Studies investigating the use of microbes to treat perched groundwaters showed that biological treatment of organic compounds and nitrates in perched aquifers may be possible.

Other studies have included characterization of playa basin sediments; geochemical characterization and dating of samples of sediments and water; and seismic studies of the geologic structure.

9.2 Groundwater Monitoring

Subsection 9.2.1 describes the program. Results of routine monitoring during 1994 are discussed in Section 9.2.2. Groundwater sampling procedures follow EPA guidelines (NWWA 1986; EPA 1990, 1991b, 1992a).

9.2.1 Program Description

The groundwater monitoring network for onsite sampling includes 13 monitoring wells and 5 drinking water production wells. Three monitoring wells and all five production wells were completed in the Ogallala aquifer. Ten monitoring wells were completed in the perched aquifers. The production wells serve as a secondary check for possible chemical migration from the perched aquifers into the Ogallala aquifer. If contamination of the Ogallala aquifer were to occur as a result of Pantex Plant operations, it would be discovered first in the Plant's production wells, before it reached the City of Amarillo's drinking water wells, which are downgradient from Pantex Plant. The water supply at a control location in Bushland, Texas, is sampled monthly to obtain control data. The control well is completed in the Ogallala aquifer upgradient from Pantex Plant and is, therefore, unaffected by Plant operations.

Table 9.1 lists the wells sampled, their dates of construction, and their depths. Figure 9.1 shows their locations. Monitoring wells are ideally sampled monthly. Production wells are sampled every other month (six times per year). Table 9.2 lists constituents for which analysis is performed. The schedule for analysis varies from monthly to semiannual. The ideal schedule was not met in 1994 because of such factors as weather and sample breakage in shipment.

Analytes include four indicators of contamination: pH, total organic carbon, total organic halogen, and specific conductivity. The indicator parameters would show a marked change if any contamination occurred.

Production wells are sampled from faucets at the pump discharge pipes. The control location is sampled at a designated faucet. Monitoring wells are sampled with air-operated double-acting piston pumps that can lift water from depths below 60 meters (200 feet). The pumps are constructed to prevent contact between the driving air and the sample, to ensure that no aeration of the water being sampled occurs. Monitoring wells are currently sampled with dedicated pumps to prevent the possibility of cross-contamination. Three pore volumes of water are pumped from the monitoring wells to purge standing water before the actual sample is taken. The pH, turbidity, conductivity, and temperature are monitored during purging to determine when formation water is being pulled into the well. Purging continues until these four parameters have stabilized. Special purging procedures have been developed for well PM-106 because of slow recharge rates in the well.

Analytical results are evaluated monthly and compared to guidelines for RCRA-regulated facilities (EPA 1989), drinking water standards, and DOE criteria. Mean values between monitored wells and the offsite or control location are compared statistically[1] to determine potential impacts of Pantex operations on groundwater. Data are compared to the Safe Drinking Water Act maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), the State of Texas Risk Reduction Levels developed for Pantex Plant, and derived concentration guides for radionuclides (DOE Order 5400.5). The Texas Risk Reduction Levels are generally at least as stringent as the Safe Drinking Water Act MCLs and also set standards for contaminants not regulated by the Safe Drinking Water Act.

Table 9.1 Groundwater Monitoring Locations

Location	Description	Date Constructed	Total Depth, meters (feet)
Perched groundwater monitoring wells			
PM-19	Playa #1 Test Well 1	01-75	107 (350)
PM-20	Zone 12 Test Well 2	02-75	107 (350)
PM-38	Northeast of Playa #1	01-88	70 (230)
PM-44	UST Test Well northwest of Zone 11	07-88	91 (298)
PM-45	UST Test Well Zone 12 North	07-88	152 (275)
PM-101	11-14 Pond	04-92	89 (291)
PM-102	11-14 Pond	04-92	90 (294)
PM-103	11-14 Pond	04-92	88 (288)
PM-104	11-14 Pond	04-92	88 (288)
PM-106	Northeast Plant corner	03-92	86 (282)
Ogallala aquifer monitoring wells[1]			
OM-39	Northwest of Playa #1	10-85	215 (707)
OM-40	Southwest of Playa #1	10-85	208 (684)
OM-105	Zone 10 Batch Plant	04-92	126 (415)
Ogallala aquifer water supply production wells			
PR-02	Production well 15-17	03-70	258 (847)
PR-06	Production well 15-6	1942	199 (653)
PR-16	Production well 15-20	11-70	226 (740)
PR-18	Production well 15-16	06-66	222 (727)
PR-41	Production well 15-26	10-85	232 (763)
Offsite water supplies			
CO-33	Bushland drinking water	--	--

[1]Wells OM-46, OM-47, and OM-48 are located northeast of the Burning Ground and are sampled quarterly by the Corps of Engineers as part of the Environmental Restoration program.

9.2.2 Results

Overall, results for 1994 were similar to those for 1993. General trends are described and compared with historical data in Section 9.3. This section discusses data by aquifer. The 1994 data are summarized in Tables 9.3 through 9.6. These tables are based on data published in a detailed compilation (Mason and Hanger 1995a).

Perched Groundwater Monitoring Wells. Six wells were sampled monthly to assess contamination in the perched aquifers: PM-19, PM-20, PM-38, PM-44, PM-45, and PM-106. Four wells were sampled quarterly: PM-101, PM-102, PM-103, and PM-104. Samples were analyzed for chemical and radiological constitutents. No biological samples were taken from these wells. Depths to water were meas-

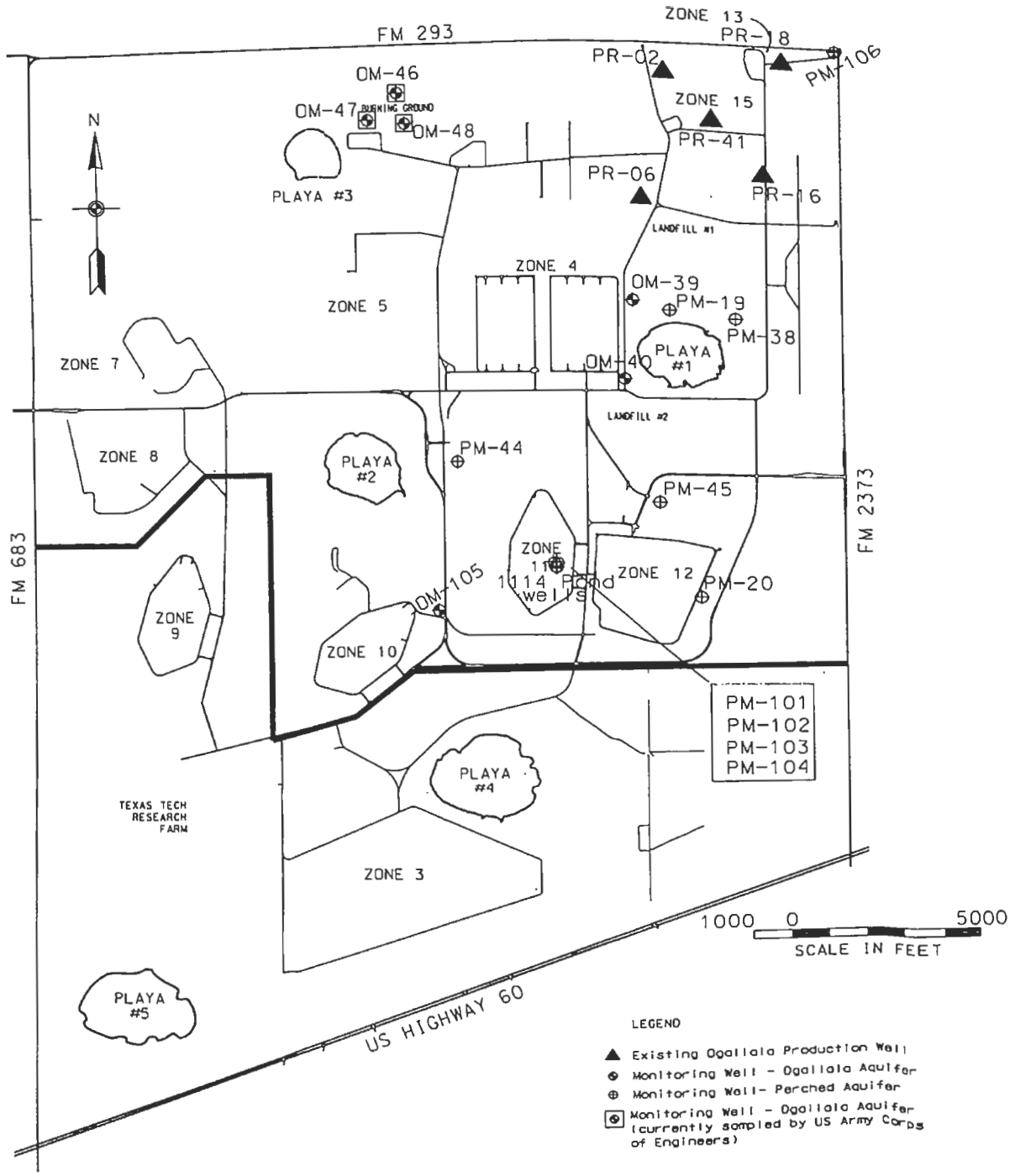


Figure 9.1: Well locations

Table 9.2 Monitored Parameters for Groundwater

Radionuclides
Gross alpha, dissolved
Gross alpha, suspended
Gross beta, dissolved
Gross beta, suspended
Tritium
Radium-226
Radium-228
Uranium-234
Uranium-238
Plutonium-239/240

Metals
Arsenic
Barium
Cadmium
Chromium
Copper
Iron
Lead
Mercury
Selenium
Silver
Zinc

Explosives
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)
Pentaerythritol tetranitrate (PETN)
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
Trinitrotoluene (TNT)

Polychlorinated Biphenyls (PCBs)
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260

Pesticides
4,4-DDD
4,4-DDE
4,4-DDT
Aldrin
alpha-BHC
beta-BHC
delta-BHC
Chlordane
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Endrin aldehyde
Heptachlor
Heptachlor epoxide
Lindane (gamma-BHC)
Methoxychlor
Toxaphene

Herbicides
2,4-D
2,4,5-T

Miscellaneous
Cyanide
Fluoride
Hardness
Nitrate (as N)
Oil and grease
pH
Phosphate
Sulfate
Total dissolved solids
Total suspended solids

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

Table 9.2 Monitored Parameters for Groundwater (cont'd)

Semivolatile Organics	Semivolatile Organics, cont'd	Semivolatile Organics, cont'd
1,2,4-Trichlorobenzene	4-Methylphenol	Diethyl phthalate
2-Chloronaphthalene	4-Nitroaniline	Di-m-butyl phthalate
2-Chlorophenol	4-Nitrophenol	Dimethyl phthalate
2-Methyl-4,6-dinitrophenol	Acenaphthene	Di-n-ocyrl phthalate
2-Methylnaphthalene	Acenaphthylene	Fluoranthene
2-Methylphenol	Anthracene	Fluorene
2-Nitroamiline	Benzo(a)anthracene	Hexachlorobenzene
2-Nitrophenol	Benzo(a)pyrene	Hexachlorobutadiene
2,4-Dichlorophenol	Benzo(b)fluoranthene	Hexachlorocyclopentadiene
2,4-Dimethylphenol	Benzo(g,h,i)perylene	Hexachloroethane
2,4-Dinitrophenol	Benzoic acid	Indeno(1,2,3-cd)pyrene
2,4-Dinitrotoluene	Benzo(k)fluoranthene	Isophorone
2,4,5-Trichlorphenol	Benzyl alcohol	Naphthalene
2,4,6-Trichlorophenol	Bibenzo(a,h)anthracene	Nitrobenzene
2,6-Dinitrotoluene	Bis(2-chloroethyl)ether	N-nitrosodi-n-propylamine
3-Nitroaniline	Bis(2-chloroethyoxy)methane	N-nitrosodiphenylamine
3,3-Dichlorobenzidine	Bis(2-chloroisopropyl)ether	Pentachlorophenol
4-Bromophenyl phenyl ether	Bis(2-ethylhexyl)phthalate	Phenanthrene
4-Chloro-3-methylphenol	Butyl benzyl phthalate	Phenol
4-Chloroaniline	Chrysene	Pyrene
4-Chlorophenyl phenyl ether	Dibenzofuran	

ured where possible and recorded. Radiological results are presented in Table 9.3. No radionuclide concentrations exceeded historical levels. All concentrations were below the derived concentration guides (DOE Order 5400.5). No pesticides or herbicides were detected in any perched groundwater.

In 1994, trichloroethylene (TCE) and 1,2-dichloroethylene were detected in PM-102. TCE was found in one of four samples from PM-101. Concentrations were similar to those detected in PM-20, PM-45, and other wells in the perched aquifer that are part of the Environmental Restoration program.

Nickel and chromium were detected in PM-38 and may reflect corrosion of the sampling pump and well material. A corroded pump was replaced in March 1994. The new pump has a plastic drop tube and screen that allow the pump to remain out of water. Chromium concentrations in PM-38 are shown in Figure 9.2.

Samples from PM-20 contained several constituents that are not naturally occurring. These included TCE, the explosives hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX), and chromium. Chromium has been found in all samples taken from PM-20 since 1990. Concentrations in 1994 ranged from 0.53 to 1.95 mg/L (Figure 9.3). These values are above the drinking water MCL and the Texas Risk Reduction Level for chromium (0.1 mg/L). The mean TCE concentration (0.094 mg/L) was above the drinking water MCL and the Texas Risk Reduction Level of 0.005 mg/L.

Nickel and TCE were detected in PM-45. The mean concentrations of nickel (0.12 mg/L) and TCE (0.007 mg/L) were above the drinking water MCL and the Texas Risk Reduction Level.

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells

Location	No. of Samples	No. BDL[1]	Mean ± Std. Dev.	Max	Min
Ammonia (as N), in mg/L					
PM-19	13	13	--[2]	<0.2	<0.1
PM-20	10	10	--	<0.2	<0.2
PM-38	12	12	--	<0.2	<0.2
PM-44	11	11	--	<0.2	<0.2
PM-45	10	10	--	<0.2	<0.2
PM-101	1	1	--	<0.2	NA[3]
PM-102	1	1	--	<0.2	NA
PM-103	1	1	--	<0.2	NA
PM-104	1	1	--	<0.2	NA
PM-106	10	10	--	<0.2	<0.2
Arsenic, in mg/L					
PM-19	13	13	--	<0.005	<0.005
PM-20	12	12	--	<0.005	<0.005
PM-38	12	12	--	<0.005	<0.005
PM-44	11	11	--	<0.005	<0.005
PM-45	10	10	--	<0.005	<0.005
PM-101	2	2	--	<0.005	<0.005
PM-102	2	2	--	<0.005	<0.005
PM-103	1	1	--	<0.005	NA
PM-104	1	1	--	<0.005	NA
PM-106	10	10	--	<0.005	<0.005
Barium, in mg/L					
PM-19	13	0	0.18 ± 0.01	0.2	0.17
PM-20	12	0	0.18 ± 0.02	0.23	0.16
PM-38	12	0	0.11 ± 0.01	0.12	0.1
PM-44	11	0	0.14 ± 0.01	0.15	0.13
PM-45	10	0	0.23 ± 0.01	0.25	0.22
PM-101	2	0	0.16 ± 0	0.16	0.15
PM-102	2	0	0.18 ± 0.1	0.18	0.17
PM-103	1	0	--	0.17	NA
PM-104	1	0	--	0.14	NA
PM-106	10	0	0.11 ± 0.03	0.18	0.047
Cadmium, in mg/L					
PM-19	13	13	--	<0.005	<0.005
PM-20	12	12	--	<0.005	<0.005
PM-38	12	12	--	<0.005	<0.005
PM-44	11	11	--	<0.005	<0.005
PM-45	10	10	--	<0.005	<0.005
PM-101	2	2	--	<0.005	<0.005
PM-102	2	2	--	<0.005	<0.005
PM-103	1	1	--	<0.005	NA
PM-104	1	1	--	<0.005	NA
PM-106	10	10	--	<0.005	<0.005

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Chloride, in mg/L					
PM-19	4	0	65 ± 2	67	61
PM-20	4	0	71 ± 11	81	53
PM-38	4	0	60 ± 3	64	55
PM-44	3	0	9 ± 0.5	10	9
PM-45	4	0	66 ± 4	72	62
PM-101	1	0	NA	7	NA
PM-102	1	0	NA	26	NA
PM-103	1	0	NA	18	NA
PM-104	1	0	NA	7	NA
PM-106	3	0	20 ± 0.1	21	20
Chromium, in mg/L					
PM-19	13	13	--	<0.005	<0.005
PM-20	12	0	1.2 ± 0.59	1.95	0.53
PM-38	12	0	0.057 ± 0.04	0.15	0.008
PM-44	11	9	--	0.007	<0.005
PM-45	10	6	--	0.01	<0.005
PM-101	2	2	--	<0.005	<0.005
PM-102	2	2	--	<0.005	<0.005
PM-103	1	1	--	<0.005	NA
PM-104	1	0	--	0.006	NA
PM-106	10	1	0.009 ± 0.003	0.014	<0.005
Copper, in mg/L					
PM-19	12	10	--	0.008	<0.005
PM-20	12	10	--	0.006	<0.005
PM-38	12	10	--	0.01	<0.005
PM-44	11	9	--	0.006	<0.005
PM-45	10	9	--	0.005	<0.005
PM-101	2	2	--	<0.005	<0.005
PM-102	2	2	--	<0.005	<0.005
PM-103	1	1	--	<0.005	NA
PM-104	1	1	--	<0.005	NA
PM-106	10	9	--	0.007	<0.005
Cyanide, in mg/L					
PM-19	4	4	--	<0.005	<0.005
PM-20	4	4	--	<0.005	<0.005
PM-38	3	3	--	<0.005	<0.005
PM-44	3	3	--	<0.005	<0.005
PM-45	4	4	--	<0.005	<0.005
PM-101	1	1	--	<0.005	NA
PM-102	1	1	--	<0.005	NA
PM-103	1	1	--	<0.005	NA
PM-104	1	1	--	<0.005	NA
PM-106	3	3	--	<0.005	<0.005

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Fluoride, in mg/L					
PM-19	4	2	--	0.2	<0.5
PM-20	4	0	1.4 ± 0.1	1.4	1.2
PM-38	4	2	--	0.3	<0.5
PM-44	3	0	0.9 ± 0.5	1	0.8
PM-45	4	0	1 ± 0.1	1	0.9
PM-101	1	0	--	1.6	NA
PM-102	1	0	--	1.6	NA
PM-103	1	0	--	1.6	NA
PM-104	1	0	--	1.7	NA
PM-106	3	1	0.3 ± 0.07	0.4	<0.5
Gross alpha-dissolved, in E-9μCi/ml					
PM-19	11	0	2 ± 1	4	1
PM-20	12	2	3 ± 3	9	<MDA[4]
PM-38	12	0	3 ± 1	6	2
PM-44	10	0	4 ± 2	11	2
PM-45	9	0	7 ± 2	10	3
PM-101	1	0	--	3	NA
PM-102	1	0	--	3	NA
PM-103	1	0	--	4	NA
PM-104	1	0	--	3	NA
PM-106	10	0	2 ± 1	4	1
Gross alpha-suspended, in E-9μCi/ml					
PM-19	11	11	--	<MDA	<MDA
PM-20	11	10	--	1	<MDA
PM-38	12	12	--	<MDA	<MDA
PM-44	10	10	--	<MDA	<MDA
PM-45	9	7	--	1	<MDA
PM-101	1	1	--	<MDA	NA
PM-102	1	1	--	<MDA	NA
PM-103	1	1	--	<MDA	NA
PM-104	1	1	--	<MDA	NA
PM-106	10	9	--	1	<MDA
Gross beta-dissolved, in E-9μCi/ml					
PM-19	11	0	5 ± 2	9	1
PM-20	12	1	8 ± 3	13	<MDA
PM-38	12	0	7 ± 3	11	2
PM-44	10	0	6 ± 2	9	4
PM-45	9	0	9 ± 2	10	5
PM-101	1	0	--	6	NA
PM-102	1	0	--	5	NA
PM-103	1	0	--	7	NA
PM-104	1	0	--	5	NA
PM-106	10	0	6 ± 1	9	4

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Gross beta-suspended, in E-9μCi/ml					
PM-19	11	8	--	1	<MDA
PM-20	12	5	0.4 ± 0.8	1	<MDA
PM-38	12	8	--	1	<MDA
PM-44	10	7	--	3	<MDA
PM-45	9	5	--	2	<MDA
PM-101	1	1	--	<MDA	NA
PM-102	1	1	--	<MDA	NA
PM-103	1	1	--	<MDA	NA
PM-104	1	1	--	<MDA	NA
PM-106	10	8	--	1	<MDA
HMX, in mg/L					
PM-19	10	10	--	<0.020	<0.020
PM-20	8	4	--	0.07	<0.020
PM-38	12	12	--	<0.020	<0.020
PM-44	9	9	--	<0.020	<0.020
PM-45	9	9	--	<0.020	<0.020
PM-101	1	1	--	<0.020	NA
PM-102	1	1	--	<0.020	NA
PM-103	1	1	--	<0.020	NA
PM-104	1	1	--	<0.020	NA
PM-106	9	9	--	<0.020	<0.020
Iron, in mg/L					
PM-19	13	0	1.64 ± 0.44	2.16	0.64
PM-20	12	0	0.7 ± 0.9	3.55	0.2
PM-38	12	0	0.33 ± 0.22	0.95	0.09
PM-44	11	0	0.04 ± 0.02	0.09	0.01
PM-45	10	0	0.05 ± 0.02	0.08	0.02
PM-101	2	1	--	0.03	<0.01
PM-102	2	0	0.02 ± 0.01	0.02	0.01
PM-103	1	0	--	0.05	NA
PM-104	1	0	--	0.03	NA
PM-106	10	0	0.1 ± 0.11	0.4	0.02
Lead, in mg/L					
PM-19	12	12	--	<0.005	<0.005
PM-20	12	12	--	<0.005	<0.005
PM-38	12	12	--	<0.005	<0.005
PM-44	11	11	--	<0.005	<0.005
PM-45	10	10	--	<0.005	<0.005
PM-101	2	2	--	<0.005	<0.005
PM-102	2	2	--	<0.005	<0.005
PM-103	1	1	--	<0.005	NA
PM-104	1	1	--	<0.005	NA
PM-106	10	10	--	<0.005	<0.005

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Mercury, in mg/L					
PM-19	12	12	--	<0.0001	<0.0001
PM-20	12	12	--	<0.0001	<0.0001
PM-38	12	11	--	0.0001	<0.0001
PM-44	11	11	--	<0.0001	<0.0001
PM-45	10	9	--	0.0001	<0.0001
PM-101	2	2	--	<0.0001	<0.0001
PM-102	2	2	--	<0.0001	<0.0001
PM-103	1	1	--	<0.0001	NA
PM-104	1	1	--	<0.0001	NA
PM-106	10	10	--	<0.0001	<0.0001
Nickel, in mg/L					
PM-19	13	12	--	0.02	<0.01
PM-20	12	12	--	<0.01	<0.01
PM-38	12	0	0.28 ± 0.05	0.39	0.21
PM-44	12	12	--	<0.01	<0.01
PM-45	10	0	0.12 ± 0.02	0.17	0.09
PM-101	1	1	--	<0.01	NA
PM-102	1	1	--	<0.01	NA
PM-103	1	0	--	0.05	NA
PM-104	1	1	--	<0.01	NA
PM-106	10	9	--	0.1	<0.01
Nitrate (as N), in mg/L					
PM-19	7	0	1.08 ± 0.15	1.22	0.754
PM-20	8	0	3.9 ± 1.1	4.8	1.5
PM-38	9	1	2.18 ± 0.87	2.8	<0.01
PM-44	8	1	1 ± 0.5	4.12	<0.01
PM-45	8	0	1.84 ± 0.6	3.19	1.02
PM-101	1	0	--	0.683	NA
PM-102	1	0	--	1.79	NA
PM-103	1	0	--	0.75	NA
PM-104	1	0	--	0.61	NA
PM-106	6	0	2.51 ± 1	3.17	0.49
Nitrite (as N), in mg/L					
PM-19	7	0	0.02 ± 0.012	0.04	0.005
PM-20	8	7	--	0.01	<0.01
PM-38	7	7	--	<0.01	<0.01
PM-44	7	6	--	0.91	<0.01
PM-45	8	8	--	<0.01	<0.01
PM-101	1	1	--	<0.01	NA
PM-102	1	1	--	<0.01	NA
PM-103	1	1	--	<0.01	NA
PM-104	1	1	--	<0.01	NA
PM-106	6	5	--	0.04	<0.01

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Oil and grease, in mg/L					
PM-19	4	3	--	5	<1
PM-20	4	2	--	3	<1
PM-38	4	3	--	2	<1
PM-44	3	3	--	<1	<1
PM-45	4	4	--	<1	<1
PM-101	1	1	--	<1	NA
PM-102	1	1	--	<1	NA
PM-103	1	1	--	<1	NA
PM-104	1	1	--	<1	NA
PM-106	3	2	--	3	<1
pH, in pH units					
PM-19	12	NA	6.9 ± 0.2	7.2	6.7
PM-20	12	NA	7.5 ± 0.2	7.9	7.2
PM-38	12	NA	7 ± 0.2	7.4	6.8
PM-44	10	NA	7.5 ± 0.1	7.6	7.3
PM-45	11	NA	7.1 ± 0.1	7.3	6.9
PM-101	5	NA	7.9 ± 0.5	8.8	7.6
PM-102	5	NA	7.8 ± 0.5	8.8	7.5
PM-103	1	NA	--	7.6	NA
PM-104	1	NA	--	7.7	NA
PM-106	10	NA	8.3 ± 0.5	9	7.6
Phenol, in mg/L					
PM-19	4	4	--	<0.005	<0.005
PM-20	4	4	--	<0.005	<0.005
PM-38	4	4	--	<0.005	<0.005
PM-44	3	2	--	0.005	<0.005
PM-45	4	4	--	<0.005	<0.005
PM-101	1	0	--	0.008	NA
PM-102	1	1	--	<0.005	NA
PM-103	1	0	--	0.007	NA
PM-104	1	0	--	0.009	NA
PM-106	3	3	--	<0.005	<0.005
Plutonium-239/240 - total, in E-9μCi/ml					
PM-19	11	8	--	0.06	<MDA
PM-20	12	6	--	0.04	<MDA
PM-38	12	7	--	0.03	<MDA
PM-44	9	7	--	0.03	<MDA
PM-45	9	7	--	0.04	<MDA
PM-101	1	1	--	<MDA	NA
PM-102	1	1	--	<MDA	NA
PM-103	1	1	--	<MDA	NA
PM-104	1	0	--	0.01	NA
PM-106	10	8	--	0.2	<MDA

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Radium-226 - total, in E-9μCi/ml					
PM-19	4	0	0.3 ± 0.1	0.4	0.1
PM-20	3	0	0.2 ± 0	0.03	0.2
PM-38	1	0	--	0.8	NA
PM-44	4	0	0.4 ± 0.2	0.8	0.2
PM-45	3	0	0.02 ± 0.05	0.1	0.2
PM-101	1	0	--	0.2	NA
PM-102	1	0	--	0.1	NA
PM-103	1	0	--	0.2	NA
PM-104	1	0	--	0.2	NA
PM-106	2	0	0.2 ± 0.1	0.2	0.1
Radium-228 - total, in E-9μCi/ml					
PM-19	3	1	0.2 ± 0.4	0.6	<MDA
PM-20	3	1	0.2 ± 0.8	0.5	<MDA
PM-38	3	0	0.6 ± 0.4	1.1	0.3
PM-44	4	0	0.5 ± 0.3	0.9	0.1
PM-45	3	0	0.8 ± 0.9	1.8	0.2
PM-101	1	0	--	0.5	NA
PM-102	1	0	--	0.1	NA
PM-103	1	0	--	0.4	NA
PM-104	1	1	--	<MDA	NA
PM-106	2	0	0.8 ± 0.4	1.1	0.4
RDX, in mg/L					
PM-19	10	10	--	<0.020	<0.020
PM-20	9	4	0.28 ± 0.8	1.1	<0.020
PM-38	12	11	--	0.02	<0.020
PM-44	9	9	--	<0.020	<0.020
PM-45	9	9	--	<0.020	<0.020
PM-101	1	1	--	<0.020	NA
PM-102	1	1	--	<0.020	NA
PM-103	1	1	--	<0.020	NA
PM-104	1	1	--	<0.020	NA
PM-106	9	9	--	<0.020	<0.020
Selenium - total, in mg/L					
PM-19	13	13	--	<0.005	<0.005
PM-20	12	11	--	0.006	<0.005
PM-38	12	12	--	<0.005	<0.005
PM-44	11	11	--	<0.005	<0.005
PM-45	10	10	--	<0.005	<0.005
PM-101	2	2	--	<0.005	<0.005
PM-102	2	2	--	<0.005	<0.005
PM-103	1	1	--	<0.005	NA
PM-104	1	1	--	<0.005	NA
PM-106	10	10	--	<0.005	<0.005

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Silver - total, in mg/L					
PM-19	11	10	--	0.018	<0.005
PM-20	12	12	--	<0.005	<0.005
PM-38	12	12	--	<0.005	<0.005
PM-44	11	11	--	<0.005	<0.005
PM-45	10	10	--	<0.005	<0.005
PM-101	2	2	--	<0.005	<0.005
PM-102	2	2	--	<0.005	<0.005
PM-103	1	1	--	<0.005	NA
PM-104	1	1	--	<0.005	NA
PM-106	10	9	--	0.005	<0.005
Specific conductance, in μmho/cm					
PM-19	11	0	734 ± 39	808	666
PM-20	10	0	624 ± 39	710	566
PM-38	10	0	788 ± 41	853	724
PM-44	10	0	350 ± 24	383	309
PM-45	10	0	697 ± 39	777	625
PM-101	4	0	334 ± 49	412	279
PM-102	4	0	375 ± 24	412	350
PM-103	1	0	--	402	NA
PM-104	1	0	--	362	NA
PM-106	10	0	330 ± 32	417	297
Sulfate (as SO_4), in mg/L					
PM-19	4	0	29 ± 2	32	26
PM-20	4	0	30 ± 7	40	24
PM-38	4	0	53 ± 2	56	51
PM-44	3	0	12 ± 0	12	12
PM-45	4	0	27 ± 1	28	25
PM-101	1	0	--	12	NA
PM-102	1	0	--	13	NA
PM-103	1	0	--	12	NA
PM-104	1	0	--	13	NA
PM-106	3	0	20 ± 0.1	20	19
Total dissolved solids, in mg/L					
PM-19	13	0	448 ± 38	518	380
PM-20	12	0	362 ± 53	500	280
PM-38	12	0	462 ± 16	490	440
PM-44	11	0	204 ± 14	230	180
PM-45	9	0	416 ± 30	460	370
PM-101	1	0	--	200	NA
PM-102	1	0	--	230	NA
PM-103	1	0	--	220	NA
PM-104	1	0	--	210	NA
PM-106	10	0	192 ± 18	220	160

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Total suspended solids, in mg/L					
PM-19	13	6	6 ± 22	60	<4
PM-20	12	11	--	5	<4
PM-38	12	12	--	<5	<4
PM-44	11	9	--	6	<4
PM-45	10	9	--	6	<5
PM-101	1	1	--	<5	NA
PM-102	1	1	--	<5	NA
PM-103	1	1	--	<5	NA
PM-104	1	1	--	<5	NA
PM-106	10	7	--	12	<4
Total organic carbon, in mg/L					
PM-19	42	39	--	15	<1
PM-20	41	38	--	1	<1
PM-38	41	38	--	3	<1
PM-44	43	42	--	2	<1
PM-45	37	36	--	3	<1
PM-101	4	4	--	<1	<1
PM-102	4	4	--	<1	<1
PM-103	4	4	--	<1	<1
PM-104	4	4	--	<1	<1
PM-106	37	36	--	2	<1
Total organic halogen, in mg/L					
PM-19	14	1	35 ± 10	43	<1
PM-20	11	0	83 ± 8	95	69
PM-38	12	0	27 ± 2	31	24
PM-44	11	9	--	8	<5
PM-45	10	0	9 ± 2	13	6
PM-101	1	0	--	9	NA
PM-102	1	0	--	16	NA
PM-103	1	0	--	7	NA
PM-104	1	0	--	259	NA
PM-106	10	6	--	18	<3
Trichloroethene, in mg/L					
PM-19	13	13	--	<0.005	<0.005
PM-20	12	1	0.094 ± 0.03	0.15	<0.005
PM-38	12	12	--	<0.005	<0.005
PM-44	9	9	--	<0.005	<0.005
PM-45	8	2	0.007 ± 0.002	0.01	<0.005
PM-101	5	4	--	0.0086	<0.005
PM-102	5	1	0.011 ± 0.004	0.015	<0.005
PM-103	1	1	--	<0.005	NA
PM-104	1	1	--	<0.005	NA
PM-106	9	9	--	<0.005	<0.005

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Tritium - total, in E-6μCi/ml					
PM-19	8	2	0.07 ± 0.12	0.33	<MDA
PM-20	12	5	0.2 ± 0.9	0.16	<MDA
PM-38	12	1	0.14 ± 0.08	0.27	<MDA
PM-44	9	5	--	0.1	<MDA
PM-45	9	3	0.01 ± 0.35	0.04	<MDA
PM-101	1	0	--	0.01	NA
PM-102	1	1	--	<MDA	NA
PM-103	1	0	--	0.06	NA
PM-104	1	1	--	<MDA	NA
PM-106	10	4	0.02 ± 0.06	0.17	<MDA
Uranium-234 - total, in E-9μCi/ml					
PM-19	11	0	1 ± 0.1	1.2	0.8
PM-20	12	0	3.3 ± 0.3	3.8	2.6
PM-38	12	0	1.6 ± 0.2	1.9	1.3
PM-44	10	0	2.3 ± 0.3	2.8	1.8
PM-45	9	0	4.9 ± 0.4	5.5	4.3
PM-101	1	0	--	2.5	NA
PM-102	1	0	--	1.9	NA
PM-103	1	0	--	2.4	NA
PM-104	1	0	--	1.9	NA
PM-106	10	0	1.2 ± 0.1	1.4	1
Uranium-238 - total, in E-9μCi/ml					
PM-19	11	0	0.7 ± 0.1	1	0.6
PM-20	12	0	1.8 ± 0.2	2.3	1.5
PM-38	12	0	0.9 ± 0.2	1.1	0.2
PM-44	10	0	1.2 ± 0.2	1.7	0.81
PM-45	9	0	2.6 ± 0.3	3	2.2
PM-101	1	0	--	1.3	NA
PM-102	1	0	--	1.1	NA
PM-103	1	0	--	1.8	NA
PM-104	1	0	--	1.1	NA
PM-106	10	0	0.6 ± 0.1	0.8	0.5
Zinc - total, in mg/L					
PM-19	13	3	0.009 ± 0.006	0.019	<0.005
PM-20	12	5	0.006 ± 0.005	0.017	<0.005
PM-38	12	2	0.01 ± 0.008	0.027	<0.005
PM-44	11	0	0.018 ± 0.008	0.038	0.011
PM-45	10	0	0.015 ± 0.007	0.032	0.006
PM-101	2	0	0.37 ± 0.32	0.684	0.048
PM-102	2	0	0.051 ± 0.02	0.065	0.038
PM-103	1	0	--	0.041	NA
PM-104	1	0	--	0.021	NA
PM-106	10	0	0.038 ± 0.03	0.099	0.006

Table 9.3 Summary of 1994 Data for Perched Groundwater Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
1,2-Dichloroethane, in mg/L					
PM-19	13	13	--	<0.005	<0.005
PM-20	12	12	--	<0.005	<0.005
PM-38	12	12	--	<0.005	<0.005
PM-44	9	9	--	<0.005	<0.005
PM-45	8	8	--	<0.005	<0.005
PM-101	5	5	--	<0.005	<0.005
PM-102	5	0	0.009 ± 0.003	0.14	0.0057
PM-103	1	1	--	<0.005	NA
PM-104	1	1	--	<0.005	NA
PM-106	9	9	--	<0.005	<0.005

Summary of radioactive results does not include counting error.
[1]BDL indicates below detection limit.
[2]Dashes (--) indicate a mean could not be calculated.
[3]NA indicates not applicable.
[4]<MDA indicates the results were less than the minimum detectable activity (MDA) of the radionuclide counting system.

Ogallala Aquifer Monitoring Wells. Three monitoring wells in the Ogallala aquifer (OM-39, OM-40, and OM-105) were sampled monthly and analyzed for chemical and radiological constituents. No biological samples were taken from the Ogallala monitoring wells. Results are presented in Table 9.4.

The mean iron concentration in OM-39 was 0.45 mg/L, which was above the MCLG of 0.3 mg/L. The elevated concentration reflects deterioration of the well casing, which was documented by videotapes of the well in 1992. Iron concentrations did not exceed 0.06 mg/L in well OM-105, which is constructed with polyvinylchloride (PVC) casing. There was no indication of contamination by explosives, organic compounds, other metals, or radiological constituents in Ogallala monitoring wells. There was no evidence of contaminated groundwater from the overlying perched zone reaching the Ogallala aquifer.

Ogallala Aquifer Water Supply Production Wells. All production wells pump water from the Ogallala aquifer. The wells were sampled every other month; results are presented in Table 9.5. No chemical or radiological contaminants exceeded the current MCLs or MCLGs in 1994. Although there are naturally occurring radionuclides and metals in these wells, there was no indication of contamination by explosives, organic compounds, or radiological substances. No bacteriological contamination was detected in the production wells in 1994.

Bushland Control. Results are shown in Table 9.6. For 1994 data, no significant variations from historical values were seen.

9.3 Historical Comparisons

Purging of wells, chain-of-custody records, and improved sampling techniques to enhance reliability were implemented in 1989. Evaluation of laboratory holding times, sample recovery rates, and other procedures began in 1992.

Ogallala Aquifer Water Consumption. Pantex Plant's water consumption in 1994 increased over 1993 consumption (Figure 9.4). Some of the water pumped by Pantex Plant is sold to Texas

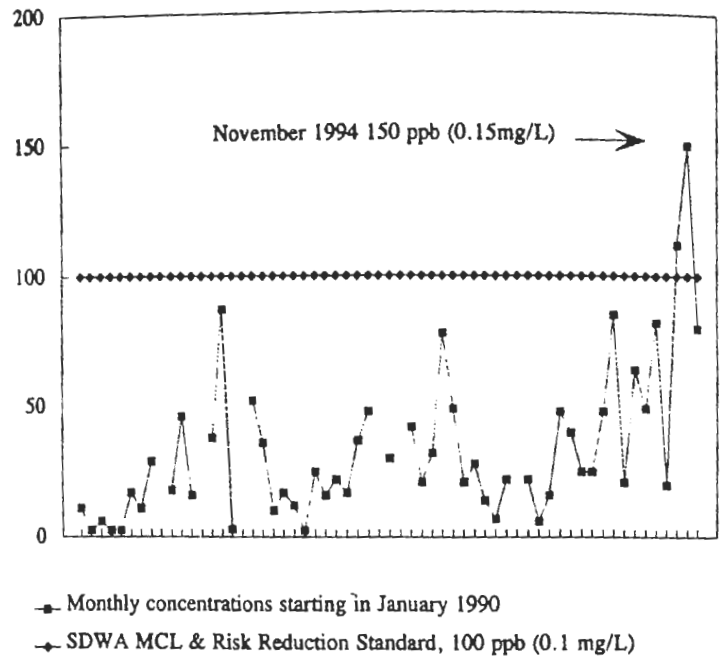


Figure 9.2: Chromium concentrations in well PM-38, in parts per billion

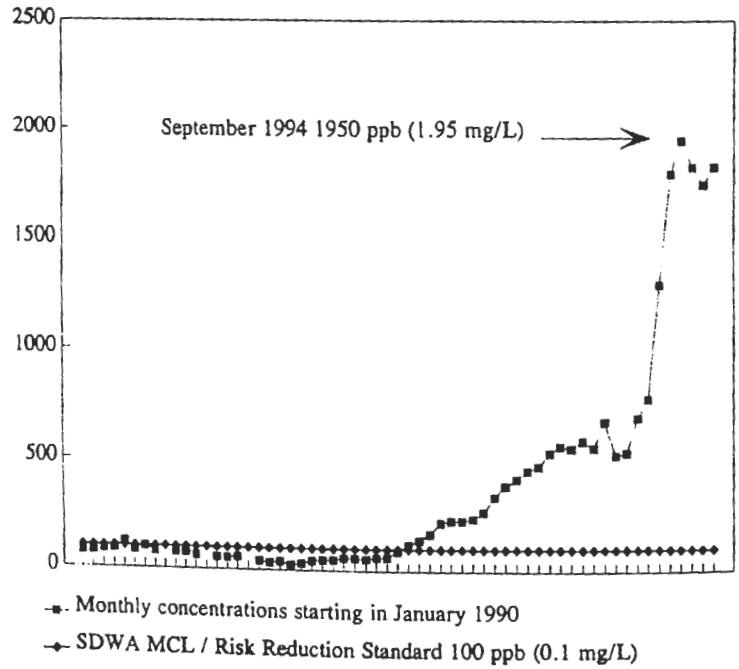


Figure 9.3: Chromium concentrations in well PM-20, in parts per billion

Tech University for irrigation south of the Plant. Texas Tech University's use has decreased since 1991.

Chemical and Radiological Quality. Mean results for 1990 through 1994 are compared for perched groundwater and Ogallala monitoring wells, production wells, and the control location (Tables 9.7 to 9.10). The decrease in pH values for the Ogallala aquifer in 1993 may be due to a change in sampling instruments. No other trends were observed in the Ogallala data.

A similar decrease in pH is seen in the perched aquifer data for 1993. Rising chloride concentrations in PM-19 and PM-20 may indicate active recharge to the perched aquifer near those wells. Rising chromium, total dissolved solids, total organic halogen, and TCE concentrations in PM-20 may indicate recharge from the area surrounding the well (Zone 12). Mean chromium concentrations in PM-38 may reflect the corrosion observed in the sampling pumps or well materials. The near-constant TCE values in PM-45 may indicate that the source of the TCE is located near the well.

The 1994 radiological results were compared to those for 1990-1993. Statistical analysis applied the central limit theorem to reported means to approximate the mean for all samples, using the reported variance to approximate the standard deviation of the samples, and calculating the coefficient of variation (relative standard deviation, or the standard deviation divided by the mean and expressed as a percentage). Table 9.11 shows results for the Ogallala aquifer as represented by samples from production wells, drinking water, and Ogallala monitoring wells OM-39 and OM-40. These sampling locations are all in the northeast corner of the Plant and are assumed to provide replicate samples of the same body of water. It was also assumed that counting errors were the same over time and they were not used. The analyses indicated no variation in the 1994 data, as represented by the coefficient of variation.

The uranium ratio is used to determine whether measured uranium is naturally occurring or a result of Plant operations. The ratio represents the activity of uranium-234 divided by that of uranium-238. The ideal (or natural) ratio is 1.0; the natural ratio for groundwater is 2.0 (based on natural radioactive decay and effects of alpha recoil), which was the ratio in 1994. The ratios for 1990-1993 were slightly lower, a fact that is probably a result of greater variation in observed uranium-238 activities. Overall, the 1994 results were similar to those for the previous four years.

Figure 9.5 shows average gross alpha-suspended activity for the perched monitoring wells along a north-south transect. All values are below the MCL of 15 picocuries per liter (pCi/L). Activities in PM-106 and PM-19 are significantly lower than the Ogallala mean. In contrast, when standard deviations are considered, results from the other four wells are not significantly different from those reported for the Ogallala aquifer. The same situation was found for many analytes, including barium. Thus, it is likely that the perched wells do not all intersect the same geochemical body of groundwater.

9.4 Summary

Neither chemical contamination nor elevated radiation levels were detected in the Ogallala aquifer in 1994. As described above, contamination was detected in perched aquifers. Chromium concentrations increased significantly in two perched groundwater wells. In one well (PM-38), its presence probably reflects corrosion of the pumps and piping. The increase in PM-20 is probably a result of movement of chromium-contaminated groundwater. Water from perched aquifers would require treatment to remove contamination before it could be used for drinking. No elevated radiological levels were observed.

