Pantex

Managed and Operated by
PANTEXAS DETERRENCE

CALENDAR YEAR | 2024

NNSA
National Nuclear Security Administration

ANNUAL SITE ENVIRONMENTAL REPORT | PANTEX PLANT

Annual Site Environmental Report

Pantex Plant

Environmental Compliance
Calendar Year 2024

Annual Site Environmental Report

Pantex Plant
Calendar Year 2024

September 2025

Prepared for
U.S. Department of Energy/National Nuclear Security Administration Pantex Field Office

Prepared by
Environmental Compliance Department
Waste Operations Department
and the Environmental Projects Department

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The results presented in this report are from samples collected by the Environment, Safety, and Health Division's Environmental Projects Department. Many other staff members in the environmental departments worked on validating data, conducting quality checks, and making the data available electronically. The *2024 Annual Site Environmental Report* for Pantex was reviewed for classification and it was determined to be unclassified.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AEC	Atomic Energy Commission
AECR	air environmental compliance requirements
AIRFA	American Indian Religious Freedom Act
ALARA	as low as reasonably achievable
ASER	Annual Site Environmental Report
BCG	biota concentration guide
CAA	Clean Air Act
CCL	Contaminant Candidate List
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNS	Consolidated Nuclear Security
COC	contaminants of concern
CY	calendar year
DBP	disinfection by-product
DCS	Derived Concentration Standard
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DOI	U. S. Department of the Interior
DOT	Department of Transportation
DQO	data quality objective
ECD	Environmental Compliance Department
EMS	environmental management system
ESA	Endangered Species Act
EO	executive order
EPA	U.S. Environmental Protection Agency
FGZ	fine-grained zone
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FM	Farm-to-Market Road
FY	fiscal year
GHG	greenhouse gas
GPS	global positioning system
GWPS	Groundwater Protection Standard
HAP	hazardous air pollutant
HE	high explosive
HPFL	high-pressure fire loop
IAG	interagency agreement
ISB	in-situ bioremediation
ISO	International Organization for Standardization
IWQP	inland water-quality parameter
LTM	long-term monitoring
M&E	material and equipment
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
MDA	minimum detection activity
MDL	method detection limit
MEI	maximally exposed individual

MRaD	Multimedia Radiochemistry
MSGP	Multi-Sector General Permit
M&O	management and operating
NAPL	non-aqueous phase liquid
NCRP	National Council on Radiation and Protection Measures
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NNSA	National Nuclear Security Administration
NRF	NEPA Review Form
NWS	National Weather Service
O&M	operation and maintenance
OSSF	on-site sewage facility
P1PTS	Playa 1 Pump-and-Treat System
P2	pollution prevention
Pantex	Pantex Plant Site
PA/CRMP	programmatic agreement/cultural resources management plan
PBR	Permits by Rule
PCB	polychlorinated biphenyl
PE	performance evaluation
PFAS	per- and polyfluoroalkyl substances
PFO	National Nuclear Security Administration Pantex Field Office
PQL	practical quantitation limit
PST	petroleum storage tank
PTE	potential-to-emit
PWF	Pantex Wind Farm
PWS	Public Water System
QA	quality assurance
QC	quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RER	replicate error ratio
ROD	record of decision
SA	supplemental analysis
SAA	satellite accumulation area
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SE	Standard Exemption
SEPTS	Southeast Pump-and-Treat System
SHPO	State Historic Preservation Office
SME	subject matter expert
SMP	site management plan
SOW	statement of work
SSP	site sustainability plan
STEERS	State of Texas Environmental Electronic Reporting System
SVE	soil vapor extraction
SWEIS	site-wide environmental impact statement
SWMU	solid waste management unit
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality

TDSHS	Texas Department of State Health Services
TTHM	Total Trihalomethanes
TLAP	Texas Land Application Permit
TLD	thermoluminescent dosimeter
TPDES	Texas Pollutant Discharge Elimination System
TPH	total petroleum hydrocarbon
TPWD	Texas Parks and Wildlife Department
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TTU	Texas Tech University
UIC	underground injection control
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Services
VOC	volatile organic compound
VMF	Vehicle Maintenance Facility
WWII	World War II
WWTF	wastewater treatment facility
WWWRC	Wild West Wildlife Rehabilitation Center

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EXECUTIVE SUMMARY

The Pantex Plant (Pantex) is the nation's primary nuclear weapons manufacturing facility. The U.S. Department of Energy (DOE) through the National Nuclear Security Administration Pantex Field Office oversees Pantex operations. PanTeXas Deterrence, LLC (PXD) is the managing and operating contractor of Pantex under Contract No. 89233224CNA000004. Like all manufacturing facilities, Pantex has the potential to release a variety of contaminants through its primary and supporting operations. PXD manages the environmental aspects of these operations in a manner consistent with integrated safety management, applicable environmental regulations, and best management practices.

PURPOSE

The *2024 Annual Site Environmental Report* (ASER) summarizes Pantex's status, data, and efforts for the environmental compliance, protection, and restoration programs. It has been prepared in accordance with DOE Order (DOE O) 231.1B, *Environment, Safety and Health Reporting*, and DOE O 458.1, *Radiation Protection of the Public and the Environment*. These orders outline the requirements for environmental protection programs at DOE facilities to ensure that programs fully comply with applicable federal, state, and local environmental laws and regulations, executive orders, and DOE policies.

MAJOR SITE PROGRAMS

The Pantex Plant site encompasses approximately 17,129 acres. As the nation's primary nuclear weapons manufacturing facility, it assembles, dismantles, modifies, and maintains the nation's stockpile of nuclear weapons. Pantex also supports the weapons stockpile through the development, testing, and fabrication of high explosive components. In addition, Pantex maintains its own steam-generating plant, drinking water treatment plant, and wastewater treatment plant. All work at Pantex is conducted under three overarching priorities: the safety and health of workers and the public, the security of weapons and information, and the protection of the environment.