Table 9.4 Summary of 1994 Data for Ogallala Aquifer Monitoring Wells

Location	No. of Samples	No. BDL[1]	Mean ± Std. Dev.	Max	Min
Ammonia (as N), in mg/L					
OM-39	14	14	--[2]		
OM-40	16	16	0	<0.2	<0.2
OM-105	12	11	0	<0.2	<0.1
				7	<0.2
Arsenic, in mg/L					
OM-39	14	14	--	<0.005	<0.005
OM-40	16	15	--	0.005	<0.005
OM-105	12	12	--	<0.005	<0.005
Barium, in mg/L					
OM-39	14	0	0.14 ± 0.02	0.19	0.12
OM-40	16	0	0.14 ± 0.03	0.17	0.14
OM-105	12	0	0.12 ± 0.005	0.13	0.12
Cadmium, in mg/L					
OM-39	14	14	--	<0.005	<0.005
OM-40	16	16	--	<0.005	<0.005
OM-105	12	12	--	<0.005	<0.005
Chloride, in mg/L					
OM-39	6	0	11 ± 2	12	7
OM-40	4	0	8 ± 1	9	7
OM-105	5	0	7 ± 0	7	7
Chromium, in mg/L					
OM-39	14	13	--	0.005	<0.005
OM-40	16	13	--	0.007	<0.005
OM-105	12	10	--	0.007	<0.005
Copper, in mg/L					
OM-39	14	14	--	<0.005	<0.005
OM-40	16	14	--	0.01	<0.005
OM-105	12	12	--	<0.005	<0.005
Cyanide, in mg/L					
OM-39	6	6	--	<0.005	<0.005
OM-40	3	3	--	<0.005	<0.005
OM-105	5	5	--	<0.005	<0.005
Fluoride, in mg/L					
OM-39	6	0	1.6 ± 0.2	1.8	1.3
OM-40	4	0	1.5 ± 0.1	1.6	1.4
OM-105	5	0	1.7 ± 0.1	1.8	1.5

Table 9.4 Summary of 1994 Data for Ogallala Aquifer Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Gross alpha-dissolved, in E-9μCi/ml					
OM-39	13	0	5 ± 2	8	2
OM-40	15	0	6 ± 1	10	4
OM-105	13	0	6 ± 2	8	2
Gross alpha-suspended, in E-9μCi/ml					
OM-39	13	12	--	1	<MDA[3]
OM-40	15	13	--	1	<MDA
OM-105	12	12	--	<MDA	<MDA
Gross beta-dissolved, in E-9μCi/ml					
OM-39	13	0	9 ± 4	20	6
OM-40	15	0	8 ± 3	16	5
OM-105	12	0	8 ± 2	14	6
Gross beta-suspended, in E-9μCi/ml					
OM-39	13	5	0.4 ± 0.8	1	<MDA
OM-40	15	9	--	1	<MDA
OM-105	11	3	0.6 ± 0.6	1	<MDA
HMX, in mg/L					
OM-39	12	12	--	<0.020	<0.020
OM-40	13	13	--	<0.020	<0.020
OM-105	11	11	--	<0.020	<0.020
Iron, in mg/L					
OM-39	14	0	0.45 ± 0.36	1.49	0.06
OM-40	16	0	0.22 ± 0.04	0.28	0.15
OM-105	12	5	0.01 ± 0.02	0.06	<0.01
Lead, in mg/L					
OM-39	13	13	--	<0.005	<0.005
OM-40	16	16	--	<0.005	<0.005
OM-105	12	11	--	0.007	<0.005
Mercury, in mg/L					
OM-39	14	14	--	<0.0001	<0.0001
OM-40	16	16	--	<0.0001	<0.0001
OM-105	12	12	--	<0.0001	<0.0001
Nitrate (as N), in mg/L					
OM-39	9	0	1.44 ± 0.4	2.19	0.767
OM-40	10	0	1.39 ± 0.15	1.77	1.24
OM-105	8	0	1.15 ± 0.18	1.41	0.92

Table 9.4 Summary of 1994 Data for Ogallala Aquifer Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Nitrite (as N), in mg/L					
OM-39	9	9	--	<0.01	<0.01
OM-40	9	9	--	<0.01	<0.01
OM-105	8	8	--	<0.01	<0.01
Oil and grease, in mg/L					
OM-39	6	6	--	<1	<1
OM-40	4	2	--	3	<1
OM-105	5	3	--	2	<1
pH, in pH units					
OM-39	11	NA[4]	7.4 ± 0.1	7.6	7.2
OM-40	12	NA	7.3 ± 0.3	7.5	6.7
OM-105	5	NA	7.7 ± 0.2	8.1	7.4
Phenol, in mg/L					
OM-39	6	5	--	0.007	<0.005
OM-40	2	2	--	<0.005	<0.005
OM-105	5	2	0.005 ± 0.001	0.007	<0.005
Plutonium-239/240 - total, in E-9μCi/ml					
OM-39	13	9	--	0.04	<MDA
OM-40	16	9	--	0.06	<MDA
OM-105	12	10	--	0.01	<MDA
Radium-226 - total, in E-9μCi/ml					
OM-39	2	0	0.3 ± 0.1	0.4	0.2
OM-40	5	0	0.4 ± 0.2	0.7	0.1
OM-105	4	2	--	0.2	<MDA
Radium-228 - total, in E-9μCi/ml					
OM-39	2	0	0.4 ± 0	0.4	0.4
OM-40	5	0	0.4 ± 0.05	0.5	0.4
OM-105	4	0	0.4 ± 0.1	0.5	0.2
RDX, in mg/L					
OM-39	12	12	--	<0.020	<0.020
OM-40	13	13	--	<0.020	<0.020
OM-105	11	11	--	<0.020	<0.020
Selenium, in mg/L					
OM-39	14	14	--	<0.005	<0.005
OM-40	16	16	--	<0.005	<0.005
OM-105	12	12	--	<0.005	<0.005

Table 9.4 Summary of 1994 Data for Ogallala Aquifer Monitoring Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Silver - total, in mg/L					
OM-39	13	12	--	0.007	<0.005
OM-40	16	16	--	<0.005	<0.005
OM-105	12	12	--	<0.005	<0.005
Specific conductance, in μmho/cm					
OM-39	13	0	462 ± 27	514	418
OM-40	13	0	475 ± 27	517	426
OM-105	10	0	459 ± 25	485	412
Sulfate (as SO_4), in mg/L					
OM-39	6	0	23 ± 3	26	16
OM-40	4	0	19 ± 2	22	18
OM-105	5	0	17 ± 1	18	16
Total dissolved solids, in mg/L					
OM-39	14	0	266 ± 27	310	210
OM-40	16	0	275 ± 40	360	220
OM-105	10	0	266 ± 47	384	220
Total suspended solids, in mg/L					
OM-39	14	13	--	6	<5
OM-40	15	15	--	<5	<4
OM-105	11	10	--	5	<4
Total organic carbon, in mg/L					
OM-39	50	47	--	1	<1
OM-40	64	60	--	2	<1
OM-105	48	48	--	<1	<1
Total organic halogen, in mg/L					
OM-39	51	48	--	23	<3
OM-40	64	60	--	6	<3
OM-105	45	43	--	8	<3
Trichloroethene, in mg/L					
OM-39	14	14	--	<0.005	<0.005
OM-40	16	16	--	<0.005	<0.005
OM-105	10	10	--	<0.005	<0.005
Tritium - total, in E-06μCi/ml					
OM-39	9	4	0.02 ± 0.07	0.1	<MDA
OM-40	13	8	--	0.05	<MDA
OM-105	11	10	--	0.14	<MDA

Table 9.5 Summary of 1994 Data for Ogallala Aquifer Water Supply Production Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Fluoride, in mg/L					
PR-2	2	0	1.3 ± 0.01	1.3	1.2
PR-6	1	0	--	1.6	NA
PR-16	1	0	--	1.5	NA
PR-41	2	0	1.4 ± 0.1	1.4	1.3
Gross alpha-dissolved, in E-9μCi/ml					
PR-2	5	0	5 ± 2	6	1
PR-6	1	1	--	<MDA[4]	NA
PR-16	2	0	7 ± 1	7	6
PR-41	5	1	4 ± 3.7	9	<MDA
Gross alpha-suspended, in E-9μCi/ml					
PR-2	5	5	--	<MDA	<MDA
PR-6	1	1	--	<MDA	NA
PR-16	2	2	--	<MDA	<MDA
PR-41	5	5	--	<MDA	<MDA
Gross beta-dissolved, in E-9μCi/ml					
PR-2	5	1	5 ± 3	7	<MDA
PR-6	1	1	--	<MDA	NA
PR-16	2	0	8 ± 2	9	6
PR-41	5	1	5 ± 3.4	6	<MDA
Gross beta-suspended, in E-9μCi/ml					
PR-2	5	4	--	1	<MDA
PR-6	1	1	--	<MDA	NA
PR-16	2	2	--	<MDA	<MDA
PR-41	5	3	--	1	<MDA
HMX, in mg/L					
PR-2	4	4	--	<0.020	<0.020
PR-6	1	1	--	<0.020	NA
PR-16	1	1	--	<0.020	NA
PR-41	3	3	--	<0.020	<0.020
Iron, in mg/L					
PR-2	5	3	--	0.04	<0.01
PR-6	1	0	--	0.06	NA
PR-16	2	1	--	0.04	<0.01
PR-41	5	1	0.015 ± 0.006	0.02	<0.01
Lead, in mg/L					
PR-2	5	5	--	<0.005	<0.005
PR-6	1	1	--	<0.005	NA
PR-16	2	2	--	<0.005	<0.005
PR-41	5	5	--	<0.005	<0.005

Table 9.5 Summary of 1994 Data for Ogallala Aquifer Water Supply Production Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Mercury, in mg/L					
PR-2	5	5	--	<0.0001	<0.0001
PR-6	1	1	--	<0.0001	NA
PR-16	2	2	--	<0.0001	<0.0001
PR-41	5	5	--	<0.0001	<0.0001
Nitrate (as N), in mg/L					
PR-2	4	0	1.48 ± 0.09	1.61	1.37
PR-6	0	NA	--	NA	NA
PR-16	1	0	--	1.68	NA
PR-41	4	0	1.64 ± 0.13	1.85	1.5
Nitrite (as N), in mg/L					
PR-2	3	3	--	<0.01	<0.01
PR-6	0	NA	--	NA	NA
PR-16	1	1	--	<0.01	NA
PR-41	4	4	--	<0.01	<0.01
Oil and grease, in mg/L					
PR-2	2	0	1 ± 2	2	1
PR-6	1	0	--	4	NA
PR-16	1	1	--	<1	NA
PR-41	2	1	--	4	<1
pH, in pH units					
PR-2	5	NA	7.4 ± 0.2	7.7	7.1
PR-6	1	NA	--	7.7	NA
PR-16	2	NA	7.4 ± 0	7.4	7.4
PR-41	5	NA	7.3 ± 0.2	7.5	7
Phenol, in mg/L					
PR-2	2	2	--	<0.005	<0.005
PR-6	1	1	--	<0.005	NA
PR-16	2	2	--	<0.005	<0.005
PR-41	2	2	--	<0.005	<0.005
Plutonium-239/240 - total, in E-9μCi/ml					
PR-2	5	2	0.01 ± 0.07	0.11	<MDA
PR-6	1	0	--	2	NA
PR-16	2	0	0.02 ± 0.01	0.1	0.02
PR-41	5	3	--	0.07	<MDA
Radium-226 - total, in E-9μCi/ml					
PR-2	0	NA	--	NA	NA
PR-6	0	NA	--	NA	NA
PR-16	3	0	0.3 ± 0.06	0.3	0.2
PR-41	0	NA	--	NA	NA

Table 9.5 Summary of 1994 Data for Ogallala Aquifer Water Supply Production Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Radium-228 - total, in E-9μCi/ml					
PR-2	0	NA	--	NA	NA
PR-6	0	NA	--	NA	NA
PR-16	3	0	0.5 ± 0.4	0.9	0.1
PR-41	0	NA	--	NA	NA
RDX, in mg/L					
PR-2	4	4	--	<0.020	<0.020
PR-6	1	1	--	<0.020	NA
PR-16	1	1	--	<0.020	NA
PR-41	3	3	--	<0.020	<0.020
Selenium - total, in mg/L					
PR-2	5	5	--	<0.005	<0.005
PR-6	1	1	--	<0.005	NA
PR-16	2	2	--	<0.005	<0.005
PR-41	5	5	--	<0.005	<0.005
Silver - total, in mg/L					
PR-2	5	5	--	<0.005	<0.005
PR-6	1	1	--	<0.005	NA
PR-16	2	2	--	<0.005	<0.005
PR-41	5	5	--	<0.005	<0.005
Specific conductance, in μmho/cm					
PR-2	4	0	465 ± 18	497	452
PR-6	1	0	--	472	NA
PR-16	2	0	465 ± 32	496	433
PR-41	5	0	474 ± 29	525	435
Sulfate (as SO_4), in mg/L					
PR-2	2	0	21 ± 0	21	21
PR-6	1	0	--	22	NA
PR-16	1	0	--	23	NA
PR-41	2	0	22 ± 0	22	22
Total dissolved solids, in mg/L					
PR-2	5	0	276 ± 15	300	254
PR-6	1	0	--	258	NA
PR-16	2	0	266 ± 6	272	260
PR-41	5	0	282 ± 30	320	240
Total suspended solids, in mg/L					
PR-2	5	5	--	<5	<4
PR-6	1	1	--	<5	NA
PR-16	2	2	--	<5	<4
PR-41	5	5	--	<5	<5

Table 9.5 Summary of 1994 Data for Ogallala Aquifer Water Supply Production Wells (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Total organic carbon, in mg/L					
PR-2	4	1	1 ± 0.007	1	<1
PR-6	1	1	--	<1	NA
PR-16	2	2	--	<1	<1
PR-41	4	3	--	1	<1
Total organic halogen, in mg/L					
PR-2	4	3	--	5	<3
PR-6	1	1	--	<5	NA
PR-16	2	2	--	<3	<3
PR-41	4	3	--	4	<1
Trichloroethene, in mg/L					
PR-2	5	5	--	<0.005	<0.005
PR-6	1	1	--	<0.005	NA
PR-16	2	2	--	<0.005	<0.005
PR-41	5	5	--	<0.005	<0.005
Tritium - total, in E-6μCi/ml					
PR-2	5	1	0.13 ± 0.09	0.2	<MDA
PR-6	1	0	--	0.06	NA
PR-16	2	1	--	0.16	<MDA
PR-41	5	3	--	0.25	<MDA
Uranium-234 - total, in E-9μCi/ml					
PR-2	5	0	4.1 ± 0.4	4.8	3.7
PR-6	1	0	--	3.8	NA
PR-16	2	0	4.5 ± 0	4.5	4.5
PR-41	5	0	4.5 ± 0.3	4.8	4
Uranium-238 - total, in E-9μCi/ml					
PR-2	5	0	2.2 ± 0.3	2.8	2
PR-6	1	0	--	2	NA
PR-16	2	0	2.3 ± 0.2	2.4	2.1
PR-41	5	0	2.1 ± 0.4	2.7	1.5
Zinc - total, in mg/L					
PR-2	5	1	0.007 ± 0.005	0.015	<0.005
PR-6	1	0	--	0.02	NA
PR-16	2	0	0.008 ± 0.002	0.009	0.006
PR-41	5	0	0.047 ± 0.07	0.18	0.012
1,2-Dichloroethane, in mg/L					
PR-2	5	5	--	<0.005	<0.005
PR-6	1	1	--	<0.005	NA
PR-16	2	2	--	<0.005	<0.005
PR-41	5	5	--	<0.005	<0.005

Table 9.5 Summary of 1994 Data for Ogallala Aquifer Water Supply Production Wells (cont'd)

Summary of radioactive results does not include counting error.
[1]BDL indicates below detection limit.
[2]Dashes (--) indicate a mean could not be calculated.
[3]NA indicates not applicable
[4]<MDA indicates the results were less than the minimum detectable activity (MDA) of the radionuclide counting system.

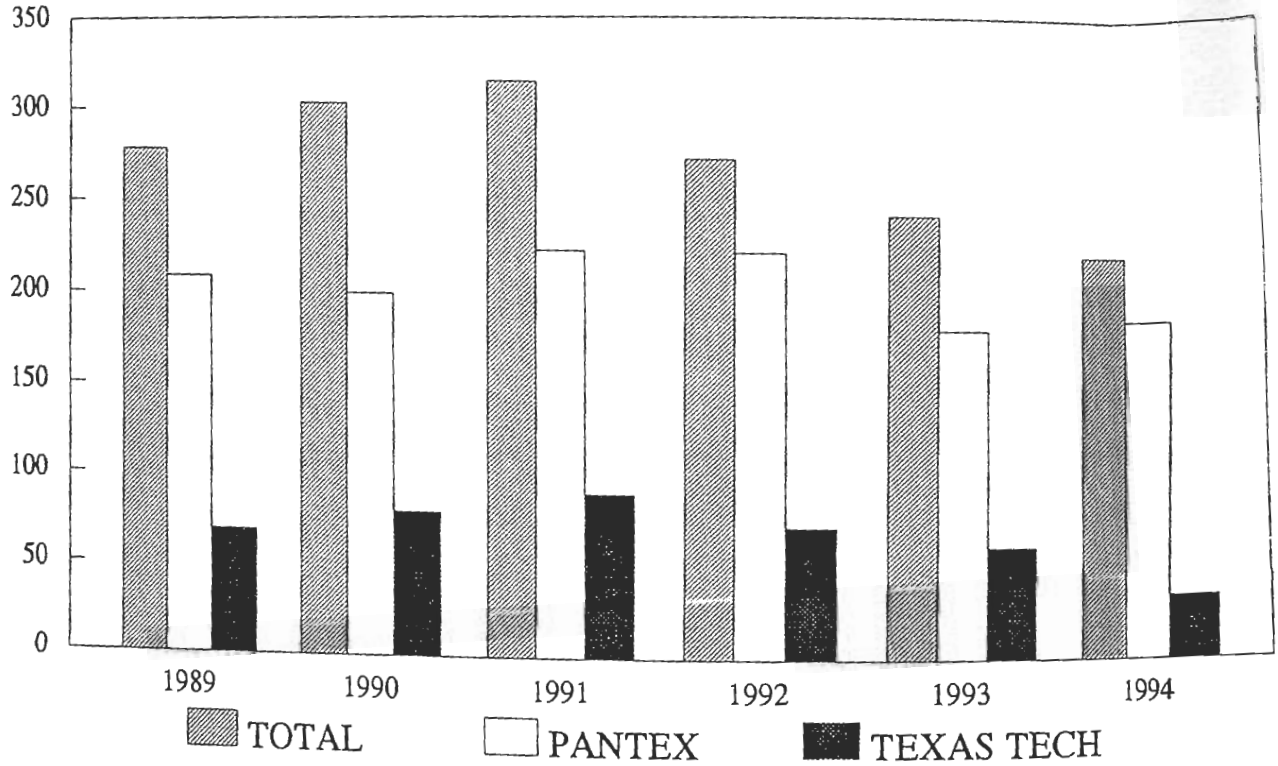


Figure 9.4: Pantex Plant's water use, in millions of gallons

Table 9.6 Summary of 1994 Data for Groundwater at the Control Location

Location	No. of Samples	No. BDL[1]	Mean ± Std. Dev.	Max	Min
Ammonia (as N), in mg/L					
CO-33	10	10	--[2]	<0.2	<0.2
Arsenic, in mg/L					
CO-33	10	10	--	<0.005	<0.005
Barium, in mg/L					
CO-33	10	0	0.06 ± 0.01	0.07	0.05
Cadmium, in mg/L					
CO-33	10	10	--	<0.005	<0.005
Chloride, in mg/L					
CO-33	3	0	7 ± 0	7	7
Chromium, in mg/L					
CO-33	10	6	--	0.007	<0.005
Copper, in mg/L					
CO-33	10	0	0.082 ± 0.026	0.118	0.043
Cyanide, in mg/L					
CO-33	3	2	--	0.035	<0.005
Fluoride, in mg/L					
CO-33	3	0	2.5 ± 0.1	2.6	2.4
Gross alpha-dissolved, in E-9μCi/ml					
CO-33	8	0	6 ± 1	7	4
Gross alpha-suspended, in E-9μCi/ml					
CO-33	8	7	--	1	<MDA[3]
Gross beta-dissolved, in E-9μCi/ml					
CO-33	8	0	6 ± 2	9	2
Gross beta-suspended, in E-9μCi/ml					
CO-33	8	6	--	1	<MDA
HMX, in mg/L					
CO-33	8	8	--	<0.020	<0.020
Iron, in mg/L					
CO-33	10	0	0.06 ± 0.03	0.1	0.02

Table 9.6 Summary of 1994 Data for Groundwater at the Control Location (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Lead, in mg/L					
CO-33	10	9	--	0.005	<0.005
Mercury, in mg/L					
CO-33	10	0	--	<0.0001	<0.0001
Nitrate (as N), in mg/L					
CO-33	6	0	1.86 ± 0.14	2.08	1.65
Nitrite (as N), in mg/L					
CO-33	5	5	--	<0.01	<0.01
Oil and grease, in mg/L					
CO-33	2	1	--	2	<1
pH, in pH units					
CO-33	11	NA[4]	7.4 ± 0.2	7.7	7
Phenol, in mg/L					
CO-33	2	2	--	<0.005	<0.005
Plutonium-239/240 - total, in E-9μCi/ml					
CO-33	8	5	--	0.01	<MDA
Radium-226 - total, in E-9μCi/ml					
CO-33	3	1	0.07 ± 0.13	1.1	<MDA
Radium-228 - total, in E-9μCi/ml					
CO-33	3	0	0.5 ± 0.4	1.1	0.1
RDX, in mg/L					
CO-33	8	8	--	<0.020	<0.020
Selenium - total, in mg/L					
CO-33	10	1	0.007 ± 0.001	0.008	<0.005
Silver - total, in mg/L					
CO-33	10	10	--	<0.005	<0.005
Specific conductance, in μmho/cm					
CO-33	10	0	555 ± 29	595	505
Sulfate (as SO_4), in mg/L					
CO-33	3	0	49 ± 1	50	48

Table 9.6 Summary of 1994 Data for Groundwater at the Control Location (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev.	Max	Min
Total dissolved solids, in mg/L					
CO-33	10	0	343 ± 26	400	300
Total suspended solids, in mg/L					
CO-33	10	9	--	6	<5
Total organic carbon, in mg/L					
CO-33	10	9	--	1	<1
Total organic halogen, in mg/L					
CO-33	10	2	6 ± 3	11	<3
Trichloroethene, in mg/L					
CO-33	8	8	--	<0.005	<0.005
Tritium - total, in E-6μCi/ml					
CO-33	7	2	0.05 ± 0.11	0.23	<MDA
Uranium-234 - total, in E-9μCi/ml					
CO-33	8	0	4.1 ± 0.4	5	3.6
Uranium-238 - total, in E-9μCi/ml					
CO-33	8	0	2.7 ± 0.2	3	2.4
Zinc - total, in mg/L					
CO-33	10	0	0.021 ± 0.011	0.052	0.009
1,2-Dichloroethane, in mg/L					
CO-33	8	8	--	<0.005	<0.005

Summary of radioactive results does not include counting error.
[1]BDL indicates below detection limit.
[2]Dashes (--) indicate a mean could not be calculated.
[3]<MDA indicates the results were less than the minimum detectable activity (MDA) of the radionuclide counting system.
[4]NA indicates not applicable.

Table 9.7 Comparison of Mean Perched Groundwater Results for 1990-1994

Location	1990	1991	1992	1993	1994
Ammonia (as N), in mg/L					
PM-19	*[1]	*	*	*	*
PM-20	--[2]	*	*	*	*
PM-38	--	*	*	*	*
PM-44	--	*	*	*	*
PM-45	--	*	*	*	*
PM-106	--	--	*	*	*
Arsenic, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*
Barium, in mg/L					
PM-19	0.18	0.18	0.18	0.19	0.18
PM-20	0.14	0.15	0.15	0.17	0.18
PM-38	0.12	0.1	0.11	0.11	0.11
PM-44	0.14	0.14	0.14	0.14	0.14
PM-45	0.2	0.21	0.19	0.22	0.23
PM-106	--	--	0.1	0.11	0.11
Cadmium, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*
Chloride, in mg/L					
PM-19	NA[3]	36	36	36	65
PM-20	--	26	31	60	71
PM-38	--	57	47	48	60
PM-44	--	12	10	2	9
PM-45	--	57	56	63	66
PM-106	--	--	18	21	20
Chromium, in mg/L					
PM-19	*	*	*	*	*
PM-20	0.083	0.043	0.11	0.45	1.2
PM-38	0.015	0.042	0.031	0.024	0.057
PM-44	*	*	*	*	*
PM-45	0.008	*	*	*	*
PM-106	--	--	0.008	0.01	0.009

Table 9.7 Comparison of Mean Perched Groundwater Results for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Chromium (hexavalent), in mg/L					
PM-19	*	*	*	*	*
PM-20	--	0.05	0.1	0.44	--
PM-38	--	*	*	*	--
PM-44	--	*	0.1	*	--
PM-45	--	*	*	*	--
PM-106	--	--	0.02	--	*
Copper, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*
Cyanide, in mg/L					
PM-19	NA	*	*	*	*
PM-20	--	*	*	*	*
PM-38	*	*	--	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*
Fluoride, in mg/L					
PM-19	NA	*	*	*	*
PM-20	--	1.6	1.6	1	1.4
PM-38	--	*	*	*	*
PM-44	--	1.2	1.14	0.8	0.9
PM-45	--	1.3	1.24	1	1
PM-106	--	--	0.7	0.6	0.3
Gross alpha-dissolved, in E-9μCi/ml					
PM-19	0.5	0.9	0.9	5	2
PM-20	7	3	2.8	4	3
PM-38	5	1.7	2.9	5	3
PM-44	5	4	3.05	4.4	4
PM-45	7	4	5	6	7
PM-106	--	--	2	3	2
Gross alpha-suspended, in E-9μCi/ml					
PM-19	*	0.6	0.6	*	*
PM-20	*	0.1	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*

Table 9.7 Comparison of Mean Perched Groundwater Results for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Gross beta-dissolved, in E-9μCi/ml					
PM-19	5	3.7	3.7	10	5
PM-20	9	7	4	7	8
PM-38	8	6	5.3	10	7
PM-44	6	4.1	4	6.1	6
PM-45	11	8	7.9	10	9
PM-106	--	--	5	6	6
Gross beta-suspended, in E-9μCi/ml					
PM-19	*	*	*	*	*
PM-20	*	*	*	1	0.4
PM-38	0.12	0.2	*	*	*
PM-44	*	0.1	*	*	*
PM-45	*	0.4	*	*	*
PM-106	--	--	1	*	*
HMX, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	0.048	0.095	0.04	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*
Iron, in mg/L					
PM-19	2.46	1.86	1.86	1.7	1.64
PM-20	1.49	1.02	0.43	0.62	0.7
PM-38	0.14	0.44	0.14	0.16	0.33
PM-44	0.04	0.31	0.042	0.02	0.04
PM-45	0.09	0.06	0.033	0.09	0.05
PM-106	--	--	0.24	0.13	0.1
Lead, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	0.011	*	*
Mercury, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*

Table 9.7 Comparison of Mean Perched Groundwater Results for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Nitrate (as N), in mg/L					
PM-19	1.08	0.69	--	1.31	1.08
PM-20	2.19	1.8	--	4.5	3.9
PM-38	1.83	1.7	--	1.5	2.18
PM-44	1.07	1.32	--	1.5	1
PM-45	1.05	1.5	--	1.55	1.84
PM-106	--	--	--	3.22	2.51
Nitrite (as N), in mg/L					
PM-19	--	*	*	*	0.02
PM-20	--	*	--	*	*
PM-38	--	*	--	*	*
PM-44	--	*	--	*	*
PM-45	--	*	--	*	*
PM-106	--	--	--	*	*
Oil and grease, in mg/L					
PM-19	--	*	*	*	*
PM-20	--	*	*	*	*
PM-38	--	*	1.6	*	*
PM-44	--	*	*	*	*
PM-45	--	*	*	*	*
PM-106	--	--	--	*	*
Orthophosphate (as P), in mg/L					
PM-19	*	*	--	--	--
PM-20	*	*	0.7	--	--
PM-38	*	*	0.06	--	--
PM-44	*	*	--	--	--
PM-45	*	*	*	--	--
PM-106	--	--	*	--	*
pH, in pH units					
PM-19	7.1	7.4	7.4	6.9	6.9
PM-20	7.1	7.8	7.7	7.2	7.5
PM-38	6.9	7.4	7.3	6.9	7
PM-44	7.5	7.8	7.7	7.1	7.5
PM-45	7.3	7.6	7.5	7.1	7.1
PM-106	--	--	8.6	8	8.3
Phenol, in mg/L					
PM-19	--	*	*	*	*
PM-20	--	--	*	*	*
PM-38	--	--	*	*	*
PM-44	--	--	*	*	*
PM-45	--	--	*	*	*
PM-106	--	--	*	--	*

Table 9.7 Comparison of Mean Perched Groundwater Results for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Plutonium-239/240 - total, in E-9μCi/ml					
PM-19	*	0.004	0.004	*	*
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	0.001	*
PM-45	*	0.001	*	*	*
PM-106	--	--	*	0.005	*
Radium-226 - total, in E-9μCi/ml					
PM-19	--	0.15	0.15	0.1	0.3
PM-20	*	0.3	*	0.1	0.2
PM-38	*	*	*	0.1	0.8
PM-44	*	0.05	0.2	0.2	0.4
PM-45	*	0.1	0.3	0.04	0.2
PM-106	--	--	*	0.1	0.2
Radium-228 - total, in E-9μCi/ml					
PM-19	--	0.5	0.5	0.2	0.2
PM-20	*	0.4	0.35	0.3	0.2
PM-38	*	0.15	0.65	0.2	0.6
PM-44	*	0.35	*	0.2	0.5
PM-45	*	0.3	0.8	0.8	0.8
PM-106	--	--	0.8	0.1	0.8
RDX, in mg/L					
PM-19	*	*	*	*	*
PM-20	1.17	0.85	0.47	0.6	0.28
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*
Selenium - total, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*
Silver - total, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*

Table 9.7 Comparison of Mean Perched Groundwater Results for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Specific conductance, in μmho/cm					
PM-19	783	706	706	780	734
PM-20	510	460	520	577	624
PM-38	912	881	840	780	788
PM-44	375	368	350	355	350
PM-45	709	645	840	712	697
PM-106	--	--	320	331	330
Sulfate (as SO_4), in mg/L					
PM-19	34	33	33	36	29
PM-20	21	25	26	27	30
PM-38	70	60	79	61	53
PM-44	11	14	17	3	12
PM-45	19	23	29	12	27
PM-106	--	--	19	21	20
Total dissolved solids, in mg/L					
PM-19	423	416	416	476	448
PM-20	307	304	325	369	362
PM-38	543	516	510	486	462
PM-44	218	216	213	220	204
PM-45	403	368	380	430	416
PM-106	--	--	--	169	192
Total suspended solids, in mg/L					
PM-19	12	*	*	*	6
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	--	8	*
Total organic carbon, in mg/L					
PM-19	2.5	4	4	3	*
PM-20	3.1	3	2.7	2	*
PM-38	3.1	3	3.2	3	*
PM-44	3.8	4	1.3	2	*
PM-45	2.8	3	2.8	2	*
PM-106	--	--	3	1	*
Total organic halogen, in mg/L					
PM-19	45.7	38	38	27	35
PM-20	27.9	20	21	58	83
PM-38	35.3	29	30	27	27
PM-44	5.9	*	*	*	*
PM-45	12.5	10	8.3	10	9
PM-106	--	--	6	*	*

itoring

Table 9.7 Comparison of Mean Perched Groundwater Results for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Trichloroethene, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	*	0.016	0.036	0.094
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	0.005	0.007	0.007	0.006	0.007
PM-106	--	--	*	*	*
Tritium - total, in E-6μCi/ml					
PM-19	0.05	0.02	0.02	0.15	0.07
PM-20	0.04	0.02	*	*	0.2
PM-38	0.02	0.17	*	0.15	0.14
PM-44	0.07	*	0.06	*	*
PM-45	0.07	0.1	0.042	0.01	0.01
PM-106	--	--	*	*	0.02
Uranium-234 - total, in E-9μCi/ml					
PM-19	1.1	1	1	2.2	1
PM-20	3.1	2.9	2.9	2.8	3.3
PM-38	1.7	1.6	1.6	2.2	1.6
PM-44	2.4	2.1	2.3	2.3	2.3
PM-45	4.3	3.8	4.1	4.1	4.9
PM-106	--	--	1.3	1	1.2
Uranium-238 - total, in E-9μCi/ml					
PM-19	0.8	0.7	0.7	1.2	0.7
PM-20	2	1.7	1.6	1.5	1.8
PM-38	0.8	0.9	1.2	1.2	0.9
PM-44	2.3	1	1.2	1.3	1.2
PM-45	2.3	2	0.7	2.3	2.6
PM-106	--	--	0.7	0.7	0.6
Zinc - total, in mg/L					
PM-19	0.164	0.008	0.008	*	0.009
PM-20	0.018	*	*	*	0.006
PM-38	0.236	0.018	0.012	0.006	0.010
PM-44	0.113	0.037	0.038	0.046	0.018
PM-45	0.14	0.016	0.019	0.013	0.015
PM-106	--	--	0.052	0.18	0.038
1,2-Dichloroethane, in mg/L					
PM-19	*	*	*	*	*
PM-20	*	*	*	*	*
PM-38	*	*	*	*	*
PM-44	*	*	*	*	*
PM-45	*	*	*	*	*
PM-106	--	--	*	*	*

Table 9.7 Comparison of Mean Perched Groundwater Results for 1990-1994 (cont'd)

Summary of radioactive results does not include counting error.
[1]Asterisks (*) indicate mean was less than detection limit.
[2]Dashes (--) indicate lack of valid data.
[3]NA indicates not analyzed.

Table 9.8 Comparison of Mean Results for Ogallala Aquifer Monitoring Wells for 1990-1994

Location	1990	1991	1992	1993	1994
Ammonia (as N), in mg/L					
OM-39	--[1]	*[2]	*	*	*
OM-40	--	*	*	*	*
OM-105	--	--	*	*	*
Arsenic, in mg/L					
OM-39	--	*	*	*	*
OM-40	--	*	*	*	*
OM-105	--	--	*	*	*
Barium, in mg/L					
OM-39	0.11	0.11	0.13	0.14	0.14
OM-40	0.14	0.14	0.13	0.14	0.14
OM-105	--	--	0.13	0.12	0.12
Cadmium, in mg/L					
OM-39	--	*	*	*	*
OM-40	--	*	*	*	*
OM-105	--	--	*	*	*
Chloride, in mg/L					
OM-39	--	12	10	9	11
OM-40	--	8	8	9	8
OM-105	--	--	7	7	7
Chromium, in mg/L					
OM-39	*	*	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	0.006	*	*
Chromium (hexavalent), in mg/L					
OM-39	--	*	*	*	--
OM-40	--	*	*	--	--
OM-105	--	--	*	--	--
Copper, in mg/L					
OM-39	*	*	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*
Cyanide, in mg/L					
OM-39	--	*	--	*	*
OM-40	--	*	*	*	*
OM-105	--	--	*	*	*

Table 9.8 Comparison of Mean Results for Ogallala Aquifer Monitoring Wells for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Fluoride, in mg/L					
OM-39	*	1.7	1.74	1.6	1.6
OM-40	*	1.5	1.76	1.9	1.5
OM-105	--	--	2.2	2.2	1.7
Gross alpha-dissolved, in E-9μCi/ml					
OM-39	7	6	4.4	5	5
OM-40	9	5	5.3	6	6
OM-105	--	--	5	3	6
Gross alpha-suspended, in E-9μCi/ml					
OM-39	*	0.1	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*
Gross beta-dissolved, in E-9μCi/ml					
OM-39	8	5	7.1	4	9
OM-40	9	7	9	8	8
OM-105	--	--	8	6	8
Gross beta-suspended, in E-9μCi/ml					
OM-39	*	0.4	0	0.1	0.4
OM-40	*	*	*	0.4	*
OM-105	--	--	2	*	0.6
HMX, in mg/L					
OM-39	*	*	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*
Iron, in mg/L					
OM-39	0.92	0.38	0.67	0.24	0.45
OM-40	0.51	0.31	0.12	0.14	0.22
OM-105	--	--	0.03	*	0.01
Lead, in mg/L					
OM-39	0.012	*	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*
Mercury, in mg/L					
OM-39	--	*	*	*	*
OM-40	--	*	*	*	*
OM-105	--	--	*	*	*
Nitrate (as N), in mg/L					
OM-39	1.12	1.2	--	0.7	1.44
OM-40	1.24	0.31	--	1.1	1.39
OM-105	--	--	--	--	1.15
Nitrite (as N), in mg/L					
OM-39	--	*	*	*	*
OM-40	--	*	*	*	*
OM-105	--	--	*	*	*

Table 9.8 Comparison of Mean Results for Ogallala Aquifer Monitoring Wells for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Oil and grease, in mg/L					
OM-39	*	*	6.25	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*
Orthophosphate (as P), in mg/L					
OM-39	--	--	--	--	--
OM-40	--	*	--	--	--
OM-105	--	--	--	--	--
pH, in pH units					
OM-39	7.5	7.7	7.7	7.1	7.4
OM-40	7.5	7.8	7.6	7.3	7.3
OM-105	--	--	7.6	7.4	7.7
Phenol, in mg/L					
OM-39	--	--	*	*	*
OM-40	--	--	*	*	*
OM-105	--	--	*	--	0.005
Plutonium-239/240 - total, in E-9μCi/ml					
OM-39	*	0.001	*	*	*
OM-40	*	0.006	*	*	*
OM-105	--	--	*	*	*
Radium-226 - total, in E-9μCi/ml					
OM-39	--	0.2	0.3	*	0.3
OM-40	--	0.2	*	0.3	0.4
OM-105	--	--	*	*	*
Radium-228 - total, in E-9μCi/ml					
OM-39	--	0.6	0.5	0.1	0.4
OM-40	--	0.9	0.45	0.4	0.4
OM-105	--	--	*	0.2	0.4
RDX, in mg/L					
OM-39	*	*	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*
Selenium - total, in mg/L					
OM-39	--	*	*	*	*
OM-40	--	*	*	*	*
OM-105	--	--	*	*	*
Silver - total, in mg/L					
OM-39	--	*	*	*	*
OM-40	--	--	*	*	*
OM-105	--	--	*	*	*
Specific conductance, in μmho/cm					
OM-39	478	460	462	441	462
OM-40	514	496	479	475	475
OM-105	--	--	468	459	459

Table 9.8 Comparison of Mean Results for Ogallala Aquifer Monitoring Wells for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Sulfate (as SO_4), in mg/L					
OM-39	17	21	26	19	23
OM-40	16	18	21	20	19
OM-105	--	--	20	18	17
Total dissolved solids, in mg/L					
OM-39	279	273	290	268	266
OM-40	292	288	290	301	275
OM-105	--	--	--	251	266
Total suspended solids, in mg/L					
OM-39	--	*	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*
Total organic carbon, in mg/L					
OM-39	2.5	2	2.3	2	*
OM-40	4.7	2	1.94	2	*
OM-105	--	--	2	*	*
Total organic halogen, in mg/L					
OM-39	4.4	*	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*
Trichloroethene, in mg/L					
OM-39	*	*	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*
Tritium - total, in E-6μCi/ml					
OM-39	0.08	*	--	*	0.02
OM-40	0.05	0.03	*	*	*
OM-105	--	--	*	*	*
Uranium-234 - total, in E-9μCi/ml					
OM-39	4.1	3.8	3.7	3.7	4.1
OM-40	4.3	4.3	4.5	4.3	4.5
OM-105	--	--	2	4	4.4
Uranium-238 - total, in E-9μCi/ml					
OM-39	2	2	1.8	1.9	2
OM-40	2.2	2.4	2.4	2.3	2.3
OM-105	--	--	2	2.1	2.4
Zinc - total, in mg/L					
OM-39	1.67	0.52	0.74	1.1	0.457
OM-40	0.429	0.19	0.08	0.04	0.041
OM-105	--	--	0.029	0.029	0.022
1,2-Dichloroethane, in mg/L					
OM-39	*	*	*	*	*
OM-40	*	*	*	*	*
OM-105	--	--	*	*	*

Summary of radioactive results does not include counting error.
[1]Dashes (--) indicate lack of valid data.
[2]Asterisks (*) indicate mean was less than detection limit or minimum detectable activity.

Table 9.9 Comparison of Mean Results for Ogallala Production Wells for 1990-1994

Location	1990	1991	1992	1993	1994
Ammonia (as N), in mg/L					
PR-2	--[1]	*[2]	*	*	*
PR-6	--	*	*	*	*
PR-16	--	*	*	*	*
PR-18	--	*	*	--	--
PR-41	--	*	*	*	*
Arsenic, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	--	*	*	*	*
PR-18	--	*	*	*	--
PR-41	*	*	*	*	*
Barium, in mg/L					
PR-2	--	0.13	0.13	0.13	0.14
PR-6	--	0.12	0.11	0.11	0.12
PR-16	0.09	0.09	0.095	0.09	0.11
PR-18	0.14	0.14	0.13	--	--
PR-41	0.12	0.12	0.12	0.11	0.12
Cadmium, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	--	*	*	*	*
PR-18	--	*	*	--	--
PR-41	*	*	*	*	*
Chloride, in mg/L					
PR-2	--	10	--	10	9
PR-6	--	11	--	12	10
PR-16	--	11	10	11	9
PR-18	--	11	--	--	--
PR-41	--	10	10	11	10
Chromium, in mg/L					
PR-2	--	*	0.006	*	*
PR-6	--	*	*	*	*
PR-16	*	*	*	0.005	*
PR-18	*	0.005	*	--	--
PR-41	*	*	*	*	*
Chromium (hexavalent), in mg/L					
PR-2	--	*	--	*	--
PR-6	--	*	*	*	--
PR-16	--	*	*	*	--
PR-18	--	*	--	--	--
PR-41	--	*	*	*	--
Copper, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	0.084	*	*	0.027	0.026
PR-18	*	0.009	*	--	--
PR-41	*	*	*	*	*

Table 9.9 Comparison of Mean Results for Ogallala Production Wells for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Cyanide, in mg/L					
PR-2	--	*	--	*	*
PR-6	--	*	--	*	*
PR-16	--	*	*	*	*
PR-18	--	*	--	--	--
PR-41	--	*	*	*	*
Fluoride, in mg/L					
PR-2	--	1.6	--	1.6	1.3
PR-6	--	1.8	--	2.2	1.6
PR-16	1.6	1.9	1.9	1.8	1.5
PR-18	1.5	1.4	--	--	--
PR-41	1.8	1.8	1.8	2.2	1.4
Gross alpha-dissolved, in E-9μCi/ml					
PR-2	--	6	4	6	5
PR-6	--	3.5	4.25	1.5	*
PR-16	7	6	4.8	7	7
PR-18	5	5	5	--	--
PR-41	8	4	4	8	4
Gross alpha-suspended, in E-9μCi/ml					
PR-2	--	*	*	*	*
PR-6	--	0.8	*	*	*
PR-16	*	*	*	*	*
PR-18	*	--	*	--	--
PR-41	*	*	*	*	*
Gross beta-dissolved, in E-9μCi/ml					
PR-2	--	6	7	7	5
PR-6	--	5	6	3	*
PR-16	8	9	7.2	9	8
PR-18	9	8	6	--	--
PR-41	8	7	7	11	5
Gross beta-suspended, in E-9μCi/ml					
PR-2	--	*	*	*	*
PR-6	--	1	0.59	2	*
PR-16	*	0.5	0.54	*	*
PR-18	*	*	*	--	--
PR-41	*	*	*	*	*
HMX, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	*	*	*	*	*
PR-18	*	*	*	--	--
PR-41	*	*	*	*	*
Iron, in mg/L					
PR-2	--	0.01	*	0.01	*
PR-6	--	*	0.028	0.02	0.06
PR-16	0.02	0.01	*	0.03	*
PR-18	0.02	*	*	--	--
PR-41	0.02	*	*	*	0.02

Table 9.9 Comparison of Mean Results for Ogallala Production Wells for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Lead, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	*	*	*	*	*
PR-18	*	*	*	--	--
PR-41	0.019	*	*	*	*
Mercury, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	--	*	*	*	*
PR-18	--	*	*	--	--
PR-41	*	*	*	*	*
Nitrate (as N), in mg/L					
PR-2	--	1.2	1.3	3.2	1.48
PR-6	--	1.4	--	5.1	--
PR-16	1.47	1.2	--	1.5	1.68
PR-18	1.5	1.4	--	--	--
PR-41	1.45	1.7	--	1.4	1.64
Nitrite (as N), in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	--	*	--
PR-16	--	*	--	*	*
PR-18	--	*	--	--	--
PR-41	--	*	--	*	*
Oil and grease, in mg/L					
PR-2	--	*	*	*	1
PR-6	--	*	*	*	4
PR-16	0.3	*	*	*	*
PR-18	*	*	--	--	--
PR-41	*	*	*	*	*
Orthophosphate (as P), in mg/L					
PR-2	--	*	--	--	--
PR-6	--	*	--	--	--
PR-16	--	*	--	--	--
PR-18	--	*	--	--	--
PR-41	*	*	--	--	--
pH, in pH units					
PR-2	--	7.7	7.4	6.8	7.4
PR-6	--	7.7	7.7	6.5	7.7
PR-16	7.8	7.9	7.6	7.2	7.4
PR-18	7.6	7.8	7.5	--	--
PR-41	7.7	7.8	7.8	7.1	7.3
Phenol, in mg/L					
PR-2	--	--	--	*	*
PR-6	--	--	*	*	*
PR-16	--	--	--	*	*
PR-18	--	--	--	--	--
PR-41	--	--	*	*	*

Table 9.9 Comparison of Mean Results for Ogallala Production Wells for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Plutonium-239/240 - total, in E-9μCi/ml					
PR-2	--	0.005	*	*	0.01
PR-6	--	*	*	*	*
PR-16	*	*	*	0.001	0.02
PR-18	*	0.002	*	--	--
PR-41	*	0.003	0.003	*	*
Radium-226 - total, in E-9μCi/ml					
PR-2	--	0.2	0.5	0.1	--
PR-6	--	0.3	--	0.1	--
PR-16	--	*	0.5	0.3	0.3
PR-18	--	*	--	--	--
PR-41	--	*	0.1	*	--
Radium-228 - total, in E-9μCi/ml					
PR-2	--	1.3	0.6	0.8	--
PR-6	--	*	--	*	--
PR-16	--	*	0.3	0.5	0.5
PR-18	--	*	--	--	--
PR-41	--	*	0.1	0.1	--
RDX, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	*	*	*	*	*
PR-18	*	*	*	--	--
PR-41	*	*	*	*	*
Selenium - total, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	--	*	*	*
PR-16	--	*	*	*	*
PR-18	--	*	--	--	--
PR-41	*	--	--	*	*
Silver - total, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	--	*	*	*	*
PR-18	--	*	*	--	--
PR-41	*	*	*	*	*
Specific conductance, in μmho/cm					
PR-2	--	488	460	450	465
PR-6	--	488	468	475	472
PR-16	470	488	498	484	496
PR-18	470	483	465	--	--
PR-41	450	513	513	458	474
Sulfate (as SO_4), in mg/L					
PR-2	--	22	--	17	21
PR-6	--	27	--	26	22
PR-16	18	*	17.5	26	23
PR-18	16	22	--	--	--
PR-41	19	23	23	26	22

Table 9.9 Comparison of Mean Results for Ogallala Production Wells for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Total dissolved solids, in mg/L					
PR-2	--	280	--	283	276
PR-6	--	295	290	295	258
PR-16	300	330	300	298	266
PR-18	292	280	--	--	--
PR-41	303	292	292	307	282
Total suspended solids, in mg/L					
PR-2	--	*	--	*	*
PR-6	--	*	--	*	*
PR-16	5	*	*	*	*
PR-18	*	*	--	--	--
PR-41	*	*	*	*	*
Total organic carbon, in mg/L					
PR-2	--	3	*	2	1
PR-6	--	7	2.5	3	*
PR-16	2	5	2	1.9	*
PR-18	4	2	*	--	--
PR-41	2	3	3	2	*
Total organic halogen, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	*	*	*	*	*
PR-18	*	*	*	--	--
PR-41	*	*	*	*	*
Trichloroethene, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	*	*	*	*	*
PR-18	*	*	--	--	--
PR-41	*	*	*	*	*
Tritium - total, in E-6μCi/ml					
PR-2	--	*	*	*	0.13
PR-6	--	*	*	*	*
PR-16	0.07	0.06	*	*	*
PR-18	0.03	*	*	--	--
PR-41	0.04	*	*	*	*
Uranium-234 - total, in E-9μCi/ml					
PR-2	--	4	3.7	3.8	4.1
PR-6	--	3.6	3.8	2.9	3.8
PR-16	4.7	4	4.5	4.6	4.5
PR-18	3.9	4	3.95	--	--
PR-41	4.3	4.1	4.1	8.3	4.5
Uranium-238 - total, in E-9μCi/ml					
PR-2	--	2	1.93	1.9	2.2
PR-6	--	1.8	1.93	3	2
PR-16	2.5	2	2.3	2.2	2.3
PR-18	1.9	1.9	1.85	--	--
PR-41	2.1	2	2	6.4	2.1

Table 9.9 Comparison of Mean Results for Ogallala Production Wells for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Zinc - total, in mg/L					
PR-2	--	*	0.006	*	0.007
PR-6	--	0.008	*	*	0.02
PR-16	0.014	*	0.033	0.006	0.008
PR-18	0.019	0.006	0.012	--	--
PR-41	0.319	0.013	0.013	0.011	0.047
1,2-Dichloroethane, in mg/L					
PR-2	--	*	*	*	*
PR-6	--	*	*	*	*
PR-16	*	*	*	*	*
PR-18	*	*	--	--	--
PR-41	*	*	*	*	*

Summary of radioactive results does not include counting error.
[1]Dashes indicate lack of valid data.
[2]Asterisks indicate mean was less than detection limit or minimum detectable activity.

Notes for Chapter 9

1. The numbers of samples in which an analyte was detected or not detected are counted. Maximum, minimum, mean, and standard deviation are determined for each location and analyte. If the number of samples in which the analyte was not detected is less than 15% of the total, the mean and standard deviation are calculated using a value equal to half the detection limit for the non-detect data points. If the number of non-detect data points is greater than 15% but less than 50%, Cohen's Method (EPA 1989) is used to calculate the mean and standard deviation. If the number of non-detect data points is greater than 50% or Cohen's Method is not applicable, no mean or standard deviation is calculated. A mean and standard deviation are reported only if less than 50% of the data points were non-detects for the analyte. The maximum and minimum values are always reported.

Table 9.10 Comparison of Mean Results for Control Location for 1990-1994

Location	1990	1991	1992	1993	1994
Ammonia (as N), in mg/L					
CO-33	--[1]	*[2]	*	*	*
Arsenic, in mg/L					
CO-33	*	*	*	*	*
Barium, in mg/L					
CO-33	0.09	0.06	0.055	0.05	0.06
Cadmium, in mg/L					
CO-33	*	*	*	*	*
Chloride, in mg/L					
CO-33	--	6	6.33	7	7
Chromium, in mg/L					
CO-33	*	*	*	0.005	*
Chromium (hexavalent), in mg/L					
CO-33	*	*	*	*	*
Copper, in mg/L					
CO-33	*	*	0.04	0.064	0.082
Cyanide, in mg/L					
CO-33	*	*	*	*	*
Fluoride, in mg/L					
CO-33	2.8	3	2.87	3	2.5
Gross alpha-dissolved, in E-9μCi/ml					
CO-33	--	4.2	4.42	6	6
Gross alpha-suspended, in E-9μCi/ml					
CO-33	--	*	*	*	*
Gross beta-dissolved, in E-9μCi/ml					
CO-33	--	6.5	7.6	9	6
Gross beta-suspended, in E-9μCi/ml					
CO-33	--	0.2	0.56	*	*
HMX, in mg/L					
CO-33	--	*	*	*	*
Iron, in mg/L					
CO-33	0.03	0.028	0.033	0.05	0.06
Lead, in mg/L					
CO-33	*	*	*	*	*
Mercury, in mg/L					
CO-33	*	*	*	*	*
Nitrate (as N), in mg/L					
CO-33	--	1.4	--	1.6	1.86
Nitrite (as N), in mg/L					
CO-33	--	*	--	*	*

Table 9.10 Comparison of Mean Results for Control Location for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Oil and grease, in mg/L					
CO-33	*	*	*	*	*
Orthophosphate (as P), in mg/L					
CO-33	*	*	--	--	--
pH, in pH units					
CO-33	--	7.8	7.6	7	7.4
Phenol, in mg/L					
CO-33	--	--	--	*	*
Plutonium-239/240 - total, in E-9μCi/ml					
CO-33	--	*	*	*	*
Radium-226 - total, in E-9μCi/ml					
CO-33	--	*	0.025	0.1	0.07
Radium-228 - total, in E-9μCi/ml					
CO-33	--	0.6	0.48	0.5	0.5
RDX, in mg/L					
CO-33	--	*	*	*	*
Selenium - total, in mg/L					
CO-33	*	*	*	0.006	0.007
Silver - total, in mg/L					
CO-33	*	*	*	*	*
Specific conductance, in μmho/cm					
CO-33	--	558	568	572	555
Sulfate (as SO_4), in mg/L					
CO-33	35	44	50	50	49
Total dissolved solids, in mg/L					
CO-33	347	347	375	385	343
Total suspended solids, in mg/L					
CO-33	*	*	*	*	*
Total organic carbon, in mg/L					
CO-33	--	3	2.85	3	*
Total organic halogen, in mg/L					
CO-33	--	11	*	6	6
Trichloroethylene, in mg/L					
CO-33	--	*	*	*	*
Tritium - total, in E-6μCi/ml					
CO-33	--	*	0.17	*	0.05
Uranium-234 - total, in E-9μCi/ml					
CO-33	--	2.7	4.12	4.3	4.1
Uranium-238 - total, in E-9μCi/ml					
CO-33	--	2.4	2.65	2.8	2.7

Table 9.10 Comparison of Mean Results for Control Location for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Zinc - total, in mg/L					
CO-33	0.35	0.213	0.017	0.014	0.21
1,2-Dichloroethane, in mg/L					
CO-33	--	*	*	*	*

Summary of radioactive results does not include counting error.
[1]Dashes indicate lack of valid data.
[2]Asterisks indicate mean was less than detection limit or minimum detectable activity.

Table 9.11 Comparison of Major Radionuclide Analyses for All Samples from the Ogallala Aquifer

Radionuclide	Date	Avg. Mean ± Avg. Std. Dev.[1]	Coeff. of variation	Total no. samples
Gross alpha, dissolved	1990-1993	5.4 ± 2.4	45%	218
	1994	4.9 ± 1.9	39%	61
Gross beta, dissolved	1990-1993	7.5 ± 4.6	62%	217
	1994	6.6 ± 3.7	56%	61
Uranium-234	1990-1993	4.2 ± 1.1	26%	218
	1994	4.4 ± 0.5	11%	62
Uranium-238	1990-1993	2.2 ± 1.1	52%	218
	1994	2.2 ± 0.3	13%	62
Uranium Ratio	1990-1993	1.86	--	--
	1994	2.00	--	--

[1] Units are E-9μCi/ml.

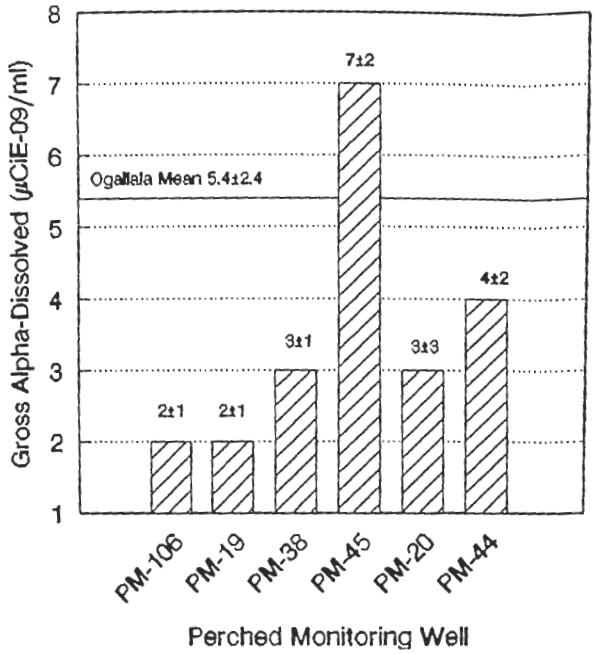


Figure 9.5: Average gross alpha-dissolved activity for the perched monitoring wells along a north-south transect.

Chapter 10

DRINKING WATER

Drinking water at Pantex Plant is obtained from five production wells that reach the Ogallala aquifer. A sixth well was under construction in December 1994. All internal Plant water needs are met by the production wells. The water is disinfected with chlorine before entering a distribution system. The Pantex Plant drinking water system is considered a non-transient, non-community public water supply system under Safe Drinking Water Act regulations. The category was created by EPA to identify private systems that continuously supply water to a small group of people (for example, in schools and factories). Water supplied by such systems is consumed daily by the same group of people over long periods. Pantex Plant also sells water to the Texas Tech Research Farm for household and irrigation use.

Samples from the drinking water system are collected and analyzed monthly for biological contaminants and every other month for chemical and radiological contaminants identified in the Safe Drinking Water Act. The constituents that are currently analyzed for are listed in Table 10.1. The list was revised in 1994 to reflect contaminants identified in current state and federal regulations. Samples are collected at locations chosen to meet regulatory requirements and to provide warning of potential health problems within the distribution system. Results of drinking water and production well analyses are compared to identify any contamination that may have entered the system through piping or during treatment.

The Texas Natural Resource Conservation Commission (TNRCC) collected samples from the drinking water supply system in September and October 1994 to determine whether regulatory requirements for drinking water quality were met. Pantex Plant collected additional samples at the same time as the TNRCC samples were collected. The TNRCC also analyzed samples collected by Pantex Plant personnel in March and June. Results for all sets of analyses were similar and within regulatory limits.

10.1 Sampling Locations

Routine drinking water samples are collected at eight locations onsite and one offsite control sampling location at Bushland, Texas (data from this location were discussed in Chapter 9). Samples for chemical and radiological analysis were collected at four locations in 1994. The other four locations were sampled monthly to identify biological contamination. Twenty additional locations were sampled once in 1994 as part of the implementation of the Lead and Copper Rule of the Safe Drinking Water Act. Two locations were sampled once for chemical and biological contamination to address complaints about taste and odor. Table 10.2 lists routine sampling sites, and Figure 10.1 shows their locations. These are the same locations used in past years, except for DR-115. Site DR-115 was added in 1994 to meet requirements for sampling at the "point of entry" to the distribution system.

10.2 1994 Results

The 1994 drinking water analyses detected no polychlorinated biphenyls (PCBs), pesticides, explosives, semivolatile organic compounds, or herbicides. Some metals, radionuclides, volatile organic compounds (trihalomethanes only), and miscellaneous compounds were detected. Data for all sample locations are published in a detailed compilation (Mason & Hanger 1995a). Table 10.3 summarizes the results. Mean values are annual averages as required by the Texas Administrative Code, Title 30, Chapter 290,

Table 10.1 Monitored Parameters for Drinking Water

Radionuclides
Gross alpha, dissolved
Gross alpha, suspended
Gross beta, dissolved
Gross beta, suspended
Tritium, total
Strontium-90
Radium-226, total
Radium-228, total
Uranium-234, total
Uranium-238, total
Plutonium-239/240

Metals
Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Sodium
Thallium
Zinc

Polychlorinated Biphenyls (PCBs)
Aroclor-1016
Aroclor-1221
Aroclor-1232
Aroclor-1242
Aroclor-1248
Aroclor-1254
Aroclor-1260

Pesticides
3-Hydroxycarbofuran
Aldicarb
Aldicarb sulfoxide
Aldicarb sulfone
Aldrin
Carbaryl
Carbofuran
Chlordane
Dibromochloropropane (DBCP)
Dieldrin
Endrin
Ethylene dibromide (EDB)

Pesticides, cont'd
Heptachlor
Heptachlor epoxide
Lindane (gamma-BHC)
Methomyl
Methoxychlor
Oxamyl (Vydate)
Toxaphene

Herbicides
2,3,7,8-TCDD (Dioxin)
2,4-D
2,4,5-TP (Silvex)
Alachlor
Atrazine
Butachlor
Dalapon
Dicamba
Dinoseb
Diquat
Endothall
Glyphosate
Metolachlor
Metribuzin
Pichloram
Propachlor
Simazine

Miscellaneous
Alkalinity
Asbestos
Calcium hardness
Chloride
Chlorine residual
Color
Corrosivity
Cyanide
Dissolved oxygen
Fluoride
Foaming agents (surfactants)
Hydrogen sulfide
Nitrate (as N)
Nitrite (as N)
Odor
pH
Specific conductance
Sulfate (as SO_4)
Temperature
Total organic carbon
Total dissolved solids
Turbidity

Volatile Organics
o-Chlorotoluene
p-Chlorotoluene
1,1-Dichloroethane
1,1-Dichloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
1,2-Dichlorethane
1,2-Dichloropropane
1,2,3-Trichloropropane
1,3-Dichloropropane
1,3-Dichloropropene
2,2-Dichloropropane
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon tetrachloride
Monochlorobenzene (chlor...)
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethylene
trans-1,2-Dichloroethylene
Dibromochloromethane
Dibromomethane
Ethylbenzene
Methylene chloride (Dichloromethane)
Styrene
Tetrachloroethylene
Toluene
Total xylenes
Trichloroethylene
Vinyl chloride

Semivolatile Organics
1,2-Dichlorobenzene (o-Di...)
1,3-Dichlorobenzene (m-Di..)
1,4-Dichlorobenzene (p-Di..)
1,2,3-Trichlorobenzene
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Benzo(a)pyrene
Bromochloromethane
Bromobenzene
sec-Butylbenzene
tert-Butylbenzene
Di-(2-ethylhexyl) adiapate
Di-(2-ethylhexyl) phthalate
Dichlorodifluoromethane

Table 10.1 Monitored Parameters for Drinking Water (cont'd)

Semivolatile Organics, cont'd	Semivolatile Organics, cont'd	Biological
Fluorotrichloromethane	Isopropyltoluene (4-Isop..)	Total coliform bacteria
Hexachlorobenzene	Naphthalene	*Escherichia coli*
Hexachlorobutadiene	n-Butylbenzene	
Hexachlorocyclopentadiene	n-Propylbenzene	
Isopropylbenzene	Pentachlorophenol	

Table 10.2 Drinking Water Sample Locations (at water faucets)

Location	Description
Chemical and Radiological Sampling	
DR-23	Building 12-2
DR-28	12-6 Cafeteria
DR-43	Firing Site One
DR-115	Building 15-26
Biological Sampling	
DR-116	Building 12-103
DR-117	Building 18-1
DR-118	Building 16-13
DR-119	Building 13-35

"Water Hygiene," which outlines specific monitoring and reporting requirements for drinking water.

10.2.1 Routine Safe Drinking Water Act Chemical Monitoring

Concentrations of all chemical constituents were below Maximum Contaminant Levels (MCLs). Chromium was detected once at each drinking water sampling location. The levels detected [0.005 to 0.007 milligrams per liter (mg/L)] were less than the MCL for drinking water (0.1 mg/L) and near or at the analytical detection limits (0.005 mg/L). Similar chromium concentrations occurred in samples from production wells and Ogallala monitoring wells, indicating that the source of the chromium is the Ogallala aquifer.

Copper was detected in all but one sample. Concentrations were below both the EPA action level for copper (1.3 mg/L under the Safe Drinking Water Act) and the secondary constituent level (1 mg/L under 30 TAC 290.113). Copper concentrations in the drinking water tap samples are slightly above those in production well water. The increase in copper concentration as the water passes through the system may reflect corrosion of pumps and piping.

Low concentrations (below MCL) of the regulated trihalomethane compounds (bromoform chloroform, dibromochloromethane, and dichlorobromomethane) were reported during the year. These compounds can be formed by the reaction of chlorine from the disinfection process with organic compounds present in the raw water or the distribution system. These compounds may cause occasional taste or odor problems.

10.2.2 Lead and Copper Rule Monitoring

None of the 20 drinking water taps sampled and analyzed under the Lead and Copper Rule of the Safe Drinking Water Act had copper concentrations that exceeded the action level. Although the concentration in one of the 20 samples exceeded the action level for lead, water from that building is not used for drinking. The Lead and Copper Rule requires that concentrations at 90% of the sampling locations remain below the action levels for lead or copper. The system met the requirements and is in compliance with the rule, and the water is safe to drink.

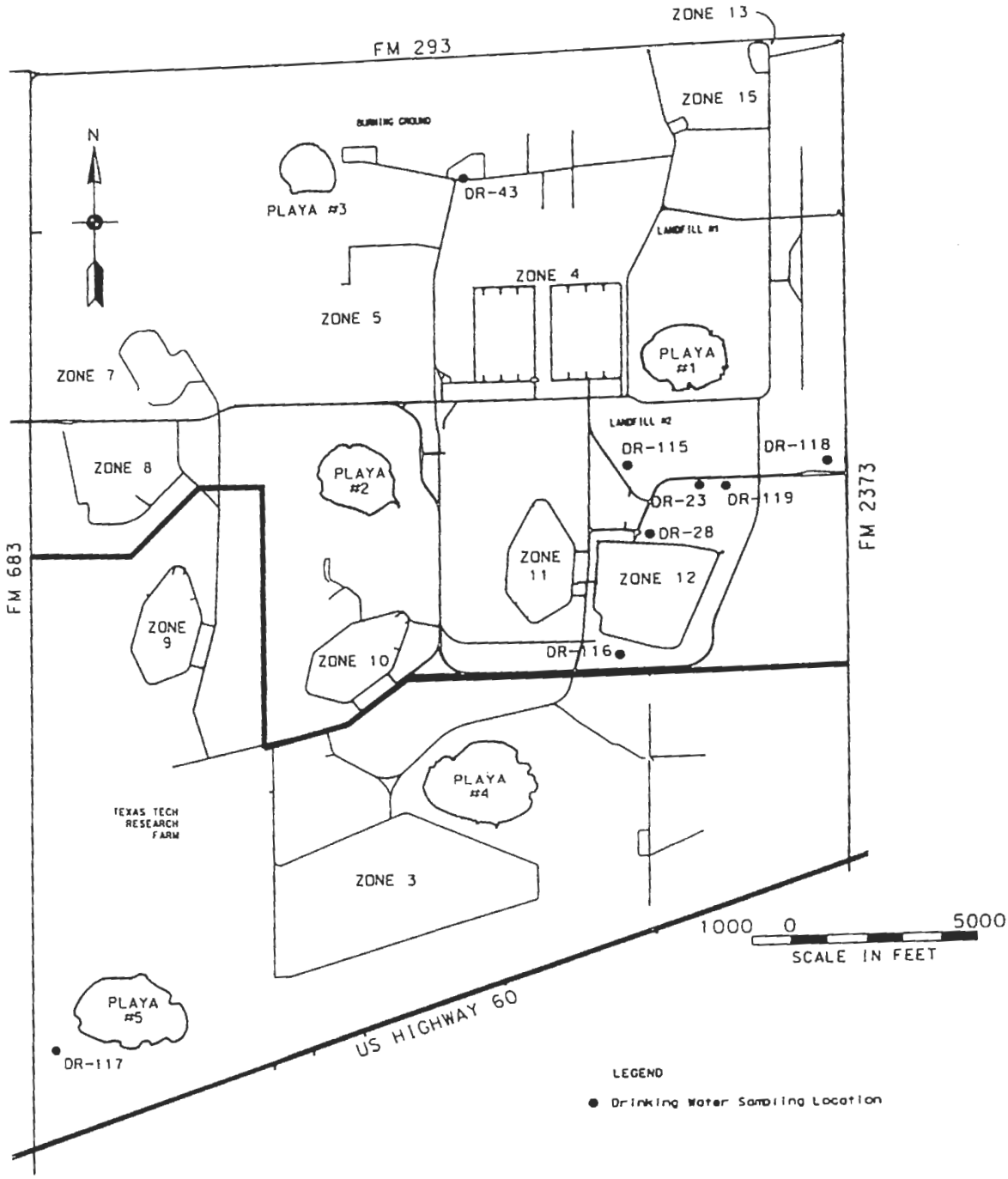


Figure 10.1: Locations of drinking water sampling sites

Table 10.3 Summary of 1994 Data for Drinking Water

Location	No. of Samples	No. BDL[1]	Mean ± Std. Dev	Max	Min
Ammonia (as N), in mg/L					
DR-115	3	2	2.5 ± 4.4	7.6	<0.1
DR-23	4	3	1.9 ± 3.8	7.6	<0.2
DR-28	4	3	2.05 ± 4.1	8.2	<0.2
DR-43	4	3	2.05 ± 4.4	8.2	<0.2
Arsenic, in mg/L					
DR-115	5	5	--[2]	<0.005	<0.005
DR-23	5	5	--	<0.005	<0.005
DR-28	5	5	--	<0.005	<0.005
DR-43	5	5	--	<0.005	<0.005
Barium, in mg/L					
DR-115	5	0	0.11 ± 0.01	0.12	0.1
DR-23	5	0	0.11 ± 0	0.12	0.11
DR-28	5	0	0.11 ± 0.01	0.12	0.1
DR-43	5	0	0.11 ± 0.01	0.12	0.1
Cadmium, in mg/L					
DR-115	5	5	--	<0.005	<0.005
DR-23	5	5	--	<0.005	<0.005
DR-28	5	5	--	<0.005	<0.005
DR-43	5	5	--	<0.005	<0.005
Chloride, in mg/L					
DR-115	3	0	10 ± 0.5	11	10
DR-23	3	0	11 ± 0.5	11	10
DR-28	3	0	11 ± 0.5	11	10
DR-43	3	0	11 ± 0.5	11	10
Chromium, in mg/L					
DR-115	5	4	--	0.006	<0.005
DR-23	5	4	--	0.007	<0.005
DR-28	5	4	--	0.006	<0.005
DR-43	5	4	--	0.005	<0.005
Copper, in mg/L					
DR-115	5	0	0.009 ± 0.002	0.013	0.007
DR-23	5	0	0.142 ± 0.06	0.201	0.032
DR-28	5	1	0.007 ± 0.004	0.011	<0.005
DR-43	5	0	0.031 ± 0.01	0.049	0.022
Cyanide, in mg/L					
DR-115	3	3	--	<0.005	<0.005
DR-23	4	4	--	<0.005	<0.005
DR-28	3	3	--	<0.005	<0.005
DR-43	3	3	--	<0.005	<0.005

Table 10.3 Summary of 1994 Data for Drinking Water (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev	Max	Min
Fluoride, in mg/L					
DR-115	3	0	1.4 ± 0.1	1.6	1.3
DR-23	3	0	1.4 ± 0	1.5	1.4
DR-28	3	0	1.5 ± 0.1	1.6	1.4
DR-43	3	0	1.5 ± 0	1.5	1.4
Gross alpha-dissolved, in E-9μCi/ml					
DR-115	5	0	5 ± 1	7	3
DR-23	5	0	5 ± 1	7	4
DR-28	5	0	6 ± 1	7	4
DR-43	5	0	6 ± 3	8	1
Gross alpha-suspended, in E-9μCi/ml					
DR-115	5	5	<MDA[3]	<MDA	<MDA
DR-23	5	5	<MDA	<MDA	<MDA
DR-28	5	5	<MDA	<MDA	<MDA
DR-43	5	5	<MDA	<MDA	<MDA
Gross beta-dissolved, in E-9μCi/ml					
DR-115	5	0	7 ± 1	8	5
DR-23	5	0	7 ± 2	9	4
DR-28	5	0	7 ± 1	8	6
DR-43	5	0	10 ± 9	28	5
Gross beta-suspended, in E-9μCi/ml					
DR-115	5	2	0.6 ± 0.5	1	<MDA
DR-23	5	3	--	1	<MDA
DR-28	5	2	0.6 ± 0.5	1	<MDA
DR-43	5	2	0.6 ± 0.5	1	<MDA
HMX, in mg/L					
DR-115	3	3	--	<0.020	<0.020
DR-23	5	5	--	<0.020	<0.020
DR-28	5	5	--	<0.020	<0.020
DR-43	3	3	--	<0.020	<0.020
Iron, in mg/L					
DR-115	5	2	--	0.02	<0.01
DR-23	5	0	0.05 ± 0.05	0.14	0.02
DR-28	5	1	0.02 ± 0.02	0.05	0.01
DR-43	5	0	0.20 ± 0.14	0.44	0.06
Lead, in mg/L					
DR-115	5	5	--	<0.005	<0.005
DR-23	5	4	--	0.013	<0.005
DR-28	5	5	--	<0.005	<0.005
DR-43	5	5	--	<0.005	<0.005

Table 10.3 Summary of 1994 Data for Drinking Water (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev	Max	Min
Mercury, in mg/L					
DR-115	5	5	--	<0.0001	<0.0001
DR-23	5	5	--	<0.0001	<0.0001
DR-28	5	5	--	<0.0001	<0.0001
DR-43	5	5	--	<0.0001	<0.0001
Nitrate (as N), in mg/L					
DR-115	4	0	1.6 ± 0.06	1.6	1.5
DR-23	3	0	1.84 ± 0.5	2.5	1.5
DR-28	2	0	1.51 ± 0.01	1.52	1.5
DR-43	2	0	1.51 ± 0.07	1.58	1.449
Nitrite (as N), in mg/L					
DR-115	4	4	--	<0.01	<0.01
DR-23	3	3	--	<0.01	<0.01
DR-28	2	2	--	<0.01	<0.01
DR-43	2	2	--	<0.01	<0.01
Oil and grease, in mg/L					
DR-115	5	5	--	<1	<1
DR-23	2	2	--	<1	<1
DR-28	2	2	--	<1	<1
DR-43	2	2	--	<1	<1
pH, in pH units					
DR-115	4	NA[4]	7.5 ± 0.2	7.8	7.3
DR-23	5	NA	7.3 ± 0.2	7.6	7.1
DR-28	5	NA	7.4 ± 0.1	7.5	7.3
DR-43	5	NA	7.4 ± 0.2	7.8	7.2
Phenol, in mg/L					
DR-115	3	3	--	<0.005	<0.005
DR-23	3	1	0.005 ± 0.01	0.017	<0.005
DR-28	3	2	--	0.007	<0.005
DR-43	3	1	0.009 ± 0.02	0.031	<0.005
Plutonium-239/240 - total, in E-9μCi/ml					
DR-115	5	4	<MDA	0.01	<MDA
DR-23	4	1	0.02 ± 0.02	0.05	<MDA
DR-28	5	1	0.01 ± 0.01	0.03	<MDA
DR-43	5	4	<MDA	0.02	<MDA
Radium-226 - total, in E-9μCi/ml					
DR-115	5	1	0.2 ± 0.2	0.4	<MDA
DR-23	4	0	0.3 ± 0.1	0.5	0.1
DR-28	4	0	0.2 ± 0.1	0.4	0.1
DR-43	4	1	0.13 ± 0.09	0.2	<MDA

Table 10.3 Summary of 1994 Data for Drinking Water (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev	Max	Min
Radium-228 - total, in E-9μCi/ml					
DR-115	5	1	0.3 ± 0.3	0.6	<MDA
DR-23	4	0	0.5 ± 0.2	0.9	0.3
DR-28	4	1	0.3 ± 0.2	0.5	<MDA
DR-43	4	0	0.3 ± 0.1	0.5	0.2
RDX, in mg/L					
DR-115	3	3	--	<0.020	<0.020
DR-23	5	5	--	<0.020	<0.020
DR-28	5	5	--	<0.020	<0.020
DR-43	3	3	--	<0.020	<0.020
Selenium - total, in mg/L					
DR-115	5	5	--	<0.005	<0.005
DR-23	5	5	--	<0.005	<0.005
DR-28	5	5	--	<0.005	<0.005
DR-43	5	5	--	<0.005	<0.005
Silver - total, in mg/L					
DR-115	5	5	--	<0.005	<0.005
DR-23	5	5	--	<0.005	<0.005
DR-28	5	5	--	<0.005	<0.005
DR-43	5	5	--	<0.005	<0.005
Specific conductance, in μmho/cm					
DR-115	4	0	450 ± 12	460	432
DR-23	5	0	483 ± 29	518	449
DR-28	5	0	477 ± 33	518	437
DR-43	5	0	493 ± 38	535	437
Sulfate (as SO_4), in mg/L					
DR-115	3	0	23 ± 1	25	22
DR-23	3	0	23 ± 2	26	21
DR-28	3	0	23 ± 1	25	22
DR-43	3	0	23 ± 1	25	22
Total dissolved solids, in mg/L					
DR-115	5	0	274 ± 29	300	230
DR-23	5	0	291 ± 19	310	260
DR-28	5	0	279 ± 26	316	250
DR-43	5	0	281 ± 20	314	260
Total suspended solids, in mg/L					
DR-115	4	4	--	<5	<5
DR-23	4	3	--	5	<4
DR-28	4	3	--	4	<4
DR-43	3	2	--	6	<4

Table 10.3 Summary of 1994 Data for Drinking Water (cont'd)

Location	No. of Samples	No. BDL	Mean ± Std. Dev	Max	Min
Total organic carbon, in mg/L					
DR-115	3	2	1.7 ± 2.9	5	<1
DR-23	4	3	1.3 ± 2.5	5	<1
DR-28	4	3	1.5 ± 3	3	<1
DR-43	4	3	1.5 ± 3	6	<1
Total organic halogen, in mg/L					
DR-115	3	1	6 ± 6.5	13	<5
DR-23	4	0	15 ± 2	18	11
DR-28	4	0	14 ± 9	29	7
DR-43	4	0	10 ± 3	12	4
Total trihalomethanes, in mg/L					
DR-115	5	5	NA	<0.0005	<0.0005
DR-23	5	2	0.00049 ±0.006	0.0148	<0.0005
DR-28	5	3	0.0018 ± 0.0026	0.0054	<0.0005
DR-43	5	3	0.0045 ± 0.0074	0.0169	<0.0005
Tritium - total, in E-6μCi/ml					
DR-115	3	1	0.06 ± 0.06	0.1	<MDA
DR-23	5	3	0.02 ± 0.02	0.05	<MDA
DR-28	5	3	0.03 ± 0.05	0.11	<MDA
DR-43	5	4	<MDA	0.03	<MDA
Uranium-234 - total, in E-9μCi/ml					
DR-115	5	0	4.5 ± 0.2	4.9	4.3
DR-23	5	0	4.5 ± 0.4	5.1	3.9
DR-28	5	0	4.7 ± 0.5	5.5	3.9
DR-43	5	0	4.8 ± 0.6	6	4.3
Uranium-238 - total, in E-9μCi/ml					
DR-115	5	0	2.2 ± 0.3	2.7	1.9
DR-23	5	0	2.2 ± 0.3	2.5	1.8
DR-28	5	0	2.3 ± 0.1	2.5	2.1
DR-43	5	0	2.4 ± 0.3	2.9	2
Zinc - total, in mg/L					
DR-115	5	1	0.01 ± 0.009	0.025	<0.005
DR-23	5	0	0.119 ± 0.039	0.163	0.048
DR-28	5	0	0.121 ± 0.014	0.143	0.103
DR-43	5	0	0.164 ± 0.057	0.239	0.089

Summary of radioactive results does not include counting error.
[1]BDL indicates below detection limit.
[2]Dashes (--) indicate a mean value could not be calculated.
[3]<MDA indicates the results were less than minimum detectable activity (MDA) of the radionuclide counting system.
[4]NA indicates not applicable.

10.2.3 Nitrate Monitoring Program

Samples were collected by Pantex Plant personnel for the TNRCC and analyzed for nitrates and nitrites at the State's laboratory. Results indicated that the drinking water system was in compliance with 40 CFR 141, "National Primary Drinking Water Regulations," and with Texas water hygiene requirements (30 TAC Chapter 290). Routine monitoring of the drinking water system by Plant personnel confirmed compliance with these rules.

10.2.4 Biological Monitoring

No biological contamination was detected in the 65 monitoring samples tested in 1994 (48 from the drinking water distribution system, 12 from untreated water, and 5 special samples). Thus the system complied with 40 CFR 141 and with Texas water hygiene requirements (30 TAC Chapter 290).

10.2.5 Radiological Monitoring

Analyses for radionuclides indicated no radiological concerns in the drinking water system. Results indicated compliance with radiological sampling and analytical requirements of 40 CFR 141, Texas water hygiene requirements (30 TAC Chapter 290), and DOE Order 5400.5, "Radiation Protection of the Public and the Environment."

10.3 Historical Comparisons

Constituent concentrations measured in 1994 were within the range of those observed in previous years (Table 10.4). No significant increasing or decreasing trends were observed.

Table 10.4 Comparison of Mean Results for Drinking Water for 1990-1994

Location	1990	1991	1992	1993	1994
Ammonia (as N), in mg/L					
DR-115	--[1]	--	--	--	2.5
DR-23	--	*[2]	--	*	1.9
DR-28	--	*	*	*	2.05
DR-43	--	*	*	*	2.05
Arsenic - total, in mg/L					
DR-115	--	--	--	--	*
DR-23	--	*	*	*	*
DR-28	--	*	*	*	*
DR-43	--	*	*	*	*
Barium - total, in mg/L					
DR-115	--	--	--	--	0.11
DR-23	0.12	0.11	0.11	0.1	0.11
DR-28	0.12	0.11	0.11	0.11	0.11
DR-43	0.13	0.11	0.08	0.1	0.11
Cadmium - total, in mg/L					
DR-115	--	--	--	--	*
DR-23	--	*	*	*	*
DR-28	--	*	*	*	*
DR-43	--	*	*	*	*
Chloride, in mg/L					
DR-115	--	--	--	--	10
DR-23	--	12	10	10	11
DR-28	--	12	*	11	11
DR-43	--	12	*	11	11
Chromium - total, in mg/L					
DR-115	--	--	--	--	*
DR-23	0.005	0.005	*	*	*
DR-28	0.005	*	*	*	*
DR-43	*	*	*	*	*
Chromium (hexavalent), in mg/L					
DR-115	--	--	--	--	--
DR-23	--	*	*	*	--
DR-28	--	*	*	*	--
DR-43	--	*	*	*	--
Copper - total, in mg/L					
DR-115	--	--	--	--	0.009
DR-23	0.277	0.13	0.15	0.15	0.142
DR-28	0.012	0.014	0.013	0.013	0.007
DR-43	0.009	0.026	0.019	0.02	0.031
Cyanide - total, in mg/L					
DR-115	--	--	--	--	*
DR-23	--	*	*	*	*
DR-28	--	*	*	*	*
DR-43	--	--	*	*	*

Table 10.4 Comparison of Mean Results for Drinking Water for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Fluoride, in mg/L					
DR-115	--	--	--	--	1.4
DR-23	1.7	1.4	1.6	1.6	1.4
DR-28	1.7	1.7	1.6	1.8	1.5
DR-43	1.6	1.6	1.6	1.7	1.5
Gross alpha - dissolved, in E-9 μCi/ml					
DR-115	--	--	--	--	5
DR-23	3.8	5.3	5.5	7	5
DR-28	4.8	4.8	4.8	6	6
DR-43	8.2	4.8	5.8	7	6
Gross alpha - suspended, in E-9 μCi/ml					
DR-115	--	--	--	--	<MDA[3]
DR-23	0.8	<MDA	<MDA	<MDA	<MDA
DR-28	<MDA	<MDA	<MDA	<MDA	<MDA
DR-43	<MDA	<MDA	<MDA	<MDA	<MDA
Gross beta - dissolved, in E-9μCi/ml					
DR-115	--	--	--	--	7
DR-23	8	6.5	7	8	7
DR-28	6.4	7.2	7.2	9	7
DR-43	19.4	7.2	5.5	8	10
Gross beta - suspended, in E-9μCi/ml					
DR-115	--	--	--	--	0.6
DR-23	1	0.5	0.77	<MDA	0.4
DR-28	0.25	0.7	1.1	1	0.6
DR-43	6	<MDA	<MDA	1	0.6
HMX, in mg/L					
DR-115	--	--	--	--	*
DR-23	*	*	*	*	*
DR-28	*	*	*	*	*
DR-43	*	*	*	*	*
Iron - total, in mg/L					
DR-115	--	--	--	--	*
DR-23	0.09	0.02	0.058	*	0.05
DR-28	0.02	0.01	0.01	0.01	0.02
DR-43	0.22	0.15	0.13	0.12	0.2
Lead - total, in mg/L					
DR-115	--	--	--	--	*
DR-23	0.093	*	*	*	*
DR-28	0.017	*	*	*	*
DR-43	0.216	*	*	*	*
Mercury - total, in mg/L					
DR-115	--	--	--	--	*
DR-23	--	*	*	*	*
DR-28	--	*	*	*	*
DR-43	--	*	*	*	*

Table 10.4 Comparison of Mean Results for Drinking Water for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Nitrate (as N), in mg/L					
DR-115	--	--	--	--	1.6
DR-23	1.36	1.4	--	1.5	1.84
DR-28	1.42	1.4	--	1.26	1.51
DR-43	1.22	2.4	--	1.2	1.51
Nitrite (as N), in mg/L					
DR-115	--	--	--	--	*
DR-23	--	*	--	*	*
DR-28	--	*	--	*	*
DR-43	--	*	--	*	*
Oil and grease, in mg/L					
DR-115	--	--	--	--	*
DR-23	*	--	*	*	*
DR-28	--	--	*	*	*
DR-43	*	--	*	*	*
Orthophosphate (as P), in mg/L					
DR-115	--	--	--	--	--
DR-23	--	*	--	*	--
DR-28	--	--	--	--	--
DR-43	--	--	--	--	--
pH, in pH units					
DR-115	--	--	--	--	7.5
DR-23	--	7.8	7.6	7	7.3
DR-28	--	7.8	7.6	7.2	7.4
DR-43	--	7.9	7.7	7	7.4
Phenol, in mg/L					
DR-115	--	--	--	--	*
DR-23	--	--	--	*	0.005
DR-28	--	--	--	*	*
DR-43	--	--	--	*	0.009
Plutonium-239/240 - total, in E-9μCi/ml					
DR-115	--	--	--	--	0.002
DR-23	*	0.01	<MDA	<MDA	0.02
DR-28	<MDA	0.02	<MDA	<MDA	0.01
DR-43	<MDA	<MDA	0.003	<MDA	<MDA
Radium-226 - total, in E-9μCi/ml					
DR-115	--	--	--	--	0.2
DR-23	--	<MDA	0.1	0.2	0.3
DR-28	--	<MDA	0.1	0.3	0.02
DR-43	--	<MDA	0.1	0.3	0.13
Radium-228 - total, in E-9μCi/ml					
DR-115	--	--	--	--	0.3
DR-23	--	1	0.5	0.3	0.5
DR-28	--	<MDA	0.9	0.5	0.3
DR-43	--	<MDA	0.5	0.5	0.3

Table 10.4 Comparison of Mean Results for Drinking Water for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
RDX, in mg/L					
DR-115	--	--	--	--	*
DR-23	*	*	*	*	*
DR-28	*	*	*	*	*
DR-43	*	*	*	*	*
Selenium - total, in mg/L					
DR-115	--	--	--	--	*
DR-23	--	--	*	*	*
DR-28	--	--	*	*	*
DR-43	--	--	*	*	*
Silver - total, in mg/L					
DR-115	--	--	--	--	*
DR-23	--	*	*	*	*
DR-28	--	*	*	*	*
DR-43	--	*	*	*	*
Specific conductance, in μmho/cm					
DR-115	--	--	--	--	450
DR-23	--	495	490	495	483
DR-28	--	503	482	496	477
DR-43	--	500	484	486	493
Sulfate (as SO_4), in mg/L					
DR-115	--	--	--	--	23
DR-23	19	22	29	28	23
DR-28	20	23	29	27	23
DR-43	18	23	25	27	23
Total dissolved solids, in mg/L					
DR-115	--	--	--	--	274
DR-23	296	288	303	301	291
DR-28	298	292	300	298	279
DR-43	298	290	300	304	281
Total suspended solids, in mg/L					
DR-115	--	--	--	--	*
DR-23	5	*	*	*	*
DR-28	*	*	10	*	*
DR-43	8	*	10	*	*
Total organic carbon , in mg/L					
DR-115	--	--	--	--	1.7
DR-23	--	3.3	*	2.6	1.3
DR-28	--	2	2.3	2	1.5
DR-43	--	2	1.7	2	1.5
Total organic halogen, in mg/L					
DR-115	--	--	--	--	6
DR-23	--	16	12	16	15
DR-28	--	14	9	11	14
DR-43	--	14	10	9	10

Table 10.4 Comparison of Mean Results for Drinking Water for 1990-1994 (cont'd)

Location	1990	1991	1992	1993	1994
Trichloroethene, in mg/L					
DR-115	--	--	--	--	*
DR-23	*	*	*	*	*
DR-28	*	*	*	*	*
DR-43	*	*	*	*	*
Tritium - total, in E-9μCi/ml					
DR-115	--	--	--	--	0.06
DR-23	0.04	<MDA	0.033	0.09	0.02
DR-28	0.06	0.14	<MDA	0.03	0.03
DR-43	0.13	<MDA	0.05	<MDA	<MDA
Uranium-234 - total, in E-9μCi/ml					
DR-115	--	--	--	--	4.5
DR-23	4	4.3	4.65	4	4.5
DR-28	4.1	4.3	4.5	4.4	4.7
DR-43	4.3	4	4.6	4.4	4.8
Uranium-238 - total, in E-9μCi/ml					
DR-115	--	--	--	--	2.2
DR-23	1.9	2.3	2.15	2	2.2
DR-28	1.8	2.3	4.2	2.1	2.3
DR-43	2	2.1	2.2	2.1	2.4
Zinc - total, in mg/L					
DR-115	--	--	--	--	0.01
DR-23	0.056	0.078	0.2	0.17	0.119
DR-28	0.118	0.16	0.14	0.16	0.121
DR-43	0.068	0.12	0.088	0.11	0.164
1,2-Dichloroethane, in mg/L					
DR-115	--	--	--	--	*
DR-23	*	*	*	*	*
DR-28	*	*	*	*	*
DR-43	*	*	*	*	*

Summary of radioactive results does not include counting error.
[1]Dashes (--) indicate not analyzed.
[2]Asterisks (*) indicate a mean value could not be calculated.
[3]<MDA indicates the results were less than the minimum detectable activity (MDA) of the radionuclide counting system.

Nesting barn swallows (*Hirundo rustica*)

Chapter 11

SURFACE WATER

There are no rivers or streams at Pantex Plant; the only surface water occurs in ditches and playas. U.S. Department of Energy (DOE)-owned and DOE-leased property is associated with six playas, two of which are owned by Texas Tech University. Stormwater runoff from DOE-owned and DOE-leased lands flows through ditches to the onsite playas. All effluents from Plant operations are treated and, along with some noncontact industrial discharges, are directed to four onsite playas (one, Playa #4, on land owned by Texas Tech University). Treated industrial discharges from Zone 12 and the eastern portion of Zone 11 flow through ditches to Playa #1. Runoff from western portions of Zone 11 is channeled to Playa #2. Stormwater runoff from the Burning Ground drains into Playa #3. Runoff from southern portions of Zones 11 and 12 flows into Playa #4. Even though DOE owns Pantex Lake, located northeast of Pantex Plant, Plant activities do not influence any current flows to this playa. The Environmental Restoration program is investigating the playas and portions of the ditch system to determine the extent of contamination from past operations, as discussed in Chapter 6. Playa #5, which is on Texas Tech University property, has not been used by DOE operations at Pantex Plant and is being investigated by the U.S. Department of Defense under the Formerly Used Defense Site remedial program.

Surface water samples are collected when flows occur. Thus, monitoring is generally dependent on rainfall or discharge events. Because flows are continuous at the Wastewater Treatment Facility (WWTF), sampling can be conducted on a regular schedule. Sampling at the WWTF is conducted in accordance with the Wastewater No-Discharge Permit issued in 1988 by the Texas Water Commission, the predecessor agency to the Texas Natural Resource Conservation Commission (TNRCC). For control purposes, offsite surface water is sampled at a playa at Bushland, Texas. The control data are compared with onsite data to identify potential environmental differences due to Plant operations. Table 11.1 lists the outfalls for ditches and related buildings and identifies the playa into which each discharges. Sampling locations are shown in Figure 11.1 and analytes are listed in Table 11.2.

11.1 Radiological Monitoring

Sampling is conducted monthly, subject to flow conditions. Samples are sent to offsite contract laboratories for analysis of uranium-234, uranium-238, plutonium-239/240, radium-226, radium-228, tritium, and suspended and dissolved gross alpha/beta particles. Results for 1994 are summarized in Table 11.3. Data for all sample locations were published in a detailed compilation (Mason & Hanger 1995a). Radionuclide concentrations in all samples were less than the derived concentration guides (DCGs) for ingested water (DOE Order 5400.5, "Radiation Protection of the Public and the Environment"). Even though no DCGs exist for gross alpha/beta levels, results indicate that 1994 radionuclide levels in surface water were similar to historical levels, levels at the control location, and levels in water from the Ogallala aquifer. Thus, Pantex operations do not affect the radiological content of discharged waters.

11.2 Nonradiological Monitoring

Samples from selected monitoring locations are analyzed for volatile organic compounds, semivolatile organic compounds, explosives, herbicides, pesticides, polychlorinated biphenyls (PCBs), metals, nutrients, and other components

Table 11.1 Effluent and Surface Water Sampling Locations

Playa	Associated Ditches and Building Discharges
Playa #1	Wastewater Treatment Facility (Outfall 001)
	Influent
	Lagoon
	Composite Sampler at Chlorinator
	Effluent
	Zone 12 East at Pantex Drive (Outfall 002)[1]
	Building 12-17 North Flume
	Building 12-17 South Flume
	Building 12-19 North Flume
	Building 12-19 South Flume
	Building 12-24N monitored at Building 12-43
	Buildings 12-21 and 12-24N monitored at ditch NE of 12-24N
	Zone 12 West at Pantex Drive (Outfall 003)[1]
	11-44 discharge, 50 yards northeast of Building 11-44
	Zone 4 East
	Pumped water from tailwater pit at old sewage treatment plant
	Stormwater runoff
Playa #2	16-1 Weir (Outfall 004)[1]
	Building 11-50 discharge
	North Ditch (Outfall 005)
	Stormwater runoff
Playa #3	Stormwater runoff
Playa #4	Zone 12 South (Outfall 006)
	Zone 11 Southwest ditch[1]
	Building 11-36 ditch
	Zone 11 Southeast ditch
	Stormwater runoff
Pantex Lake	Stormwater runoff
Bushland Playa	Stormwater runoff

[1] Weir location. Indented entries below are associated discharges.

reflecting water quality and treatment performance. Analytical data presented in the tables include minimum and maximum values and calculated means with standard deviations for the following analytes: volatile organic compounds (Table 11.4); semivolatile organic compounds (Table 11.5); explosives, herbicides, and pesticides (Table 11.6); metals (Table 11.7); and nutrients and other analytes (Table 11.8). No PCBs were detected in 1994.