ENVIRONMENTAL MANAGEMENT AND MONITORING

The PXD environmental policy defines a comprehensive environmental management system (EMS) that focuses on protecting the environment, preventing pollution, strictly complying with all regulatory requirements, and improving continually. These efforts are supported by environmental monitoring conducted by Pantex and the State of Texas, program audits, and stakeholder input.

Data obtained from various monitoring programs in past years are summarized in previous ASERs. Those reports are available in the DOE Information Repositories at the Amarillo Public Library Downtown Branch, in Amarillo, Texas and at the Carson County Library in Panhandle, Texas. The monitoring data, as well as the ASERs since 2011, are available on the Pantex website at http://pantex.energy.gov. Copies of the Pantex ASER from previous years can be acquired by contacting Pantex Communications at public_communications@pantex.doe.gov.

The purpose of the environmental monitoring component of Pantex's EMS is to provide indicators of the potential impact to human health and the environment and to demonstrate compliance with applicable regulatory limits. The environmental monitoring program monitors air, groundwater, drinking water, surface water, wastewater, soil, vegetation, and fauna. Pantex also operates a meteorological monitoring program that supports several of these requirements. Samples for 2024 were routinely collected at diverse locations, and analyses were performed for substances including explosives, metals, organic chemicals, inorganic chemicals, radionuclides, and water-quality indicators.

Pantex EMS provides the foundation to administer sound stewardship practices that protect natural and cultural resources while cost-effectively demonstrating compliance with environmental, public health and resource protection laws, regulations, and DOE requirements. Notable accomplishments in 2024 relating to the Pantex EMS are listed below:

- Continued promotion of sustainable acquisition and procurement to the maximum extent practicable, ensuring bio-preferred and bio-based provisions and clauses are included in 95% of applicable contracts,
- Received a Gold Level DOE Green Buy Award in 2024 for Pantex's efforts to purchase twelve priority products in six different categories,
- Purchased 94% of electronics that have met criteria for being environmentally sustainable, and
- Diverted approximately 42% of municipal solid waste and approximately 100% construction and demolition material/debris from landfill disposal to alternate pathways for beneficial reuse.

Pantex EMS is audited every three years to determine the level of conformance with the International Organization for Standardization (ISO) 14001, *Environmental Management Systems – Requirements with Guidance for Use*. The last audit conducted at Pantex was during Fiscal Year (FY) 2022 and was performed by a qualified party outside the control or scope of the Pantex EMS program. The outcome of the audit indicated that Pantex continues to implement an EMS program that conforms to ISO 14001 [2004(e)] standards. The next validation audit is scheduled to be performed in FY 2025.

Radiation Dose

In 2024, the calculated annual radiation dose from releases to the atmosphere generated by Pantex operations was 1.600E-04 mrem/yr for a hypothetical, maximally exposed member of the public (Table ES.1). This annual dose continues to be several orders of magnitude below the U.S. Environmental Protection Agency's (EPA's) standard for the air pathway of 10 mrem/yr above background and is consistent with those of previous years. No unplanned radionuclide releases occurred at Pantex in 2024. The ambient air-monitoring results for 2024 were generally similar to those from previous years. All results were below the applicable DOE-derived concentration standard. Figure ES.1 provides a comparison of radiation doses from multiple exposure categories.

Table ES.1 Pantex Radiation Dose for 2024 Compared to Regulatory Dosage Allowances

Pantex Radiation Dose (mrem)	Environmental Protection Agency Standard Air Pathway (mrem)	Department of Energy Standard All Pathways (mrem)
1.60E-04	10	100

Drinking Water Monitoring

Results from routine drinking water compliance monitoring in 2024 confirmed that the drinking water system at Pantex met water-quality regulatory requirements. All analytical results for bacteria, chemical compounds, and disinfection by-products (DBP) were below regulatory limits, and adequate levels of disinfectant were maintained in the distribution system. The Pantex Public Water System was last inspected by the Texas Commission on Environmental Quality (TCEQ) in November 2021 with no compliance issues noted. The TCEQ did not conduct an inspection of the Pantex Public Water System in 2024. The system continues to be recognized by the TCEQ as a "Superior" supply system, the highest rating assigned by the state.