Where appropriate, results were compared to Maximum Contaminant Levels (MCLs) established in Texas Administrative Code (TAC), Title 30, Chapter 319.22. When no MCL was available, results were compared to historical values and results from the control location. Comparisons to historical limits are primarily for metals, explosives, and inorganic constituents. When values were below the detection limit of the sample method, means were calculated using 95% of the detection limit to represent the lower

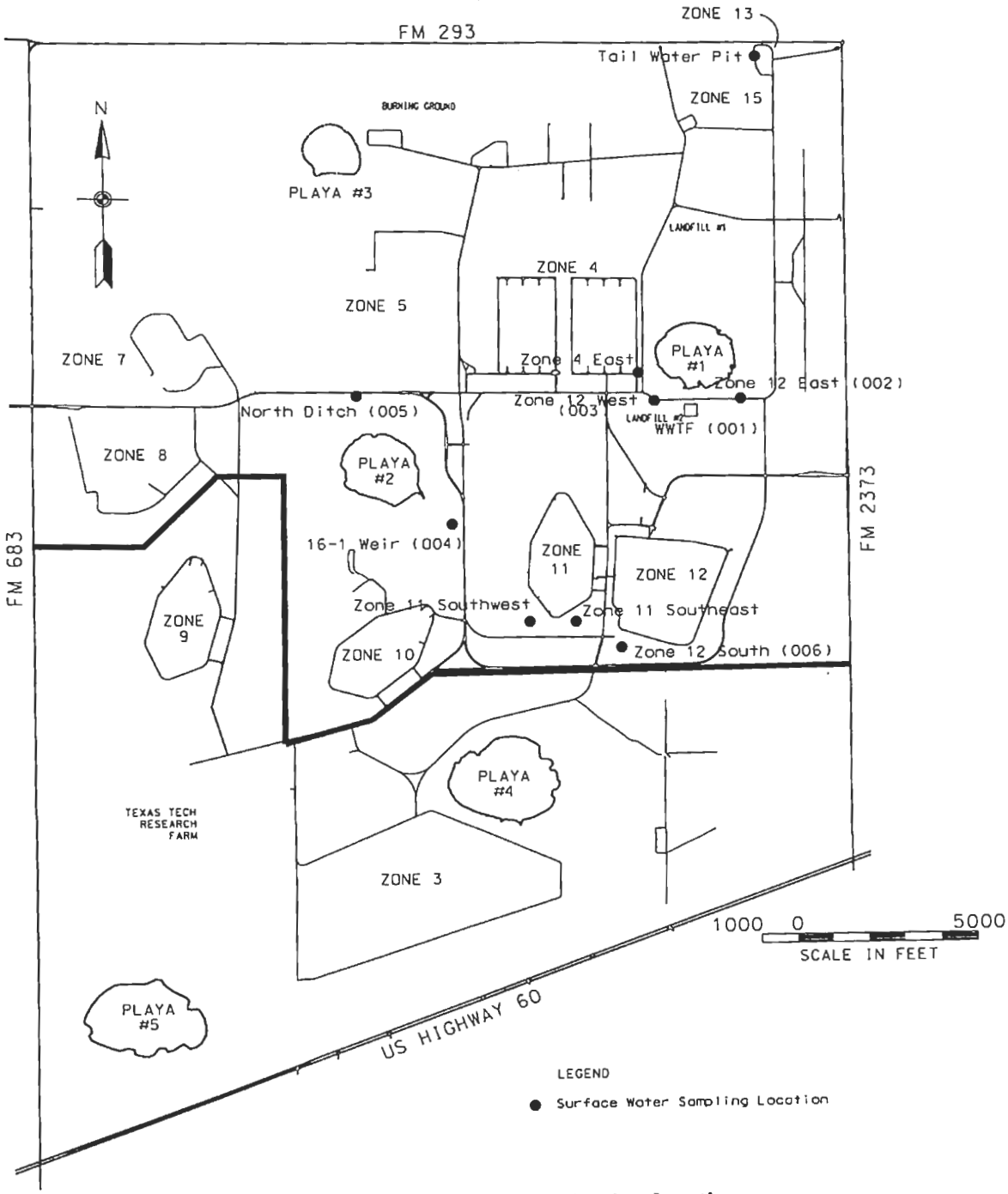


Figure 11.1 Surface water monitoring locations

Table 11.2 Monitored Parameters for Surface Water

Radionuclides
Gross alpha, dissolved
Gross alpha, suspended
Gross beta, dissolved
Gross beta, suspended
Tritium
Radium-226
Radium-228
Uranium-234
Uranium-238
Plutonium-239/240

Metals
Aluminum
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Molybdenum
Nickel
Potassium
Selenium
Silica
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Vanadium
Zinc

Explosives
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)
Pentaerythritol tetranitrate (PETN)
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
Trinitrotoluene (TNT)

Polychlorinated Biphenyls (PCBs)[1]
Aroclor-1016
Aroclor-1221
Aroclor-1232
Aroclor-1242
Aroclor-1248
Aroclor-1254
Aroclor-1260

Pesticides
4,4'-DDT
4,4'-DDE
4,4'-DDD
Aldrin
alpha-BHC
beta-BHC
delta-BHC
Chlordane
Dieldrin
alpha-Endosulfan
beta-Endosulfan
Endosulfan sulfate
Endrin
Endrin aldehyde
Heptachlor
Heptachlor epoxide
Lindane (gamma-BHC)
Methoxychlor
Toxaphene

Herbicides
2,4-D
2,4,5-TP (Silvex)

Miscellaneous
Ammonia (as N)
Biological oxygen demand
Chemical oxygen demand
Chloride
Chromium (hexavalent)
Cyanide, total
Fluoride
Nitrate (as N)
Nitrite (as N)
Oil and grease
pH
Phenols
Specific conductance
Sulfate (as SO_4)
Temperature
Total dissolved solids
Total suspended solids
Total organic carbon
Total organic halogen

Volatile Organics
1,1-Dichloroethane
1,1-Dichloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dichlorethane
1,2-Dichloroethene, total
1,2-Dichloropropane
2-Butanone
2-Chloroethyl vinyl ether
2-Hexanone
4-Methyl-2-pentanone
Acetone
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
cis-1,3-Dichloropropene
Dibromochlormethane
Ethylbenzene
Methylene chloride (Dichloromethane)
Styrene
Tetrachloroethene
Tetrahydrofuran
Toluene
Total xylenes
trans-1,3-Dichloropropene
Trichloroethene
Vinyl acetate
Vinyl chloride

Semivolatile Organics[1]
1,2-Dichlorobenzene
1,2,4-Trichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2-Chloronaphthalene
2-Chlorophenol
2-Methylnaphthalene
2-Methylphenol
2-Nitroaniline
2-Nitrophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2-4-Dinitrophenol
2,4-Dinitrotoluene

Table 11.2 Monitored Parameters for Surface Water (cont'd)

Semivolatile Organics, cont'd	Semivolatile Organics, cont'd	Semivolatile Organics, cont'd
2,4,5-Trichlorophenol	Benzo(a)pyrene	Di-n-octyl phthalate
2,4,6-Trichlorophenol	Benzo(b)fluoranthene	Fluoranthene
2,6-Dinitrotoluene	Benzo(g,h,i)pyrene	Fluorene
3-Nitronaniline	Benzoic acid	Hexachlorobenzene
3,3'-Dichlorobenzidine	Benzo(k)fluoranthene	Hexachlorobutadiene
4-Bromophenyl phenyl ether	Benzyl alcohol	Hexachlorocyclopentadiene
4-Chloro-3-methylphenol	bis(2-Chloroethoxy) methane	Hexachloroethane
4-Chloroaniline	bis(2-Chloroethyl) ether	Indeno(1,2,3-cd)pyrene
4-Chlorophenylether	bis(2-Chloroisopropyl)ether	Isophorone
4-Methylphenol	bis(2-ethylhexyl)phthalate	Naphthalene
4-Nitroaniline	Butyl benzyl phthalate	Nitrobenzene
4-Nitrophenol	Chrysene	N-Nitroso-Di-N-propylamine
4,6-Dinitro-2-methylphenenol	Dibenz(a,h)anthracene	N-Nitrosodiphenylamine
Acenaphthene	Dibenzofuran	Pentachlorophenol
Acenaphthylene	Diethylphthalate	Phenanthrene
Anthracene	Dimethyl phthalate	Phenol
Benzo(a)anthracene	Di-n-butylphthalate	Pyrene

[1] Semivolatile organic compounds and PCBs are sampled only in the playas.

values. This overestimates the mean value and generates a conservative (worst-case) estimate for review. The discussions below are organized by location and include a general summary and explanations of detections in chronological order of occurrence. As at any 50-year-old industrial facility, a variety of constituents are occasionally detected at very low concentrations.

11.2.1 Playas and Playa Basins

11.2.1.1 Playa #1 Basin

Playa #1 receives water from six small channels: three are associated with Plant activities, and the other three receive only storm runoff. Of these, the only channel with continuous flow is from the WWTF and keeps the playa wet all year. The three channels along the south edge of Playa #1 include Outfall 001 (discharge from WWTF), Outfall 002 (Zone 12 East at Pantex Drive), and Outfall 003 (Zone 12 West at Pantex Drive). The western edge of Playa #1 receives runoff from Zone 4. The two northern channels receive runoff from agricultural areas. No volatile organic compounds, semivolatile organic compounds, or explosives were detected in Playa #1 in 1994. In November, pesticides were detected at the following concentrations: Lindane (gamma-BHC) at 0.0005 mg/L, Dieldrin at 0.0024 mg/L, Endrin at 0.0005 mg/L, and Heptachlor at 0.0006 mg/L. None of these pesticides are used at the Plant. The pesticides were not detected in previous samples or in samples taken in December, indicating that there is no persistent problem. Other constituents were below TNRCC MCLs or, if none were available, within historical limits.

In June 1994, the water level in Playa #1 exceeded the extent of the Randall Clay (the soil mapped in the bottom of the playa), which is specified as a limit in the permit. This exceedance was a result of heavy rainfall during previous weeks.

Wastewater Treatment Facility (Outfall 001). The WWTF system consists of a constructed lagoon divided into two treatment areas: an aerated section (about 60% of the lagoon) and a facultative section. Facultative treatment involves bacteria that live in normal-oxygen and reduced-oxygen environments. Before release, treated water is chlorinated and retained in a

Table 11.3 Summary of 1994 Radiological Data for Surface Water, in E-9 μCi/ml[1]

Location	No. of Samples	Mean ± Std. Dev[2]	Max[2]	Min[2]
Gross alpha-dissolved				
Bushland	4	1.50 ± 1.0	2 ± 1	1 ± 1
Tailwater pit	4	1.25 ± 1.0	2 ± 1	1 ± 1
Outfall-002	3	0.33 ± 1.0	1 ± 1	0 ± 1
Outfall-003	9	1.03 ± 0.82	2 ± 1	0 ± 1
Outfall-004	7	0.92 ± 0.90	2 ± 1	0 ± 1
Outfall-006	7	0.80 ± 0.90	2 ± 1	0 ± 1
Pantex Lake	3	2.0 ± 1.0	3 ± 1	1 ± 1
Playa #1	14	2.93 ± 2.71	7 ± 3	0 ± 4
Playa #2	5	1.4 ± 1.6	3 ± 2	0 ± 1
Playa #4	1	NA[3]	1 ± 1	NA
WWTF Incoming	14	5.0 ± 2.79	8 ± 3	1 ± 2
WWTF Lagoon	14	6.93 ± 3.86	13 ± 5	3 ± 2
WWTF Outfall-001	15	7.20 ± 3.53	12 ± 5	3 ± 2
Zone 4-E	2	1.0 ± 0.72	1.01 ± 0.43	1 ± 1
Zone 11-SE	1	NA	0 ± 1	NA
Gross alpha-suspended				
Bushland	4	8.5 ± 4.0	12 ± 5	7 ± 3
Tailwater pit	4	26.5 ± 7.75	53 ± 12	8 ± 2
Outfall-002	3	0.33 ± 1.0	1 ± 1	0 ± 1
Outfall-003	9	0.74 ± 0.78	2 ± 1	0 ± 1
Outfall-004	7	1.22 ± 0.87	2 ± 1	0 ± 1
Outfall-006	7	2.32 ± 1.15	5 ± 2	0.27 ± 0.03
Pantex Lake	3	9.67 ± 3.67	17 ± 6	1 ± 1
Playa #1	14	1.93 ± 1.07	5 ± 2	0 ± 1
Playa #2	5	3.4 ± 2.2	5 ± 2	1 ± 2
Playa #4	1	NA	0 ± 1	NA
WWTF Incoming	14	1.43 ± 1.0	5 ± 1	0 ± 1
WWTF Lagoon	14	0.29 ± 1.0	1 ± 1	0 ± 1
WWTF Outfall-001	15	0.20 ± 1.0	1 ± 1	0 ± 1
Zone 4-E	2	1.30 ± 0.53	2 ± 1	0.59 ± 0.06
Zone 11-SE	1	NA	0 ± 1	NA
Gross beta-dissolved				
Bushland	4	29.5 ± 3.0	62 ± 6	17 ± 2
Tailwater pit	4	12.0 ± 1.25	13 ± 2	11 ± 1
Outfall-002	3	7.67 ± 1.0	9 ± 1	7 ± 1
Outfall-003	9	8.26 ± 1.21	20 ± 3	5 ± 1
Outfall-004	7	12.14 ± 1.68	37 ± 5	4 ± 1
Outfall-006	7	5.44 ± 1.07	11 ± 2	4 ± 1
Pantex Lake	3	11.33 ± 2.0	15 ± 2	9 ± 2
Playa #1	14	17.21 ± 3.71	22 ± 4	8 ± 6
Playa #2	5	17.0 ± 2.2	24 ± 3	11 ± 1
Playa #4	1	NA	8 ± 1	NA
WWTF Incoming	14	11.5 ± 2.93	22 ± 4	7 ± 3
WWTF Lagoon	14	11.43 ± 4.07	18 ± 5	8 ± 5
WWTF Outfall-001	15	13.20 ± 4.67	46 ± 12	6 ± 4
Zone 4-E	2	8.91 ± 0.84	10.81 ± 0.67	7 ± 1
Zone 11-SE	1	NA	10 ± 1	NA

Table 11.3 Summary of 1994 Radiological Data for Surface Water, in E-9 μCi/ml (cont'd)

Location	No. of Samples	Mean ± Std. Dev	Max	Min
Gross beta-suspended				
Bushland	4	13.3 ± 4.0	16 ± 5	11 ± 3
Tailwater pit	4	58.5 ± 11.5	100 ± 20	38 ± 7
Outfall-002	3	2.67 ± 1.33	5 ± 2	1 ± 1
Outfall-003	9	1.45 ± 0.79	3 ± 1	0 ± 1
Outfall-004	7	2.42 ± 1.02	4 ± 1	0.94 ± 0.15
Outfall-006	7	4.48 ± 1.15	8 ± 2	0.39 ± 0.05
Pantex Lake	3	14.0 ± 3.33	24 ± 4	3 ± 1
Playa #1	14	4.0 ± 1.14	9 ± 1	1 ± 1
Playa #2	5	10.4 ± 2.6	14 ± 5	8 ± 2
Playa #4	1	NA	0 ± 1	NA
WWTF Incoming	14	1.07 ± 1.07	2 ± 1	0 ± 1
WWTF Lagoon	14	1.64 ± 1.14	4 ± 1	1 ± 1
WWTF Outfall-001	15	1.27 ± 1.0	3 ± 1	0 ± 1
Zone 4-E	2	3.21 ± 0.55	4 ± 1	2.41 ± 0.1
Zone 11-SE	1	NA	0 ± 1	NA
Plutonium 239/240				
Bushland	4	0.015 ± 0.033	0.03 ± 0.04	0 ± 0.01
Tailwater pit	4	0.040 ± 0.048	0.08 ± 0.07	0.02 ± 0.04
Outfall-002	3	0.020 ± 0.37	0.04 ± 0.07	0 ± 0.01
Outfall-003	9	0.023 ± 0.038	0.08 ± 0.07	0 ± 0.01
Outfall-004	7	0.03 ± 0.067	0.09 ± 0.18	0 ± 0.06
Outfall-006	7	0.033 ± 0.054	0.18 ± 0.15	0 ± 0.01
Pantex Lake	4	0.008 ± 0.020	0.02 ± 0.02	0 ± 0.01
Playa #1	14	0.016 ± 0.039	0.03 ± 0.07	0 ± 0.03
Playa #2	5	0.016 ± 0.036	0.04 ± 0.07	0 ± 0.01
Playa #4	1	NA	0.02 ± 0.02	NA
WWTF Incoming	14	0.010 ± 0.033	0.04 ± 0.06	0 ± 0.05
WWTF Lagoon	14	0.039 ± 0.039	0.30 ± 0.05	0 ± 0.05
WWTF Outfall-001	15	0.009 ± 0.028	0.02 ± 0.02	0 ± 0.01
Zone 4-E	2	0.005 ± 0.050	0.01 ± 0.04	0 ± 0.06
Zone 11-SE	1	NA	0 ± 0.07	NA
Radium-226				
Bushland	4	0.65 ± 0.33	0.9 ± 0.4	0.4 ± 0.2
Tailwater pit	4	3.08 ± 0.65	8.6 ± 0.9	0.3 ± 0.3
Outfall-002	3	0.20 ± 0.80	0.4 ± 0.4	0.1 ± 0.2
Outfall-003	9	0.12 ± 0.27	0.40 ± 0.40	0 ± 0.30
Outfall-004	7	0.17 ± 0.30	0.4 ± 0.30	0 ± 0.50
Outfall-006	7	0.39 ± 0.36	0.60 ± 0.60	0.20 ± 0.30
Pantex Lake	3	0.67 ± 0.43	1.3 ± 0.5	0.1 ± 0.2
Playa #1	14	0.31 ± 0.31	0.6 ± 0.4	0.1 ± 0.2
Playa #2	5	0.58 ± 0.36	1.3 ± 0.5	0.3 ± 0.4
Playa #4	1	NA	0.3 ± 0.3	NA
WWTF Incoming	14	0.25 ± 0.29	0.7 ± 0.4	0 ± 0.2
WWTF Lagoon	14	0.27 ± 0.29	1.3 ± 0.4	0 ± 0.2
WWTF Outfall-001	15	0.17 ± 0.27	0.4 ± 0.3	0 ± 0.3
Zone 4-E	2	0.16 ± 0.20	0.21 ± 0.2	0.10 ± 0.2
Zone 11-SE	1	NA	0.2 ± 0.3	NA

Table 11.3 Summary of 1994 Radiological Data for Surface Water, in E-9 μCi/ml (cont'd)

Location	No. of Samples	Mean ± Std. Dev	Max	Min
Radium-228				
Bushland	4	1.15 ± 0.60	1.4 ± 0.5	0.6 ± 0.4
Tailwater pit	4	2.25 ± 1.03	3.4 ± 1.1	0.3 ± 0.4
Outfall-002	3	0.47 ± 0.93	0.6 ± 1.8	0.3 ± 0.4
Outfall-003	9	0.58 ± 1.62	2.28 ± 6.05	0 ± 4.96
Outfall-004	7	0.36 ± 1.53	1.0 ± 0.90	0 ± 6.99
Outfall-006	7	0.45 ± 1.13	0.70 ± 0.80	0.10 ± 0.60
Pantex Lake	3	1.23 ± 0.67	1.6 ± 0.9	0.5 ± 0.6
Playa #1	14	0.42 ± 0.63	1.1 ± 0.7	0 ± 0.5
Playa #2	5	1.0 ± 0.84	1.2 ± 0.9	0.5 ± 0.5
Playa #4	1	NA	0 ± 0.5	NA
WWTF Incoming	14	0.37 ± 0.63	1.0 ± 0.8	0 ± 0.7
WWTF Lagoon	14	0.41 ± 0.63	1.6 ± 0.7	0.1 ± 0.6
WWTF Outfall-001	15	0.39 ± 0.67	0.8 ± 0.5	0 ± 0.7
Zone 4-E	2	1.87 ± 2.98	2.74 ± 5.26	1.00 ± 0.70
Zone 11-SE	1	NA	0.5 ± 0.9	NA
Tritium				
Bushland	4	0.078 ± 0.205	0.12 ± 0.21	0.02 ± 0.19
Tailwater pit	4	0.088 ± 0.180	0.20 ± 0.20	0.03 ± 0.19
Outfall-002	3	0.077 ± 0.183	0.15 ± 0.16	0.02 ± 0.20
Outfall-003	9	0.081 ± 0.157	0.33 ± 0.18	0 ± 0.10
Outfall-004	7	0.08 ± 0.17	0.16 ± 0.22	0 ± 0.14
Outfall-006	7	0.13 ± 0.18	0.36 ± 0.18	0 ± 0.19
Pantex Lake	3	0.087 ± 0.19	0.10 ± 0.20	0.06 ± 0.21
Playa #1	14	0.081 ± 0.179	0.23 ± 0.21	0 ± 0.15
Playa #2	5	0.086 ± 0.188	0.12 ± 0.16	0.05 ± 0.21
Playa #4	1	NA	0.09 ± 0.22	NA
WWTF Incoming	14	0.09 ± 0.16	0.23 ± 0.16	0.01 ± 0.02
WWTF Lagoon	14	0.07 ± 0.17	0.18 ± 0.20	0 ± 0.14
WWTF Outfall-001	15	0.35 ± 0.19	4.10 ± 0.50	0 ± 0.14
Zone 4-E	2	0.17 ± 0.17	0.27 ± 0.17	0.06 ± 0.16
Zone 11-SE	1	NA	0.22 ± 0.22	NA
Uranium-234				
Bushland	4	0.30 ± 0.15	0.6 ± 0.2	0.1 ± 0.1
Tailwater pit	4	0.65 ± 0.15	1.7 ± 0.2	0.1 ± 0.1
Outfall-002	3	0.23 ± 0.13	0.3 ± 0.2	0.2 ± 0.1
Outfall-003	9	0.36 ± 0.21	2 ± 1	0 ± 0.10
Outfall-004	6	0.19 ± 0.14	0.61 ± 0.26	0 ± 0.10
Outfall-006	7	0.23 ± 0.13	0.40 ± 0.2	0.10 ± 0.1
Pantex Lake	4	2.93 ± 0.35	4 ± 0.4	1.2 ± 0.2
Playa #1	14	2.21 ± 0.29	4.3 ± 0.4	0 ± 0
Playa #2	5	0.52 ± 0.14	1 ± 0.2	0.2 ± 0.1
Playa #4	1	NA	0.1 ± 0.1	NA
WWTF Incoming	14	5.01 ± 0.49	6.4 ± 0.7	4.0 ± 0.4
WWTF Lagoon	14	5.05 ± 0.47	6.7 ± 0.5	3.9 ± 0.4
WWTF Outfall-001	15	4.79 ± 0.47	6.2 ± 0.6	2.1 ± 0.4
Zone 4-E	2	0.34 ± 0.17	0.37 ± 0.13	0.30 ± 0.20
Zone 11-SE	1	NA	0 ± 0.1	NA

Table 11.3 Summary of 1994 Radiological Data for Surface Water, in E-9 μCi/ml (cont'd)

Location	No. of Samples	Mean ± Std. Dev	Max	Min
Uranium-238				
Bushland	4	0.23 ± 0.15	0.3 ± 0.2	0.2 ± 0.1
Tailwater pit	4	0.60 ± 0.12	1.5 ± 0.1	0.1 ± 0.1
Outfall-002	3	0.1 ± 0.1	0.2 ± 0.1	0 ± 0.1
Outfall-003	9	0.042 ± 0.097	0.12 ± 0.09	0 ± 0.10
Outfall-004	6	0.11 ± 0.13	0.30 ± 0.20	0 ± 0.10
Outfall-006	7	0.12 ± 0.11	0.26 ± 0.16	0 ± 0.10
Pantex Lake	4	1.50 ± 0.28	2 ± 0.3	0.7 ± 0.2
Playa #1	14	1.14 ± 0.21	2.1 ± 0.3	0.1 ± 0.1
Playa #2	5	0.40 ± 0.14	0.8 ± 0.2	0.1 ± 0.1
Playa #4	1	NA	0.1 ± 0.1	NA
WWTF Incoming	14	2.66 ± 0.34	3.9 ± 0.5	1.9 ± 0.3
WWTF Lagoon	14	2.41 ± 0.31	2.9 ± 0.4	1.9 ± 0.3
WWTF Outfall-001	15	2.15 ± 0.33	3.1 ± 0.4	0.1 ± 0.2
Zone 4-E	2	0.19 ± 0.10	0.20 ± 0.10	0.18 ± 0.09
Zone 11-SE	1	NA	0 ± 0.1	NA

[1]Units are E-9 μCi/ml, except tritium, which is E-6 μCi/ml.
[2]Counting error at 95% confidence interval level is indicated by the ± value.
[3]NA indicates not available.

chlorine contact chamber for more than 30 minutes. In accordance with state requirements, residual chlorine in release waters ranged between 1.0 and 4.0 mg/L.

During 1994, the permitted pH range of 6.0 to 9.0 was not exceeded. Indicators of proper wastewater treatment are 5-day biochemical oxygen demand (BOD) and chemical oxygen demand (COD), which were within the limits specified in the wastewater permit. The WWTF and its associated permitted outfall (001) are sampled daily for pH and temperature; twice per week for metals, BOD, and COD; and monthly for volatile organic compounds, explosives, nutrients, and other components. Samples are obtained at the incoming weir, within the lagoon, at the chlorinator, and at the discharge point (the outfall proper). Table 11.9 lists the BOD and COD results for 1994. Table 11.10 lists water usage and treated wastewater discharges for 1994.

In January 1994, mercury (0.00022 and 0.00024 mg/L) was detected in the WWTF effluent. Cadmium was detected at the incoming weir at a concentration of 0.0036 mg/L. These values are below the MCLs established by the Safe Drinking Water Act (40 CFR 141.62 and 143.3). Acetone (0.15 and 0.16 mg/L), 4-methylphenol (0.0304 mg/L), and benzoic acid (0.134 mg/L) were also detected at the incoming weir. However, none of these elements or compounds were detected in the outfall and none were transmitted to Playa #1. In March, acetone (0.2 mg/L) was detected at the incoming weir and methylene chloride (0.006 mg/L) was detected both at the incoming weir and in the effluent. In June, acetone (0.34 mg/L) was detected at the incoming weir and toluene (0.021 mg/L) was detected in the WWTF effluent. Toluene was again detected in July (0.008 mg/L) and August (0.006 mg/L), both with a detection level of 0.005 mg/L. Toluene was not detected in samples taken in the lagoon

Table 11.4 Results of Volatile Organic Compound Sampling for 1994

Location	Compound Detected	Concentration, mg/L	Date
Wastewater Treatment Incoming Weir	Methylene chloride	0.006	4/94
		0.005	10/94
		0.020/0.031[1]	12/94
	Acetone	0.15/0.16	1/94
		0.2	3/94
		0.34	6/94
		0.57/0.65	12/94
	Tetrahydrofuran	0.084	12/94
Wastewater Treatment Lagoon	Toluene	0.007	10/94
Wastewater Treatment Outfall 001	Methylene chloride	0.006	4/94
		0.005/0.005[2]	10/94
	Toluene	0.021	6/94
		0.008	7/94
		0.006	8/94
Outfall 002	No detections	--	--
Outfall 003	Methylene chloride	0.006	3/94
Outfall 004	No detections	--	--
Outfall 005	No detections	--	--
Outfall 006	Methylene chloride	0.006	3/94
Zone-11-SE	No detections	--	--
Zone-11-SW	No detections	--	--
Zone-4-E	Methylene chloride	0.006	3/94
Tailwater Pit	No detections	--	--
Pantex Lake	No detections	--	--
Playa #1	No detections	--	--
Playa #2	No detections	--	--
Playa #3	No detections	--	--
Playa #4	No detections	--	--

1 Values given with a virgule (/) indicate duplicate samples were taken.
2 The minimum detection level is 0.005 mg/L; these values are at the detection limit.

Table 11.5 Semivolatile Organic Compound Results for 1994

Location	Compound Detected	Concentration, mg/L	Date
Wastewater Treatment Incoming Weir	4-Methylphenol	0.0304	1/94
	Benzoic acid	0.134	1/94

or at the incoming weir during this period. Mercury was detected in July (0.0004 mg/L) and September (0.0013 mg/L). These concentrations are below the MCL of 0.002 mg/L specified in 40 CFR 141.62. In October, toluene was detected within the lagoon at a concentration of 0.007 mg/L. Silver was detected at 0.16 mg/L in the WWTF in November, with 0.04 mg/L observed at the outfall; analysis of duplicate samples did not confirm these results. Methylene chloride was detected at the detection limit (0.005 mg/L) both at the incoming weir and in the effluent. In December, methylene chloride (0.02 and 0.031 mg/L), acetone (0.57 and 0.65 mg/L), and tetrahydrofuran (0.084 mg/L) were detected at the incoming weir. These three solvents are used when working with polyvinylchloride (PVC) piping; their presence is attributed to utilities work. These three solvents were not detected in samples taken within the lagoon or effluent outfall during the same period. Other constituents were below TNRCC MCLs or, if none were available, within historical limits.

Zone 12 East at Pantex Drive (Outfall 002). Flow to this location originates in Zone 12 East and includes discharges from the following buildings:

- Building 12-17 North
- Building 12-17 South
- Building 12-19 North
- Building 12-19 South
- Building 12-43 (explosive filter facility for Building 12-24 North)
- Buildings 12-21 and 12-24 North.

Permit limits for both pH and COD were met. Constituents were below TNRCC MCLs or, if none were available, within historical limits.

Zone 12 West at Pantex Drive (Outfall 003). Discharge from this location flows into Playa #1 and includes stormwater. Permit limits for pH and COD were met. In January 1994, lead was detected (0.0032 mg/L) below the Safe Drinking Water Act MCL of 0.05 mg/L. In March, methylene chloride was detected (0.006 mg/L) near the detection limit of 0.005 mg/L. Results for the remainder of the year did not indicate the presence of methylene chloride. Constituents were below TNRCC MCLs or, if none were available, within historical limits.

Zone 4 East. Flow is generated when stormwater runoff from Zone 4 enters Playa #1 along its western edge. Because the area drained does not contain industrial activities, no industrial pollutants are expected. In March, methylene chloride was detected at a level (0.006 mg/L) near the detection limit of 0.005 mg/L. This compound was not detected during the rest of the year. Other constituents were below TNRCC MCLs or, if none were available, within historical limits.

Tailwater Pit. Stormwater runoff from the northeast corner of the Plant collects in the tailwater pit adjacent to the old sewage treatment plant. The collected runoff is then pumped to the ditch adjacent to the WWTF. Before pumping, samples are collected at the tailwater pit using an automatic sampler. In June, the herbicide 2,4-D

Table 11.6 Detections of Explosive Components, Herbicides, and Pesticides

Location	Category Detected	Specific Analyte	Concentration, mg/L	Date
Pantex Lake	Explosive	RDX	0.014	5/94
Zone 11 Southeast	Explosive	HMX	0.051	7/94
Tailwater Pit	Herbicide	2,4-D	0.034	6/94
Playa #1	Pesticide	Lindane (gamma-BHC)	0.0005	11/94
		Dieldrin	0.0024	11/94
		Endrin	0.0005	11/94
		Heptachlor	0.0006	11/94

was detected at a concentration of 0.034 mg/L; its presence is attributed to agricultural activity. Metal concentrations were below MCLs established in 30 TAC Section 319.22. Other constituents were below TNRCC MCLs or, if none were available, within historical limits.

11.2.1.2 Playa #2 Basin

Playa #2 receives runoff from the west side of Zone 11, the north side of Zone 10, the vehicle maintenance facility, and a small area of plowed fields. Monitoring at Playa #2 is conducted at two influent points within the playa basin, but sampling is limited because flow is intermittent.

Weir 16-1 (Outfall 004). This channel receives stormwater and treated discharges from the vehicle maintenance facility and buildings in Zone 11. Permit limits for pH and COD were met. Constituents were below TNRCC MCLs or, if none were available, within historical limits.

North Ditch (Outfall 005). Flows from this location are due entirely to stormwater. The drainage area includes open and agricultural land in the north-central portion of the Plant. Constituents were below TNRCC MCLs or, if none were available, within historical limits.

11.2.1.3 Playa #3 Basin

Playa #3 receives stormwater from agricultural land and portions of the Burning Ground. There are no well-defined channels feeding into the playa, and runoff occurs primarily as sheet flow. No samples were collected in 1994 due to lack of water.

11.2.1.4 Playa #4 Basin

Playa #4 is on land owned by Texas Tech University and receives stormwater and some discharges from Zone 12 South and Zone 11 South. The discharges are mainly cooling water and steam condensates that have not come into contact with industrial processes (these are referred to as noncontact waters). Two primary channels flow into the playa from the Plant. Additional flow to Playa #4 comes from open land on the west, south, and east. Playa #4 was dry for most of 1994. In the samples taken, neither volatile organic compounds, semivolatile organic compounds, explosives, herbicides, nor pesticides were detected. Other constituents were below TNRCC MCLs or, if none were available, within historical limits.

Zone 12 South (Outfall 006). Water monitored at this site includes stormwater, noncontact waters, and steam condensate from the buildings

Table 11.7 **Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L.** Numbers have been rounded.

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Aluminum				
Bushland	6	9.5 ± 9.9	22.7	0.17
Tailwater pit	4	31.0 ± 14.2	46	17
Outfall-002	9	8.0 ± 13.8	44	0.66
Outfall-003	15	1.5 ± 1.5	6.3	0.04
Outfall-004	12	4.5 ± 7.3	27	0.34
Outfall-005	1	NA[1]	2.4	NA
Outfall-006	21	5.3 ± 5.5	18	0.19
Pantex Lake	3	19.6 ± 15.0	32	2.88
Playa #1	16	3.5 ± 5.0	16.7	0.75
Playa #2	5	9.7 ± 5.3	15	3.96
Playa #4	1	NA	2.1	NA
WWTF Autosampler	87	0.07 ± 0.03	0.2	0.03
WWTF Incoming	14	0.2 ± 0.1	0.5	0.05
WWTF Lagoon	14	0.1 ± 0.1	0.2	0.05
WWTF Outfall-001	14	0.1 ± 0.03	0.1	0.05
Zone 4-E	5	11.8 ± 6.8	21	2.26
Zone 11-SE	2	3.1 ± 0.9	3.7	2.4
Zone 11-SW	2	1.4 ± 0.2	1.5	1.2
Antimony				
Bushland	6	0.048 ± 0	*[2]	*
Tailwater pit	4	0.04 ± 0.02	*	*
Outfall-002	9	0.04 ± 0.02	*	*
Outfall-003	15	0.03 ± 0.02	*	*
Outfall-004	12	0.03 ± 0.02	*	*
Outfall-005	1	NA	*	NA
Outfall-006	21	0.04 ± 0.02	*	*
Pantex Lake	3	0.03 ± 0.03	*	*
Playa #1	16	0.04 ± 0.01	0.03	0.02
Playa #2	5	0.03 ± 0.02	*	*
Playa #4	1	NA	*	NA
WWTF Autosampler	91	0.03 ± 0.02	0.06	0.02
WWTF Incoming	16	0.04 ± 0.02	*	*
WWTF Lagoon	15	0.03 ± 0.01	*	*
WWTF Outfall-001	17	0.03 ± 0.02	0.02	0.02
Zone 4-E	5	0.03 ± 0.02	*	*
Zone 11-SE	2	0.05 ± 0	*	*
Zone 11-SW	2	0.05 ± 0	*	*
Arsenic				
Bushland	6	0.01 ± 0.008	0.03	0.007
Tailwater pit	4	0.02 ± 0.01	0.03	0.006
Outfall-002	9	0.006 ± 0.006	0.02	0.002

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Arsenic (cont'd)				
Outfall-003	15	0.004 ± 0.003	0.002	0.001
Outfall-004	12	0.005 ± 0.003	0.01	0.002
Outfall-005	1	NA	*	NA
Outfall-006	21	0.005 ± 0.002	0.007	0.002
Pantex Lake	3	0.008 ± 0.005	0.01	0.003
Playa #1	13	0.006 ± 0.002	0.01	0.004
Playa #2	5	0.01 ± 0.003	0.01	0.007
Playa #4	1	NA	0.005	NA
WWTF Autosampler	78	0.005 ± 0.003	0.03	0.001
WWTF Incoming	11	0.005 ± 0.0004	0.004	0.004
WWTF Lagoon	11	0.006 ± 0.005	0.02	0.002
WWTF Outfall-001	12	0.004 ± 0.0009	0.005	0.002
Zone 4-E	5	0.007 ± 0.002	0.008	0.003
Zone 11-SE	2	0.005 ± 0	*	*
Zone 11-SW	2	0.005 ± 0	*	*
Barium				
Bushland	6	0.27 ± 0.1	0.3	0.2
Tailwater pit	4	0.2 ± 0.08	0.3	0.11
Outfall-002	9	0.2 ± 0.1	0.5	0.09
Outfall-003	15	0.1 ± 0.1	0.2	0.05
Outfall-004	12	0.1 ± 0.08	0.4	0.05
Outfall-005	1	NA	0.06	NA
Outfall-006	21	0.2 ± 0.05	0.4	0.12
Pantex Lake	3	0.3 ± 0.1	0.4	0.17
Playa #1	16	0.2 ± 0.06	0.3	0.1
Playa #2	5	0.2 ± 0.07	0.3	0.14
Playa #4	1	NA	0.1	NA
WWTF Autosampler	91	0.14 ± 0.05	0.48	0.12
WWTF Incoming	16	0.1 ± 0.02	0.2	0.1
WWTF Lagoon	15	0.1 ± 0.009	0.2	0.12
WWTF Outfall-001	17	0.1 ± 0.009	0.2	0.12
Zone 4-E	5	0.3 ± 0.2	0.4	0.12
Zone 11-SE	2	0.1 ± 0.02	0.2	0.12
Zone 11-SW	2	0.09 ± 0.01	0.1	0.08
Beryllium				
Bushland	6	0.008 ± 0.008	*	*
Tailwater pit	4	0.004 ± 0.001	0.002	0
Outfall-002	9	0.003 ± 0.002	*	*
Outfall-003	15	0.004 ± 0.006	*	*
Outfall-004	12	0.003 ± 0.002	*	*
Outfall-005	1	NA	*	NA

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Beryllium (cont'd)				
Outfall-006	21	0.004 ± 0.002	0.001	0.001
Pantex Lake	3	0.003 ± 0.002	*	*
Playa #1	16	0.003 ± 0.002	*	*
Playa #2	5	0.003 ± 0.002	*	*
Playa #4	1	NA	*	NA
WWTF Autosampler	91	0.003 ± 0.004	0.005	0.001
WWTF Incoming	16	0.003 ± 0.002	*	*
WWTF Lagoon	15	0.003 ± 0.002	*	*
WWTF Outfall-001	17	0.003 ± 0.002	*	*
Zone 4-E	5	0.007 ± 0.010	0.001	0.001
Zone 11-SE	2	0.005 ± 0	*	*
Zone 11-SW	2	0.005 ± 0	*	*
Boron				
Bushland	6	0.075 ± 0.04	0.1	0.05
Tailwater pit	4	0.09 ± 0.02	0.06	0.06
Outfall-002	9	0.2 ± 0.08	0.3	0.1
Outfall-003	15	0.16 ± 0.02	0.2	0.06
Outfall-004	12	0.2 ± 0.2	0.1	0.08
Outfall-005	1	NA	*	NA
Outfall-006	21	0.19 ± 0.3	0.2	0.06
Pantex Lake	3	0.09 ± 0.005	0.09	0.09
Playa #1	16	0.2 ± 0.06	0.3	0.19
Playa #2	5	0.2 ± 0.05	0.2	0.13
Playa #4	1	NA	*	NA
WWTF Autosampler	91	0.2 ± 0.1	0.3	0.17
WWTF Incoming	16	0.2 ± 0.05	0.3	0.02
WWTF Lagoon	15	0.2 ± 0.03	0.3	0.2
WWTF Outfall-001	17	0.2 ± 0.04	0.3	0.19
Zone 4-E	5	0.2 ± 0.4	0.1	0.05
Zone 11-SE	2	0.2 ± 0.2	0.4	0.4
Zone 11-SW	2	0.10 ± 0.004	0.1	0.1
Cadmium				
Bushland	6	0.0043 ± 0.001	*	*
Tailwater pit	4	0.004 ± 0.002	*	*
Outfall-002	9	0.004 ± 0.002	*	*
Outfall-003	15	0.003 ± 0.002	*	*
Outfall-004	12	0.004 ± 0.002	0.001	0.001
Outfall-005	1	NA	*	NA
Outfall-006	21	0.004 ± 0.001	*	*
Pantex Lake	3	0.004 ± 0.001	*	*
Playa #1	16	0.004 ± 0.001	*	*

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Cadmium (cont'd)				
Playa #2	5	0.004 ± 0.001	*	*
Playa #4	1	NA	*	NA
WWTF Autosampler	91	0.003 ± 0.002	0.005	0.001
WWTF Incoming	16	0.004 ± 0.0009	0.004	0.003
WWTF Lagoon	15	0.004 ± 0.0009	*	*
WWTF Outfall-001	17	0.004 ± 0.001	*	*
Zone 4-E	5	0.003 ± 0.002	*	*
Zone 11-SE	2	0.005 ± 0	*	*
Zone 11-SW	2	0.005 ± 0	*	*
Calcium				
Bushland	6	39.7 ± 10.1	47.8	23
Tailwater pit	4	17.3 ± 4.4	22.3	12
Outfall-002	9	35.8 ± 19.5	87	23
Outfall-003	15	27.2 ± 11.4	53.8	15.2
Outfall-004	12	29.3 ± 15.5	73	12
Outfall-005	1	NA	16	NA
Outfall-006	21	41.3 ± 20.3	113	15
Pantex Lake	3	43.9 ± 3.4	47.6	41
Playa #1	16	43.3 ± 16.8	70.1	22
Playa #2	5	63.1 ± 17.8	77	33
Playa #4	1	NA	35	NA
WWTF Autosampler	91	47.1 ± 3.6	64.7	39
WWTF Incoming	16	40.6 ± 12.5	86.1	34
WWTF Lagoon	15	47.0 ± 2.2	49.7	43
WWTF Outfall-001	17	46.7 ± 2.1	49.2	43
Zone 4-E	5	41.9 ± 18.7	70	21
Zone 11-SE	2	32.0 ± 9.9	39	25
Zone 11-SW	2	32.5 ± 4.9	36	29
Chromium				
Bushland	6	0.009 ± 0.006	0.02	0.008
Tailwater pit	4	0.03 ± 0.01	0.04	0.01
Outfall-002	9	0.01 ± 0.01	0.04	0.004
Outfall-003	15	0.005 ± 0.002	0.008	0.002
Outfall-004	12	0.006 ± 0.006	0.02	0.002
Outfall-005	1	NA	0.005	NA
Outfall-006	21	0.007 ± 0.004	0.02	0.001
Pantex Lake	3	0.02 ± 0.01	0.03	0.005
Playa #1	16	0.006 ± 0.003	0.01	0.003
Playa #2	5	0.010 ± 0.006	0.02	0.005
Playa #4	1	NA	*	NA
WWTF Autosampler	89	0.004 ± 0.002	0.01	0.001

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Chromium (cont'd)				
WWTF Incoming	16	0.03 ± 0.08	0.3	0.005
WWTF Lagoon	15	0.005 ± 0.001	0.007	0.003
WWTF Outfall-001	17	0.004 ± 0.001	0.008	0.002
Zone 4-E	5	0.01 ± 0.006	0.02	0.002
Zone 11-SE	2	0.02 ± 0.03	0.04	0.005
Zone 11-SW	2	0.005 ± 0	*	*
Cobalt				
Bushland	6	0.012 ± 0.017	0.005	0.005
Tailwater pit	4	0.01 ± 0.004	0.02	0.005
Outfall-002	9	0.004 ± 0.004	0.01	0.001
Outfall-003	15	0.006 ± 0.01	0.002	0.002
Outfall-004	12	0.008 ± 0.01	0.01	0.001
Outfall-005	1	NA	*	NA
Outfall-006	21	0.009 ± 0.01	0.006	0.002
Pantex Lake	3	0.008 ± 0.007	0.02	0.002
Playa #1	16	0.004 ± 0.0007	0.005	0.003
Playa #2	5	0.005 ± 0.002	0.008	0.004
Playa #4	1	NA	*	NA
WWTF Autosampler	88	0.006 ± 0.009	0.05	0.001
WWTF Incoming	14	0.005 ± 0.001	0.006	0.006
WWTF Lagoon	14	0.004 ± 0.001	0.002	0.002
WWTF Outfall-001	16	0.004 ± 0.002	0.002	0.002
Zone 4-E	5	0.01 ± 0.02	0.01	0.002
Zone 11-SE	2	0.005 ± 0	*	*
Zone 11-SW	2	0.005 ± 0	*	*
Copper				
Bushland	6	0.016 ± 0.01	0.04	0.008
Tailwater pit	4	0.02 ± 0.009	0.03	0.008
Outfall-002	9	0.009 ± 0.008	0.03	0.005
Outfall-003	15	0.006 ± 0.002	0.01	0.003
Outfall-004	12	0.009 ± 0.006	0.02	0.005
Outfall-005	1	NA	*	NA
Outfall-006	21	0.01 ± 0.02	0.1	0.005
Pantex Lake	3	0.02 ± 0.007	0.02	0.008
Playa #1	16	0.007 ± 0.003	0.01	0.005
Playa #2	5	0.01 ± 0.004	0.02	0.006
Playa #4	1	NA	*	NA
WWTF Autosampler	91	0.01 ± 0.006	0.03	0.005
WWTF Incoming	16	0.8 ± 3.2	13	0.01
WWTF Lagoon	15	0.01 ± 0.003	0.02	0.005
WWTF Outfall-001	17	0.009 ± 0.004	0.02	0.005

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Copper (cont'd)				
Zone 4-E	5	0.01 ± 0.001	0.01	0.01
Zone 11-SE	2	0.005 ± 0.0009	0.006	0.006
Zone 11-SW	2	0.005 ± 0.0002	0.005	0.005
Iron				
Bushland	6	6.4 ± 6.7	15.4	0.33
Tailwater pit	4	24.3 ± 12.0	37	12
Outfall-002	9	5.2 ± 9.1	29	0.42
Outfall-003	15	0.95 ± 1.0	4.1	0.03
Outfall-004	12	2.86 ± 5.2	19	0.22
Outfall-005	1	NA	1.2	NA
Outfall-006	21	3.3 ± 3.5	11	0.13
Pantex Lake	3	13.1 ± 10.1	22	2.16
Playa #1	16	2.5 ± 3.3	11	0.51
Playa #2	5	6.8 ± 3.6	11	2.91
Playa #4	1	NA	1.3	NA
WWTF Autosampler	91	0.2 ± 0.1	0.6	0.05
WWTF Incoming	16	0.7 ± 1.8	7.6	0.08
WWTF Lagoon	15	0.1 ± 0.04	0.2	0.06
WWTF Outfall-001	17	0.2 ± 0.1	0.6	0.06
Zone 4-E	5	7.9 ± 4.4	14	1.63
Zone 11-SE	2	1.9 ± 0.6	2.3	1.4
Zone 11-SW	2	0.9 ± 0.1	10	0.79
Lead				
Bushland	6	0.01 ± 0.005	0.02	0.007
Tailwater pit	4	0.02 ± 0.008	0.02	0.006
Outfall-002	9	0.03 ± 0.08	0.2	0.002
Outfall-003	14	0.005 ± 0.004	0.02	0.001
Outfall-004	12	0.005 ± 0.004	0.02	0.002
Outfall-005	1	NA	*	NA
Outfall-006	20	0.005 ± 0.002	0.01	0.005
Pantex Lake	3	0.01 ± 0.008	0.02	0.003
Playa #1	16	0.004 ± 0.001	0.005	0.002
Playa #2	5	0.007 ± 0.001	0.008	0.006
Playa #4	1	NA	*	NA
WWTF Autosampler	90	0.004 ± 0.001	0.006	0.001
WWTF Incoming	16	0.006 ± 0.006	0.03	0.003
WWTF Lagoon	15	0.004 ± 0.002	0.005	0.002
WWTF Outfall-001	17	0.004 ± 0.002	0.007	0.002
Zone 4-E	5	0.009 ± 0.007	0.02	0.003
Zone 11-SE	2	0.005 ± 0	*	*
Zone 11-SW	2	0.005 ± 0	*	*

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Magnesium				
Bushland	6	7.2 ± 1.5	9	6.31
Tailwater pit	4	8.8 ± 2.8	12	5.2
Outfall-002	9	4.8 ± 2.4	11	2.7
Outfall-003	15	5.7 ± 5.1	20.1	2.4
Outfall-004	12	4.0 ± 2.0	9.8	1.85
Outfall-005	1	NA	2	NA
Outfall-006	21	10.4 ± 8.5	24.8	3.35
Pantex Lake	3	16.8 ± 4.1	21.5	14
Playa #1	16	21.4 ± 10.6	36.6	6.2
Playa #2	5	7.51 ± 2.0	9.7	4.9
Playa #4	1	NA	3.4	NA
WWTF Autosampler	91	28.7 ± 2.4	39.9	22
WWTF Incoming	16	22.9 ± 2.1	28	20
WWTF Lagoon	15	28.4 ± 1.3	30.3	26
WWTF Outfall-001	17	29.3 ± 4.9	47.4	26
Zone 4-E	5	5.6 ± 1.3	7.1	4.1
Zone 11-SE	2	2.7 ± 0.6	3.1	2.3
Zone 11-SW	2	4.4 ± 2.0	5.8	3
Manganese				
Bushland	6	0.2 ± 0.1	0.2	0.01
Tailwater pit	4	0.5 ± 0.2	0.7	0.17
Outfall-002	9	0.1 ± 0.2	0.6	0.01
Outfall-003	15	0.02 ± 0.02	0.09	0.004
Outfall-004	12	0.08 ± 0.2	0.6	0.02
Outfall-005	1	NA	0.02	NA
Outfall-006	21	0.1 ± 0.1	0.6	0.008
Pantex Lake	3	0.7 ± 0.5	1.1	0.1
Playa #1	16	0.2 ± 0.1	0.4	0.07
Playa #2	5	0.2 ± 0.1	0.3	0.1
Playa #4	1	NA	0.02	NA
WWTF Autosampler	91	0.01 ± 0.01	0.1	0.005
WWTF Incoming	16	0.02 ± 0.03	0.1	0.006
WWTF Lagoon	15	0.01 ± 0.001	0.01	0.008
WWTF Outfall-001	17	0.03 ± 0.09	0.4	0.008
Zone 4-E	5	0.3 ± 0.2	0.6	0.11
Zone 11-SE	2	0.05 ± 0.04	0.08	0.02
Zone 11-SW	2	0.03 ± 0.007	0.03	0.02
Mercury				
Bushland	6	0.0001 ± 0.00004	*	*
Tailwater pit	4	0.0002 ± 0.0002	0.0005	0.0005
Outfall-002	7	0.00010 ± 0	*	*