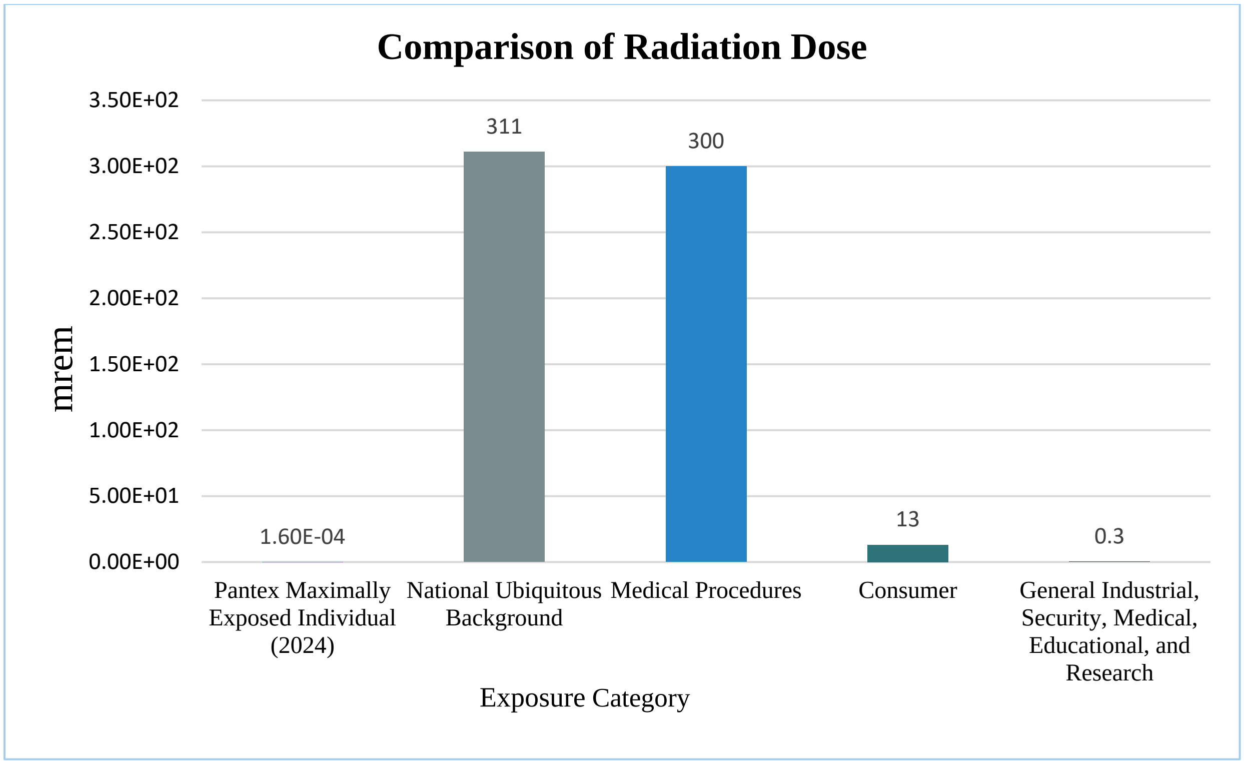

Figure ES.1 Comparison of radiation dose

Wastewater Monitoring

During 2024 Pantex discharged approximately 50 million gal of treated wastewater to the on-site playa lake. The surface irrigation system was used during 2024 with limited downtime to apply over 53 million gal. The subsurface irrigation system was not operational during 2024 due to ongoing repairs.

In September 2024, the Total Suspended Solids (TSS) Daily Average concentration was measured at 65.0 mg/L. The Daily Average limitation for TSS is 60.0 mg/L. All corrective actions for reporting and mitigating this exceedance were completed.

Stormwater Monitoring

Sampling of stormwater runoff from industrial areas at Pantex was conducted in accordance with Texas Pollutant Discharge Elimination System Multi-Sector General Permit No. TXR050000. Monitoring conducted during 2024 was consistent with past monitoring results. All sample results were within effluent limitations established by the general permit.

Environmental surveillance monitoring was conducted at the playas as a best management practice. Results obtained during 2024 were similar to past monitoring results. The playa data continues to support the position that operations at Pantex are not negatively affecting the water quality of the playas.

Soil Monitoring

On-site Burning Ground surface–soil–monitoring results for 2024 were within the concentration ranges of the established background levels. Results of soil monitoring conducted at the surface and subsurface irrigation systems for 2024 were consistent with previous years' results and indicate operations are not having a negative impact on the environment.

Flora and Fauna Monitoring

Flora and fauna surveillance is complementary to air, soil, and water monitoring in assessing potential short-term and long-term effects of operations at Pantex on the environment. Fauna at Pantex were sampled to determine whether Pantex activities had an impact on them. Black-tailed prairie dogs and cottontail rabbits were the species selected for sampling because they interact with both primary (air, water) and secondary (vegetation) environmental media also being analyzed. All analyses of black-tailed prairie dogs and cottontail rabbits were below minimum detection activity. Native vegetation and crops were sampled and results were consistent with results from previous years, as wells as at established control locations.

Quality Assurance

Due to its unique mission and service to the country, Pantex must strive to be a high reliability organization. High reliability includes robust quality assurance (QA) that ensures all environmental monitoring data provides definitive evidence of the status of regulatory compliance and protection of human health and the environment. The complexity of analytical chemistry and radiochemistry performed to support environmental monitoring programs necessitates that Pantex maintain an unparalleled QA and Quality Control Program that meets the need for high reliability.

Environmental Remediation

Historical waste management practices at Pantex have resulted in impacts to on-site soil and perched groundwater. High explosives (HEs), solvents, and metals were found in the soil in the main operational areas, the Burning Ground, and in the perched groundwater beneath Pantex. Groundwater data collected in 2024 demonstrated that current remedial actions continue to progress toward cleanup of perched groundwater contaminants and that drinking water resources are safe. Four deeper wells in the drinking water aquifer were found to have HE constituents above the cleanup standards established for the Pantex Remedial Action. The wells are located away from drinking water sources, and other monitor wells indicate there is no concern for nearby drinking water resources or irrigation use in the area. Pantex is planning to install more wells in 2025 to investigate the extent of the plume.

Pantex has completed investigations and soil cleanup of all solid waste management units, with the exception of units that remain in an active status. This allowed Pantex to transition to long-term stewardship in 2009. A *Record of Decision for Groundwater, Soil, and Associated Media* was issued by the EPA in September 2008 that described the final remedial actions for all investigated units (Pantex Plant and Sapere Consulting 2008).

As part of the transition to long-term stewardship, Pantex operated and maintained the groundwater remediation systems, monitored the systems to determine effectiveness of the remedy, and maintained the soil remedies. Pantex installed two types of perched groundwater remediation systems: four in-situ bioremediation and two pump-and-treat systems. Monitoring results indicate that the groundwater systems are effectively treating contamination and reducing saturated thickness in the perched aquifer as designed. The systems will continue to be monitored to determine the effectiveness of the remedy and to determine if changes to the systems will be required over time to ensure the continued success of remedial actions.

Pollution Prevention

Efforts to reduce and eliminate waste from routine operations at Pantex have resulted in significant waste reductions over the past 30 years. The reduction of waste is even more important considering Pantex population and workload has increased as waste amounts have decreased. During 2024, Pantex successfully recycled over 9.27 million pounds of materials including over 33,000 pounds of electronics.

CHAPTER 1 - INTRODUCTION

Pantex Plant site, consisting of 17,129 ac, is located 17 mi northeast of Amarillo, Texas, in Carson County. Pantex was a World War II munitions factory (Figure 1.1) and was converted to a nuclear weapons assembly facility in 1951. Today, it is the nation's primary assembly/disassembly facility supporting the nuclear weapons arsenal. Included within this chapter are brief discussions of Pantex location, history and mission, and facility description, followed by the climate, geology, hydrology, seismology, land use, and population.

1.1 PANTEX SITE LOCATION AND ENVIRONMENTAL SETTING

The Pantex Plant (Pantex) site is located in Carson County in the Texas Panhandle, north of United States (U.S.) Highway 60, approximately 17 mi northeast of downtown Amarillo (Figure 1.2). The area is part of the Llano Estacado (staked plains) portion of the Southern Great Plains and sits at an elevation of approximately 3,500 ft. The topography is relatively flat, characterized by rolling grassy plains and numerous natural playa basins. The term "playa" is used to describe ephemeral shallow lakes, mostly less than 0.6 mi in diameter. The region is semi-arid and primarily agricultural; however, several industrial facilities are located near Pantex.

Figure 1.1 Pantex workers preparing 23 lb fragmentation bombs in April 1943

Photo by U.S. War Department

Pantex is centered on a site that is approximately 17,129 ac. The site consists of land owned and leased by the U.S. Department of Energy (DOE). The DOE owns 11,329 ac of the site, including the following:

- 8,726 ac - Pantex area,
- 1,526 ac - Four tracts east of Farm-to-Market (FM) 2373 near Pantex area, and
- 1,077 ac - Pantex Lake, located approximately 2.5 mi northeast of Pantex area.

There are no government industrial operations conducted at the Pantex Lake property. The remaining 5,800 ac are located south of the main Pantex area and are leased from Texas Tech University (TTU) for a safety and security buffer zone.

1.2 FACILITY HISTORY AND MISSION

Pantex is a government-owned, contractor-operated facility. DOE oversees the operation of Pantex through the National Nuclear Security Administration (NNSA) Pantex Field Office (PFO). At the end of 2024, approximately 6,596 persons (including Pantex contracted employees, federal employees, and subcontracted employees) were employed at Pantex. Mason & Hanger Corporation was the management and operating (M&O) contractor of Pantex from 1956 through May 1999 when the contractor became a subsidiary of Day & Zimmermann, Inc. Mason & Hanger Corporation (Day & Zimmermann, Inc.) was replaced as contractor by BWX Technologies, LLC (BWXT) on February 1, 2001. BWXT combined elements of BWXT, Honeywell, and Bechtel. Effective in January 2008, the name of the company was officially changed to Babcock & Wilcox Technical Services, LLC. On July 1, 2014, Consolidated Nuclear Security, LLC (CNS) became the M&O contractor. On November 1, 2024, PanTeXas Deterrence, LLC became the M&O contractor of Pantex.