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Mercury (cont'd)				
Outfall-003	12	0.0001 ± 0.00009	0.0004	0.0001
Outfall-004	10	0.0001 ± 0.00003	*	*
Outfall-005	1	NA	*	NA
Outfall-006	19	0.0001 ± 0.00003	*	*
Pantex Lake	3	0.00010 ± 0	*	*
Playa #1	14	0.0001 ± 0.00002	0.0002	0.0002
Playa #2	5	0.00010 ± 0	*	*
Playa #4	1	NA	*	NA
WWTF Autosampler	79	0.0002 ± 0.0004	0.001	0.0001
WWTF Incoming	14	0.0001 ± 0.00005	0.0003	0.0003
WWTF Lagoon	12	0.0005 ± 0.001	*	*
WWTF Outfall-001	14	0.0001 ± 0.00004	0.0002	0.0002
Zone 4-E	4	0.0001 ± 0.00005	*	*
Zone 11-SE	2	0.00010 ± 0	*	*
Zone 11-SW	2	0.00010 ± 0	*	*
Molybdenum				
Bushland	6	0.2 ± 0.4	*	*
Tailwater pit	4	0.005 ± 0	*	*
Outfall-002	7	0.007 ± 0.002	0.01	0.005
Outfall-003	12	0.08 ± 0.3	0.006	0.006
Outfall-004	9	0.1 ± 0.3	*	*
Outfall-005	1	NA	*	NA
Outfall-006	19	0.1 ± 0.3	0.01	0.005
Pantex Lake	3	0.005 ± 0.0007	0.006	0.006
Playa #1	11	0.005 ± 0.00008	0.005	0.005
Playa #2	5	0.010 ± 0.006	0.02	0.007
Playa #4	1	NA	*	NA
WWTF Autosampler	63	0.07 ± 0.2	1	0.005
WWTF Incoming	11	0.007 ± 0.005	0.02	0.005
WWTF Lagoon	11	0.005 ± 0.0007	0.007	0.005
WWTF Outfall-001	12	0.005 ± 0.008	0.007	0.005
Zone 4-E	4	0.2 ± 0.5	*	*
Zone 11-SE	2	0.02 ± 0.02	0.04	0.04
Zone 11-SW	2	0.005 ± 0	*	*
Nickel				
Bushland	6	0.011 ± 0.004	0.02	0.01
Tailwater pit	4	0.02 ± 0.008	0.03	0.02
Outfall-002	9	0.009 ± 0.009	0.03	0.002
Outfall-003	15	0.006 ± 0.004	0.002	0.002
Outfall-004	12	0.01 ± 0.01	0.02	0.003
Outfall-005	1	NA	*	NA

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Nickel (cont'd)				
Outfall-006	21	0.01 ± 0.009	0.01	0.002
Pantex Lake	3	0.02 ± 0.01	0.03	0.005
Playa #1	16	0.009 ± 0.002	0.01	0.004
Playa #2	5	0.01 ± 0.006	0.02	0.009
Playa #4	1	NA	*	NA
WWTF Autosampler	91	0.008 ± 0.007	0.04	0.001
WWTF Incoming	16	0.02 ± 0.07	0.3	0.002
WWTF Lagoon	15	0.007 ± 0.004	0.002	0.002
WWTF Outfall-001	17	0.007 ± 0.004	0.01	0.001
Zone 4-E	5	0.01 ± 0.006	0.02	0.004
Zone 11-SE	2	0.010 ± 0	*	*
Zone 11-SW	2	0.010 ± 0	*	*
Potassium				
Bushland	6	19.8 ± 5.7	23.4	8.4
Tailwater pit	4	17.3 ± 5.6	22	11
Outfall-002	9	7.37 ± 3.6	14	6.3
Outfall-003	15	5.9 ± 1.3	8	3.28
Outfall-004	12	7.1 ± 3.5	13	2.7
Outfall-005	1	NA	7.6	NA
Outfall-006	21	7.3 ± 8.3	43	2.7
Pantex Lake	3	15.2 ± 4.3	20	11.6
Playa #1	16	18.9 ± 6.3	31.5	15.8
Playa #2	5	18.9 ± 4.5	23	12
Playa #4	1	NA	6.7	NA
WWTF Autosampler	91	10.4 ± 1.1	13.2	8.4
WWTF Incoming	16	10.6 ± 2.6	15	6.6
WWTF Lagoon	15	10.3 ± 1.1	12.5	8.8
WWTF Outfall-001	17	10.5 ± 2.4	19.4	8.2
Zone 4-E	5	7.9 ± 2.3	10	4.53
Zone 11-SE	2	9.5 ± 3.6	12	6.9
Zone 11-SW	2	8.8 ± 1.3	9.7	7.9
Selenium				
Bushland	6	0.005 ± 0	*	*
Tailwater pit	4	0.005 ± 0.003	*	*
Outfall-002	9	0.005 ± 0.0006	0.006	0.004
Outfall-003	14	0.007 ± 0.01	0.005	0.002
Outfall-004	12	0.004 ± 0.001	0.003	0.003
Outfall-005	1	NA	*	NA
Outfall-006	21	0.006 ± 0.006	0.03	0.005
Pantex Lake	3	0.004 ± 0.002	*	*
Playa #1	16	0.007 ± 0.01	0.01	0.01

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Selenium (cont'd)				
Playa #2	5	0.004 ± 0.002	*	*
Playa #4	1	NA	*	NA
WWTF Autosampler	91	0.004 ± 0.001	0.009	0.002
WWTF Incoming	16	0.004 ± 0.0008	0.003	0.003
WWTF Lagoon	15	0.004 ± 0.0010	0.003	0.002
WWTF Outfall-001	17	0.004 ± 0.001	0.003	0.002
Zone 4-E	5	0.004 ± 0.001	0.003	0.002
Zone 11-SE	2	0.008 ± 0.004	0.01	0.01
Zone 11-SW	2	0.005 ± 0	*	*
Silica				
Bushland	5	26.1 ± 18.6	53	9.7
Tailwater pit	4	48.8 ± 12.4	65	35
Outfall-002	9	16.6 ± 17.8	62	6.83
Outfall-003	14	9.5 ± 3.8	16.4	5.45
Outfall-004	11	13.6 ± 14.4	56	4.62
Outfall-005	1	NA	8.7	NA
Outfall-006	19	15.6 ± 7.7	38	5.6
Pantex Lake	3	39.8 ± 17.2	53	20.3
Playa #1	16	8.1 ± 7.9	31.6	1.8
Playa #2	5	25.9 ± 13.7	41	12.6
Playa #4	1	NA	12	NA
WWTF Autosampler	86	17.6 ± 14.7	147	4.1
WWTF Incoming	16	16.6 ± 4.0	19.6	2.8
WWTF Lagoon	15	16.3 ± 2.5	19.7	12.9
WWTF Outfall-001	17	16.6 ± 2.2	19.6	12
Zone 4-E	4	23.4 ± 10.3	34	9.25
Zone 11-SE	2	10.1 ± 2.8	12	8.1
Zone 11-SW	2	9.9 ± 3.0	12	7.7
Silver				
Bushland	6	0.005 ± 0	*	*
Tailwater pit	4	0.004 ± 0.002	*	*
Outfall-002	9	0.004 ± 0.001	*	*
Outfall-003	15	0.003 ± 0.002	0.001	0.001
Outfall-004	12	0.004 ± 0.002	*	*
Outfall-005	1	NA	*	NA
Outfall-006	21	0.004 ± 0.002	0.001	0.001
Pantex Lake	3	0.003 ± 0.002	*	*
Playa #1	16	0.004 ± 0.001	0.005	0.005
Playa #2	5	0.003 ± 0.002	*	*
Playa #4	1	NA	*	NA
WWTF Autosampler	91	0.004 ± 0.003	0.02	0.0002

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Silver (cont'd)				
WWTF Incoming	16	0.01 ± 0.03	0.1	0.002
WWTF Lagoon	15	0.01 ± 0.04	0.16	0.002
WWTF Outfall-001	17	0.006 ± 0.009	0.04	0.002
Zone 4-E	5	0.004 ± 0.002	*	*
Zone 11-SE	2	0.005 ± 0	*	*
Zone 11-SW	2	0.005 ± 0	*	*
Sodium				
Bushland	6	5.7 ± 9.5	25	1.7
Tailwater pit	4	2.4 ± 1.1	3.7	1.2
Outfall-002	9	6.7 ± 4.1	10.9	2.9
Outfall-003	15	7.7 ± 9.3	30.6	1.3
Outfall-004	12	2.7 ± 1.3	4.2	0.9
Outfall-005	1	NA	0.3	NA
Outfall-006	21	11.7 ± 12.9	33.5	1
Pantex Lake	3	12.6 ± 4.2	17.1	8.7
Playa #1	16	73.9 ± 60.2	183	0.2
Playa #2	5	5.4 ± 1.9	6.4	2
Playa #4	1	NA	1.9	NA
WWTF Autosampler	91	125.9 ± 27.7	189	13.1
WWTF Incoming	15	73.9 ± 20.3	134	51
WWTF Lagoon	14	125.3 ± 21.5	167	98
WWTF Outfall-001	15	117.8 ± 38.0	166	94
Zone 4-E	5	3.5 ± 0.9	4.1	2.7
Zone 11-SE	2	8.0 ± 9.9	15	1
Zone 11-SW	2	5.4 ± 5.0	8.9	1.8
Strontium				
Bushland	6	0.2 ± 0.04	0.17	0.07
Tailwater pit	4	0.13 ± 0.03	0.2	0.1
Outfall-002	9	0.2 ± 0.04	0.3	0.11
Outfall-003	15	0.3 ± 0.3	0.7	0.09
Outfall-004	12	0.2 ± 0.2	0.2	0.07
Outfall-005	1	NA	0.07	NA
Outfall-006	21	0.4 ± 0.3	0.9	0.12
Pantex Lake	3	0.4 ± 0.2	0.6	0.29
Playa #1	16	0.7 ± 0.3	1.2	0.25
Playa #2	5	0.2 ± 0.06	0.3	0.14
Playa #4	1	NA	0.2	NA
WWTF Autosampler	91	1.1 ± 0.1	1.5	0.21
WWTF Incoming	16	0.9 ± 0.2	1.7	0.73
WWTF Lagoon	15	1.1 ± 0.1	1.2	0.98
WWTF Outfall-001	17	1.1 ± 0.008	1.2	0.94

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Strontium (cont'd)				
Zone 4-E	5	0.16 ± 0.2	0.2	0.12
Zone 11-SE	2	0.1 ± 0	0.1	0.1
Zone 11-SW	2	0.2 ± 0.05	0.2	0.13
Thallium				
Bushland	6	0.2 ± 0.2	*	*
Tailwater pit	4	0.1 ± 0.04	*	*
Outfall-002	9	0.6 ± 1.5	4.7	0.007
Outfall-003	15	0.07 ± 0.04	0.1	0.01
Outfall-004	12	0.07 ± 0.04	0.01	0.007
Outfall-005	1	NA	*	NA
Outfall-006	21	0.07 ± 0.04	0.1	0.01
Pantex Lake	3	0.1 ± 0.06	0.2	0.2
Playa #1	16	0.07 ± 0.03	0.1	0.1
Playa #2	5	0.2 ± 0.09	0.3	0.2
Playa #4	1	NA	*	NA
WWTF Autosampler	91	0.06 ± 0.04	0.1	0.01
WWTF Incoming	15	0.1 ± 0.04	*	*
WWTF Lagoon	14	0.08 ± 0.03	*	*
WWTF Outfall-001	16	0.08 ± 0.08	0.3	0.2
Zone 4-E	5	0.06 ± 0.06	0.008	0.008
Zone 11-SE	2	0.1 ± 0	*	*
Zone 11-SW	2	0.1 ± 0	*	*
Tin				
Bushland	6	0.04 ± 0.03	*	*
Tailwater pit	4	0.03 ± 0.006	0.04	0.04
Outfall-002	7	0.04 ± 0.04	0.1	0.12
Outfall-003	12	0.03 ± 0.02	0.03	0.02
Outfall-004	9	0.1 ± 0.3	0.03	0.03
Outfall-005	1	NA	*	NA
Outfall-006	19	0.1 ± 0.3	0.03	0.03
Pantex Lake	3	0.03 ± 0.005	*	*
Playa #1	11	0.03 ± 0.003	*	*
Playa #2	5	0.02 ± 0.005	*	*
Playa #4	1	NA	*	NA
WWTF Autosampler	66	0.08 ± 0.2	1	0.03
WWTF Incoming	11	0.03 ± 0.007	0.05	0.05
WWTF Lagoon	11	0.03 ± 0.007	0.05	0.05
WWTF Outfall-001	12	0.03 ± 0.005	0.04	0.03
Zone 4-E	4	0.05 ± 0.03	0.03	0.03
Zone 11-SE	2	0.03 ± 0	*	*
Zone 11-SW	2	0.03 ± 0	*	*

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Titanium				
Bushland	6	0.13 ± 0.12	0.3	0.01
Tailwater pit	4	0.4 ± 0.1	0.6	0.28
Outfall-002	7	0.1 ± 0.2	0.5	0.009
Outfall-003	13	0.03 ± 0.03	0.1	0.008
Outfall-004	9	0.2 ± 0.3	0.4	0.01
Outfall-005	1	NA	0.03	NA
Outfall-006	19	0.2 ± 0.3	0.3	0.02
Pantex Lake	3	0.2 ± 0.2	0.4	0.06
Playa #1	13	0.08 ± 0.1	0.3	0.01
Playa #2	5	0.2 ± 0.07	0.2	0.09
Playa #4	1	NA	0.03	NA
WWTF Autosampler	67	0.05 ± 0.2	1	0.01
WWTF Incoming	12	0.009 ± 0.004	0.01	0.01
WWTF Lagoon	12	0.008 ± 0.005	*	*
WWTF Outfall-001	13	0.008 ± 0.005	*	*
Zone 4-E	4	0.2 ± 0.1	0.4	0.21
Zone 11-SE	2	0.1 ± 0.01	0.1	0.04
Zone 11-SW	2	0.02 ± 0	0.02	0.02
Vanadium				
Bushland	6	0.03 ± 0.010	0.04	0.02
Tailwater pit	4	0.06 ± 0.02	0.08	0.04
Outfall-002	9	0.02 ± 0.02	0.08	0.01
Outfall-003	15	0.01 ± 0.01	0.02	0.004
Outfall-004	12	0.02 ± 0.02	0.06	0.005
Outfall-005	1	NA	0.01	NA
Outfall-006	21	0.03 ± 0.03	0.1	0.008
Pantex Lake	3	0.05 ± 0.03	0.07	0.01
Playa #1	16	0.02 ± 0.01	0.05	0.009
Playa #2	5	0.09 ± 0.1	0.3	0.03
Playa #4	1	NA	0.03	NA
WWTF Autosampler	91	0.02 ± 0.01	0.1	0.009
WWTF Incoming	16	0.02 ± 0.004	0.02	0.01
WWTF Lagoon	15	0.01 ± 0.004	0.02	0.01
WWTF Outfall-001	17	0.01 ± 0.003	0.02	0.009
Zone 4-E	5	0.03 ± 0.01	0.04	0.01
Zone 11-SE	2	0.01 ± 0	0.01	0.01
Zone 11-SW	2	0.01 ± 0.002	0.01	0.009
Zinc				
Bushland	6	0.07 ± 0.06	0.2	0.02
Tailwater pit	4	0.1 ± 0.04	0.1	0.06
Outfall-002	9	0.03 ± 0.03	0.1	0.009

Table 11.7 Summary of 1994 Concentrations of Total Metals in Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Zinc (cont'd)				
Outfall-003	15	0.02 ± 0.02	0.08	0.003
Outfall-004	12	0.03 ± 0.03	0.1	0.008
Outfall-005	1	NA	0.01	NA
Outfall-006	21	0.05 ± 0.04	0.1	0.005
Pantex Lake	3	0.05 ± 0.04	0.09	0.01
Playa #1	16	0.02 ± 0.02	0.08	0.006
Playa #2	5	0.04 ± 0.02	0.06	0.02
Playa #4	1	NA	0.01	NA
WWTF Autosampler	91	0.03 ± 0.01	0.08	0.01
WWTF Incoming	16	0.09 ± 0.2	0.7	0.002
WWTF Lagoon	15	0.03 ± 0.01	0.06	0.01
WWTF Outfall-001	17	0.02 ± 0.006	0.03	0.007
Zone 4-E	5	0.06 ± 0.03	0.09	0.02
Zone 11-SE	2	0.02 ± 0	0.02	0.02
Zone 11-SW	2	0.015 ± 0.0007	0.02	0.01

[1]NA indicates not applicable.
[2]Asterisks (*) indicate all samples were below detection limits. Detection limits varied throughout the year.

in the south end of Zone 12. In March, methylene chloride (0.006 mg/L) was detected near the detection limit of 0.005 mg/L. Constituents were below TNRCC MCLs or, if none were available, within historical limits.

Zone 11 Southwest Ditch. When flow occurs, it is discharged into Playa #4. Building 11-36 discharges small quantities of steam condensate to this ditch. Flow sufficient for sampling occurs only during storms. Constituents were below TNRCC MCLs or, if none were available, within historical limits.

Zone 11 Southeast Ditch. This location receives stormwater from the south end of Zone 11; no industrial sources affect flow. In July, the explosive octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX) was detected (0.051 mg/L). No other explosive components were detected during the year. Other constituents were below TNRCC MCLs or, if none were available, within historical limits.

11.2.1.5 Pantex Lake

Discharges to Pantex Lake were discontinued several years ago. Monitoring is conducted because of past wastewater discharge to this playa. The area surrounding Pantex Lake is used for agricultural purposes, and currently stormwater is the only contributor to water in the playa. The explosive hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) was detected in May at the detection limit of 0.014 mg/L. Constituents were below TNRCC MCLs or, if none were available, within historical limits.

11.2.1.6 Bushland Playa

Bushland playa contained water in August, September, November, and December. No volatile organic compounds, semivolatile organic compounds, explosives, pesticides, herbicides, or PCBs were detected. The results of other analyses were within established historical levels.

Table 11.8 Summary of Results for Miscellaneous Water Quality Parameters for Surface Water, in mg/L

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Ammonia				
Bushland	6	0.18 ± 0.04	0.2	0.1
Tailwater pit	0	*[1]	*	*
Outfall 002	2	0.19 ± 0	0.19	0.19
Outfall 003	4	0.17 ± 0.05	0.19	0.1
Outfall 004	4	0.38 ± 0.26	1.2	0.475
Outfall 005	1	NA[2]	0.19	NA
Outfall 006	6	0.31 ± 0.34	1	0.095
Pantex Lake	2	0.25 ± 0.08	0.3	0.19
Playa #1	10	0.42 ± 0.54	1.5	0.095
Playa #2	3	0.19 ± 0	0.19	0.19
Playa #4	1	NA	0.19	NA
WWTF Incoming	15	7.93 ± 3.78	12.5	1.3
WWTF Lagoon	10	2.88 ± 1.63	5.4	0.19
WWTF Outfall 001	10	2.69 ± 1.62	5.6	0.3
Zone 4-E	2	0.19 ± 0	0.19	0.19
Zone 11-SE	2	0.19 ± 0	0.19	0.19
Zone 11-SW	2	0.19 ± 0	0.19	0.19
Biological oxygen demand (5-day)				
Bushland	5	11.8 ± 6.98	21	5
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	0	*	*	*
Outfall 004	0	*	*	*
Outfall 005	0	*	*	*
Outfall 006	2	7.50 ± 2.12	9	6
Pantex Lake	3	16.67 ± 12.50	31	8
Playa #1	13	12.85 ± 9.79	32	4
Playa #2	5	13 ± 4.69	17	5
Playa #4	1	NA	5	NA
WWTF Incoming	80	45 ± 28.29	152	6
WWTF Lagoon	82	17.84 ± 6.24	45	7
WWTF Outfall 001	97	11.15 ± 6.63	29	2
Zone 4-E	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*
Bromide				
Bushland	6	0.61 ± 0.51	1.3	0.09
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	0	*	*	*
Outfall 004	0	*	*	*
Outfall 005	0	*	*	*
Outfall 006	0	*	*	*
Pantex Lake	2	1.43 ± 0.67	1.9	0.95

Table 11.8 Summary of Results for Miscellaneous Water Quality Parameters for Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Bromide (cont'd)				
Playa #1	15	0.90 ± 0.73	2.1	0.09
Playa #2	2	1.42 ± 0.67	1.9	0.95
Playa #4	1	NA	0.95	NA
WWTF Incoming	0	*	*	*
WWTF Lagoon	0	*	*	*
WWTF Outfall 001	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*
Zone 4-E	0	*	*	*
Chloride				
Bushland	6	4.50 ± 1.38	7	3
Tailwater pit	0	*	*	*
Outfall 002	3	3.33 ± 0.84	4.3	2.85
Outfall 003	6	4.22 ± 1.61	6.3	2.85
Outfall 004	4	3.65 ± 1.03	5	2.85
Outfall 005	1	NA	2.85	NA
Outfall 006	7	4.16 ± 3.33	11.7	2.6
Pantex Lake	2	17 ± 11.31	25	9
Playa #1	15	100.60 ± 84.09	270	16
Playa #2	3	11.95 ± 7.89	17	2.85
Playa #4	1	NA	2.85	NA
WWTF Incoming	11	33.31 ± 8.11	51.8	23
WWTF Lagoon	9	162.22 ± 29.10	206	117
WWTF Outfall 001	7	154 ± 32.48	206	115
Zone 4-E	4	3.64 ± 0.98	5	2.85
Zone 11-SE	1	NA	3	NA
Zone 11-SW	2	3.43 ± 0.81	4	2.85
Chromium, hexavalent				
Bushland	3	0.02 ± 0.003	0.02	0.01
Tailwater pit	0	*	*	*
Outfall 002	1	NA	0.01	NA
Outfall 003	2	NA	0.008	NA
Outfall 004	1	NA	0.004	NA
Outfall 005	0	*	*	*
Outfall 006	1	NA	0.004	NA
Pantex Lake	1	NA	0.02	NA
Playa #1	7	0.008 ± 0.006	0.02	0.0009
Playa #2	2	0.007 ± 0.002	0.009	0.006
Playa #4	0	*	*	*
WWTF Incoming	6	0.009 ± 0.01	0.03	0.0009
WWTF Lagoon	6	0.01 ± 007	0.02	0.0009
WWTF Outfall 001	4	0.01 ± 0.01	0.03	0.009
Zone 4-E	1	NA	0.005	NA
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*

Table 11.8 Summary of Results for Miscellaneous Water Quality Parameters for Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Chemical oxygen demand				
Bushland	3	67 ± 52.03	120	16
Tailwater pit	0	*	*	*
Outfall 002	9	22.89 ± 6.57	37	17
Outfall 003	16	18.75 ± 11.77	41	0
Outfall 004	12	25.75 ± 12.09	48	1
Outfall 005	2	46 ± 18.38	59	33
Outfall 006	19	10.79 ± 11.18	42	0
Pantex Lake	3	22.67 ± 17.50	40	5
Playa #1	11	42.82 ± 32.74	94	1
Playa #2	5	40 ± 22.84	63	10
Playa #4	1	NA	10	NA
WWTF Incoming	104	36.95 ± 27.77	126	0
WWTF Lagoon	114	54.03 ± 24.42	128	2
WWTF Outfall 001	116	47.08 ± 17.06	88	8
Zone 4-E	8	17.50 ± 14.86	38	0
Zone 11-SE	3	39 ± 40.15	11	85
Zone 11-SW	3	27.33 ± 7.51	35	20
Cyanide				
Bushland	4	0.006 ± 0.002	0.01	0.005
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	0	*	*	*
Outfall 004	0	*	*	*
Outfall 005	0	*	*	*
Outfall 006	0	*	*	*
Pantex Lake	2	0.008 ± 0.005	0.01	0.005
Playa #1	13	0.006 ± 0.002	0.009	0.005
Playa #2	3	0.005 ± 0	0.005	0.005
Playa #4	1	NA	0.004	NA
WWTF Incoming	0	*	*	*
WWTF Lagoon	0	*	*	*
WWTF Outfall 001	0	*	*	*
Zone 4-E	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*
Fluoride				
Bushland	6	0.50 ± 0.05	0.6	0.48
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	0	*	*	*
Outfall 004	0	*	*	*
Outfall 005	0	*	*	*
Outfall 006	0	*	*	*
Pantex Lake	2	0.70 ± 0	0.7	0.7

Table 11.8 Summary of Results for Miscellaneous Water Quality Parameters for Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Fluoride (cont'd)				
Playa #1	12	1.18 ± 0.59	2.4	0.48
Playa #2	3	0.56 ± 0.07	0.6	0.48
Playa #4	1	NA	0.48	NA
WWTF Incoming	0	*	*	*
WWTF Lagoon	0	*	*	*
WWTF Outfall 001	0	*	*	*
Zone 4-E	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*
Laboratory pH (pH units)				
Bushland	4	7.94 ± 0.79	8.8	6.9
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	1	NA	8.3	NA
Outfall 004	1	NA	8.3	NA
Outfall 005	0	*	*	*
Outfall 006	1	NA	8.5	NA
Pantex Lake	4	8.35 ± 0.58	9.2	7.9
Playa #1	96	8.77 ± 0.72	10.1	7.2
Playa #2	3	7.73 ± 0.32	8.1	7.5
Playa #4	1	NA	7.9	NA
WWTF Incoming	20	7.90 ± 0.24	8.3	7.2
WWTF Lagoon	21	8.86 ± 0.14	9.2	8.7
WWTF Outfall 001	23	7.95 ± 0.60	9	7.1
Zone 4-E	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*
Nitrate				
Bushland	5	0.50 ± 0.34	0.89	0.05
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	0	*	*	*
Outfall 004	0	*	*	*
Outfall 005	0	*	*	*
Outfall 006	0	*	*	*
Pantex Lake	2	2.55 ± 3.40	4.95	0.15
Playa #1	12	0.24 ± 0.20	0.72	0.03
Playa #2	3	0.37 ± 0.15	0.5	0.21
Playa #4	1	NA	0.01	NA
WWTF Incoming	0	*	*	*
WWTF Lagoon	0	*	*	*
WWTF Outfall 001	0	*	*	*
Zone 4-E	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*

Table 11.8 Summary of Results for Miscellaneous Water Quality Parameters for Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Nitrite				
Bushland	5	0.15 ± 0.20	0.49	0.009
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	0	*	*	*
Outfall 004	0	*	*	*
Outfall 005	0	*	*	*
Outfall 006	0	*	*	*
Pantex Lake	2	0.81 ± 0.39	1.08	0.53
Playa #1	12	0.08 ± 0.17	0.62	0.005
Playa #2	3	0.21 ± 0.04	0.24	0.16
Playa #4	1	NA	0.03	NA
WWTF Incoming	0	*	*	*
WWTF Lagoon	0	*	*	*
WWTF Outfall 001	0	*	*	*
Zone 4-E	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*
Oil and grease				
Bushland	6	2.32 ± 1.88	6	0.95
Tailwater pit	0	*	*	*
Outfall 002	3	0.79 ± 0.27	0.95	0.475
Outfall 003	6	0.77 ± 0.21	0.95	0.475
Outfall 004	5	0.91 ± 0.26	1.2	0.48
Outfall 005	1	NA	0.95	NA
Outfall 006	7	0.86 ± 0.15	0.95	0.6
Pantex Lake	2	0.95 ± 0	0.95	0.95
Playa #1	13	2.36 ± 3.77	14	0.48
Playa #2	3	0.95 ± 0	0.95	0.95
Playa #4	1	NA	0.95	NA
WWTF Incoming	13	24.38 ± 41.64	160	2
WWTF Lagoon	12	1.65 ± 1.42	4	0.7
WWTF Outfall 001	13	1.20 ± 1.15	5	0.6
Zone 4-E	4	0.71 ± 0.27	0.95	0.475
Zone 11-SE	1	NA	0.95	NA
Zone 11-SW	2	0.95 ± 0	0.95	0.95
Phenol				
Bushland	5	0.02 ± 0.01	0.03	0.005
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	0	*	*	*
Outfall 004	0	*	*	*
Outfall 005	0	*	*	*
Outfall 006	0	*	*	*
Pantex Lake	2	0.03 ± 0.03	0.04	0.005

Table 11.8 Summary of Results for Miscellaneous Water Quality Parameters for Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Phenol, cont'd				
Playa #1	11	0.01 ± 0.14	0.05	0.005
Playa #2	3	0.005 ± 0	0.005	0.005
Playa #4	1	NA	0.005	NA
WWTF Incoming	0	*	*	*
WWTF Lagoon	0	*	*	*
WWTF Outfall 001	0	*	*	*
Zone 4-E	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*
Specific conductance (μmho/cm)				
Bushland	0	*	*	*
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	0	*	*	*
Outfall 004	0	*	*	*
Outfall 005	0	*	*	*
Outfall 006	0	*	*	*
Pantex Lake	0	*	*	*
Playa #1	2	827.50 ± 7.78	833	822
Playa #2	0	*	*	*
Playa #4	0	*	*	*
WWTF Incoming	0	*	*	*
WWTF Lagoon	0	*	*	*
WWTF Outfall 001	0	*	*	*
Zone 4-E	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*
Sulfate				
Bushland	6	6.46 ± 3.23	13	4.75
Tailwater pit	0	*	*	*
Outfall 002	3	8 ± 1	9	7
Outfall 003	7	4.50 ± 0.001	9.1	1.1
Outfall 004	5	5.42 ± 2.79	10	2.4
Outfall 005	1	NA	4.75	NA
Outfall 006	7	9.90 ± 7.94	26	2.6
Pantex Lake	2	11.50 ± 4.95	15	8
Playa #1	15	36.67 ± 29.94	80.2	4
Playa #2	3	5.92 ± 1.13	7	4.75
Playa #4	1	NA	4.75	NA
WWTF Incoming	14	32.06 ± 4.14	38.2	26
WWTF Lagoon	12	35.41 ± 3.15	43	31
WWTF Outfall 001	12	49.79 ± 10.67	63	32
Zone 4-E	4	3.71 ± 1.42	5	2
Zone 11-SE	2	22.38 ± 24.93	40	4.75
Zone 11-SW	2	9.88 ± 7.25	15	4.75

Table 11.8 Summary of Results for Miscellaneous Water Quality Parameters for Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Total dissolved solids				
Bushland	6	331.67 ± 70.83	420	250
Tailwater pit	0	*	*	*
Outfall 002	3	145.33 ± 28.38	176	120
Outfall 003	7	103.47 ± 48.52	160	5.3
Outfall 004	5	113.86 ± 68.64	180	7.3
Outfall 005	1	NA	94	NA
Outfall 006	7	130.51 ± 89.91	298	5.6
Pantex Lake	2	305 ± 35.36	330	280
Playa #1	15	470.40 ± 216.06	860	180
Playa #2	3	340 ± 78.10	390	250
Playa #4	1	NA	150	NA
WWTF Incoming	12	392.42 ± 67.83	544	280
WWTF Lagoon	11	575.09 ± 71.20	662	450
WWTF Outfall 001	12	595.75 ± 76.28	720	460
Zone 4-E	4	139.25 ± 29.23	168	99
Zone 11-SE	2	140 ± 42.43	170	110
Zone 11-SW	2	165 ± 35.36	190	140
Total suspended solids				
Bushland	6	280.33 ± 237.40	557	35
Tailwater pit	0	*	*	*
Outfall 002	2	19 ± 1.41	20	18
Outfall 003	6	23.50 ± 13.56	42	10
Outfall 004	5	55.47 ± 60.69	150	4.75
Outfall 005	1	NA	18	NA
Outfall 006	7	91 ± 58.74	190	6
Pantex Lake	2	465 ± 190.92	600	330
Playa #1	15	125.93 ± 70.36	240	40
Playa #2	3	191.67 ± 97	255	80
Playa #4	1	NA	30	NA
WWTF Incoming	14	64.21 ± 58.66	240	12
WWTF Lagoon	12	26.33 ± 8.18	40	16
WWTF Outfall 001	13	22.31 ± 10.10	46	6
Zone 4-E	3	220.33 ± 256.50	510	22
Zone 11-SE	2	26 ± 5.66	30	22
Zone 11-SW	2	13.38 ± 12.20	22	4.75
Total organic carbon				
Bushland	6	15.67 ± 9.75	31	9
Tailwater pit	0	*	*	*
Outfall 002	3	10.60 ± 1.22	12	9.8
Outfall 003	6	10.37 ± 2.95	15	7
Outfall 004	5	11.14 ± 4.96	16	4.8
Outfall 005	1	NA	13	NA
Outfall 006	7	6.10 ± 2.80	9	2
Pantex Lake	2	13 ± 0	13	13

Table 11.8 Summary of Results for Miscellaneous Water Quality Parameters for Surface Water, in mg/L (cont'd)

Location	No. of Samples	Mean ± Std. Dev.	Max	Min
Total organic carbon, cont'd				
Playa #1	15	13.62 ± 5.62	70	0.01
Playa #2	3	21.33 ± 8.08	26	12
Playa #4	1	NA	9	NA
WWTF Incoming	13	26.90 ± 18.08	74.5	6
WWTF Lagoon	12	8.72 ± 3.39	17	5
WWTF Outfall 001	14	8.93 ± 2.88	16	4
Zone 4-E	4	9.05 ± 3.54	14	5.9
Zone 11-SE	2	9 ± 1.41	10	8
Zone 11-SW	2	15 ± 4.24	18	12
Total organic halogen				
Bushland	6	9.34 ± 5.12	14	0.01
Tailwater pit	0	*	*	*
Outfall 002	0	*	*	*
Outfall 003	0	*	*	*
Outfall 004	0	*	*	*
Outfall 005	0	*	*	*
Outfall 006	0	*	*	*
Pantex Lake	2	20 ± 7.07	25	15
Playa #1	14	21.64 ± 21.12	70	0.01
Playa #2	3	18.67 ± 1.15	20	18
Playa #4	1	NA	12	NA
WWTF Incoming	0	*	*	*
WWTF Lagoon	0	*	*	*
WWTF Outfall 001	0	*	*	*
Zone 4-E	0	*	*	*
Zone 11-SE	0	*	*	*
Zone 11-SW	0	*	*	*

[1]Asterisks (*) indicate no analysis for analyte. Detection limits varied throughout the year.
[2]NA indicates not applicable.

11.2.2 Building Discharges

The locations of buildings associated with discharges are shown in Figure 11.2.

Building 12-17 North and South. Building 12-17 is located along the east side of Zone 12 and discharges rainwater and steam condensate that reach Playa #1 through Outfall 002. Process water was internally contained and none was discharged to the environment.

Building 12-19 North and South. Building 12-19 is located along the east side of Zone 12 and discharges steam condensate, noncontact cooling water, and rainwater to Playa #1 through Outfall 002. Process water was internally contained and none was discharged to the environment.

Building 12-43. Building 12-43 is the wastewater treatment facility for process water from Buildings 12-24 North and 12-78. Treat-

Table 11.9 Water Quality Results for the Wastewater Treatment Facility, in mg/L

Month	Average BOD[1]	Maximum COD[2]
January	7.7	45.0
February	9.8	51.0
March	20.8	66.0
April	22.2	88.0
May	15.3	68.0
June	16.8	77.0
July	15.0	58.0
August	13.0	45.0
September	7.0	41.0
October	5.8	35.0
November	5.9	51.0
December	7.6	63.0

1 Maximum BOD allowed is 50 mg/L.
2 Maximum COD allowed is 300 mg/L.

ment is a three-stage process. Stage 1, which occurs in the working bays, filters the water with a 1.0-micron filter. Stage 2 occurs at Building 12-43 and involves settling and refiltering with mechanical filters. In stage 3, water is passed through carbon absorption filters twice to remove dissolved materials. When treated water is released, it flows through Outfall 002 into Playa #1.

Building 12-24 North. All process water from Building 12-24 North is diverted to Building 12-43 for treatment. Rainfall runoff and noncontact cooling water are released to the ditch system. When flows occur, the water enters Playa #1 through Outfall 002.

Building 11-44. Discharge from Building 11-44 consists of steam condensate and rainfall waters that collect in the lined ditch system along the south and east sides of Buildings 11-20, 11-17, 11-18, and 11-49. No industrial waters are associated with this system. Water from this area enters Playa #1 through Outfall 003.

Building 11-50. Building 11-50 is used to process explosives, is located in the western portion of Zone 11, and has an internal treatment system for process water, similar to that at Building 12-43. The facility discharges treated process water, steam condensates, and rainfall runoff through Outfall 004 into Playa #2.

Building 11-36. Building 11-36 is located in the western portion of Zone 11. The only discharges during 1994 were steam condensates and rainwater. Water from process work is contained within a closed treatment system. The three-stage system filters the water before it is evaporated through an air-scrubber filtration system.

11.3 Data Summary for 1994

Results from 1994 surface water sampling confirm that Pantex Plant was in compliance with all regulations regarding discharge water quality. There were no exceedances of the TNRCC MCLs established by 30 TAC 319.22. With the exception of the high water level in Playa #1 in June, all the requirements of TNRCC Wastewater No-Discharge Permit No. 02296 were met.

Table 11.10 Pantex Plant 1994 Water and Wastewater Production, in liters per month (gallons per month)

Month	Plant Use	Texas Tech Use	Total Pumped	WWTF Discharge
January	58,238,040 (15,325,800)	141,360 (37,200)	58,379,400 (15,363,000)	32,395,380 (8,525,100)
February	58,769,660 (15,465,700)	127,680 (33,600)	58,897,340 (15,499,300)	31,710,620 (8,344,900)
March	65,741,983 (17,300,522)	12,928,276 (3,402,178)	78,670,260 (20,702,700)	24,762,700 (6,516,500)
April	62,491,273 (16,445,072)	47,505,806 (12,501,528)	109,997,080 (28,946,600)	31,743,680 (8,353,600)
May	73,415,639 (19,319,905)	16,273,481 (4,282,495)	89,677,720 (23,599,400)	47,459,340 (12,489,300)
June	60,776,839 (15,993,905)	8,770,761 (2,308,095)	69,547,600 (18,302,000)	47,447,560 (12,486,200)
July	54,162,084 (14,253,180)	23,351,456 (6,145,120)	77,513,540 (20,398,300)	49,398,100 (12,999,500)
August	57,657,286 (15,172,970)	22,963,894 (6,043,130)	80,621,180 (21,216,100)	49,591,140 (13,050,300)
September	53,792,230 (14,155,850)	154,850 (40,750)	53,947,080 (14,196,600)	43,297,960 (11,394,200)
October	56,497,032 (14,867,640)	161,348 (42,460)	56,658,380 (14,910,100)	45,412,660 (11,950,700)
November	52,130,832 (13,718,640)	159,448 (41,960)	52,290,280 (13,760,600)	39,615,760 (10,425,200)
December	53,911,892 (14,187,340)	305,748 (80,460)	54,217,640 (14,267,800)	35,500,740 (9,342,300)
TOTALS	707,573,391 (186,203,524)	132,844,109 (34,958,976)	840,417,500 (221,162,500)	478,335,640 (125,877,800)
Average per day	1,938,559 (510,147)	363,956 (95,778)	2,302,515 (605,925)	1,310,510 (344,871)

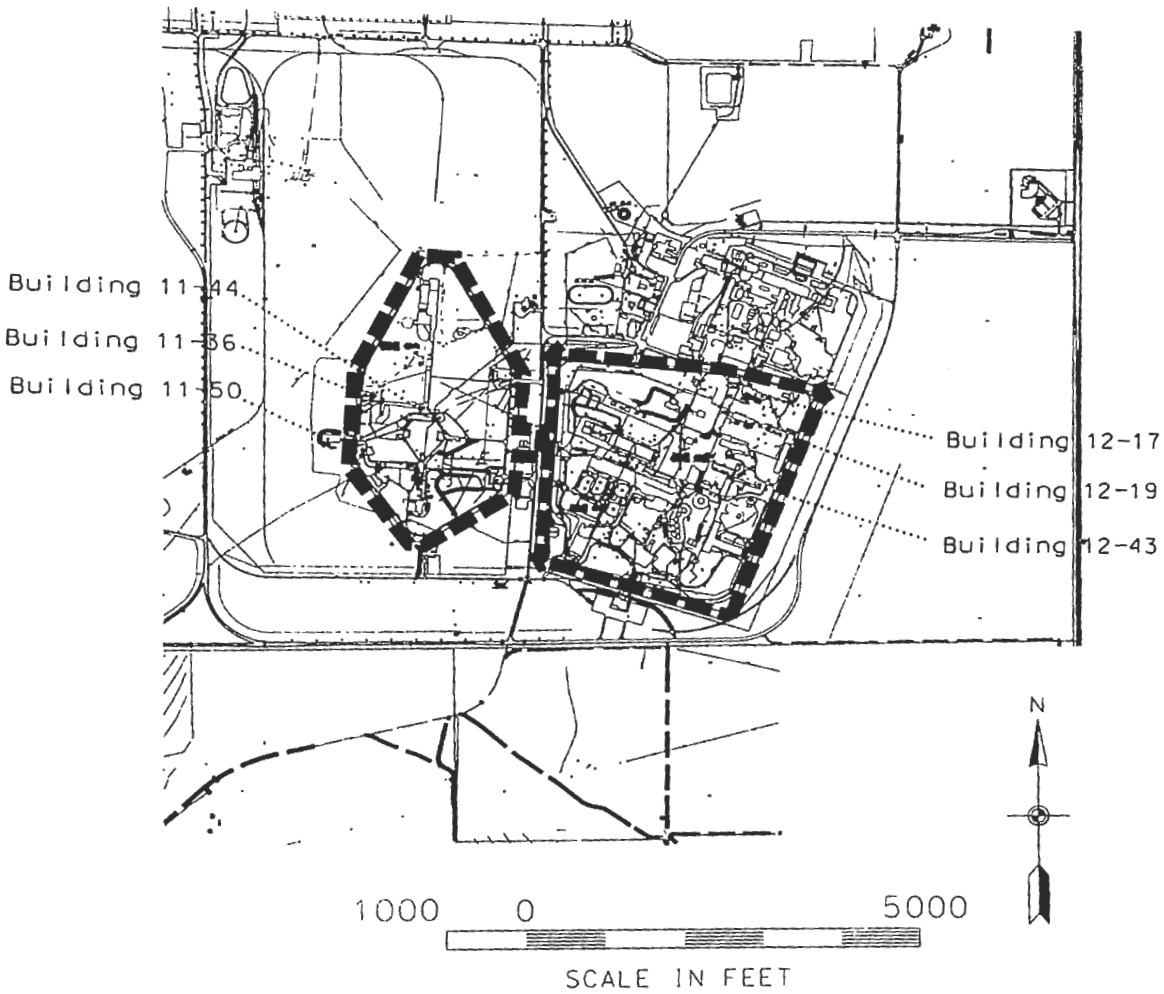
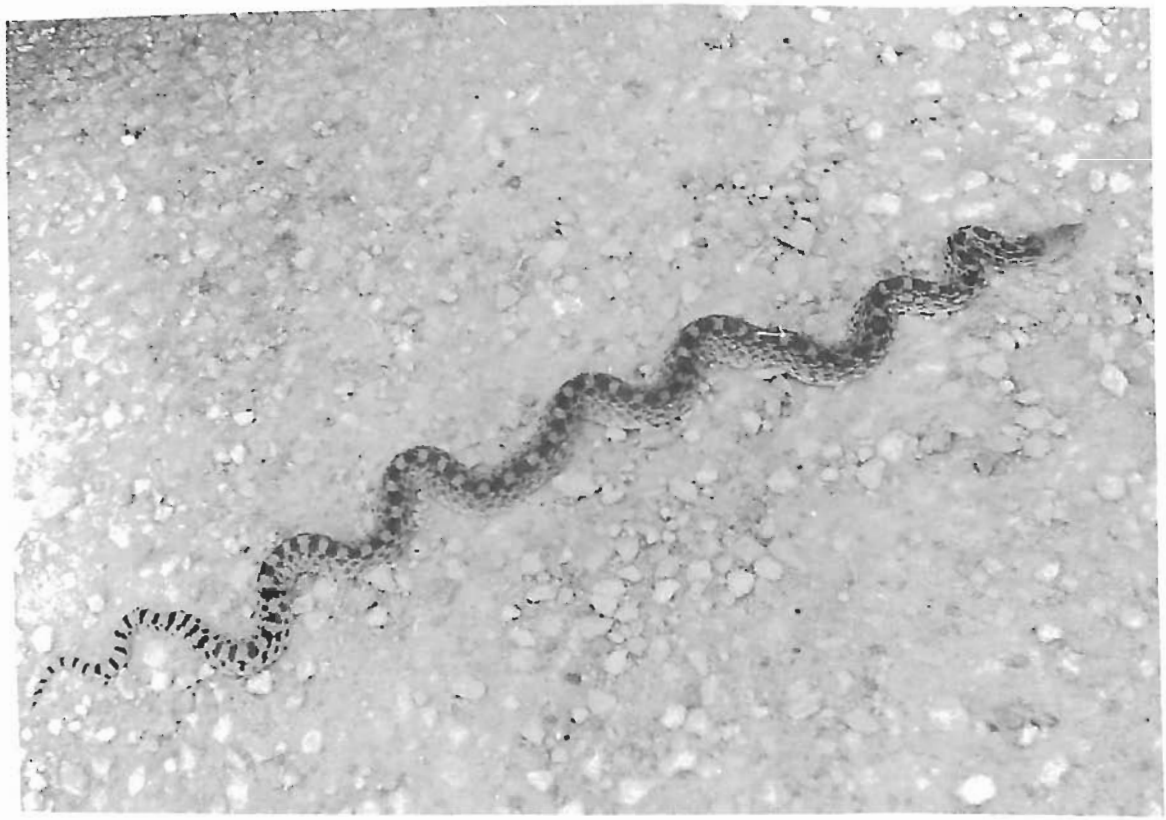


Figure 11.2 Locations of buildings associated with industrial discharges



Bull snake (*Pituophis* sp.)

Chapter 12

SOIL

This chapter presents results of routine and nonroutine (special request) surface soil surveillance at Pantex Plant. During 1994, soil samples were collected both onsite and offsite and analyzed for radionuclides, metals, explosives, and volatile organic compounds (Table 12.1).

12.1 Routine Soil Surveillance Program

The routine soil surveillance program plays an important role in assessing the potential environmental impacts of operations at Pantex Plant. Soil surveillance provides a direct measure of environmental contamination because soil accumulates contaminants that are deposited from the air over time. Thus, soil surveillance allows evaluation of long-term trends.

During 1994, soil was routinely sampled at 31 onsite and 17 offsite locations. All soil samples were collected according to sampling procedures outlined in internal operating procedure D4235, "Soil Sampling Procedures."

Soil samples were collected from two general landscape positions: playa bottoms and interplaya uplands. The characteristic soil types for these landscape positions are Randall clay in playa bottoms and Pullman clay loam in most of the interplaya uplands.

Table 12.1 Monitored Parameters for Soils

Radionuclides	Metals, cont'd	Volatile Organics, cont'd
Tritium[1]	Nickel	Benzene
Uranium-234	Silver	Bromomethane
Uranium-238	Zinc	Carbon tetrachloride
Plutonium-239/240		Chlorobenzene
	Explosives[1]	Chloroform
Metals[1]	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	Ethylbenzene
Aluminum	Pentaerythritol tetranitrate (PETN)	Methylene chloride (Dichloromethane)
Boron	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	Perchloroethylene
Cadmium	Trinitrotoluene (TNT)	Styrene
Chromium		Toluene
Cobalt	**Volatile Organics**[2]	Total xylenes
Copper	1,1,1-Trichloroethane	Trichloroethylene
Magnesium	1,2-Dichloroethane	Trichlorofluoromethane
Manganese	1,2-Dichloropropane	Vinyl chloride
Mercury		
Molybdenum		

[1] Burning Ground, Playa 3, and Bushland only.
[2] Playa 3 and Bushland only.

Sampling locations and their descriptions are listed in Table 12.2 and illustrated in Figures 12.1 through 12.3. Two offsite sampling locations (OS-SS-32, an upland location, and PB-SS-01, a playa bottom) are located at Bushland, Texas (Figure 1.1). Samples collected at these locations are considered the controls, indicating background levels of contamination. The control site was chosen because it is 56 kilometers (35 miles) from the Plant in a direction that is generally upwind; as a result, it should not be affected by Plant operations.

Onsite soil samples were taken monthly from five areas: firing sites, the Burning Ground, Playa #1, Playa #2, and Playa #3. Offsite samples were collected quarterly from areas within an 8-kilometer (5-mile) radius of the Plant. Samples from the control locations were collected monthly.