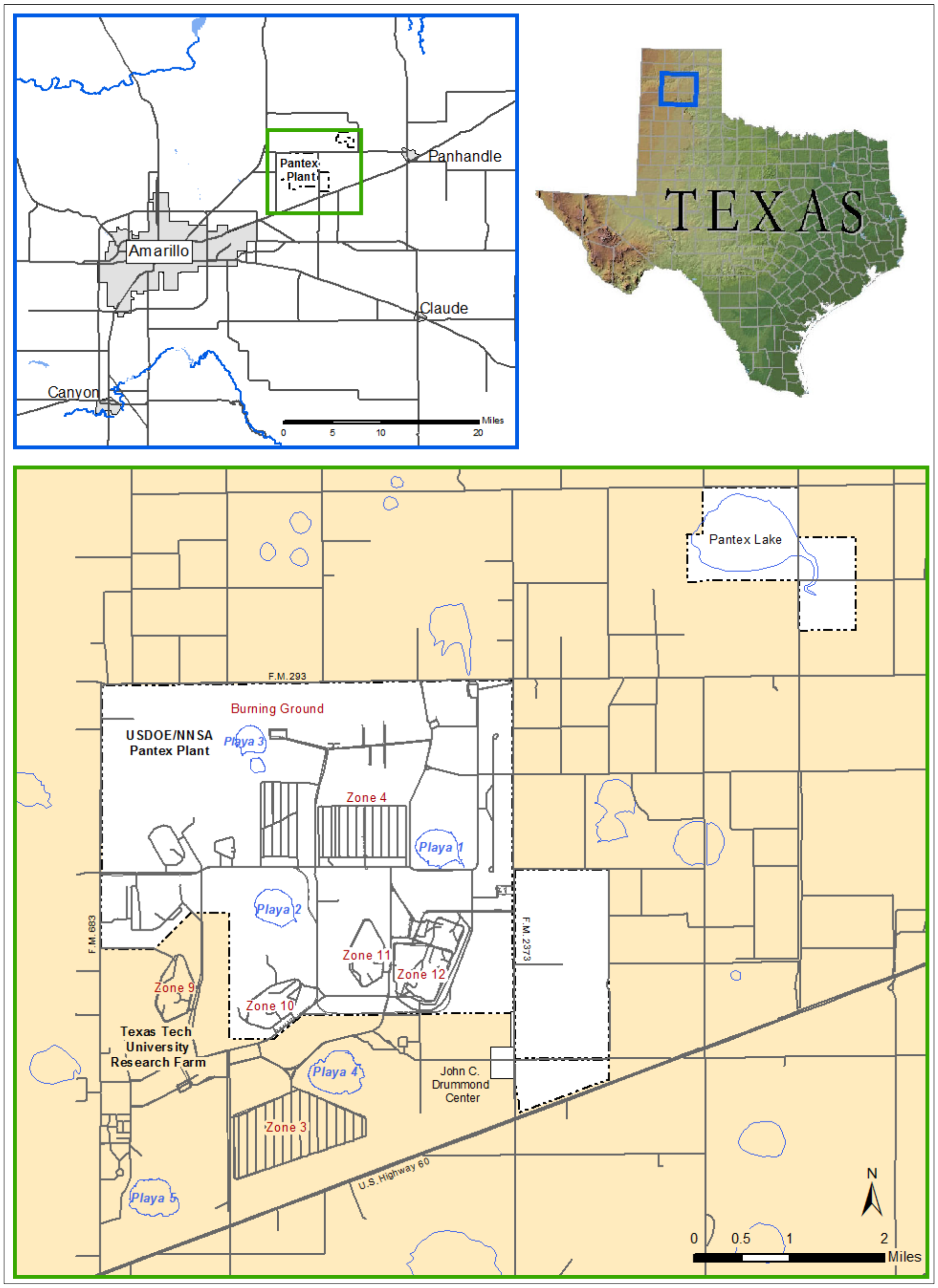

Figure 1.2 Pantex site location and zones

From 1942 to 1945, the U.S. used the Pantex Ordnance Plant for loading conventional artillery shells and bombs. In 1951, the Atomic Energy Commission (AEC) arranged to begin rehabilitating portions of the original Pantex site and constructing new facilities for nuclear weapons operations. In 1974, the Energy Research and Development Administration replaced the AEC and took responsibility for the operation of Pantex, and in 1977, the Energy Research and Development Administration was replaced by the DOE. In 2000, the DOE created and designated the NNSA to manage the nuclear weapons facilities and laboratories.

The primary missions of Pantex are as follows:

- Provide a nuclear deterrent for the nation and its allies as the nation's primary site for assembly, modification, and disassembly of nuclear weapons for the nation's stockpile,

- Ensure the stockpile is strong and viable by evaluating, repairing, and retrofitting the nuclear weapons in the stockpile,
- Reduce the total number of nuclear weapons in the stockpile through the dismantling of retired weapons and dispositions of various components and materials, and
- Support the stockpile as the High Explosives Center of Excellence that develops, tests, and fabricates high-explosive components for nuclear weapons and to support DOE initiatives.

Weapon assembly, disassembly, maintenance, and evaluation activities involve short-term handling (but not processing) of encapsulated tritium, uranium, and plutonium, as well as a variety of nonradioactive hazardous or toxic chemicals. In addition, environmental restoration of the facility is an integral part of the DOE environmental management's mission to clean up its sites.

1.3 FACILITY DESCRIPTION

Pantex is composed of several functional areas, commonly referred to as numbered zones (refer to the lower portion of Figure 1.2). Included within the zones are a weapons assembly/disassembly area, a weapons staging area, an experimental explosives development area, a drinking water treatment plant, a sanitary and industrial wastewater treatment facility (WWTF), a vehicle maintenance facility (VMF), and administrative areas. Other functional areas include a utilities area for steam and compressed air, an explosives test-firing facility, a burning ground for thermally processing (i.e., burning or flashing) explosive materials, pump-and-treat groundwater remediation facilities, several agricultural tracts which are irrigated via a subsurface and surface fluid distribution system, and landfills. Overall, there are approximately 518 buildings at Pantex.

The weapons assembly/disassembly area covers approximately 200 ac and contains more than 100 buildings. In this area, nuclear weapons can be assembled from nuclear components and non-nuclear parts received from other DOE plants; and chemical explosive components and metal parts fabricated at Pantex. The weapons can also be disassembled in this area.

Zone 4 is used for general warehousing and temporary holding (or staging) of weapons and weapon components awaiting movement to another area for modification, repair, or disassembly; for shipment to other DOE facilities for reworking; for shipment to a facility for sanitization; or for shipment to the military. The warehouse area is also used for interim storage of plutonium components from disassembly operations.

The explosives development area consists of facilities for synthesizing, formulating, and characterizing experimental explosives. This zone is under construction to become the Pantex Center of Excellence for High Explosives (HE).

The explosives test-firing facility (commonly called "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 support facilities for setting up test shots, interpreting results, and sanitizing components.

The Burning Ground is used for processing explosives, explosive components, and explosives-contaminated materials and waste by means of controlled open burning and flashing.

The land disposal area, north of Zone 10, is divided into two landfill sites. One currently receives non-hazardous solid wastes, primarily construction debris. The other receives non-hazardous solid waste management unit debris. Before 1989, Pantex's domestic solid waste was sent to an on-site sanitary landfill for disposal. Since then, this waste has been processed to remove recyclable materials. The non-recyclable material is sent to an off-site landfill. Practices preclude disposal of hazardous materials in on-site landfills; therefore, hazardous materials are transported off-site for disposal in accordance with applicable regulations.

Wastewater generated at Pantex is routed through a wastewater collection system to a WWTF. On October 6, 2003, the Texas Commission on Environmental Quality (TCEQ) issued Pantex a Texas Land Application Permit (TLAP) that authorizes beneficial reuse of the treated wastewater for the purpose of agricultural irrigation via a subsurface irrigation system. The TLAP was amended and reissued on August 11, 2020 to include authorization for a surface irrigation system (Center-Pivot irrigation). Pantex is also authorized to discharge wastewater to an on-site playa lake pursuant to Texas Water Quality Permit WQ000229600 (TCEQ 2020).