All soil samples were analyzed for uranium-234, uranium-238, and plutonium-239/240. Because open burning operations have the potential to release tritium, metals, or explosives that may be deposited as particulate matter or incorporated in surface water runoff, soil samples from the Burning Ground, Playa #3, and Bushland (control) were analyzed for tritium, metals, and explosives. Open burning may also release volatile organic compounds that may be incorporated into surface water runoff; therefore samples from Playa #3 (directly west of the Burning Ground) were analyzed for volatile organic compounds. All samples were analyzed according to procedures outlined in Chapter 14 by an offsite contract laboratory that meets U.S. Environmental Protection Agency (EPA) requirements. Radiological samples were prepared for analysis by chemical leaching rather than by total digestion, as has been done historically. This change produced slightly lower concentrations, but comparisons to historical and control concentrations are still valid.

Analytical results were compared to historical averages at the locations where samples were collected, the historical average at control locations, and risk reduction rule standards (Texas Administrative Code, Title 30, Sections 335.551-335.569) calculated by the U.S. Army Corps of Engineers (1994) for the Pantex Plant's Resource Conservation and Recovery Act (RCRA) Facility Investigations. Historical averages for each location were calculated using routine surveillance data from 1988-1993.

Concentrations of tritium, uranium-234, uranium-238, and plutonium-239/240 are listed by location in Tables 12.3, 12.4, 12.5, and 12.6, respectively. Results for metals are listed in Table 12.7, and results for explosives in Table 12.8. These summary tables are based on raw data available in a detailed compilation (Mason & Hanger 1995a).

Table 12.9 lists average concentrations for uranium-234, uranium-238, and plutonium-239/240 in soil by general area in 1994. Averages for uranium-234 and uranium-238 are compared to historical and 1993 averages in Figure 12.4. Average concentrations of plutonium-239/240 in 1994 were similar to historical and Bushland averages, indicating no detectable plutonium contamination from Pantex Plant in area soils.

Uranium-234 and uranium-238 average concentrations for 1994 were generally similar to historical averages for each area. However, one sample from location BG-SS-02 showed uranium-234 and uranium-238 concentrations above historical levels. Analysis of another aliquot from the same sample and of five other samples collected from the same location showed concentrations below the historical average and the historical Bushland average. Because they could not be confirmed, the original results were not used in calculating the 1994 average concentration for that location.

Table 12.2 Routine Onsite and Offsite Soil Sampling Locations

Location	Description
Onsite	
Burning Ground:	
BG-SS-01	On west fence line 228.8 meters (750 feet) from northwest corner of perimeter fence
BG-SS-02	On north fence line 228.8 meters (750 feet) from northwest corner of perimeter fence
BG-SS-03	30.5 meters (100 feet) south of southwest pad
BG-SS-04	On south fence line 183 meters (600 feet) from southwest corner of perimeter fence
BG-SS-05	On east fence line 228.8 meters (750 feet) from northeast corner of perimeter fence
BG-SS-06	305 meters (1,000 feet) north from northwest corner of perimeter fence
BG-SS-07	533.8 meters (1,750 feet) north of BG-SS-02
BG-SS-08	305 meters (1,000 feet) north from northeast corner of perimeter fence
BG-SS-09	305 meters (1,000 feet) east from northeast corner of perimeter fence
BG-SS-10	228.8 meters (750 feet) south from southeast corner of perimeter fence
BG-SS-11	533.8 meters (1,750 feet) south of BG-SS-04
Firing Site 4:	
FA-SS-01	30.5 meters (100 feet) east of east bunker
Firing Site 5:	
FB-SS-01	9.2 meters (30 feet) north of northwest corner of bunker
FB-SS-02	39.6 meters (130 feet) north of northwest corner of bunker
FB-SS-03	70.2 meters (230 feet) north of northwest corner of bunker
FB-SS-04	100.6 meters (330 feet) north of northwest corner of bunker
FB-SS-05	45.8 meters (150 feet) northeast of northeast corner of bunker
FB-SS-06	76.2 meters (250 feet) northeast of northeast corner of bunker
FB-SS-07	106.8 meters (350 feet) northeast of northeast corner of bunker
FB-SS-08	137.2 meters (450 feet) northeast of northeast corner of bunker
FB-SS-09	30.5 meters (100 feet) south of southwest corner of bunker
Firing Site 10:	
FC-SS-01	45.8 meters (150 feet) north of north bunker
FC-SS-02	85.4 meters (280 feet) north of north bunker
FC-SS-03	122.0 meters (400 feet) north of north bunker
FC-SS-04	30.5 meters (100 feet) northeast of northeast corner of bunker
FC-SS-05	70.2 meters (230 feet) northeast of northeast corner of bunker
Playa #1:	
P1-SS-01	South side of playa where ditch from WWTF reaches the playa boundary
P1-SS-02	North side of playa west of irrigation pit
Playa #2:	
P2-SS-01	East side of playa where ditch from 16-1 weir reaches playa boundary
Playa #3:	
P3-SS-01	East side of playa where ditch from burning ground reaches the playa boundary
P3-SS-02	South side of playa where ditch from Zone 7 reaches playa boundary

Table 12.2 Routine Onsite and Offsite Soil Sampling Locations (cont'd)

Location	Description
Offsite	
OS-SS-01	Southwest corner of intersection of FM 683 and FM 293, at survey marker
OS-SS-04	2.4 kilometers (1.5 miles) south of intersection of FM 683 and FM 293, west fence at gate
OS-SS-05	Northwest corner of intersection of FM 2373 and FM 293, north fence
OS-SS-10	3.4 kilometers (2.1 miles) west of intersection of FM 2373 and FM 293, fenceline west of house
OS-SS-18	3.2 kilometers (2.0 miles) west of intersection of FM 683 and FM 245, north fence
OS-SS-20	0.5 kilometers (0.3 mile) east of intersection of FM 683 and FM 293, 2.6 kilometers (1.6 miles) north, west fence
OS-SS-21	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 3.2 kilometers (2.0 miles) west, 2.1 kilometers (1.3 miles) north
OS-SS-22	3.7 kilometers (2.3 miles) north of intersection of FM 2373 and FM 293, northwest corner
OS-SS-24	3.2 kilometers (2.0 miles) south of intersection of FM 2373 and FM 293, 3.2 kilometers (2.0 miles) east, southwest corner
OS-SS-25	6.6 kilometers (4.1 miles) east of intersection of FM 2373 and US 60, south fence
OS-SS-27	3.9 kilometers (2.4 miles) south of intersection of US 60 and FM 2373, southeast corner of intersection at fence
OS-SS-28	2.4 kilometers (1.5 miles) east of intersection of US 60 and FM 683, 1.6 kilometers (1.0 mile) south, west fence
OS-SS-29	6.8 kilometers (4.2 miles) south of intersection of FM 245 and FM 683, fence north of railroad tracks
OS-SS-30	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 3.2 kilometers (2.0 miles) east, 1.6 kilometers (1.0 mile) north, 0.5 kilometer (0.3 mile) west
OS-SS-31	2.4 kilometers (1.5 miles) east of intersection of FM 2373 and FM 293, 0.6 kilometers (0.4 mile) north, by utility pole
OS-SS-32	Bushland, Texas, near air monitor
PB-SS-01	West side of Bushland Playa where water sample is taken

Although the 1994 average uranium-234 and uranium-238 concentrations at Firing Site #4 were higher than 1993 averages, they were below the historical average for that location (Figure 12.4).

As in the past, uranium-238 concentrations at firing sites were higher than concentrations of other radionuclides at Pantex Plant. The higher levels can be attributed to the use of depleted uranium during test firings of explosives, which ceased in 1986. The presence of depleted uranium in an environmental sample can be confirmed by calculating the uranium-234:uranium-238 isotopic activity ratio for a given sample (Lide 1993). This ratio is close to 1.0 for natural uranium and significantly less than 1.0 for areas contaminated with depleted uranium, as at the firing sites (Table 12.9). The firing sites are currently scheduled for investigation and remediation under the Environmental Restoration program (discussed in Chapter 6). Monitoring data for 1994 do not show any change from the expected levels of uranium-234 and uranium-238 at the three firing site areas where samples were collected.

A program to monitor metals in soil was initiated at the Burning Ground in 1994 (Table 12.7). Average concentrations of metals were compared to standards for surface soil set by

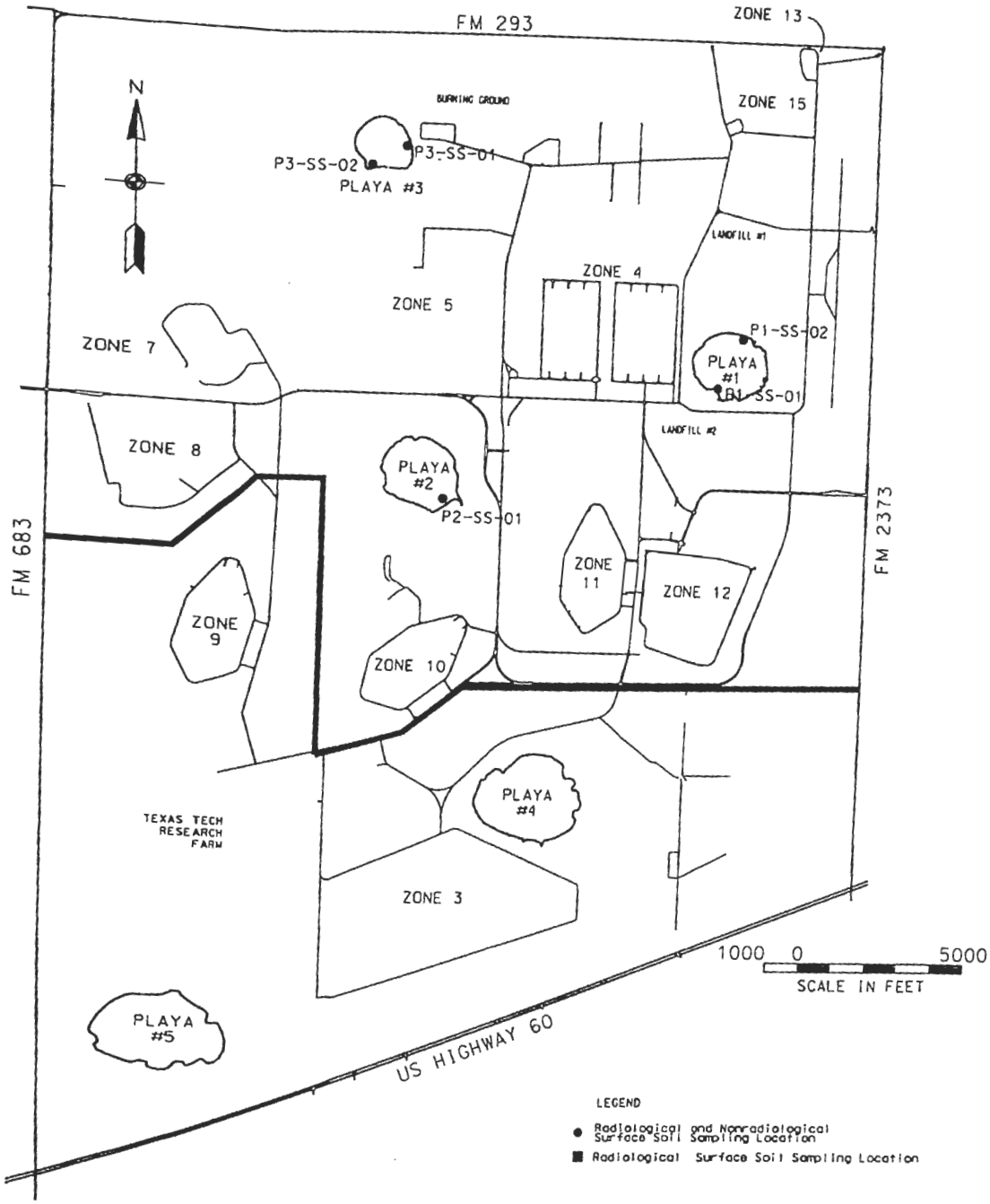


Figure 12.1: Routine soil surveillance locations for playas

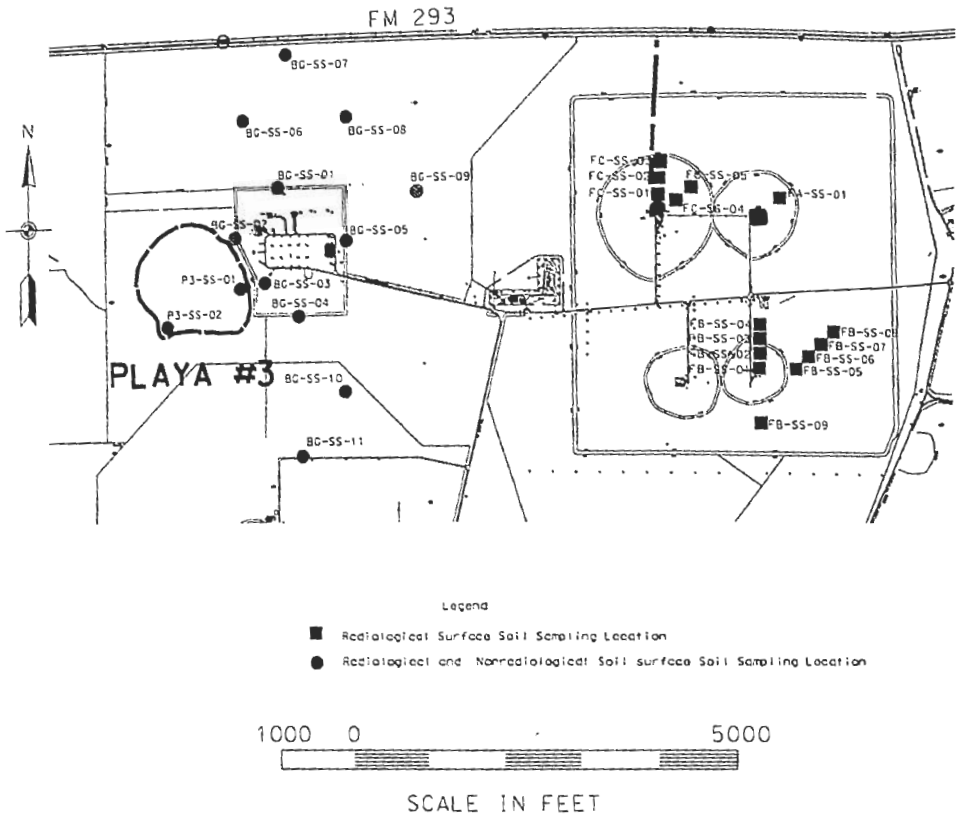


Figure 12.2: Routine soil surveillance locations at the Burning Ground and firing sites

the risk reduction rule (which applies to cadmium, chromium, copper, mercury, nickel, silver, and zinc; Corps of Engineers 1994), the results of analyses of Bushland soil, and published averages for loamy and clay soils in the United States (Pendias and Pendias 1991). Averages for all metals were close to the risk reduction standards, the Bushland analyses, and published averages. No areas of contamination were indicated.

Starting in 1994, soil samples collected from Playa #3 and areas surrounding the Burning Ground were also analyzed for explosives. Average concentrations were not calculated for hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), pentaerythritol tetranitrate (PETN), and trinitrotoluene (TNT) because the proportion of sample results below the minimum detection limits was so large (Table 12.8). Concentrations of octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX), RDX, and TNT detected in soil samples were below risk reduction standards; no risk reduction standards have been published for PETN. Results for HMX at several locations exceeded those for Bushland samples, which were below detection limits.

Starting in 1994, soil samples from Playa #3 were analyzed for volatile organic compounds that could be released by open burning. In the past, volatile organic compounds were monitored in surface water and groundwater only. The addition of soil analysis makes it possible to monitor for volatile organic compounds even when surface water is not available. In the soil samples collected from Playa #3, none of the listed volatile organic compounds were found at levels above the minimum detection limits.

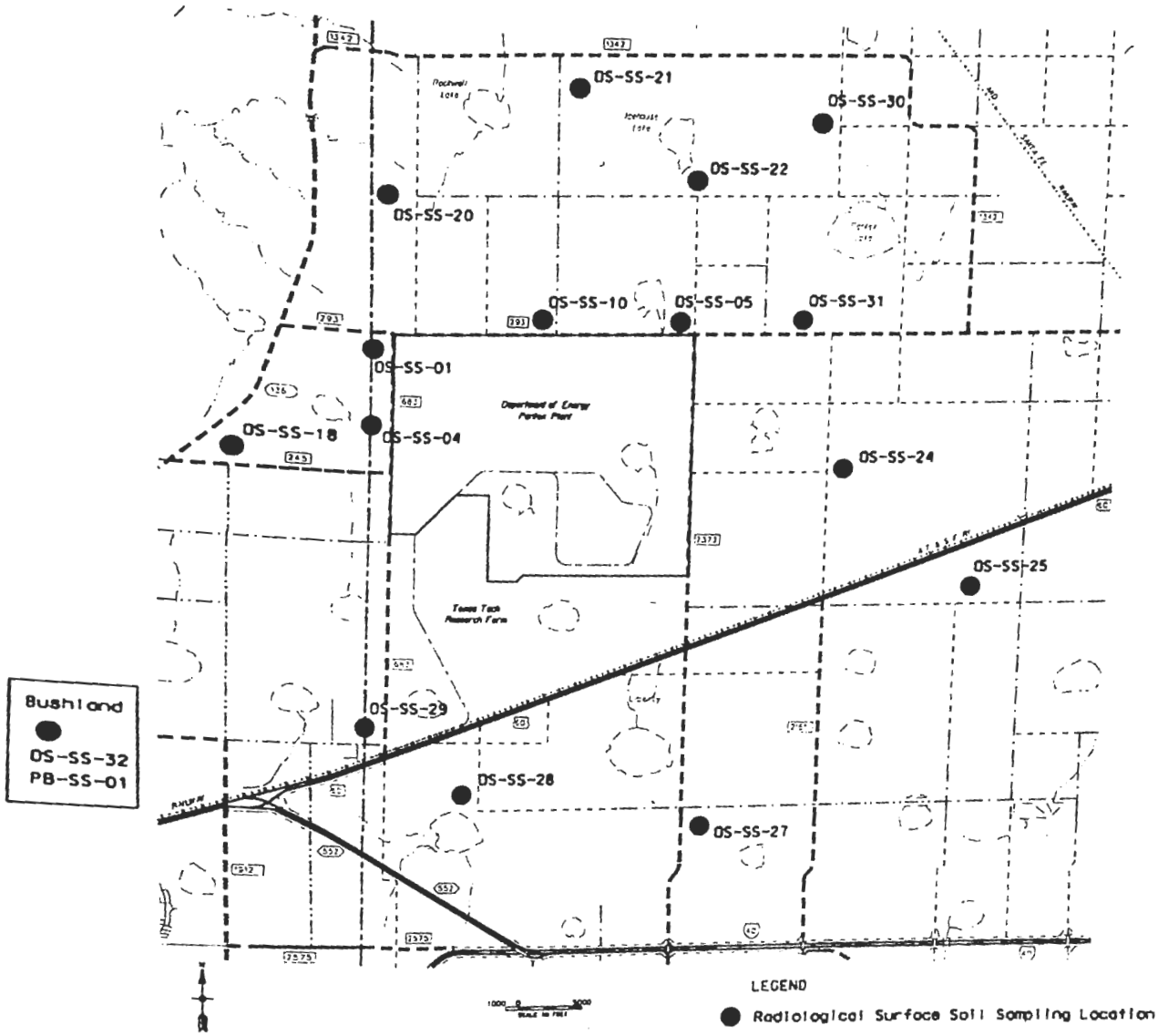


Figure 12.3: Routine offsite soil surveillance locations

12.2 Special Sampling Program

During April 1994, Pantex Plant's Environmental Protection and Radiation Safety Departments conducted a baseline study of soil radioactivity within the Zone 4 West staging area. The results provide a baseline for comparison in future soil radioactivity and dose rate monitoring as more weapons components are stored at Pantex Plant. Soil samples were collected and radiation dose rates were measured at 60 points on a grid of squares 92 meters (300 feet) on a side within Zone 4 West. An offsite contract laboratory analyzed soil samples for uranium-234, uranium-238, plutonium-239/240, and tritium. Neutron and gamma dose rates were measured using a 23-

centimeter (9-inch) Bonner Sphere and a pressurized ion chamber, respectively.

Soil radionuclide concentrations in Zone 4 West samples were close to the historical average and the range for offsite and Bushland monitoring results (Table 12.10). The average radiation dose rate within Zone 4 West was close to the average historical thermoluminescent dosimetry results from offsite and Bushland locations [0.01 millirem per hour (mrem/hr)]. The offsite dose rate was measured directly during April 1994; it also averaged 0.01 mrem/hr.

Soil samples and dose rate measurements will be obtained from Zone 4 West again during 1995. Results will be compared to those from the baseline study as part of the continuing support for the Secretary of Energy's commitments to the public.

Table 12.3 Summary of 1994 Concentrations of Tritium in Soil, in pCi/g

Location	No. of Samples	Mean[1]	Max[1]	Min[1]	Historical[2] Mean
Onsite					
Burning Ground:					
BG-SS-01	7	0.16 ± 0.56	1.39 ± 1.33	-0.62 ± 1.12	--
BG-SS-02	9	-0.03 ± 0.56	0.23 ± 1.24	-0.48 ± 1.12	--
BG-SS-03	0	--	--	--	--
BG-SS-04	8	0.12 ± 0.61	1.35 ± 1.37	-0.43 ± 1.04	--
BG-SS-05	10	0.13 ± 0.65	2.63 ± 1.37	-0.82 ± 1.30	--
BG-SS-06	8	0.14 ± 0.49	1.39 ± 1.29	-0.30 ± 1.08	--
BG-SS-07	8	0.06 ± 0.48	0.98 ± 1.24	-0.74 ± 1.04	--
BG-SS-08	7	0.27 ± 0.54	1.04 ± 1.25	-0.09 ± 0.93	--
BG-SS-09	6	0.23 ± 0.46	0.65 ± 1.24	0.01 ± 0.12	--
BG-SS-10	7	0.25 ± 0.56	1.38 ± 1.30	-0.44 ± 1.13	--
BG-SS-11	8	0.11 ± 0.62	0.75 ± 1.32	-0.50 ± 1.07	--
Playa #3:					
P3-SS-01	7	0.05 ± 0.57	0.30 ± 1.39	-0.34 ± 0.95	--
P3-SS-02	8	0.12 ± 0.62	0.78 ± 1.37	-0.57 ± 0.96	--
Offsite					
OS-22-01	6	0.16 ± 0.90	0.71 ± 1.03	-0.07 ± 3.19	--
PB-SS-01	6	0.10 ± 1.04	0.94 ± 1.48	-0.27 ± 3.47	--

[1] Counting error at 95% confidence level is indicated by the ± value.
[2] Dashes (--) indicate first year sampled.

Table 12.4 Summary of 1994 Concentrations of Uranium-234 in Soil, in pCi/g

Location	No. of Samples	Mean[1]	Max[1]	Min[1]	Historical[2] Mean
Onsite					
Burning Ground:					
BG-SS-01	14	0.30 ± 0.07	1.10 ± 0.21	0.08 ± 0.04	0.55 ± 0.12
BG-SS-02	13	0.39 ± 0.08	22.8 ± 1.71[3]	0.12 ± 0.02	0.56 ± 0.12
BG-SS-03	5	0.34 ± 0.07	0.61 ± 0.11	0.17 ± 0.04	0.62 ± 0.13
BG-SS-04	15	0.31 ± 0.07	1.10 ± 0.16	0.12 ± 0.04	0.67 ± 0.14
BG-SS-05	10	0.33 ± 0.09	0.70 ± 0.11	0.05 ± 0.20	--[4]
BG-SS-06	8	0.49 ± 0.09	1.20 ± 0.21	0.16 ± 0.06	--
BG-SS-07	8	0.41 ± 0.08	0.63 ± 0.11	0.10 ± 0.05	--
BG-SS-08	7	0.52 ± 0.10	1.40 ± 0.23	0.12 ± 0.06	--
BG-SS-09	7	0.37 ± 0.08	0.59 ± 0.09	0.14 ± 0.06	--
BG-SS-10	7	0.48 ± 0.10	1.20 ± 0.22	0.17 ± 0.05	--
BG-SS-11	8	0.43 ± 0.09	1.30 ± 0.24	0.08 ± 0.04	--
Firing Site 4:					
FA-SS-01	12	1.02 ± 0.16	3.22 ± 0.32	0.34 ± 0.09	4.96 ± 0.53
Firing Site 5:					
FB-SS-01	11	5.13 ± 0.55	12.84 ± 1.45	1.09 ± 0.14	3.86 ± 0.33
FB-SS-02	12	0.84 ± 0.13	2.73 ± 0.33	0.33 ± 0.06	1.67 ± 0.21
FB-SS-03	12	0.84 ± 0.13	1.64 ± 0.17	0.37 ± 0.10	1.36 ± 0.18
FB-SS-04	12	0.90 ± 0.15	2.07 ± 0.30	0.45 ± 0.12	1.31 ± 0.17
FB-SS-05	12	1.19 ± 0.17	2.28 ± 0.30	0.68 ± 0.11	3.09 ± 0.42
FB-SS-06	12	0.49 ± 0.10	1.03 ± 0.16	0.14 ± 0.04	1.66 ± 0.18
FB-SS-07	12	0.42 ± 0.09	0.81 ± 0.12	0.18 ± 0.05	0.99 ± 0.16
FB-SS-08	13	0.35 ± 0.08	1.41 ± 0.23	0.17 ± 0.06	0.82 ± 0.14
FB-SS-09	11	1.16 ± 0.16	1.78 ± 0.25	0.71 ± 0.14	3.01 ± 0.26
Firing Site 10:					
FC-SS-01	11	0.33 ± 0.08	0.52 ± 0.13	0.17 ± 0.04	0.85 ± 0.14
FC-SS-02	12	0.21 ± 0.06	0.31 ± 0.09	0.15 ± 0.05	0.78 ± 0.13
FC-SS-03	11	0.18 ± 0.06	0.30 ± 0.09	0.12 ± 0.05	0.85 ± 0.15
FC-SS-04	11	0.59 ± 0.10	0.80 ± 0.14	0.43 ± 0.10	1.16 ± 0.16
FC-SS-05	12	0.39 ± 0.09	0.65 ± 0.06	0.22 ± 0.08	1.77 ± 0.17
Playa #1:					
P1-SS-01	9	0.73 ± 0.13	1.29 ± 0.16	0.28 ± 0.11	--
P1-SS-02	9	1.44 ± 0.20	2.75 ± 0.27	0.81 ± 0.13	--
Playa #2:					
P2-SS-01	9	0.28 ± 0.08	0.54 ± 0.09	0.15 ± 0.06	--
Playa #3:					
P3-SS-01	11	0.49 ± 0.10	1.00 ± 0.16	0.18 ± 0.07	--
P3-SS-02	11	0.49 ± 0.10	1.20 ± 0.17	0.15 ± 0.05	--

Table 12.4 Summary of 1994 Concentrations of Uranium-234 in Soil, in pCi/g (cont'd)

Location	No. of Samples	Mean	Max	Min	Historical Mean
Offsite					
OS-SS-01	4	0.21 ± 0.07	0.30 ± 0.09	0.13 ± 0.05	0.68 ± 0.11
OS-SS-04	3	NA[5]	0.21 ± 0.08	0.12 ± 0.04	0.64 ± 0.12
OS-SS-05	5	0.21 ± 0.07	0.25 ± 0.06	0.13 ± 0.05	0.59 ± 0.12
OS-SS-10	4	0.24 ± 0.08	0.30 ± 0.10	0.19 ± 0.05	0.61 ± 0.11
OS-SS-18	5	0.20 ± 0.08	0.26 ± 0.08	0.16 ± 0.05	0.65 ± 0.13
OS-SS-20	4	0.26 ± 0.08	0.31 ± 0.11	0.17 ± 0.05	0.70 ± 0.12
OS-SS-21	4	0.28 ± 0.07	0.41 ± 0.12	0.15 ± 0.05	0.56 ± 0.13
OS-SS-22	3	NA	0.29 ± 0.06	0.25 ± 0.10	0.60 ± 0.14
OS-SS-24	4	0.21 ± 0.07	0.28 ± 0.08	0.11 ± 0.04	0.55 ± 0.12
OS-SS-25	4	0.22 ± 0.07	0.26 ± 0.07	0.16 ± 0.06	0.58 ± 0.12
OS-SS-27	4	0.15 ± 0.05	0.21 ± 0.06	0.11 ± 0.04	0.56 ± 0.12
OS-SS-28	5	0.22 ± 0.06	0.31 ± 0.08	0.14 ± 0.05	0.52 ± 0.10
OS-SS-29	4	0.27 ± 0.08	0.31 ± 0.10	0.22 ± 0.06	0.69 ± 0.13
OS-SS-30	4	0.37 ± 0.08	0.84 ± 0.12	0.12 ± 0.05	0.61 ± 0.12
OS-SS-31	4	0.18 ± 0.07	0.22 ± 0.09	0.15 ± 0.06	0.59 ± 0.12
OS-SS-32	9	0.35 ± 0.08	0.63 ± 0.11	0.13 ± 0.05	0.58 ± 0.11
PB-SS-01	7	0.32 ± 0.07	0.64 ± 0.10	0.28 ± 0.11	--

1 Counting error at 95% confidence level is indicated by the ± value.
2 Historical averages (1988-1993).
3 Value was not included in calculation of mean.
4 Dashes (--) indicate first year sampled.
5 NA indicates not applicable.

Table 12.5 Summary of 1994 Concentrations of Uranium-238 in Soil, in pCi/g

Location	No. of Samples	Mean[1]	Max[1]	Min[1]	Historical[2] Mean
Onsite					
Burning Ground:					
BG-SS-01	14	0.35 ± 0.07	1.20 ± 0.21	0.11 ± 0.03	0.70 ± 0.13
BG-SS-02	14	0.46 ± 0.08	4.89 ± 0.42[3]	0.12 ± 0.02	0.64 ± 0.12
BG-SS-03	5	0.34 ± 0.07	0.38 ± 0.08	0.28 ± 0.07	0.78 ± 0.14
BG-SS-04	15	0.33 ± 0.07	1.40 ± 0.17	0.13 ± 0.04	1.14 ± 0.15
BG-SS-05	10	0.42 ± 0.08	1.10 ± 0.20	0.13 ± 0.05	--[4]
BG-SS-06	8	0.47 ± 0.09	1.10 ± 0.20	0.12 ± 0.05	--
BG-SS-07	8	0.42 ± 0.08	0.66 ± 0.11	0.13 ± 0.06	--
BG-SS-08	7	0.51 ± 0.09	1.30 ± 0.21	0.11 ± 0.06	--
BG-SS-09	7	0.40 ± 0.08	0.68 ± 0.09	0.15 ± 0.06	--
BG-SS-10	7	0.51 ± 0.10	1.20 ± 0.20	0.14 ± 0.05	--
BG-SS-11	8	0.44 ± 0.09	1.10 ± 0.21	0.13 ± 0.05	--
Firing Site 4:					
FA-SS-01	12	6.33 ± 0.60	20.57 ± 1.62	1.39 ± 0.16	35.8 ± 2.45
Firing Site 5:					
FB-SS-01	11	38.6 ± 3.30	92.52 ± 8.97	8.14 ± 0.66	26.2 ± 1.07
FB-SS-02	12	5.36 ± 0.49	21.05 ± 1.81	1.19 ± 0.14	9.27 ± 0.62
FB-SS-03	12	4.93 ± 0.47	11.48 ± 0.90	1.37 ± 0.21	6.93 ± 0.43
FB-SS-04	12	5.85 ± 0.57	14.43 ± 1.36	2.81 ± 0.37	6.02 ± 0.36
FB-SS-05	12	8.02 ± 0.71	17.21 ± 1.56	3.59 ± 0.34	20.7 ± 1.26
FB-SS-06	12	2.40 ± 0.27	5.83 ± 0.50	0.30 ± 0.06	5.30 ± 0.40
FB-SS-07	12	2.04 ± 0.23	5.03 ± 0.46	0.66 ± 0.10	3.25 ± 0.29
FB-SS-08	13	0.92 ± 0.14	1.82 ± 0.27	0.30 ± 0.02	2.06 ± 0.22
FB-SS-09	11	7.48 ± 0.68	11.58 ± 1.05	3.95 ± 0.35	18.8 ± 1.05
Firing Site 10:					
FC-SS-01	11	1.14 ± 0.17	2.60 ± 0.34	0.56 ± 0.10	2.11 ± 0.21
FC-SS-02	12	0.44 ± 0.09	0.91 ± 0.17	0.17 ± 0.05	1.52 ± 0.19
FC-SS-03	11	0.26 ± 0.07	0.44 ± 0.11	0.17 ± 0.05	1.28 ± 0.15
FC-SS-04	11	2.91 ± 0.31	4.28 ± 0.44	1.84 ± 0.24	4.55 ± 0.32
FC-SS-05	12	1.43 ± 0.19	3.31 ± 0.43	0.47 ± 0.11	12.3 ± 0.39
Playa #1:					
P1-SS-01	9	0.43 ± 0.09	0.77 ± 0.11	0.17 ± 0.08	--
P1-SS-02	9	0.76 ± 0.13	1.32 ± 0.16	0.41 ± 0.09	--
Playa #2:					
P2-SS-01	9	0.27 ± 0.07	0.56 ± 0.09	0.14 ± 0.04	--
Playa #3:					
P3-SS-01	11	0.39 ± 0.09	0.72 ± 0.14	0.15 ± 0.06	--
P3-SS-02	11	0.46 ± 0.09	1.40 ± 0.17	0.16 ± 0.05	--

Table 12.5 Summary of 1994 Concentrations of Uranium-238 in Soil, in pCi/g (cont'd)

Location	No. of Samples	Mean	Max	Min	Historical Mean
Offsite					
OS-SS-01	4	0.15 ± 0.06	0.18 ± 0.08	0.10 ± 0.04	0.66 ± 0.12
OS-SS-04	3	NA[5]	0.22 ± 0.05	0.17 ± 0.05	0.73 ± 0.13
OS-SS-05	5	0.20 ± 0.07	0.29 ± 0.12	0.14 ± 0.05	0.64 ± 0.12
OS-SS-10	4	0.21 ± 0.07	0.22 ± 0.09	0.19 ± 0.05	0.66 ± 0.12
OS-SS-18	5	0.18 ± 0.06	0.19 ± 0.06	0.17 ± 0.05	0.63 ± 0.13
OS-SS-20	4	0.19 ± 0.07	0.23 ± 0.05	0.15 ± 0.09	0.75 ± 0.13
OS-SS-21	4	0.22 ± 0.09	0.32 ± 0.10	0.12 ± 0.05	0.53 ± 0.11
OS-SS-22	3	NA	0.28 ± 0.10	0.20 ± 0.08	0.61 ± 0.12
OS-SS-24	4	0.21 ± 0.06	0.25 ± 0.07	0.13 ± 0.04	0.60 ± 0.13
OS-SS-25	4	0.18 ± 0.06	0.26 ± 0.07	0.12 ± 0.06	0.61 ± 0.12
OS-SS-27	4	0.12 ± 0.04	0.14 ± 0.05	0.11 ± 0.04	0.58 ± 0.12
OS-SS-28	5	0.14 ± 0.05	0.20 ± 0.07	0.08 ± 0.03	0.55 ± 0.11
OS-SS-29	4	0.28 ± 0.08	0.39 ± 0.11	0.23 ± 0.06	0.73 ± 0.13
OS-SS-30	4	0.24 ± 0.07	0.33 ± 0.07	0.15 ± 0.05	0.65 ± 0.13
OS-SS-31	4	0.16 ± 0.06	0.23 ± 0.09	0.13 ± 0.06	0.61 ± 0.13
OS-SS-32	9	0.33 ± 0.08	0.67 ± 0.11	0.15 ± 0.05	0.74 ± 0.11
PB-SS-01	7	0.34 ± 0.07	0.69 ± 0.12	0.12 ± 0.05	--

1 Counting error at 95% confidence level is indicated by the ± value.
2 Historical averages (1988-1993).
3 Value was not included in calculation of mean.
4 Dashes (--) indicate first year sampled.
5 NA indicates not applicable.

Table 12.6 Summary of 1994 Concentrations of Plutonium in Soil, in pCi/g

Location	No. of Samples	Mean[1]	Max[1]	Min[1]	Historical[2] Mean
Onsite					
Burning Ground:					
BG-SS-01	14	0.02 ± 0.02	0.05 ± 0.02	-0.03 ± 0.03	0.01 ± 0.02
BG-SS-02	14	0.02 ± 0.03	0.11 ± 0.04	-0.02 ± 0.04	0.01 ± 0.02
BG-SS-03	5	0.05 ± 0.03	0.07 ± 0.04	0.01 ± 0.01	0.02 ± 0.02
BG-SS-04	15	0.04 ± 0.03	0.10 ± 0.04	-0.02 ± 0.04	0.02 ± 0.02
BG-SS-05	10	0.04 ± 0.04	0.12 ± 0.04	0.00 ± 0.02	--[3]
BG-SS-06	8	0.03 ± 0.04	0.05 ± 0.07	0.00 ± 0.02	--
BG-SS-07	8	0.02 ± 0.03	0.05 ± 0.07	0.00 ± 0.03	--
BG-SS-08	7	0.03 ± 0.04	0.08 ± 0.04	0.00 ± 0.01	--
BG-SS-09	7	0.02 ± 0.03	0.09 ± 0.05	0.00 ± 0.03	--
BG-SS-10	7	0.01 ± 0.03	0.02 ± 0.04	-0.02 ± 0.02	--
BG-SS-11	8	0.01 ± 0.03	0.08 ± 0.07	-0.03 ± 0.03	--
Firing Site 4:					
FA-SS-01	13	0.03 ± 0.03	0.09 ± 0.07	0.00 ± 0.00	0.01 ± 0.02
Firing Site 5:					
FB-SS-01	11	0.03 ± 0.02	0.12 ± 0.04	0.00 ± 0.00	0.01 ± 0.02
FB-SS-02	12	0.04 ± 0.03	0.09 ± 0.04	0.02 ± 0.01	0.01 ± 0.02
FB-SS-03	12	0.03 ± 0.02	0.10 ± 0.04	-0.01 ± 0.04	0.02 ± 0.02
FB-SS-04	12	0.03 ± 0.03	0.07 ± 0.03	0.00 ± 0.02	0.02 ± 0.02
FB-SS-05	12	0.04 ± 0.03	0.10 ± 0.04	0.02 ± 0.02	0.01 ± 0.02
FB-SS-06	12	0.03 ± 0.03	0.06 ± 0.03	0.00 ± 0.03	0.01 ± 0.02
FB-SS-07	12	0.03 ± 0.03	0.07 ± 0.03	-0.01 ± 0.02	0.01 ± 0.02
FB-SS-08	13	0.03 ± 0.03	0.15 ± 0.05	-0.03 ± 0.06	0.01 ± 0.02
FB-SS-09	11	0.03 ± 0.03	0.08 ± 0.04	0.00 ± 0.03	0.01 ± 0.02
Firing Site 10:					
FC-SS-01	11	0.04 ± 0.05	0.17 ± 0.05	0.00 ± 0.20	0.02 ± 0.02
FC-SS-02	12	0.03 ± 0.03	0.06 ± 0.04	0.00 ± 0.03	0.02 ± 0.02
FC-SS-03	11	0.02 ± 0.03	0.04 ± 0.03	0.00 ± 0.02	0.02 ± 0.02
FC-SS-04	11	0.02 ± 0.03	0.06 ± 0.03	0.00 ± 0.02	0.01 ± 0.02
FC-SS-05	12	0.04 ± 0.03	0.09 ± 0.06	0.01 ± 0.03	0.01 ± 0.02
Playa 1:					
P1-SS-01	9	0.02 ± 0.03	0.04 ± 0.04	0.01 ± 0.04	--
P1-SS-02	9	0.02 ± 0.03	0.06 ± 0.05	-0.01 ± 0.02	--
Playa 2:					
P2-SS-01	9	0.05 ± 0.04	0.08 ± 0.05	0.02 ± 0.03	--
Playa 3:					
P3-SS-01	10	0.03 ± 0.03	0.06 ± 0.04	0.00 ± 0.03	--
P3-SS-02	11	0.04 ± 0.04	0.09 ± 0.05	0.00 ± 0.04	--

Table 12.6 Summary of 1994 Concentrations of Plutonium in Soil, in pCi/g (cont'd)

Location	No. of Samples	Mean	Max	Min	Historical Mean
Offsite					
OS-SS-01	4	0.02 ± 0.03	0.03 ± 0.04	0.01 ± 0.02	0.01 ± 0.02
OS-SS-04	3	NA[4]	0.02 ± 0.03	-0.01 ± 0.02	0.01 ± 0.01
OS-SS-05	5	0.02 ± 0.03	0.03 ± 0.04	0.00 ± 0.01	0.01 ± 0.02
OS-SS-10	4	0.03 ± 0.04	0.05 ± 0.06	-0.01 ± 0.03	0.01 ± 0.02
OS-SS-18	5	0.03 ± 0.04	0.06 ± 0.04	-0.02 ± 0.03	0.01 ± 0.02
OS-SS-20	4	0.02 ± 0.03	0.04 ± 0.03	0.00 ± 0.02	0.01 ± 0.02
OS-SS-21	4	0.03 ± 0.03	0.04 ± 0.05	0.02 ± 0.02	0.02 ± 0.02
OS-SS-22	3	NA	0.04 ± 0.02	0.00 ± 0.00	0.02 ± 0.02
OS-SS-24	4	0.02 ± 0.03	0.03 ± 0.03	0.00 ± 0.03	0.01 ± 0.02
OS-SS-25	4	0.03 ± 0.05	0.06 ± 0.07	0.01 ± 0.04	0.02 ± 0.02
OS-SS-27	4	0.05 ± 0.03	0.09 ± 0.04	0.00 ± 0.00	0.01 ± 0.02
OS-SS-28	5	0.01 ± 0.04	0.07 ± 0.05	-0.06 ± 0.07	0.01 ± 0.01
OS-SS-29	4	0.04 ± 0.03	0.08 ± 0.04	0.02 ± 0.03	0.01 ± 0.02
OS-SS-30	4	0.01 ± 0.03	0.02 ± 0.03	0.00 ± 0.02	0.01 ± 0.02
OS-SS-31	4	0.02 ± 0.04	0.04 ± 0.04	0.00 ± 0.03	0.02 ± 0.02
OS-SS-32	9	0.02 ± 0.03	0.05 ± 0.03	-0.02 ± 0.06	0.01 ± 0.02
PB-SS-01	7	0.03 ± 0.03	0.07 ± 0.07	0.01 ± 0.01	--

1 Counting error at 95% confidence level is indicated by the ± value.
2 Historical averages (1988-1993).
3 Dashes (--) indicate first year sampled.
4 NA indicates not applicable.