The drinking water system which serves multiple zones consists of production wells, water treatment/pumping facilities, storage tanks, and associated distribution lines. This system also supplies water to the high-pressure fire protection system.

Land east of FM 2373 has not been assigned a formal zone designation; however, wind turbines for the generation of electrical power and associated support equipment have been installed for generation of renewable electricity. Center-pivot irrigation has been completed and will further support the beneficial reuse of treated wastewater for irrigation of agricultural crops.

1.4 CLIMATOLOGICAL DATA

The area's climate is classified as semi-arid. It is characterized by hot summers and relatively cold winters. It experiences large variations in daily temperatures, low relative humidity, and irregularly spaced moderate rainfall. According to the National Weather Service's (NWS) website, the average annual precipitation is 19.71 in. (U.S. Department of Commerce 2016). Approximately 70% of the average annual rainfall occurs from April to September. This is considered growing season precipitation and is commonly associated with thunderstorm activity. The average annual snowfall is 17.9 in. (U.S. Department of Commerce 2016). Snow typically melts within a few days after it falls. Heavier snowfalls of 10 in. or more, usually with near-blizzard conditions, average once every five years and with snow mass generally remaining less than two to three days. The estimated potential gross lake surface evaporation in the area is about 55 in. (Bomar 1995) or 280% of the average annual precipitation.

The Amarillo area is subject to extreme and rapid temperature changes, especially during the fall and winter months when cold fronts from the northern Rocky Mountain and Plains states sweep across the area. Substantial temperature drops within a 12-hour period are common (U.S. Department of Commerce 2016).

Humidity averages are low, occasionally dropping below 20% in the spring. Low humidity moderates the effect of summer afternoon high temperatures and permits evaporative cooling systems to be very effective. Severe local storms are infrequent throughout the cool season, but occasional thunderstorms with large hail, lightning, and damaging wind occur during the warm season, especially during the spring. These storms are often accompanied by heavy rain, which can produce local flooding in low-lying areas.

Pantex is located in an area with a relatively high frequency of tornadoes, convective wind events, and hail. An average of 17 tornadoes occurred each year in the 20 counties of the Texas Panhandle and the adjacent three counties of the Oklahoma Panhandle during the period between 1950 and 2022 according to the NWS Tornado Climatology of The Texas and Oklahoma Panhandles database (U.S. Department of Commerce 2023). While the threat of tornadoes is real, tornado occurrences in Amarillo are generally rare. Tornadoes are most common from April to June. The National Oceanic and Atmospheric Administration (NOAA) Storm Events Database reported a total of 5 tornadoes in the Texas and Oklahoma Panhandles during 2024 (U. S. Department of Commerce 2025). The frequencies of wind direction and wind speed during 2024 are illustrated by the wind-rose in Figure 1.3, generated from the Iowa Environmental Mesonet database, which contains data from cooperating observing networks, including those at Pantex. The figure indicates, as in most previous years, that the predominant wind direction is a southerly wind.