Table 12.7 Summary of 1994 Concentrations of Metals in Soil, in mg/kg

Location	No. of Samples	No. BDL[1]	Mean[2] ± Std.Dev.	Max	Min
Aluminum					
BG-SS-01	6	0	16,333 ± 3,300	21,000	12,000
BG-SS-02	7	0	13,485 ± 4,200	19,000	62,000
BG-SS-04	6	0	15,116 ± 5,600	23,000	7,000
BG-SS-05	8	0	16,350 ± 4,000	24,000	11,800
BG-SS-06	7	0	13,842 ± 3,300	20,000	10,000
BG-SS-07	7	0	15,342 ± 2,900	21,000	12,000
BG-SS-08	6	0	14,850 ± 2,600	18,000	12,000
BG-SS-09	6	0	15,283 ± 3,800	21,000	11,000
BG-SS-10	6	0	17,700 ± 2,000	20,000	15,000
BG-SS-11	6	0	15,316 ± 7,700	30,000	9,400
OS-SS-32	3	0	19,000 ± 3,600	23,000	16,000
P3-SS-01	6	0	19,250 ± 4,900	26,000	11,000
P3-SS-02	7	0	15,085 ± 5,000	22,000	8,100
PB-SS-01	3	0	21,000 ± 4,000	25,000	17,000
Boron					
BG-SS-01	6	6	--	--	--
BG-SS-02	7	7	--	--	--
BG-SS-04	6	4	--	20	10
BG-SS-05	8	3	13 ± 7	20	5.7
BG-SS-06	7	7	--	--	--
BG-SS-07	6	6	--	--	--
BG-SS-08	6	6	--	--	--
BG-SS-09	5	5	--	--	--
BG-SS-10	6	6	--	--	--
BG-SS-11	6	5	--	10	--
OS-SS-32	3	3	--	--	--
P3-SS-01	6	5	--	10	--
P3-SS-02	7	7	--	--	--
PB-SS-01	3	3	--	--	--
Cadmium					
BG-SS-01	6	3	--	0.8	0.5
BG-SS-02	7	2	0.7 ± 0.1	0.8	0.6
BG-SS-04	6	3	--	0.8	0.6
BG-SS-05	8	4	0.7 ± 0.1	0.9	0.6
BG-SS-06	7	4	--	0.8	0.5
BG-SS-07	6	5	--	0.5	--
BG-SS-08	6	4	--	0.6	0.5
BG-SS-09	5	4	--	0.7	--
BG-SS-10	6	4	--	0.9	0.8
BG-SS-11	6	4	--	0.8	0.7
OS-SS-32	3	2	--	0.7	--
P3-SS-01	5	4	--	0.9	0.8
P3-SS-02	7	3	0.8 ± 0.2	1	0.5
PB-SS-01	3	2	--	0.7	--

Table 12.7 Summary of 1994 Concentrations of Metals in Soil, in mg/kg (cont'd)

Location	No. of Samples	No. BDL	Mean[1] ± Std.Dev.	Max	Min
Chromium					
BG-SS-01	6	0	21 ± 7.6	30	12
BG-SS-02	7	0	20 ± 8.7	29	7.5
BG-SS-04	6	0	21 ± 9.1	32	8.2
BG-SS-05	8	0	20 ± 7.2	33	12
BG-SS-06	7	0	20 ± 6.6	29	11
BG-SS-07	7	0	20 ± 5	26	13
BG-SS-08	6	0	20 ± 5.8	25	13
BG-SS-09	6	0	21 ± 7.6	29	11
BG-SS-10	6	0	22 ± 5.3	27	14
BG-SS-11	6	0	19 ± 7.7	31	10
OS-SS-32	3	0	26 ± 6.1	30	19
P3-SS-01	6	0	22 ± 6.6	31	12
P3-SS-02	7	0	18 ± 8.6	34	8.9
PB-SS-01	3	0	26 ± 7.2	32	18
Cobalt					
BG-SS-01	6	0	6.7 ± 0.7	7.8	6
BG-SS-02	7	0	7.1 ± 0.8	8	5.8
BG-SS-04	6	0	7.3 ± 0.6	8	6.6
BG-SS-05	8	0	7.5 ± 0.9	9.2	6.3
BG-SS-06	7	0	7.7 ± 0.5	8.2	7
BG-SS-07	7	0	7.8 ± 0.2	8.2	7.5
BG-SS-08	6	0	7.5 ± 0.5	8.2	6.8
BG-SS-09	6	0	7.4 ± 0.5	8.3	6.7
BG-SS-10	6	0	7.6 ± 0.5	8.6	7
BG-SS-11	6	0	7.9 ± 1.6	11	6.0
OS-SS-32	3	0	7.2 ± 0.9	8	6.3
P3-SS-01	6	0	9.6 ± 3	15	6.1
P3-SS-02	5	0	6.5 ± 0.9	7.7	5.5
PB-SS-01	3	0	7.1 ± 0.9	8	6.3
Copper					
BG-SS-01	6	0	14 ± 1.4	15	12
BG-SS-02	7	0	13 ± 2.8	17	7.5
BG-SS-04	6	0	13 ± 1.4	15	11
BG-SS-05	8	0	14 ± 1.7	16	12
BG-SS-06	7	0	11 ± 1.3	13	9.1
BG-SS-07	7	0	13 ± 5.2	25	10
BG-SS-08	6	0	12 ± 0.9	13	11
BG-SS-09	6	0	12 ± 0.8	13	11
BG-SS-10	6	0	13 ± 0.4	14	13
BG-SS-11	6	0	13 ± 3.4	19	10
OS-SS-32	3	0	15 ± 1.5	16	13
P3-SS-01	6	0	18 ± 1.8	20	15
P3-SS-02	7	0	15 ± 2.4	17	11
PB-SS-01	3	0	16 ± 5.9	23	12

Table 12.7 Summary of 1994 Concentrations of Metals on Soil, in mg/kg (cont'd)

Location	No. of Samples	No. BDL	Mean[1] ± Std.Dev.	Max	Min
Magnesium					
BG-SS-01	6	0	3,200 ± 350	3,700	2,700
BG-SS-02	7	0	2,800 ± 530	3,600	1,800
BG-SS-04	6	0	2,800 ± 670	3,600	1,800
BG-SS-05	8	0	3,000 ± 570	4,000	2,200
BG-SS-06	7	0	2,300 ± 370	2,900	1,800
BG-SS-07	7	0	2,500 ± 570	3,800	2,200
BG-SS-08	6	0	2,500 ± 390	3,200	2,200
BG-SS-09	6	0	2,600 ± 470	3,400	2,200
BG-SS-10	6	0	3,000 ± 170	3,200	2,800
BG-SS-11	6	0	2,800 ± 1,100	5,100	2,000
OS-SS-32	3	0	3,800 ± 460	4,300	3,500
P3-SS-01	6	0	3,800 ± 620	4,600	3,000
P3-SS-02	7	0	2,700 ± 620	3,500	1,800
PB-SS-01	3	0	4,000 ± 500	4,500	3,500
Manganese					
BG-SS-01	6	0	330 ± 47	420	290
BG-SS-02	7	0	450 ± 54	540	380
BG-SS-04	6	0	420 ± 31	460	380
BG-SS-05	8	0	440 ± 45	500	390
BG-SS-06	7	0	480 ± 48	540	400
BG-SS-07	7	0	480 ± 40	530	420
BG-SS-08	6	0	460 ± 34	500	420
BG-SS-09	6	0	440 ± 37	500	400
BG-SS-10	6	0	430 ± 33	480	400
BG-SS-11	6	0	520 ± 150	830	430
OS-SS-32	3	0	380 ± 120	460	250
P3-SS-01	6	0	640 ± 310	1,100	290
P3-SS-02	7	0	280 ± 120	540	180
PB-SS-01	3	0	390 ± 190	610	250
Molybdenum					
BG-SS-01	6	5	--	1	--
BG-SS-02	7	6	--	1	--
BG-SS-04	6	6	--	--	--
BG-SS-05	8	6	--	1	1
BG-SS-06	7	7	--	--	--
BG-SS-07	7	6	--	2	--
BG-SS-08	6	5	--	1	--
BG-SS-09	6	6	--	--	--
BG-SS-10	6	5	--	5	--
BG-SS-11	6	6	--	--	--
OS-SS-32	3	2	--	2	--
P3-SS-01	6	5	--	1	--
P3-SS-02	7	7	--	--	--
PB-SS-01	3	2	--	2	--

Table 12.7 Summary of 1994 Concentrations of Metals in Soil, in mg/kg (cont'd)

Location	No. of Samples	No. BDL	Mean[1] ± Std.Dev.	Max	Min
Chromium					
BG-SS-01	6	0	21 ± 7.6	30	12
BG-SS-02	7	0	20 ± 8.7	29	7.5
BG-SS-04	6	0	21 ± 9.1	32	8.2
BG-SS-05	8	0	20 ± 7.2	33	12
BG-SS-06	7	0	20 ± 6.6	29	11
BG-SS-07	7	0	20 ± 5	26	13
BG-SS-08	6	0	20 ± 5.8	25	13
BG-SS-09	6	0	21 ± 7.6	29	11
BG-SS-10	6	0	22 ± 5.3	27	14
BG-SS-11	6	0	19 ± 7.7	31	10
OS-SS-32	3	0	26 ± 6.1	30	19
P3-SS-01	6	0	22 ± 6.6	31	12
P3-SS-02	7	0	18 ± 8.6	34	8.9
PB-SS-01	3	0	26 ± 7.2	32	18
Cobalt					
BG-SS-01	6	0	6.7 ± 0.7	7.8	6
BG-SS-02	7	0	7.1 ± 0.8	8	5.8
BG-SS-04	6	0	7.3 ± 0.6	8	6.6
BG-SS-05	8	0	7.5 ± 0.9	9.2	6.3
BG-SS-06	7	0	7.7 ± 0.5	8.2	7
BG-SS-07	7	0	7.8 ± 0.2	8.2	7.5
BG-SS-08	6	0	7.5 ± 0.5	8.2	6.8
BG-SS-09	6	0	7.4 ± 0.5	8.3	6.7
BG-SS-10	6	0	7.6 ± 0.5	8.6	7
BG-SS-11	6	0	7.9 ± 1.6	11	6.8
OS-SS-32	3	0	7.2 ± 0.9	8	6.3
P3-SS-01	6	0	9.6 ± 3	15	6.1
P3-SS-02	5	0	6.5 ± 0.9	7.7	5.5
PB-SS-01	3	0	7.1 ± 0.9	8	6.3
Copper					
BG-SS-01	6	0	14 ± 1.4	15	12
BG-SS-02	7	0	13 ± 2.8	17	7.5
BG-SS-04	6	0	13 ± 1.4	15	11
BG-SS-05	8	0	14 ± 1.7	16	12
BG-SS-06	7	0	11 ± 1.3	13	9.1
BG-SS-07	7	0	13 ± 5.2	25	10
BG-SS-08	6	0	12 ± 0.9	13	11
BG-SS-09	6	0	12 ± 0.8	13	11
BG-SS-10	6	0	13 ± 0.4	14	13
BG-SS-11	6	0	13 ± 3.4	19	10
OS-SS-32	3	0	15 ± 1.5	16	13
P3-SS-01	6	0	18 ± 1.8	20	15
P3-SS-02	7	0	15 ± 2.4	17	11
PB-SS-01	3	0	16 ± 5.9	23	12

Table 12.7 Summary of 1994 Concentrations of Metals on Soil, in mg/kg (cont'd)

Location	No. of Samples	No. BDL	Mean[1] ± Std.Dev.	Max	Min
Magnesium					
BG-SS-01	6	0	3,200 ± 350	3,700	2,700
BG-SS-02	7	0	2,800 ± 530	3,600	1,800
BG-SS-04	6	0	2,800 ± 670	3,600	1,800
BG-SS-05	8	0	3,000 ± 570	4,000	2,200
BG-SS-06	7	0	2,300 ± 370	2,900	1,800
BG-SS-07	7	0	2,500 ± 570	3,800	2,200
BG-SS-08	6	0	2,500 ± 390	3,200	2,200
BG-SS-09	6	0	2,600 ± 470	3,400	2,200
BG-SS-10	6	0	3,000 ± 170	3,200	2,800
BG-SS-11	6	0	2,800 ± 1,100	5,100	2,000
OS-SS-32	3	0	3,800 ± 460	4,300	3,500
P3-SS-01	6	0	3,800 ± 620	4,600	3,000
P3-SS-02	7	0	2,700 ± 620	3,500	1,800
PB-SS-01	3	0	4,000 ± 500	4,500	3,500
Manganese					
BG-SS-01	6	0	330 ± 47	420	290
BG-SS-02	7	0	450 ± 54	540	380
BG-SS-04	6	0	420 ± 31	460	380
BG-SS-05	8	0	440 ± 45	500	390
BG-SS-06	7	0	480 ± 48	540	400
BG-SS-07	7	0	480 ± 40	530	420
BG-SS-08	6	0	460 ± 34	500	420
BG-SS-09	6	0	440 ± 37	500	400
BG-SS-10	6	0	430 ± 33	480	400
BG-SS-11	6	0	520 ± 150	830	430
OS-SS-32	3	0	380 ± 120	460	250
P3-SS-01	6	0	640 ± 310	1,100	290
P3-SS-02	7	0	280 ± 120	540	180
PB-SS-01	3	0	390 ± 190	610	250
Molybdenum					
BG-SS-01	6	5	--	1	--
BG-SS-02	7	6	--	1	--
BG-SS-04	6	6	--	--	--
BG-SS-05	8	6	--	1	1
BG-SS-06	7	7	--	--	--
BG-SS-07	7	6	--	2	--
BG-SS-08	6	5	--	1	--
BG-SS-09	6	6	--	--	--
BG-SS-10	6	5	--	5	--
BG-SS-11	6	6	--	--	--
OS-SS-32	3	2	--	2	--
P3-SS-01	6	5	--	1	--
P3-SS-02	7	7	--	--	--
PB-SS-01	3	2	--	2	--

Table 12.7 Summary of 1994 Concentrations of Metals in Soil, in mg/kg (cont'd)

Location	No. of Samples	No. BDL	Mean[1] ± Std.Dev.	Max	Min
Mercury					
BG-SS-01	6	6	--	--	--
BG-SS-02	7	6	--	0.1	--
BG-SS-04	6	6	--	--	--
BG-SS-05	8	8	--	--	--
BG-SS-06	7	7	--	--	--
BG-SS-07	7	7	--	--	--
BG-SS-08	6	6	--	--	--
BG-SS-09	6	6	--	--	--
BG-SS-10	6	6	--	--	--
BG-SS-11	6	6	--	--	--
OS-SS-32	3	3	--	--	--
P3-SS-01	6	6	--	--	--
P3-SS-02	7	7	--	--	--
PB-SS-01	3	3	--	--	--
Nickel					
BG-SS-01	6	0	13 ± 1.9	16	11
BG-SS-02	7	0	13 ± 2.2	16	9.9
BG-SS-04	6	0	14 ± 2.2	17	11
BG-SS-05	8	0	13 ± 1.6	17	12
BG-SS-06	7	0	13 ± 2.8	18	10
BG-SS-07	7	0	14 ± 1.5	16	12
BG-SS-08	6	0	13 ± 1.9	16	12
BG-SS-09	6	0	14 ± 2.4	17	11
BG-SS-10	6	0	15 ± 1.6	18	14
BG-SS-11	6	0	13 ± 3.6	20	10
OS-SS-32	3	0	14 ± 0.6	15	14
P3-SS-01	6	0	16 ± 2.4	19	13
P3-SS-02	7	0	12 ± 2.1	14	8.9
PB-SS-01	3	0	14 ± 1.5	16	13
Silver					
BG-SS-01	6	5	--	0.5	--
BG-SS-02	7	4	--	0.8	0.5
BG-SS-04	6	5	--	0.5	--
BG-SS-05	8	8	--	--	--
BG-SS-06	7	7	--	--	--
BG-SS-07	7	7	--	--	--
BG-SS-08	6	6	--	--	--
BG-SS-09	6	5	--	0.5	--
BG-SS-10	6	6	--	--	--
BG-SS-11	6	6	--	--	--
OS-SS-32	3	3	--	--	--
P3-SS-01	6	6	--	--	--
P3-SS-02	7	7	--	--	--
PB-SS-01	3	3	--	--	--

Table 12.7 Summary of 1994 Concentrations of Metals in Soil, in mg/kg (cont'd)

Location	No. of Samples	No. BDL	Mean[1] ± Std.Dev.	Max	Min
Zinc					
BG-SS-01	6	0	52 ± 5.6	60	46
BG-SS-02	7	0	51 ± 11	66	33
BG-SS-04	6	0	49 ± 12	64	32
BG-SS-05	8	0	55 ± 8.7	74	47
BG-SS-06	7	0	47 ± 6.9	57	36
BG-SS-07	7	0	50 ± 4.3	56	43
BG-SS-08	6	0	51 ± 3.6	55	47
BG-SS-09	6	0	49 ± 5.4	54	42
BG-SS-10	6	0	52 ± 4.6	59	46
BG-SS-11	6	0	52 ± 14	76	38
OS-SS-32	3	0	54 ± 4.4	59	51
P3-SS-01	6	0	73 ± 13	90	59
P3-SS-02	7	0	76 ± 18	95	51
PB-SS-01	3	0	58 ± 9.2	66	48

[1]BDL indicates below detection limit.
[2]Mean was not calculated if fewer than four observations were above detection limits.

Table 12.8 Summary of 1994 Concentrations of Explosive Compounds in Soil, in mg/kg

Location	No. of Samples	No. BDL[1]	Mean[2] ± Std.Dev.	Max	Min
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)					
BG-SS-01	7	5	--	0.4	0.03
BG-SS-02	7	1	0.11 ± 0.14	0.4	0.04
BG-SS-04	7	2	0.53 ± 0.33	1.1	0.3
BG-SS-05	9	1	3.54 ± 2.47	8.2	0.4
BG-SS-06	7	4	--	0.4	0.05
BG-SS-07	7	5	--	0.4	0.02
BG-SS-08	6	2	0.14 ± 0.17	0.4	0.04
BG-SS-09	6	3	--	0.4	0.03
BG-SS-10	6	4	--	0.4	0.03
BG-SS-11	7	6	--	0.4	--
OS-SS-32	2	2	--	--	--
P3-SS-01	6	3	--	0.4	0.06
P3-SS-02	7	4	--	0.4	0.02
PB-SS-01	2	1	--	0.02	--
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)					
BG-SS-01	7	6	--	0.4	--
BG-SS-02	7	6	--	0.4	--
BG-SS-04	7	6	--	0.4	--
BG-SS-05	9	8	--	0.4	--
BG-SS-06	7	6	--	0.4	--
BG-SS-07	7	6	--	0.4	--
BG-SS-08	6	5	--	0.4	--
BG-SS-09	6	5	--	0.4	--
BG-SS-10	6	5	--	0.4	--
BG-SS-11	7	6	--	0.4	--
OS-SS-32	2	2	--	--	--
P3-SS-01	6	5	--	0.4	--
P3-SS-02	7	5	--	0.4	0.4
PB-SS-01	2	2	--	--	--
Pentaerythritol tetranitrate (PETN)					
BG-SS-01	7	6	--	8	--
BG-SS-02	7	6	--	8	--
BG-SS-04	7	6	--	8	--
BG-SS-05	9	8	--	8	--
BG-SS-06	7	6	--	8	--
BG-SS-07	7	6	--	8	--
BG-SS-08	6	5	--	8	--
BG-SS-09	6	5	--	8	--
BG-SS-10	6	5	--	8	--
BG-SS-11	7	6	--	8	--
OS-SS-32	2	2	--	--	--
P3-SS-01	6	4	--	10	8
P3-SS-02	7	5	--	8	--
PB-SS-01	2	2	--	--	--

Table 12.8 Summary of 1994 Concentrations of Explosive Compounds in Soil, in mg/kg (cont'd)

Location	No. of Samples	No. BDL	Mean[1] ± Std.Dev.	Max	Min
Trinitrotoluene (TNT)					
BG-SS-01	7	6	--	0.4	--
BG-SS-02	7	6	--	0.4	--
BG-SS-04	7	6	--	0.4	--
BG-SS-05	9	8	--	0.4	--
BG-SS-06	7	6	--	0.4	--
BG-SS-07	7	6	--	0.4	--
BG-SS-08	6	5	--	0.4	--
BG-SS-09	6	5	--	0.4	--
BG-SS-10	6	5	--	0.4	--
BG-SS-11	7	6	--	0.4	--
OS-SS-32	2	2	--	--	--
P3-SS-01	6	5	--	0.4	--
P3-SS-02	7	5	--	0.4	0.4
PB-SS-01	2	2	--	--	--

[1]BDL indicates below detection limit.
[2] Mean was not calculated if fewer than four observations were above detection limits.

Table 12.9 Average Concentrations, by Area, of Uranium-234, Uranium-238, and Plutonium-239/240 in Soil in 1994

Area	Uranium-234[1,2]	Uranium-238[1,2]	Uranium-234: Uranium-238 Ratio	Plutonium-239/240[1,2]
Firing Site 4	1.02 ± 0.16	6.33 ± 0.60	0.21	0.03 ± 0.03
Firing Site 5	1.21 ± 0.17	8.06 ± 0.73	0.21	0.03 ± 0.03
Firing Site 10	0.34 ± 0.08	1.22 ± 0.16	0.43	0.03 ± 0.03
Burning Ground	0.39 ± 0.08	0.46 ± 0.08	1.03	0.02 ± 0.03
Offsite	0.25 ± 0.07	0.21 ± 0.07	1.22	0.02 ± 0.03
Bushland	0.35 ± 0.08	0.33 ± 0.08	1.07	0.02 ± 0.030

[1] Concentrations are expressed as pCi/g.
[2] Counting error at 95% confidence level is indicated by the ± value.

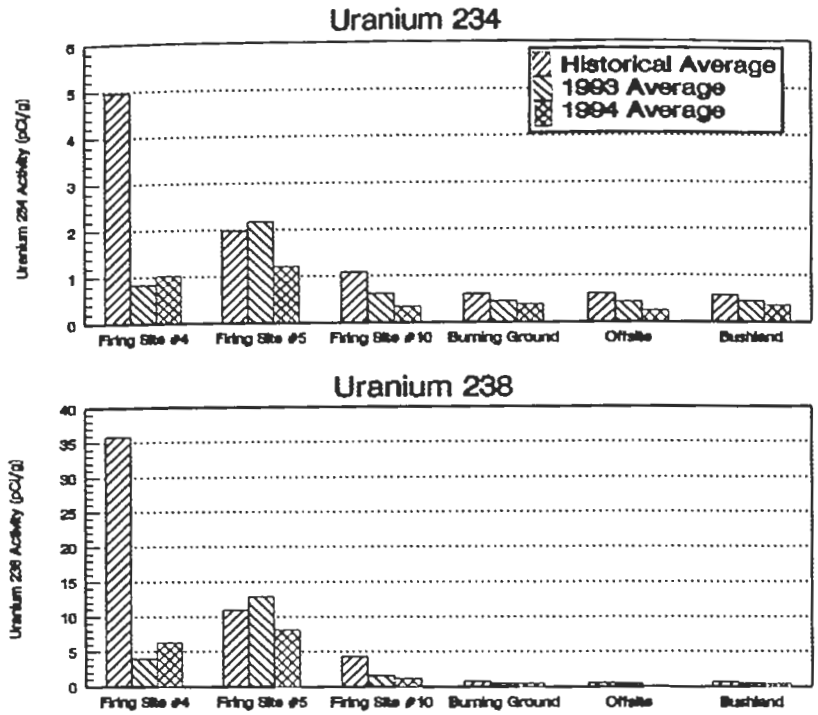


Figure 12.4: Average 1994, 1993, and historical uranium-234 and uranium-238 concentrations

Table 12.10 Average Radionuclide Concentrations in Soil

Analysis	Zone 4 West	Bushland[1]	Offsite[1]
Uranium-234[2,3]	0.49 ± 0.09	0.58 ± 0.11	0.61 ± 0.12
Uranium 238[2,3]	0.51 ± 0.09	0.74 ± 0.11	0.64 ± 0.12
Plutonium-239/240[2,3]	0.01 ± 0.04	0.01 ± 0.02	0.01 ± 0.02
Tritium[2,3]	0.05 ± 0.15	0.16 ± 0.90[4]	0.16 ± 0.90[4]
Radiation Dose Rate[5]	0.01	0.01	0.01

[1] Historical averages (1988-1993).
[2] Concentrations are expressed as pCi/g.
[3] Counting error at 95% confidence level is indicated by the ± value.
[4] 1994 average.
[5] Units are millirem/hour.

Chapter 13

FLORA

Environmental surveillance of flora is important to understanding and assessing effects that Plant operations may have on the environment. The terms "flora" and "vegetation" are used interchangeably throughout this chapter, both defined as general plant life. Crops are defined as any agricultural product that can be harvested or gathered for food, forage, or fiber. Forage is plant matter composed of leaves and stems (fodder) used as food by domestic animals. Samples for radionuclide and fluoride analyses represent native vegetation (such as range grasses and weeds) and crops. Because various species and individuals take up contaminants differently under different growing conditions, data interpretation is complex, and results must be considered and evaluated in concert with results of surveillance of other media, such as soil and air. This chapter summarizes results of the 1994 onsite and offsite surveillance of flora at Pantex Plant, including analytical data for radionuclides and fluorides in flora.

13.1 Radiological Surveillance of Flora

Radionuclide analyses of native vegetation are used to determine whether plants have taken up tritium, uranium-234, uranium-238, or plutonium-239/240 from air or soil. Naturally occurring radioactive materials, cosmic sources, and global fallout (such as from the testing of nuclear explosive devices) are other sources of radiation that could be taken up by vegetation. Vegetation is monitored to determine whether radiological activities exceed background and historical levels at onsite and offsite locations.

Samples were collected at 5 onsite and 17 offsite locations during 1994 (Table 13.1 and Figures 13.1 and 13.2). One offsite control sampling station (OV-VS-17) is located at Bushland, Texas (Figure 1.1). This location was selected because of its distance from Pantex Plant, its ease of access, and its typical Southern High Plains vegetation, which is unaffected by industrial activities.

Vegetation was collected monthly at the five onsite locations and Bushland and quarterly at the other offsite locations. Samples were collected in accordance with internal operating procedure D4260, "Vegetation Sampling Procedures." Vegetation sampled consisted of native, exotic, and/or domestic grasses, and weeds indigenous to the area. Stems and leaves were collected at each sampling location.

An offsite contract laboratory analyzed vegetation samples for tritium, uranium-234, and uranium-238. Four onsite vegetation, three offsite vegetation, and one onsite crop sample were also analyzed for plutonium-239/240. Analytical procedures were conducted according to guidelines discussed in Chapter 14. Currently, there are no regulatory limits for tritium, uranium, or plutonium in vegetation. Therefore, the data are compared to historical values and an offsite background concentration to allow identification of trends or changes. Historical averages for tritium, uranium-234, and uranium-238 are based on routine surveillance data from 1989 through 1993. Tables 13.2 through 13.4 summarize radiological results for 1994 vegetation samples. These tables are based on raw data published in a detailed compilation (Mason & Hanger 1995a).

13.2 Radiological Surveillance of Crops

Farming and ranching activities onsite managed by Texas Tech University are an integral land use at Pantex Plant. During the 1994 growing season, approximately 236 hectares (584 acres) of

Table 13.1 Locations of Routine Onsite and Offsite Vegetation Sample Sites

Location	Description
Onsite	
Burning Ground:	
BG-VS-01	100.6 meters (330 feet) northwest of northwest pad, 11 meters (36 feet) east of west fe line
Firing Site 5:	
FB-VS-01	91.5 meters (300 feet) northwest of northwest corner of bunker
FB-VS-02	76.2 meters (250 feet) north of northwest corner of bunker
FB-VS-03	122 meters (400 feet) south of southwest corner of bunker
Firing Site 10:	
FC-VS-01	91.5 meters (300 feet) northeast of northeast corner of bunker
Offsite	
OV-VS-01	Northwest corner of intersection of FM 683 and FM 245
OV-VS-02	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 3.2 kilomete (2.0 miles) east at cattle guard
OV-VS-03	3.2 kilometers (2.0 miles) west of intersection of FM 683 and FM 245, north fence
OV-VS-04	1.6 kilometers (1.0 mile) west of intersection of FM 683 and FM 293, north fence
OV-VS-05	0.5 kilometers (0.3 mile) east of intersection of FM 683 and FM 293, 2.6 kilometers (miles) north, west fence
OV-VS-06	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 3.2 kilomete (2.0 miles) west, 2.1 kilometers (1.3 miles) north, east fence
OV-VS-07	3.7 kilometers (2.3 miles) north of intersection of FM 2373 and FM 293, northwest cor
OV-VS-08	5.5 kilometers (3.4 miles) east of intersection of FM 2373 and FM 293, south fence
OV-VS-09	3.2 kilometers (2.0 miles) south of intersection of FM 2373 and FM 293, 3.2 kilomete (2.0 miles) east, southwest corner
OV-VS-10	6.6 kilometers (4.1 miles) east of intersection of FM 2373 and US 60, south fence
OV-VS-11	4.3 kilometers (2.7 miles) south of intersection of US 60 and FM 2161, east fence at marker
OV-VS-12	3.9 kilometers (2.4 miles) south of intersection of US 60 and FM 2373, southeast cor intersection at fence
OV-VS-13	2.4 kilometers (1.5 miles) east of intersection of US 60 and FM 683, 1.6 kilometers (mile) south, west fence
OV-VS-14	6.8 kilometers (4.2 miles) south of intersection of FM 245 and FM 683, fence north railroad tracks
OV-VS-15	3.2 kilometers (2.0 miles) north of intersection of FM 2373 and FM 293, 3.2 kilome miles) east, 1.6 kilometers (1.0 mile) north, 0.5 kilometer (0.3 mile) west
OV-VS-16	2.4 kilometers (1.5 miles) east of intersection of FM 2373 and FM 293, 0.6 kilomete mile) north
OV-VS-17	Bushland, Texas, near air monitor

grain sorghum (*Sorghum bicolor*) were harvested, and 1,090 hectares (2,694acres) of winter wheat (*Triticum aestivum*) were planted for harvest in June 1995. Forage sorghum, fallow areas, and pasture/grassland totaling 1,141 hectares (2,818 acres) made up the rest of the farm ranching activities onsite.

Crop surveillance is important to potential health risks to employees, the pu

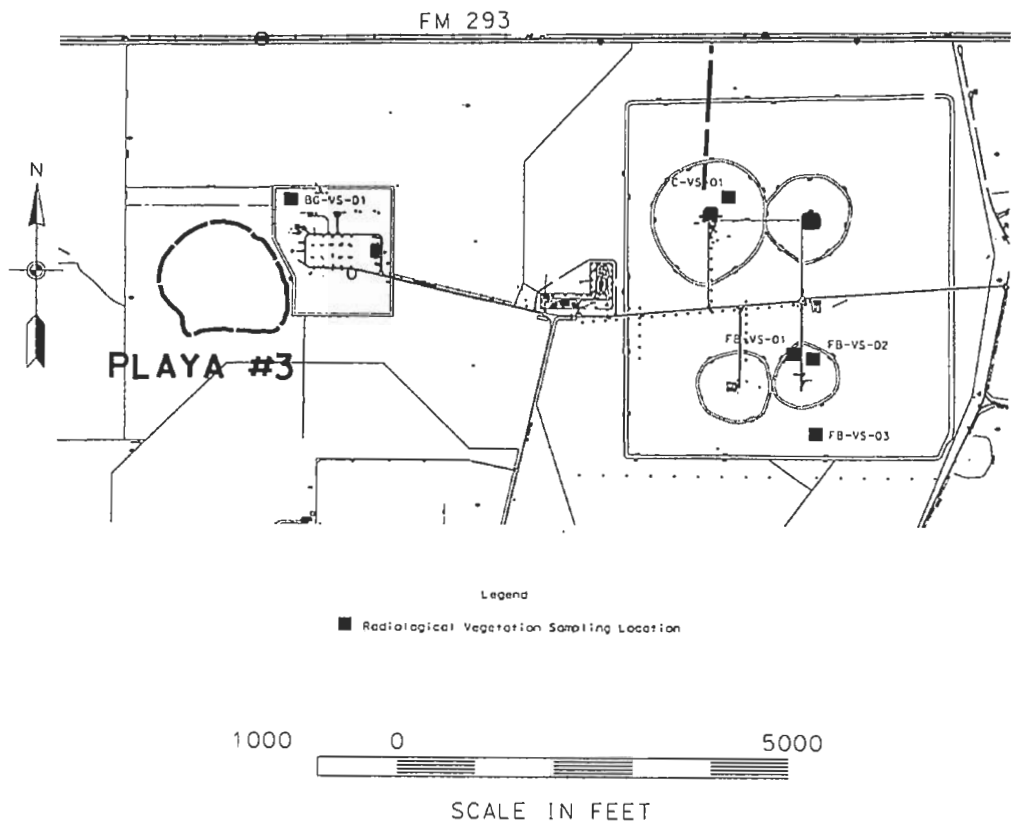


Figure 13.1: Routine vegetation sampling locations at the Burning Ground and firing sites. These are the only onsite vegetation sampling locations.

animals from Plant operations. Samples consisting of stems and leaves of winter wheat and grain sorghum were collected onsite and at Bushland. Crop sampling locations vary each year according to crop rotations established by the farmer. As a result, crop samples were collected at 8 locations onsite in 1994 and at 17 locations in 1993 (Tables 13.5 and 13.6). Each crop sample was analyzed for tritium, uranium-234, and uranium-238; some were also analyzed for plutonium-239/240. Table 13.7 summarizes radiological data for winter wheat and grain sorghum for 1994; Table 13.8 presents corresponding information for 1993.

13.3 Fluoride in Vegetation

Pantex Plant's current operations include treatment of explosives and explosive-contaminated materials by burning at the Burning Ground, which may release fluoride particulates to the atmosphere that can be taken up through microscopic openings (stoma) in the leaves of vegetation. Some animals, particularly cattle, are more sensitive than people to high fluoride concentrations and may develop fluorosis from grazing on contaminated vegetation. The Texas Air Control Board, a predecessor agency of the Texas Natural Resource Conservation Commission (TNRCC), established limits for

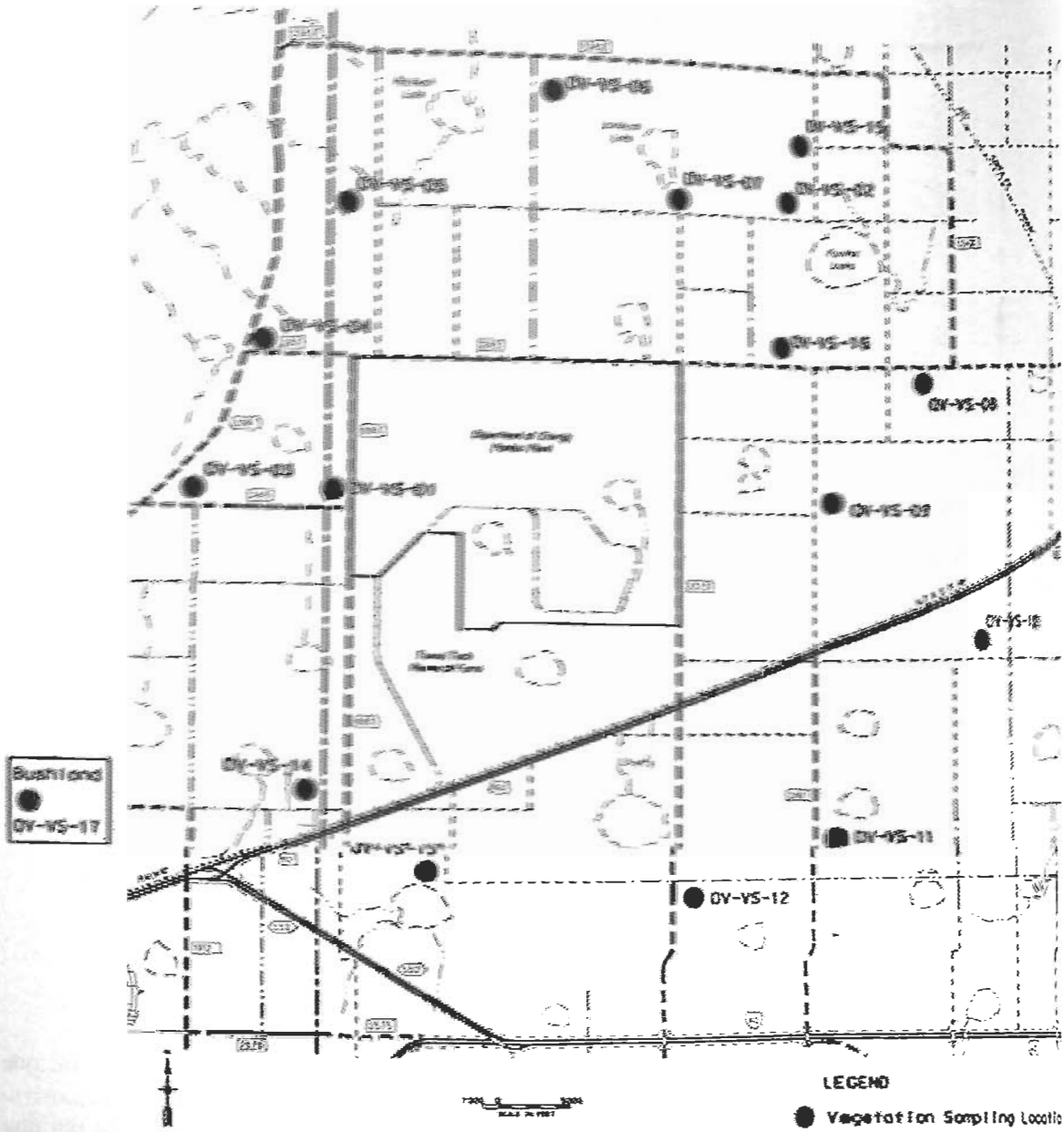


Figure 13.2: Locations for offsite routine vegetation sampling

inorganic fluoride in air and forage in Texas Administrative Code, Title 31, Chapter 113, "Control of Air Pollution from Toxic Materials."

Winter wheat, grain sorghum, and forage sorghum are eaten by cattle at Pantex Plant; therefore these plants are analyzed for fluoride. Results are shown in Table 13.9. Winter wheat was collected from areas adjacent to the Burning Ground during its growing season (Ma through June). Grain sorghum was colle from areas near the Burning Ground during growing season (July through October). C vegetation was also collected at 42 surveill locations during 1994. Sampling locations h varied, depending on crop rotations near Burning Ground.

Table 13.2 Summary of 1994 Concentrations of Tritium in Vegetation, in pCi/g

Location	No. of Samples	Mean[1]	Max[1]	Min[1]	Historical[2] Mean
Onsite					
Burning Ground:					
BG-VS-01	4	9.58 ± 2.48	33.0 ± 5.68	0.00 ± 0.12	1.02 ± 0.21
Firing Site 5:					
FB-VS-01	5	2.39 ± 2.54	9.54 ± 3.94	-1.46 ± 3.95	0.43 ± 0.18
FB-VS-02	5	-0.17 ± 2.93	1.23 ± 2.20	-3.42 ± 3.90	0.99 ± 0.21
FB-VS-03	5	0.80 ± 2.04	3.79 ± 1.93	-0.63 ± 3.13	0.56 ± 0.19
Firing Site 10:					
FC-VS-01	4	1.29 ± 2.19	3.99 ± 2.01	-0.25 ± 3.31	5.33 ± 0.23
Offsite					
OV-VS-01	2	NA[3]	10.3 ± 3.35	2.19 ± 4.94	0.06 ± 0.17
OV-VS-02	2	NA	1.69 ± 3.66	-3.68 ± 4.95	0.11 ± 0.17
OV-VS-03	2	NA	22.4 ± 4.63	0.35 ± 3.61	0.17 ± 0.18
OV-VS-04	2	NA	14.5 ± 4.53	0.92 ± 2.31	0.12 ± 0.18
OV-VS-05	2	NA	7.11 ± 4.50	3.59 ± 3.50	0.38 ± 0.19
OV-VS-06	2	NA	16.8 ± 4.48	4.73 ± 3.30	0.24 ± 0.19
OV-VS-07	2	NA	3.44 ± 2.72	1.05 ± 2.49	0.11 ± 0.18
OV-VS-08	2	NA	4.76 ± 3.46	2.12 ± 4.34	0.13 ± 0.18
OV-VS-09	2	NA	7.81 ± 5.59	2.84 ± 4.22	0.28 ± 0.20
OV-VS-10	2	NA	3.71 ± 3.47	2.91 ± 5.52	0.16 ± 0.18
OV-VS-11	2	NA	5.38 ± 3.65	0.99 ± 3.41	0.30 ± 0.19
OV-VS-12	2	NA	22.4 ± 10.4	8.98 ± 4.26	0.20 ± 0.19
OV-VS-13	3	15.9 ± 3.97	39.1 ± 4.44	3.63 ± 3.86	0.15 ± 0.18
OV-VS-14	2	NA	8.74 ± 4.21	4.65 ± 5.02	0.50 ± 0.18
OV-VS-15	1	NA	0.75 ± 5.79	NA	0.10 ± 0.18
OV-VS-16	2	NA	3.91 ± 4.00	1.93 ± 3.15	0.13 ± 0.18
OV-VS-17	6	5.72 ± 3.64	10.0 ± 3.30	-0.02 ± 0.12	0.33 ± 0.17

1 Counting error at 95% confidence level is indicated by the ± value.
2 Historical averages (1989-1993).
3 NA indicates not applicable.

13.4 Summary of Results

Tritium in vegetation (Table 13.2) at 19 of 22 locations in 1994 was significantly above historical (1989-1993) maximums for the same locations. The increase may not be attributable to Plant operations, but may rather be an artifact of changing analytical laboratories. Accu-Labs Research, Inc. (ALR), of Golden, Colorado, analyzed all vegetation samples until September 1993. IEA Laboratories, Inc., of Cary, North Carolina, analyzed vegetation samples from April to September 1994. Because of the variability of the IEA data for the Bushland location (Figure 13.3), the October samples were sent to ALR. The 1994 values do not represent a risk to human health or the environment.

Table 13.5 Crop Sampling Locations for 1994

Location	Description
Wheat	
CR-WW-01	East of Burning Ground
Sorghum	
CR-SO-01	West of Range 1
CR-SO-02	West of PTR Building
CR-SO-03	Northeast near PM-106
CR-SO-04	Near BG-SS-05
CR-SO-05	Duplicate of CR-SO-04
CR-SO-06	Northeast corner of Burning Ground
CR-SO-07	Northwest corner of Burning Ground

Table 13.6 Crop Sampling Locations for 1993

Location	Description
Wheat	
CR-WW-01	Field north of Burning Ground, ⅓ of way down from northwest corner
CR-WW-02	Duplicate of CR-WW-01
CR-WW-03	Field north of Burning Ground, ⅔ of way down from northwest corner
CR-WW-04	Field east of Burning Ground, ¼ of way down from northeast corner
CR-WW-05	Field east of Burning Ground, ½ of way down from northeast corner
CR-WW-06	Field east of Burning Ground, ¾ of way down from northeast corner
CR-WW-07	Field south of Burning Ground, ⅓ of way down from southeast corner
CR-WW-08	Field south of Burning Ground, ⅔ of way down from southeast corner
CR-WW-09	Offsite field north of Trailer 9-25 by highline pole
Sorghum	
CR-SO-01	Field northwest of Burning Ground near fence line on FM 293
CR-SO-02	Field northwest of Burning Ground 91.5 meters (300 feet) south of CR-SO-01
CR-SO-03	Field northeast of Burning Ground near fence line on FM 293
CR-SO-04	Duplicate of CR-SO-03
CR-SO-05	Field northeast of Burning Ground 91.5 meters (300 feet) south of CR-SO-03
CR-SO-06	Field northeast of Burning Ground at intersection of CC Road and FM 293
CR-SO-07	Field northeast of Burning Ground 91.5 meters (300 feet) north of CR-SO-06
CR-SO-08	Offsite field at intersection of US 60 and Carson County Road B, 2.1 kilometers (1.3 miles) south, 0.8 kilometer (0.5 mile) east

Table 13.7 Summary of Mean[1] 1994 Concentrations of Radionuclides in Crops, in pCi/g

Location	Tritium	Uranium-234	Uranium-238	Plutonium-239/240[2]
Wheat				
CR-WW-01	0.13 ± 0.17	0.01 ± 0.01	0.01 ± 0.01	0.00 ± 0.10
Sorghum				
CR-SO-01	0.04 ± 0.12	0.06 ± 0.03	0.05 ± 0.02	--
CR-SO-02	0.04 ± 0.12	0.03 ± 0.02	0.03 ± 0.02	--
CR-SO-03	0.08 ± 0.12	0.02 ± 0.02	0.05 ± 0.02	--
CR-SO-04	0.12 ± 0.12	0.06 ± 0.03	0.08 ± 0.03	--
CR-SO-05	0.14 ± 0.12	0.06 ± 0.02	0.08 ± 0.02	--
CR-SO-06	0.09 ± 0.12	0.10 ± 0.03	0.07 ± 0.02	--
CR-SO-07	0.16 ± 0.12	0.03 ± 0.02	0.06 ± 0.02	--

1 Counting error at 95% confidence level is indicated by the ± value.
2 Sorghum samples were not analyzed for plutonium-239/240.

Table 13.8 Summary of Mean[1] 1993 Concentrations of Radionuclides in Crops, in pCi/g

Location	Tritium	Uranium-234	Uranium-238	Plutonium-239/240[2]
Wheat				
CR-WW-01	0.13 ± 0.17	0.01 ± 0.01	0.01 ± 0.01	--
CR-WW-02	0.02 ± 0.17	0.01 ± 0.01	0.01 ± 0.01	--
CR-WW-03	0.04 ± 0.17	0.02 ± 0.01	0.01 ± 0.01	--
CR-WW-04	0.15 ± 0.17	0.00 ± 0.01	0.00 ± 0.01	--
CR-WW-05	0.05 ± 0.17	0.01 ± 0.01	0.01 ± 0.01	--
CR-WW-06	0.08 ± 0.17	0.01 ± 0.01	0.01 ± 0.01	--
CR-WW-07	0.05 ± 0.17	0.01 ± 0.01	0.01 ± 0.01	--
CR-WW-08	0.08 ± 0.17	0.02 ± 0.01	0.01 ± 0.01	--
CR-WW-09	0.04 ± 0.17	0.01 ± 0.01	0.02 ± 0.01	--
Sorghum				
CR-SO-01	0.02 ± 0.13	0.01 ± 0.01	0.01 ± 0.01	0.00 ± 0.10
CR-SO-02	0.08 ± 0.13	0.01 ± 0.01	0.01 ± 0.01	0.00 ± 0.10
CR-SO-03	0.03 ± 0.13	0.02 ± 0.01	0.00 ± 0.01	0.00 ± 0.10
CR-SO-04	0.00 ± 0.13	0.00 ± 0.01	0.00 ± 0.01	0.00 ± 0.10
CR-SO-05	0.03 ± 0.18	0.01 ± 0.01	0.01 ± 0.02	0.00 ± 0.10
CR-SO-06	0.01 ± 0.13	0.00 ± 0.01	0.00 ± 0.01	0.00 ± 0.10
CR-SO-07	0.00 ± 0.13	0.00 ± 0.01	0.00 ± 0.01	0.00 ± 0.10
CR-SO-08	0.18 ± 0.14	0.01 ± 0.01	0.02 ± 0.01	0.00 ± 0.10

1 Counting error at 95% confidence level is indicated by the ± value.
2 Wheat samples were not analyzed for plutonium-239/240.

Table 13.9 1994 Concentrations of Fluoride in Crops, in parts per million

Crop or NV[1]/Month	No. of Samples	No. BDL[2]	Mean[3] ± Std. Dev.	Max.	M
Sorghum/August	19	10	29.5 ± 14.3	68	B
Sorghum/September	11	11	20.0 ± 0.0	BDL	B
Sorghum/October	12	5	29.0 ± 10.4	46	B

1 NV indicates native vegetation (kochin, range grasses, etc.)
2 BDL indicates below detection limit (<20).
3 Mean is reported as a less-than (<) mean, where values below detection limit are evaluated at the detection limit (20 ppm).

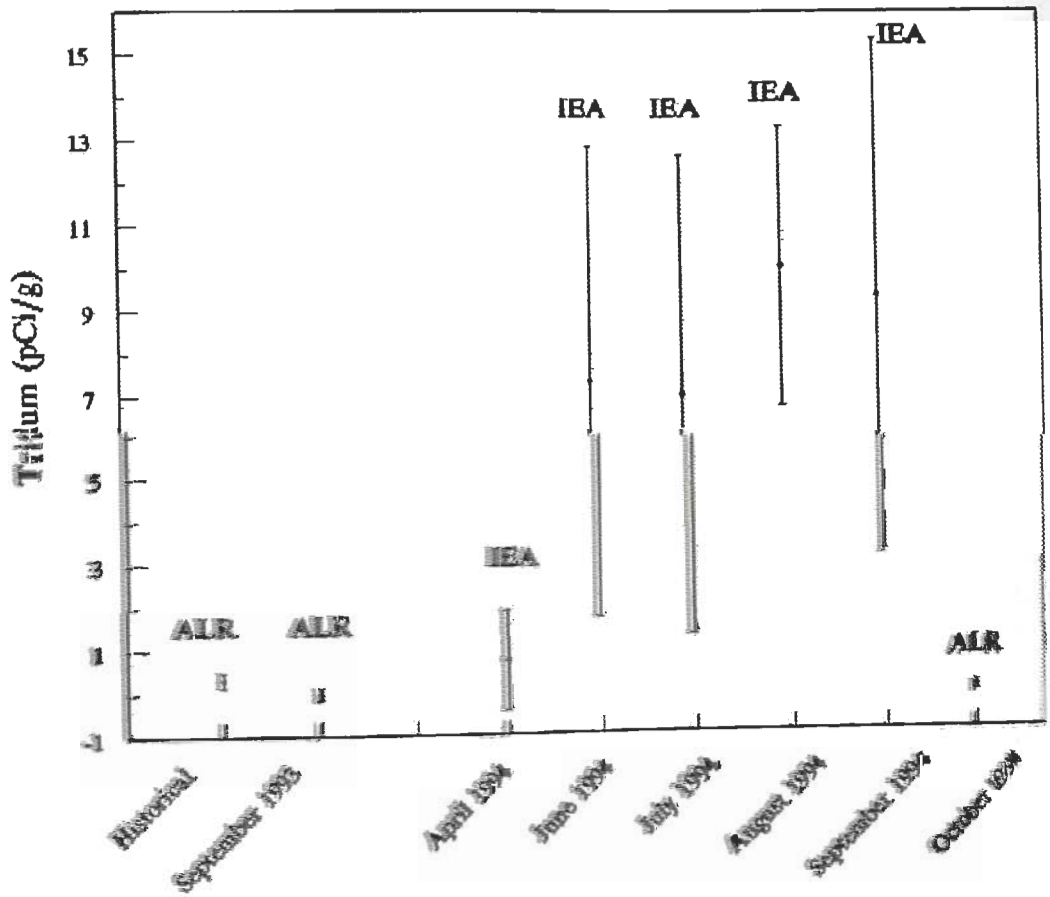


Figure 13.3: Tritium concentrations at Bushland in 1994, comparing IEA results to historical and 1994 ALR results. Error bars around the data points represent counting error. Data were collected only during the growing season.

Chapter 14

QUALITY ASSURANCE

As required by DOE Order 5400.1, "General Environmental Protection Program," Pantex Plant has established a quality assurance/quality control (QA/QC) program that ensures the accuracy, precision, and reliability of analytical results generated during environmental monitoring consistent with the requirements of DOE Order 5700.6C, "Quality Assurance." Quality assurance (QA) for environmental monitoring is defined as an integrated system of management activities including planning, implementation, assessment, reporting, and quality improvement to ensure that a process or service is of the type and quality needed and expected by the individuals and agencies using the environmental monitoring data. Quality control (QC) for environmental monitoring is defined as the overall system of technical activities that measures the attributes and performance of a process or service against defined standards to verify that they meet the requirements established by the individuals and agencies using the environmental monitoring data. Activities related to QA are promulgated or described in such documents as DOE Orders, Plant policy directives, and specific internal operating procedures for specific environmental media. The current hierarchy of QA documents for environmental monitoring activities is depicted in Figure 14.1.

QA/QC features are present in all aspects of the Pantex Plant environmental monitoring program. The first phase of the monitoring program is the collection of samples, and QA/QC methods are used in all collection activities in the field, as described in Section 14.1. To ensure that the integrity of each sample is maintained between collection and delivery to the analyzing laboratory, a sample custody control process is employed. This process is described in Section 14.2.

The next phase of the environmental monitoring program is analysis of the samples to obtain results that can be compared against regulatory standards, results from separate concurrent sampling events, and results from previous and future sampling events. For these comparisons to be valid, samples must be analyzed in a consistent manner. Each analytical laboratory used by Pantex Plant during 1994 was therefore required to have an internal QA program that ensured consistent, repeatable performance and documentation of analyses. All samples were analyzed by methods approved by EPA when such methods were available. Analytical procedures are discussed in Section 14.3; QA programs associated with each laboratory are discussed in Section 14.4.

Independent verification of the quality of analytical laboratories is the next phase of the environmental monitoring QA program. The activities used as external checks on the laboratories' performance are discussed in Section 14.5. Following data validation, the analytical results were entered into databases and provided to those scientists responsible for data interpretation. Section 14.6 discusses the sample tracking and data management processes used, and Section 14.7 discusses the performance indicators used during 1994 to discover laboratory quality or monitoring program problems.

During 1994, Pantex Plant staff prepared a draft Quality Assurance Manual for Environmental Monitoring that describes in more detail the various aspects of quality as they affect the environmental monitoring program. The final version of this manual, incorporating changes recommended by reviewers, will be completed and implemented during 1995.

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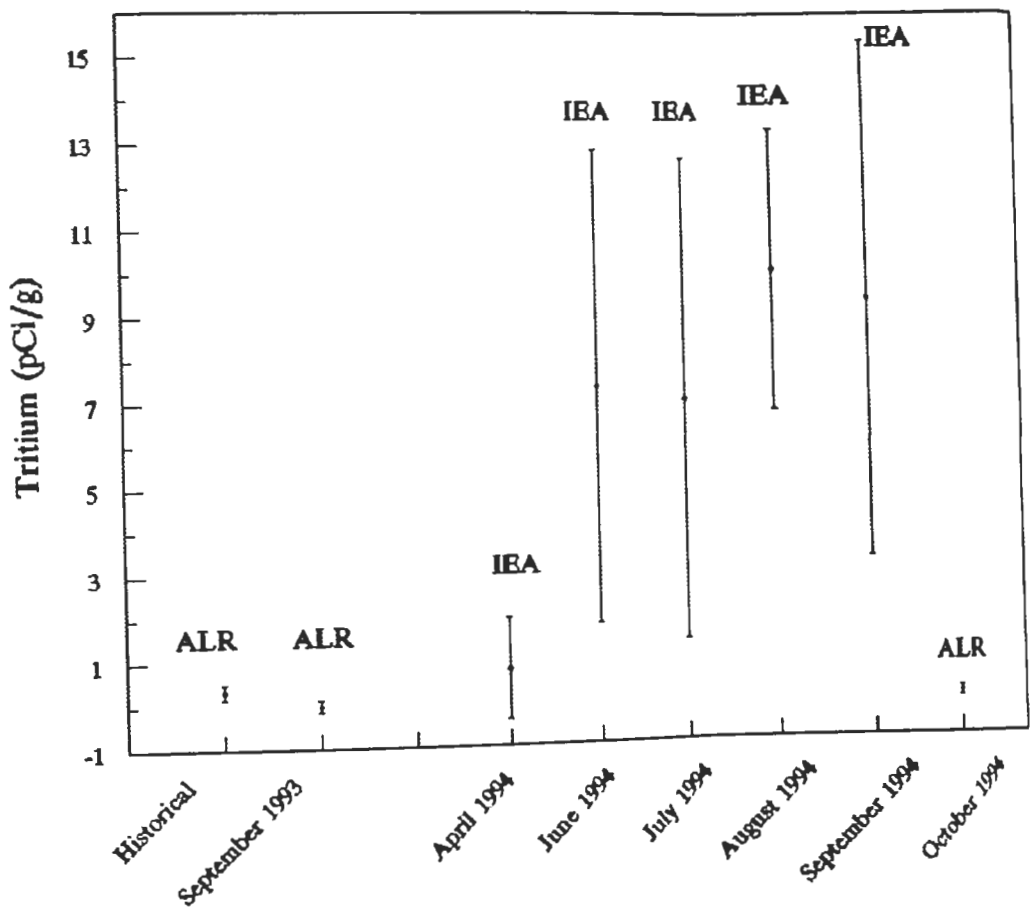

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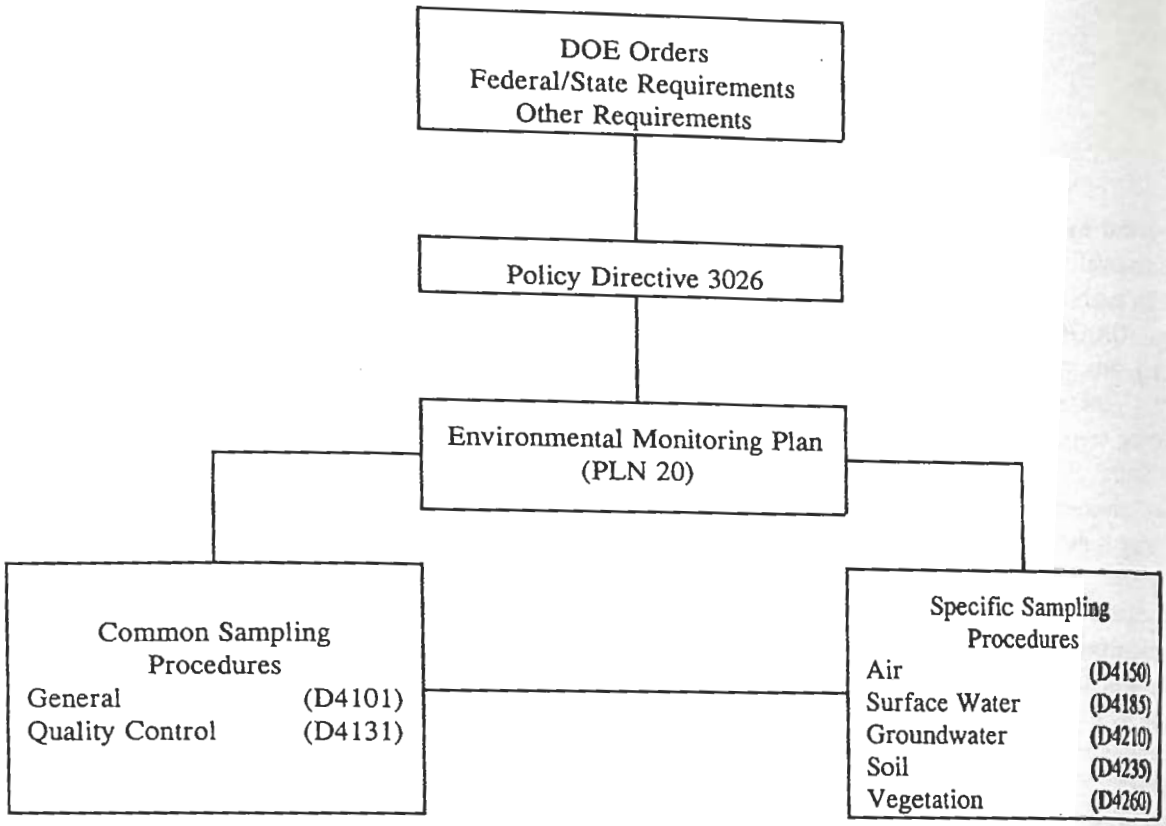

Figure 14.1: Quality assurance hierarchy. Specific plans and procedures are indicated in parenthese

14.1 Quality Assurance in the Field

Samples of various environmental media were routinely collected during 1994. Sampling staff who collected the samples are trained, experienced, and knowledgeable in sample collection procedures. To ensure comparability of results between sampling events, sampling staff performed all sampling according to documented internal operating procedures for the specific environmental media being measured. At the time of sample collection, a logbook entry was made assigning a unique sample number. Entries included the date and time of sampling, sample location, analyses to be run, media sampled, weather conditions at the time of sampling, and the initials of the sampling technicians. Only the sample number was provided to the analytical laboratory as a sample identifier. This ensured that the analytical **laboratory** was not biased by (it was "blind" to) the sample location. In addition, samp technicians collected and submitted field (samples. These included duplicate samp decontamination rinsates, trip blanks, and fi blanks. These samples (described below) a assigned numbers similar to those of environmental samples and were shipped to analytical laboratory with the environm samples. Because the analytical laboratory "blind" to the sample location or type, it not distinguish the QC samples from any environmental samples, and an unb evaluation of laboratory quality was obtai

During 1994, a second (or duplicate) samp randomly collected during sampling to that the environmental monitoring/a process was consistent. For analytes oth radionuclides, the measurement of cons between duplicate samples ("repeatabilit determined by calculating the relative

difference (*RPD*). That term is defined by the equation

$$RPD = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} \; X \; 100\%$$

where D_1 and D_2 represent analytical measurements on duplicate samples. For radionuclides, repeatability was determined by calculating the duplicate error ratio (*DER*), which is defined by the equation

$$DER = \frac{|S - D|}{(2\sigma_S + 2\sigma_D)}$$

where S represents the original sample value, D represents the duplicate value, and 2 σ_S and 2 σ_D represent the sample uncertainties of the original and duplicate samples, respectively. Duplicate analytes for which *RPD* was less than 20% or *DER* was less than 1.5 were considered acceptable (referred to as being "in control"). Results for the duplicate measurement program are discussed in Section 14.7.

The other major category of field QC samples, blanks and rinsates, were collected during sampling to verify that none of the contaminants being measured were inadvertently introduced into samples during collection, transport, or analysis. After sampling equipment was decontaminated, rinsates from the "clean" equipment were obtained and analyzed to determine whether sequential samples might be cross-contaminated by inadequately decontaminated equipment. Trip blanks are laboratory-created water samples sent with each shipment of water samples and analyzed for volatile organic compounds to ensure that samples were not cross-contaminated with volatile organic compounds during sample bottle preparation, shipment, handling, and storage. Field blanks are samples of clean water made up in the field to ensure that samples were not contaminated with volatile organic compounds present in ambient air during sampling. Analytical results for the blanks and rinsates were reviewed to determine whether cross-contamination of samples had occurred. The results of the review are discussed in Section 14.7.

14.2 Sample Custody Control Process

Custody of samples was controlled to ensure their integrity between collection and analysis. Figure 14.2 depicts the custody control process.

At the time of sampling, technicians initialed and attached a custody seal to the sample container. The seal was placed so that the sample container could not be opened without breaking the seal. The sample was then placed in a cooler in the sampling crew's vehicle. The cooler remained with the crew or was locked within the vehicle while sampling continued. At the end of a sampling round (generally at the end of the day), all samples were taken to a locked storage area until they were to be shipped to an analytical laboratory.

When the samples were removed from storage, a Chain-of-Custody (COC) form was initiated, and the form number was listed in the sampling logbook. Water, soil, or vegetation samples and the associated COC forms were placed within a cooler, and a custody label similar to the sample seal was placed on the cooler in such a way that the cooler could not be opened without breaking the label. Filters and/or silica gel samples were generally not placed in a cooler, but were placed in other containers that were sealed in the same manner as the coolers. Samples were then delivered to a Pantex Plant laboratory or to the Plant's General Stores for shipment to an offsite laboratory. The person releasing the samples retained a copy of the COC form for tracking purposes, as discussed in Section 14.6. Pantex Plant personnel kept track of all bills of lading for each offsite shipment. When the samples ar-

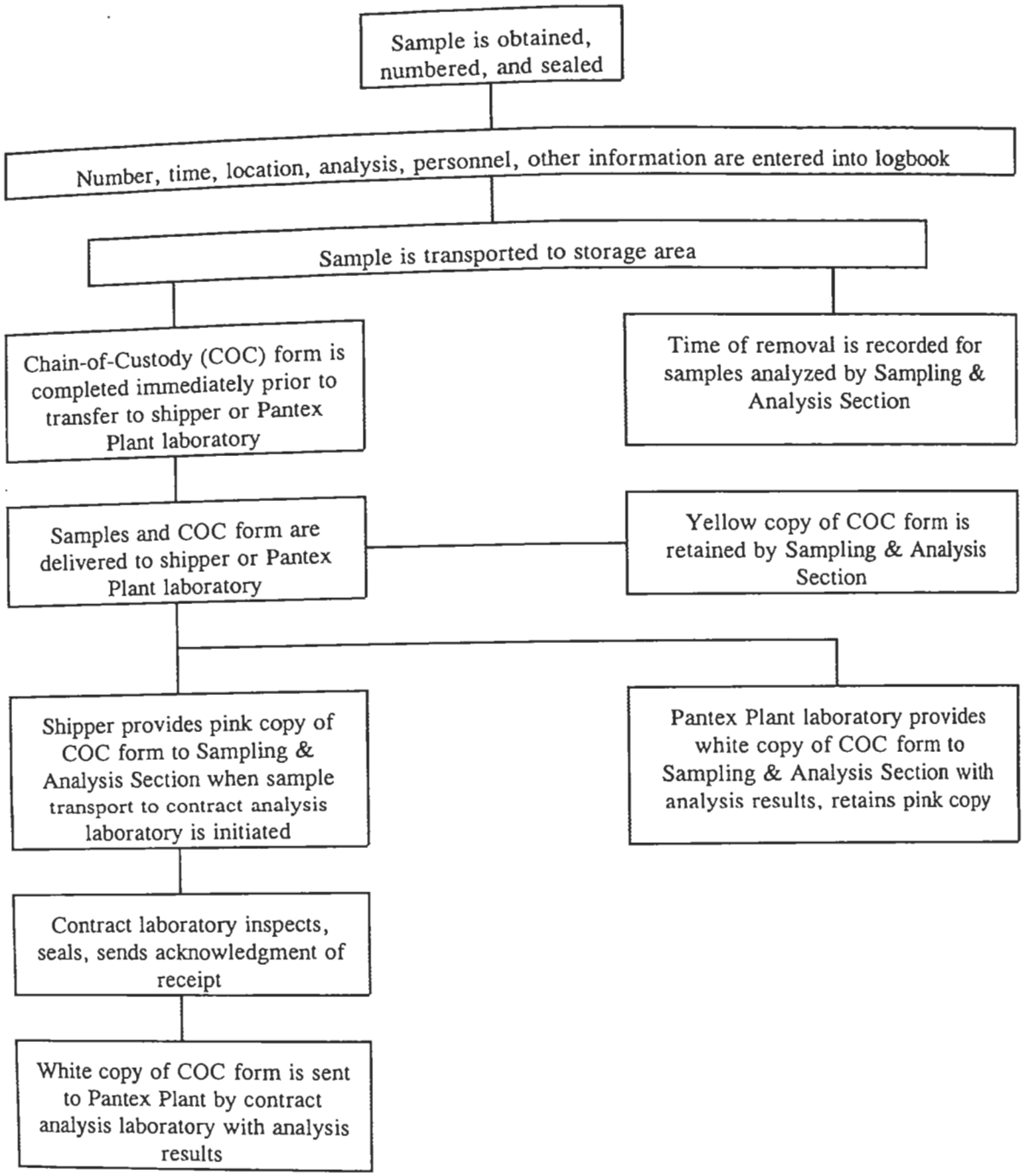

Figure 14.2: Chain-of-custody process

rived at the analytical laboratory, laboratory personnel reviewed the COC form to ensure that the listed samples were received, verified the integrity of the custody seal on each sample container, noted the condition of each sample, and signed the COC form. A sample acknowledgment was then sent from the offsite or Pantex Plant laboratory to the Environmental Protection Department, acknowledging the receipt of the samples and noting any discrepancies with the form. The sample acknowledgment was reviewed by Environmental Protection Depart-

ment personnel when received and, if necessary, adjustments were made to the sample tracking database described in Section 14.6. When analyses were completed, the laboratory returned a copy of the COC form with the analytical results.

14.3 Analytical Laboratory Procedures

Analysis procedures used in 1994 were consistent with those used in previous years to ensure comparability of results. All samples were analyzed by EPA-approved methods and associated QA/QC procedures where these methods were available. The methods used are summarized below.

Laboratories that performed the majority of the analyses in 1994 were Accu-Labs Research, Inc., in Golden, Colorado; Barringer Laboratories, Inc., in Golden, Colorado; IEA, Inc., in Cary, North Carolina; and Southwest Laboratory of Oklahoma, Inc., in Broken Arrow, Oklahoma. Radiological analyses were performed by Accu-Labs Research and IEA only. All laboratories performed nonradiological analyses, with the following exceptions: From January through March 1994, the City of Amarillo's River Road Waste Water Treatment Plant Laboratory performed those analyses for which the EPA method requires that analysis be initiated within 48 hours of sampling. During the remainder of the year, these short-holding-time analyses were performed by the Lubbock Christian University Institute of Water Research in Lubbock, Texas. In addition, from June through September 1994, the services of BIOTOX Laboratories of Baton Rouge, Louisiana, were used to determine the biological toxicity of wastewaters.

A limited number of analyses were conducted using onsite laboratories during 1994. These analyses included screening of environmental air filters for gross alpha/beta activity by the Pantex Plant Radiation Safety Department and analysis of wastewaters for chemical oxygen demand (COD) and for free chlorine by the Environmental Protection Department.

14.3.1 Analysis of Nonradiological Analytes Other Than Explosives

The EPA-approved methods used for each nonradioactive analyte are listed in Table 14.1. These methods are described in *Methods for Chemical Analysis of Water and Wastes* (EPA 1983) unless otherwise noted. Methods annotated "SW-846" are described in *Test Methods for Evaluating Solid Waste* (EPA 1986). The annotation "ASTM" refers to methods established by the American Society for Testing and Materials.

14.3.2 Analysis of Explosives

Chemical analysis of explosives in various media remained a problem during 1994. The EPA method (8330) for analysis of explosives was used for the analysis of most explosives, though it does not address analyses for pentaerythritol tetranitrate (PETN), which is a crystalline explosive that has been used at Pantex Plant. In the absence of an EPA method for PETN, the analytical laboratories used a liquid chromatography procedure based on that of Jenkins (1986). This procedure involved sequential injection (by syringe) of the sample and of standard solutions (of known concentrations) into a high-pressure liquid chromatograph and comparison of the results obtained for the sample to those obtained for the standards. Samples of solid materials, such as soils, were first treated with an acetonitrile/water solution. The dissolved portion that was extracted was then filtered using a pressure filtration system before injection to remove any suspended particles that might be present so that they would not clog the instrumentation. Samples of liquid media were filtered before injection for the same reason.

Table 14.1 Analytical Methods Used in 1994

Analyte	EPA Method
Volatile organics	8260
Semivolatile organics	8270
Pesticides and polychlorinated biphenyls (PCBs)	8080
Herbicides	8150
Explosives	8330 (modified by ALR)
Arsenic	206.2
Chromium (hexavalent)	218.5
Lead	239.2
Mercury	245.1
Selenium	270.2
All other metals	6010 or 200.7
Total organic carbon	415.1 (ASTM D4129)
Total organic halogen	450.1
Ammonia	350.3
Nitrate/Nitrite	353.2
Cyanide	335.3
Total suspended solids	160.2
Total dissolved solids	160.1
Oil and grease	413.2
Sulfate	375.4
Chloride	325.2
Fluoride	340.2
Phenol	420.1
Phosphate and orthophosphate	365.2

14.3.3 Analysis of Air Samples for Radionuclides

The prefilters from low-volume air samplers (see Chapter 8) were counted by an onsite laboratory using a low-background internal flow-proportional counter. Mathematical corrections were applied for counter efficiency (the ratio of radiation decay events measured by the counting system to the actual number of radiation decay

events that occurred) and other parameters as required.

The 20- × 25-cm (8- × 10-inch) particulate filters from the high-volume air samplers were analyzed for uranium-234, uranium-238, and plutonium-239/240 by an offsite laboratory. On arrival at the laboratory, known quantities of uranium-232 and plutonium-236 "tracers" were added to each filter. The individual filters and any particulate matter that they may have collected were dissolved in a nitric/hydrofluoric acid solution and heated to dryness to remove excess hydrofluoric acid; the residue was redissolved in nitric acid. The resulting solution containing uranium and plutonium salts was then adsorbed onto an ion exchange column and a nitric acid/sodium nitrite solution was used to elute uranium salts off the column. After further treatment, the solution was evaporated to dryness and the residue electroplated onto a stainless-steel planchet. A solid-state alpha spectrometer was used to determine the activity of uranium isotopes on the planchet. The ratio of the measured activity of uranium tracer to that added to the original sample before addition of the acid solution was determined. This "chemical recovery" ratio was used to calculate the activities of uranium-234 and uranium-238 in the original sample. Plutonium salts remaining on the ion exchange column were eluted with a hydrochloric acid/hydrogen peroxide solution and evaporated to dryness; the residue was electroplated onto a stainless-steel planchet and analyzed in the same manner as uranium. Chemical recovery was determined from the ratio of the measured activity of plutonium tracer to the known amount added to the original sample and used to determine the activity of plutonium-239/240[1] in the original sample.

Silica gel collected from the low-volume air samplers was analyzed for tritiated water vapor by offsite laboratories. Moisture extracted from air during sampling was vacuum-distilled from the silica gel. A portion of the distillate was mixed with a scintillation solution and counted in a liquid scintillation spectrometer. The concentration of tritiated water vapor in the atmosphere at the longer-established locations was calculated by correcting for the average absolute humidity for the period during which the sample was collected. At the newer fenceline locations (see Chapter 8), where the samplers measured both tritiated water vapor and elemental tritium, the concentrations of these species in ambient air were determined by correcting the measured value for the amount of moisture collected, the sampling flow rate, and other factors.

14.3.4 Analysis of Water Samples for Radionuclides

Water samples were analyzed for several radiological parameters. The samples were thoroughly agitated to ensure the resuspension of any settled material, and the analysis of dissolved gross alpha/beta solids was performed prior to any other analysis. There was no set sequence for other analyses.

For the analysis of dissolved gross alpha/beta solids, a 100-milliliter aliquot was acidified and evaporated to near dryness on a hot plate. The resulting residue was dissolved in 1 N (normal) nitric acid and transferred to a planchet. Gross alpha/beta activity was determined by counting the planchet and sample in an internal flow-proportional counter. The resulting measurement was corrected for counter efficiency and self-absorption.

For analysis of suspended gross alpha/beta solids, a similar aliquot of water was filtered through a 0.45-micron filter. The filter was counted by an internal flow-proportional counter. Corrections were again applied for counter efficiency and self-absorption.

Water was analyzed for radium isotopes by adding sulfuric acid (along with barium and lead carrier solutions added to cause coprecipitation) to the sample. The resulting precipitate was

transferred to a stainless steel planchet with a minimum amount of water, evaporated to dryness, and ignited in an oven. The planchet was counted by an internal flow-proportional counter. Corrections were applied for counter efficiency and self-absorption.

Analysis of uranium-234, uranium-238, and plutonium-239/240 in water samples was accomplished by acidifying the sample and adding known quantities of uranium-232 and plutonium-236 as tracers. The liquid was evaporated to dryness and the residue dissolved in nitric acid. The resulting uranium and plutonium salts were adsorbed onto an ion exchange column. Isotopic analysis was then conducted in the same way as for air filters.

For analysis of tritium in water, the sample was completely distilled to remove nonvolatile radioactive materials as well as organic materials (which could "quench" or interfere with the optical signal of the liquid scintillation spectrometer) and to ensure complete transfer of the tritium to the distillate. A portion of the distillate was mixed with scintillation solution and counted in a liquid scintillation spectrometer. Standard tritium and background samples were prepared and counted simultaneously, and appropriate correction factors were applied to the results for the distillate to determine the activity of tritium in the original water sample.

14.3.5 Analysis of Soil Samples for Radionuclides

Water for tritium analysis was extracted from soil samples by freeze-drying distillation. A portion of the distillate was mixed with scintillation solution and counted using a liquid scintillation spectrometer. Standard tritium and background samples were prepared and counted at the same time, and appropriate correction factors were applied to the results for the distillate to determine the activity of tritium in the original sample.

Two similar methods were used to analyze for uranium-234, uranium-238, and plutonium-239/240. In both methods, known quantities of uranium and plutonium tracers were added to the soil sample. In the one method, the treated sample was dissolved in a nitric/hydrofluoric acid solution, and the resulting solution was heated to dryness to drive off any excess hydrofluoric acid and then redissolved with nitric acid. In the other method, nitric acid was used to extract uranium and plutonium compounds present on the surface of the soil particles. Any uranium and/or plutonium compounds more tightly bound within the soil matrix would not be extracted. In both methods, the solution containing the resulting uranium and plutonium salts was then adsorbed onto an ion exchange column. Analysis for the indicated isotopes was conducted in the same manner as that described for air filters.

14.3.6 Analysis of Vegetation Samples for Radionuclides

Water for tritium analysis was extracted from vegetation by freeze-drying distillation. A portion of the distillate was mixed with scintillation solution and counted using a liquid scintillation spectrometer. Standard tritium and background samples were prepared and counted simultaneously and appropriate correction factors were applied to the results for the distillate to determine the activity of tritium in the origina sample.

To analyze for uranium-234 and uranium-238 dry vegetation was ashed in a muffle furnace. A uranium tracer was added, and the samples wer analyzed in the same manner as soil samples.

14.3.7 Biotoxicity

The toxicity of wastewater effluents w determined in accordance with requiremer outlined by EPA (1989, 1990). Samples wastewater were subjected to a series of dilutic

with distilled water, resulting in various effluent concentrations. Five common water fleas (*Daphnia pulex*) and ten fathead minnows (*Pimepahles promelas*) were placed in samples of each of the various effluent concentrations and the numbers of individuals surviving after 48 hours or 7 days (depending on the desired parameter) were determined. The concentration that was lethal to 50% of the individuals (referred to as the LC_{50}) was then determined by analyzing survival rates in the various effluent concentrations.

14.4 Quality Assurance in the Laboratory

Samples collected under the environmental monitoring program in 1994 were analyzed by both onsite and offsite laboratories. Quality programs associated with each laboratory are discussed below.

14.4.1 Quality Assurance in Onsite Laboratories

As discussed in Section 14.3, the Pantex Plant Radiation Safety Department screened environmental air filters for gross alpha/beta activity. To ensure consistency in the operation of the low-background alpha/beta counter, Radiation Safety Department personnel determined the alpha/beta radiation backgrounds and efficiencies immediately before performing the screening measurement. If background values and efficiencies were significantly different from those in previous operational checks, the instrument was removed from service until the cause of the drift was determined and corrective actions were initiated. A blank filter and an empty planchet were also counted with each set of filters. Results that were statistically different from zero signaled that the counting instrument required repair. Results for periods when the counting equipment was not operating correctly were not entered into the database discussed in Section 14.6.

To ensure consistency of COD analyses performed by Environmental Protection Department personnel, duplicate solutions of an externally procured COD standard were run with each batch of wastewater samples. Results for duplicate spiked samples (samples with known concentrations) run before and after the environmental samples were compared to ensure that the equipment used to perform the analysis was operating correctly during the entire period of analysis. If the instrument was not operating within limits, corrective actions were initiated. Results for periods in which the instrument was not operating properly were not entered into the database discussed in Section 14.6.

14.4.2 Quality Assurance in Offsite Contract Laboratories

Offsite laboratories were contractually required to maintain a QA/QC program meeting the requirements of SW-846 (EPA 1986).

QC procedures covering instrument calibration and adjustment or tuning procedures are specific to the individual test methods and are incorporated into the specific procedures. In addition, other QC features, such as accuracy limits and repeatability requirements, are incorporated into many of the analytical procedures.

14.5 Verification of Quality Assurance

Because the analyzing laboratory was "blind" to the sample location or type, it could not distinguish the QC samples from the environmental samples (Section 14.2). It was therefore possible to obtain an unbiased evaluation of laboratory quality by comparing the results for duplicate samples and for blanks and rinsates. In addition, to verify that contractual QA requirements were being met, Pantex Plant personnel conducted audits of the laboratories, validated data packages, and required that the contract laboratories participate in performance evaluation programs.

14.5.1 Audits of Laboratories

Pantex Plant personnel conducted audits of each laboratory on a biannual schedule (twice per year) to ensure that operations relevant to Pantex Plant were being conducted according to terms specified in the contracts. Results of each audit were forwarded to the affected laboratory and responses were evaluated to ensure that audit findings were addressed. Audits performed during 1994 are listed in Table 14.2.

14.5.2 Data Validation

Data received from analytical laboratories were evaluated by Pantex Plant personnel to guarantee that laboratory results were within contractual QA/QC guidelines. The following items were evaluated during 1994:

- Were proper test methods as described i SW-846 used?
- Were holding times within limit established in SW-846?
- Were calibrations conducted according t procedural requirements?
- Were detection limits achieved?
- Were calculations performed correctly?
- Were matrix spikes and blanks analyze with the samples analyzed according t the correct method, and were result within acceptable[2] limits?
- Was the chemical recovery of interna standards or tracers added to the sampl within acceptable limits?

Samples or data packages that failed to mee validation standards were not incorporated int the database.

Table 14.2 Audits of Labs Performing Environmental Analyses - 1994

Location	Designation	Report Date	Closure Date
Accu-Labs Research	Q-94-062	04/07/94	07/22/94
Barringer Laboratories	Q-94-063	04/07/94	05/25/94
Biotox Labs	Q-94-016	11/19/93	08/08/94
IEA	Q-94-074	06/01/94	--[1]
	Q-95-015	--[2]	--[2]
Lubbock Christian University Institute of Water Research	Q-94-031	12/20/93	02/07/94
	Q-94-092	07/15/94	09/08/94
Southwest Laboratory	Q-94-061	04/07/94	05/11/94
	Q-95-006	01/09/95	--[1]

[1] Because there were no findings, no closure was needed.
[2] An audit was conducted in November 1994; the final report is still pending.

14.5.3 DOE Quality Assessment Program

DOE Order 5400.1 requires all contract laboratories that conduct analytical work in support of DOE environmental radiological monitoring programs to participate in the Quality Assessment Program conducted by DOE's Environmental Measurements Laboratory (EML). Under this program, EML added known activities of radionuclides to water, soil, and vegetation samples, as well as air filters. Two sets of these spiked samples were forwarded to Pantex Plant. Pantex Plant provided the samples to each contract laboratory for the analyses described in Section 14.3. When results were received, they were forwarded to EML for tabulation and comparison to EML's own results. EML then published evaluation reports approximately four months after providing the original samples. Results for the 1994 Quality Assessment Program are presented in Section 14.7.

14.5.4 Performance Indicator Program

During 1994, Pantex Plant also tracked the performance of the laboratories analyzing samples. The number of individual analyses that failed to meet one or more of the following performance criteria was obtained each month for individual laboratories and summed for all laboratories:

1. **Holding Time Missed.** The analysis was not started within the time frame established by EPA or required by Pantex Plant.

2. **Incorrect Test Method.** The analysis was not performed according to a method established by EPA or required by Pantex Plant.

3. **Poor Recoveries.** Compounds and/or radioisotopes added to the sample prior to laboratory processing were not recovered at the ratio of recovery required by the Plant.

4. **Insufficient QA/QC Data.** The data received from the analytical laboratory were insufficient to allow validation of results.

5. **Wrong Minimum Detectable Limit (MDL).** The laboratory reported extremely low levels of analytes as "less than minimum detectable," but the required MDL was not used.

Results for the laboratory performance indicator program are discussed in Section 14.7.

14.6 Sample Tracking and Data Management

An internally developed database, the Environmental Monitoring Tracking System (EMTS), was used to track the current status of samples sent to all analytical laboratories during 1994. The information tracked included

- Sample number
- COC number
- Location of sampling
- Date of sampling
- Analyses requested
- Date that samples were submitted for shipment to an offsite laboratory or the date that samples were provided to an onsite laboratory
- Date that analysis began at laboratory
- Date that analysis results were received from laboratory
- Identification number for laboratory sample batch.[3]

The EMTS database was also used to store all validated analytical results. Data tables prepared from the database's reporting function were incorporated into monthly, quarterly, and annual compilations of environmental monitoring data. The reports were provided to individual media managers who interpreted the data. Another

database was used to track the number and dates of batch validation and invoicing information.

All relevant documentation associated with each sample batch was retained by Pantex Plant. This documentation included all laboratory sample results, laboratory QA/QC results, any notations that would validate or invalidate data, and laboratory audit results.

14.7 Results of Sampling and Analysis Quality Programs

14.7.1 Duplicate Analyses

The number of duplicate analytes measured and the number and percentage of duplicates within the indicated control limits for each of several environmental contaminant classifications are presented in Table 14.3. Normal variations in levels of measured constituents in soil and vegetation are the most likely reason for the somewhat lower percentages of duplicates within control levels in the "metals" and "radionuclides" categories. Several types of analyses are combined within the "miscellaneous" category. During 1995, these several types of analyses will not be combined but individual trends will be examined to find the root cause of the higher rate of inconsistency in these analyses, and corrective actions will be implemented as appropriate.

14.7.2 Blanks and Rinsates

The number of analytes measured and the number and percentage of results that were less than the detection limit[4] for the analytes being measured for each of several environmental contaminant classifications are presented in Table 14.4. Most detections in the "volatiles" category were of methylene chloride, acetone, and other common laboratory solvents. However, the rate of occurrence of these "false positives" is very low. As noted above, several types of analyses are combined within the "miscellaneous" category. To find the root cause of the higher rate of detection of analytes in this category, these analyses will be individually trended during 1995, and corrective actions will be implemented as appropriate.

14.7.3 DOE Quality Assessment Program

Results of the 1994 evaluation for Pantex Plant's samples are provided in Tables 14.5 through 14.8. The ratios of contract laboratory results to EML results fall within "acceptable" or "acceptable with warning" limits as defined by EML (1995) in most instances.

Several anomalies were observed. The result for plutonium-239/240 in the October vegetation sample analyzed by Accu-Labs Research (see Table 14.7) was high compared to the EML result, although within acceptable limits. This discrepancy may have been caused by the presence of a single large particle of plutonium in the vegetation matrix. The successful analysis of all other samples did not indicate systemic problems with the analysis. Accu-Labs Research will continue to participate in the Quality Assessment Program. If results for 1995 samples of plutonium in the vegetation matrix are again statistically different from the EML result, it would suggest systemic problems with the analysis. If this should be the case, Accu-Labs Research will not be sent any vegetation samples for analysis until the root cause can be identified, corrective actions implemented, and a third Quality Assessment Program sample successfully analyzed.

Another anomaly was noted in the October air filters analysis conducted by IEA (Table 14.8). Results for uranium-234 and uranium-238 were lower than the EML value. However, the result for uranium-234 was within "acceptable" limits and the result for uranium-238 was only slightly less than "acceptable with warning." The root cause of these discrepancies is still being investigated. IEA will continue to participate in the Quality Assessment Program. If results obtained by IEA for 1995 air filter samples are again statistically different from EML results,

Table 14.3 Summary of Results from Analysis of Duplicate Samples

Analysis	No. of Duplicate Analytes	No. of Duplicates Exceeding Control Limits	% In Control
Volatiles	845	1	99.9
Semivolatiles	585	0	100
Pesticides	152	0	100
Polychlorinated biphenyls (PCBs)	56	0	100
Herbicides	16	0	100
Explosives	116	2	98.3
Metals	561	48	91.4
Miscellaneous	326	51	84.4
Radionuclides	247	15	93.9

Table 14.4 Summary of Results above Detection Limit for Blanks and Rinsates

Analysis	No. of Analytes	No. Exceeding DL[1]	% In Control (Less than DL)
Volatiles	5796	16	99.8
Semivolatiles	130	0	100
Pesticides	95	0	100
Polychlorinated biphenyls (PCBs)	35	0	100
Herbicides	10	0	100
Explosives	40	0	100
Metals	104	2	98.1
Miscellaneous	118	8	93.3
Radionuclides	36	1	97.2

[1] Number of blank or rinsate analyses with reported values exceeding the required method detection limit (DL).

Table 14.5 Performance Evaluation for ALR, March 1994

Medium	Isotope	ALR[1] Value[2]	EML[1] Value	ALR/EML Ratio	EML Rating[3]
Air Filter	Uranium-234	0.16 ± 0.02	0.197 ± 0.002	0.81	W
	Uranium-238	0.17 ± 0.02	0.203 ± 0.002	0.84	W
	Plutonium-239/240	0.40 ± 0.02	0.310 ± 0.003	1.29	W
Soil	Uranium-234	34.2 ± 4.7	27.1 ± 2.44	1.26	W
	Uranium-238	34.9 ± 5.0	27.1 ± 2.44	1.29	W
	Plutonium-239/240	4.05 ± 0.85	3.56 ± 0.178	1.14	A
Vegetation	Plutonium-239/240	4.31 ± 0.37	3.90 ± 0.351	1.11	A
Water	Tritium	191 ± 9	187 ± 3.74	1.02	A
	Uranium-234	0.535 ± 0.048	0.520 ± 0.026	1.03	A
	Uranium-238	0.508 ± 0.046	0.528 ± 0.026	0.96	A
	Plutonium-239/240	1.09 ± 0.08	0.956 ± 0.029	1.14	A

1 EML - Environmental Measurements Laboratory, New York City, New York; ALR - Accu-Labs Research, Inc., Golden, Colorado.

2 Data are presented in units of becquerel/filter for air filters, becquerel/kilogram for soil and vegetation samples, and becquerel/liter for water samples.

3 A - Acceptable. Laboratory test data were between the 15th and 85th percentile of all data for the radionuclide and medium of concern.
W - Acceptable with Warning. Laboratory test data were between the 5th and 15th percentile or the 85th and 95th percentile of all data for the radionuclide and medium of concern.
N - Not Acceptable. Laboratory test data were between the 0 and 5th percentile or the 95th and 100th percentile of all test data for the radionuclide and medium of concern.

IEA will not be sent any air filters for analysis until the root cause can be identified, corrective actions implemented, and a third Quality Assessment Program sample successfully analyzed.

Other anomalies were noted in both sets of analyses for uranium in soil conducted by IEA (Tables 14.6 and 14.8). Results were low by a factor of three, apparently as a result of the analysis process used. Unlike that used by EML, the procedure employed by IEA used an acid mixture that did not totally dissolve the soil, but instead extracted uranium oxide from the surface of the soil particles being analyzed. Any uranium oxide within the soil matrix would not have been extracted into the acid. Review of eleven years of data from several laboratories performing analyses for DOE organizations indicated that only 30-40% of the uranium in the matrix and sample is extracted into the acid solution using the IEA extraction process (EML 1995).[5] If the IEA results were corrected by this factor, good agreement with the EML results would be obtained. Specifications for analysis of soil samples are being rewritten to ensure that all future analyses for uranium in soil are conducted using the EML methods.

Table 14.6 Performance Evaluation for IEA, March 1994

Medium	Isotope	IEA[1] Value[2]	EML[1] Value	IEA/EML Ratio	EML Rating[3]
Air Filter	Uranium-234	0.208 ± 0.0185	0.197 ± 0.002	1.06	A
	Uranium-238	0.201 ± 0.0185	0.203 ± 0.002	0.99	A
	Plutonium-239/240	0.309 ± 0.0318	0.310 ± 0.003	1.00	A
Soil	Uranium-234	9.99 ± 1.11	27.1 ± 2.44	0.37	N
	Uranium-238	10.4 ± 1.11	27.1 ± 2.44	0.38	N
	Plutonium-239/240	3.70 ± 0.37	3.56 ± 0.178	1.04	A
Vegetation	Plutonium-239/240	4.07 ± 0.74	3.90 ± 0.351	1.04	A
Water	Tritium	213 ± 12.8	187 ± 3.74	1.14	A
	Uranium-234	0.484 ± 0.073	0.520 ± 0.026	0.93	A
	Uranium-238	0.506 ± 0.074	0.528 ± 0.026	0.96	A
	Plutonium-239/240	1.01 ± 0.129	0.956 ± 0.029	1.06	A

1 EML - Environmental Measurements Laboratory, New York City, New York; IEA - IEA, Inc., Cary, North Carolina.

2 Data are presented in units of becquerel/filter for air filters, becquerel/kilogram for soil and vegetation samples, and becquerel/liter for water samples.

3 A - Acceptable. Laboratory test data were between the 15th and 85th percentile of all data for the radionuclide and medium of concern.
W - Acceptable with Warning. Laboratory test data were between the 5th and 15th percentile or the 85th and 95th percentile of all data for the radionuclide and medium of concern.
N - Not Acceptable. Laboratory test data were between the 0 and 5th percentile or the 95th and 100th percentile of all test data for the radionuclide and medium of concern.

14.7.4 Performance Indicator Program

A total of 99,808 analyses were obtained during 1994. Table 14.9 shows the total number of analyses that failed in any of the criteria listed in Section 14.5 and the number in each of several categories. The error rate did not exceed 2% for any individual criterion, and the sum for all was significantly less than 5%. Pantex Plant will continue to monitor the performance of laboratories to determine ways to reduce the number of analyses not performed within EPA holding times or for which QA/QC data were insufficient for validation.

Table 14.7 Performance Evaluation for ALR, October 1994.

Medium	Isotope	ALR[1] Value[2]	EML[1] Value	ALR/EML Ratio	EML Rating[3]
Air Filter	Uranium-234	0.113 ± 0.020	0.112 ± 0.004	1.01	A
	Uranium-238	0.096 ± 0.018	0.112 ± 0.003	0.85	W
	Plutonium-239/240	0.656 ± 0.071	0.648 ± 0.027	1.01	A
Soil	Uranium-234	26.1 ± 3.5	32.6 ± 0.779	0.80	A
	Uranium-238	24.6 ± 2.6	33.0 ± 2.41	0.75	A
	Plutonium-239/240	10.3 ± 2.3	7.78 ± 0.35	1.32	W
Vegetation	Plutonium-239/240	2.36 ± 0.77	1.25 ± 0.150	1.89	W
Water	Tritium	111 ± 10	113 ± 7.0	0.98	A
	Uranium-234	1.11 ± 0.21	1.11 ± 0.013	1.00	A
	Uranium-238	1.15 ± 0.18	1.11 ± 0.047	1.04	A
	Plutonium-239/240	0.554 ± 0.082	0.602 ± 0.063	0.92	A

1 EML - Environmental Measurements Laboratory, New York City, New York; ALR - Accu-Labs Research, Inc., Golden, Colorado.

2 Data are presented in units of becquerel/filter for air filters, becquerel/kilogram for soil and vegetation samples, and becquerel/liter for water samples.

3 A - Acceptable. Laboratory test data were between the 15th and 85th percentile of all data for the radionuclide and medium of concern.
W - Acceptable with Warning. Laboratory test data were between the 5th and 15th percentile or the 85th and 95th percentile of all data for the radionuclide and medium of concern.
N - Not Acceptable. Laboratory test data were between the 0 and 5th percentile or the 95th and 100th percentile of all test data for the radionuclide and medium of concern.

Table 14.8 Performance Evaluation for IEA, October 1994

Medium	Isotope	IEA[1] Value[2]	EML[1] Value	IEA/EML Ratio	EML Rating[3]
Air Filter	Uranium-234	0.100 ± 0.024	0.112 ± 0.004	0.89	A
	Uranium-238	0.080 ± 0.021	0.112 ± 0.003	0.71	N
	Plutonium-239/240	0.620 ± 0.071	0.648 ± 0.027	0.96	A
Soil	Uranium-234	9.99 ± 1.11	32.6 ± 0.779	0.31	N
	Uranium-238	9.99 ± 1.11	33.0 ± 2.41	0.30	N
	Plutonium-239/240	7.77 ± 0.74	7.78 ± 0.35	1.00	A
Vegetation	Plutonium-239/240	1.48 ± 0.00	1.25 ± 0.150	1.18	A
Water	Tritium	116 ± 0.48	113 ± 7.0	1.03	A
	Uranium-234	1.13 ± 0.151	1.11 ± 0.013	1.02	A
	Uranium-238	0.995 ± 0.138	1.11 ± 0.047	0.90	A
	Plutonium-239/240	0.552 ± 0.091	0.602 ± 0.063	0.92	A

1 EML - Environmental Measurements Laboratory, New York City, New York; IEA - IEA, Inc., Cary, North Carolina.

2 Data are presented in units of becquerel/filter for air filters, becquerel/kilogram for soil and vegetation samples, and becquerel/liter for water samples.

3 A - Acceptable. Laboratory test data were between the 15th and 85th percentile of all data for the radionuclide and medium of concern.
W - Acceptable with Warning. Laboratory test data were between the 5th and 15th percentile or the 85th and 95th percentile of all data for the radionuclide and medium of concern.
N - Not Acceptable. Laboratory test data were between the 0 and 5th percentile or the 95th and 100th percentile of all test data for the radionuclide and medium of concern.

Table 14.9 Causes of Invalid Data for All Laboratories, 1994

Parameter	Number Invalid Analytes	% Invalid Analyses[1]
Holding Time Missed	1372	1.37
Wrong Test Method	141	0.14
Poor Recoveries	160	0.16
Insufficient QA/QC	1078	1.08
Wrong MDL	219	0.22
All Causes	2970	2.98

[1] A total of 99,808 analyses were performed in 1994.

Notes for Chapter 14

1. The alpha energies of plutonium-239 and plutonium-240 are very similar, and the alpha spectrophotometer is not sensitive enough to distinguish between these isotopes. Therefore the measurement is the sum of the activities resulting from both isotopes.

2. Acceptable ranges of results are specific to each method (see Section 14.4).

3. The term "batch" refers to a group of samples analyzed at the same time.

4. For nonradionuclide analyses, the result is compared to detection limits listed in the analytical methods established by EPA and/or state regulatory agencies. For radionuclide analyses, it is necessary to perform statistical analyses to determine whether the measured value and associated counting errors are statistically different from zero.

5. Personal communication between D. Griffis, Battelle Pantex, and C. Sanderson, EML, on March 13, 1995.

Chapter 15

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APPENDIX

DEFINITIONS OF ABBREVIATIONS AND ACRONYMS

AIP	agreement in principle
ALR	Accu-Labs Research, Inc.
ARPA	Archeological Resource Protection Act
ASTM	American Society for Testing and Materials
BDL	below detection limits
<BG	less than background
BOD	5-day biochemical oxygen demand
Bq	becquerel
Bq/g	becquerels per gram
Bq/ml	becquerels per milliliter
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	curie
cm	centimeter
COC	chain of custody
COD	chemical oxygen demand
CRM	cultural resource management
CRMP	cultural resource management plan
CWA	Clean Water Act
DCG	derived concentration guide
DL	detection limit
DMSO	a particular organic solvent always referred to by this name
DOE	U.S. Department of Energy
DOE/AAO	DOE/Amarillo Area Office
DOE/AL	DOE/Albuquerque Operations Office
EA	environmental assessment
EIS	environmental impact statement
EML	Environmental Measurements Laboratory
EMTS	Environmental Monitoring Tracking System
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ESA	Endangered Species Act
ES&H	Environment, Safety, and Health
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
g	gram

GIA	grant in aid
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine
HVAC	heating—ventilation—air conditioning
in.	inch
IO	isolated occurrence
LCU	Lubbock Christian University
m^3	cubic meter
Max	maximum
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
<MDA	less than minimum detectable activity
MDL	minimum detectable limit
mg/L	milligrams per liter
Min	minimum
ml	milliliter
mph	miles per hour
mR	milliroentgen
mrem	millirem
mrem/yr	millirem per year
m/sec	meters per second
mSv	millisievert
mSv/yr	millisievert per year
μCi/ml	microcuries per milliliter
μCi/g	microcuries per gram
μmho/cm	micromhos per centimeter
μR	microroentgen
NA	not applicable
NAGPRA	Native American Graves and Repatriation Act
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
No.	number
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NV	native vegetation
NWWA	National Water Well Association
PANAL	Panhandle Area Neighbors and Landowners
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
pCi/L	picocuries per liter

PETN	pentaerythritol tetranitrate
PGWCD	Panhandle Ground Water Conservation District
ppb	parts per billion
PVC	polyvinylchloride
QA	quality assurance
QC	quality control
Qtr	quarter
R	roentgen
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
rem	radiation equivalent man
RFI	RCRA Facility Investigation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Office
Std. Dev.	standard deviation
Sv	Sievert
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TCAA	Texas Clean Air Act
TCE	trichloroethylene
TDH—BRC	Texas Department of Health—Bureau of Radiation Control
TDS	total dissolved solids
TLD	thermoluminescent dosimeter
TNRCC	Texas Natural Resource Conservation Commission
TNT	trinitrotoluene
TSCA	Toxic Substances Control Act
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
WTSU	West Texas State University
WWTF	wastewater treatment facility
yr	year
°C	degrees Celsius
°F	degrees Fahrenheit

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