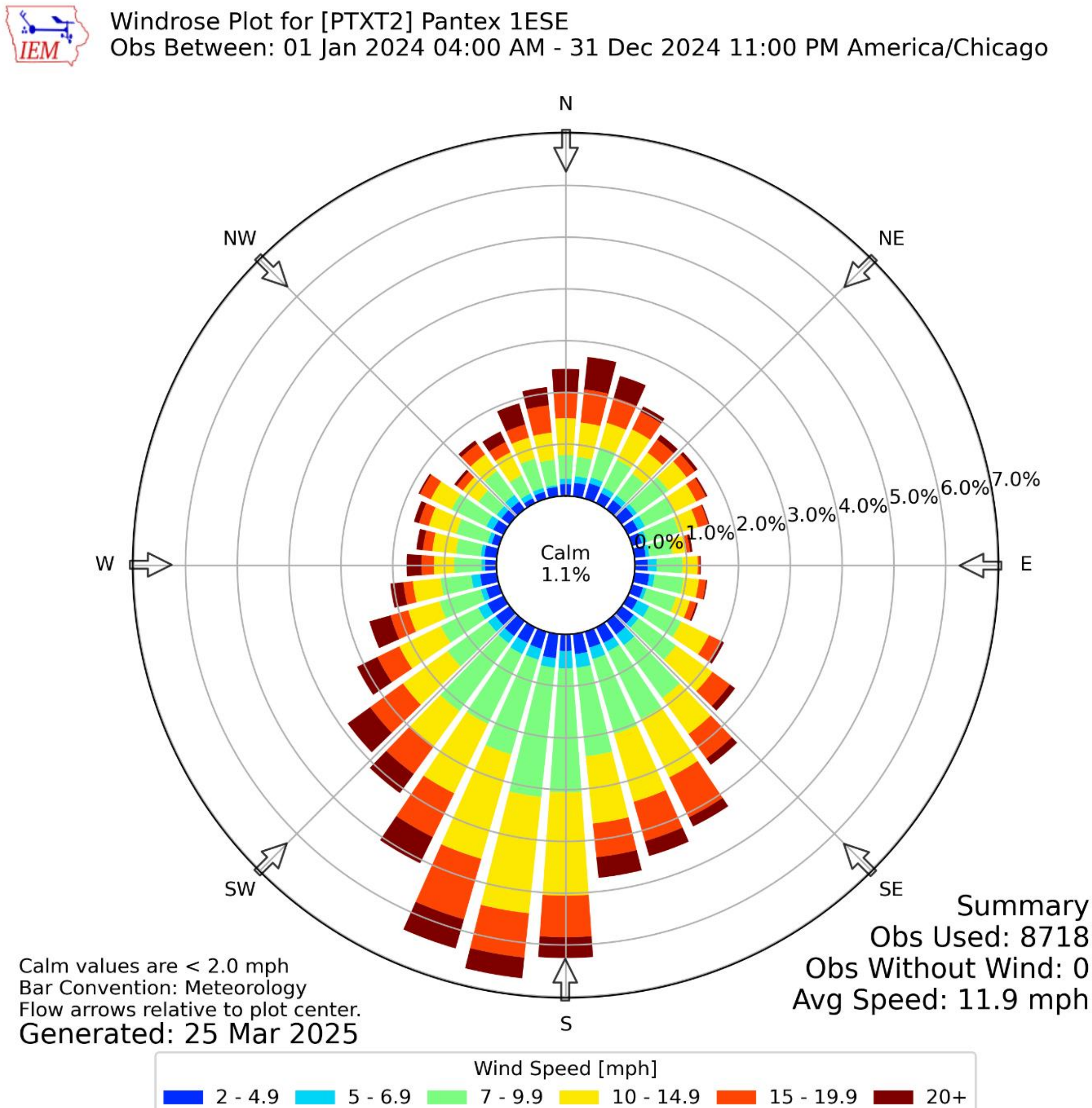

Figure 1.3 Pantex annual wind-rose for 2024 (Iowa Environmental Mesonet)

Based upon monthly climatological data forms published by the NWS Forecast Office for Amarillo (located at Rick Husband International Airport), the mean temperature at the official NWS location during 2024 was 61.9°F, slightly above the historical annual mean temperature in Amarillo of 58.7°F. During 2024, the West Texas Mesonet rain gauge located at Pantex recorded 21.9 in. of precipitation. Table 1.1 is a compilation of climatological data [temperature, relative humidity, monthly precipitation totals (including the water equivalent of any snowfall), and wind speed] for 2024 from the Amarillo Airport NWS and the West Texas Mesonet meteorological instrumentation located at Pantex. The range of mean monthly temperatures and the monthly precipitation summaries are shown in Figures 1.4 and 1.5.

Table 1.1 Pantex 2024 Climatological Data by Month

Month	Temperature (°F)			Mean Relative Humidity (percent)	Precipitation[a] (inches)	Wind Speed (mph)	
	Maximum	Minimum	Mean Monthly			Mean	Maximum
January	69	0	34.3	67.9	1.17	14.8	69.1
February	83	19	46.2	57.5	0.64	16.2	59.2
March	79	24	50.9	53.7	0.7	16.4	58.1
April	88	35	58.9	46.9	2.32	17.5	64.7
May	97	45	68.5	52.8	1.33	16.0	57.0
June	102	59	80.6	61.8	2.51	16.3	50.2
July	106	61	81.9	53.8	3.48	13.9	48.4
August	108	61	84.4	49.3	2.65	12.3	53.3
September	101	47	74.2	53.1	0.81	12.4	43.3
October	95	33	66.7	44.6	0	15.3	43.5
November	79	25	50.3	70.6	6.31	15.2	44.3
December	72	21	45.3	53.6	0	13.5	39.2
Annual			**61.9**	55.5	**21.9**	15.0	69.1

[a] Includes water equivalent of snowfall

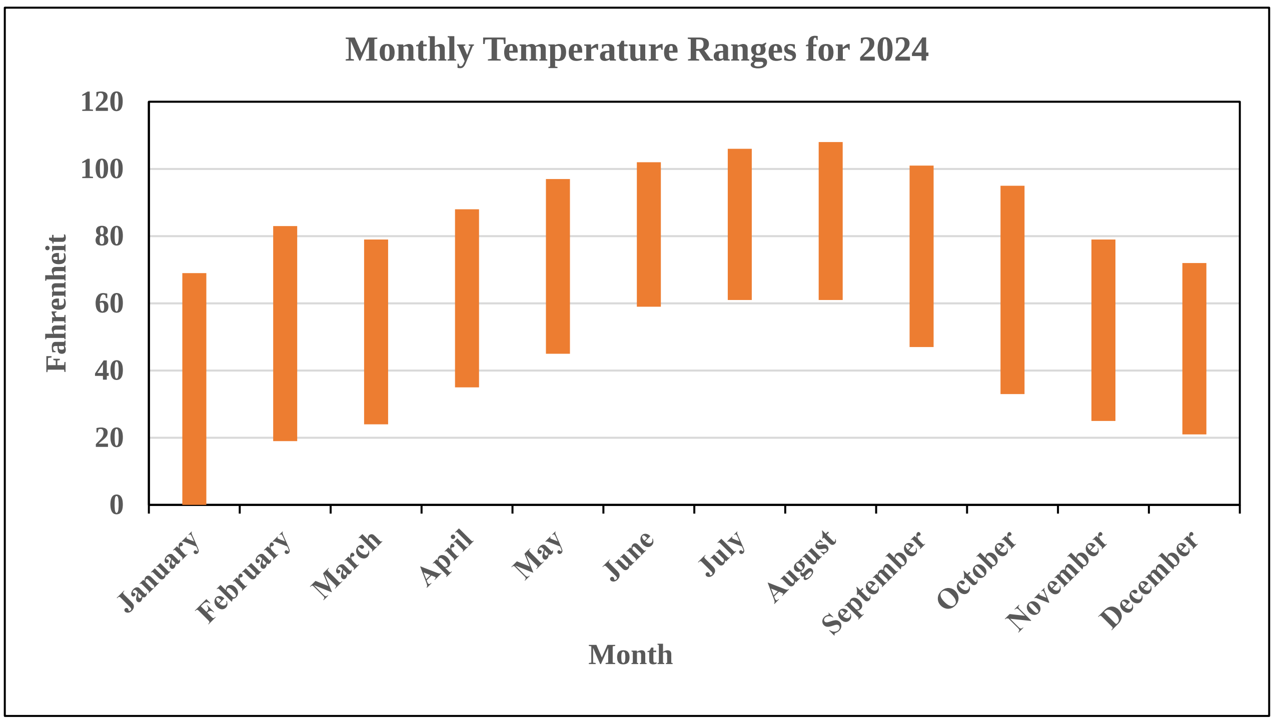

Figure 1.4 Pantex monthly temperature ranges during 2024

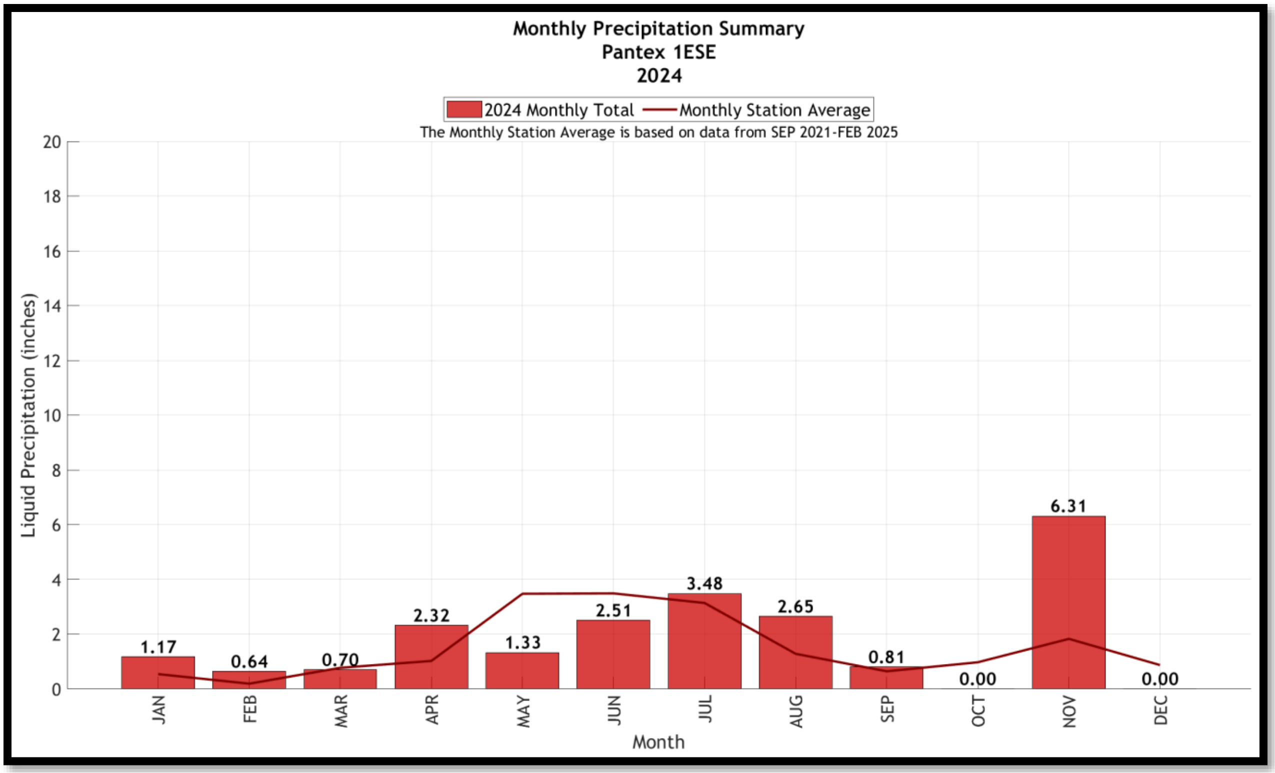

Figure 1.5 Pantex precipitation during 2024

Pantex maintains a meteorological monitoring station on the northeast corner of Pantex. The data from Pantex's meteorological tower are compared with those obtained from the Amarillo Airport NWS site, located approximately 10 mi to the west-southwest, to determine if the instrumentation is operating correctly. On a monthly basis, data outliers are identified and, when necessary, eliminated from the meteorological data set. The meteorological tower includes temperature/humidity sensors located at a height of 33 ft for plume modeling purposes. Pantex also has a Texas Tech West Texas Mesonet site, located just across from the John C. Drummond Center and FM 2373. Data from this site can be accessed at https://www.mesonet.ttu.edu/latest-obs. The Mesonet site has official meteorological instrumentation that includes a temperature/humidity sensor at five feet, which is the official height for the NWS. The NWS observes Mesonet data and has deemed it as "meteorologically official" due to the standardized height of the instrumentation. Pantex added a second Mesonet site at the TTU Research Farm, located half-a-mile north of the Kilgore Facility and along FM 683 in 2022 and is operational.

1.5 GEOLOGY

The primary surface deposits at Pantex are the Pullman and Randall soil series, which grade downward to the Blackwater Draw Formation. This formation consists of about 50 ft of interbedded silty clays with caliche and very fine sands with caliche.

Underlying the Blackwater Draw Formation, the Ogallala Formation consists of interbedded sands, silts, clays, and gravels. The base of the 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, the vertical distance to the base of the Ogallala varies from 300 ft at the southwest corner to 720 ft at the northeast corner of the property (Purtymun and Becker 1982). Underlying the Ogallala Formation is the Dockum Group, consisting of shale, clayey siltstone, and sandstone. Radon released from the underlying granitic rocks in the deep geology (>4,000 ft) below Pantex has a major influence on the natural radiation environment.

1.6 HYDROLOGY

The closest riverine water feature on the Southern High Plains is the Canadian River approximately 17 mi north of Pantex, which flows southwest to northeast. Surface waters at Pantex do not drain into this system but for the most part discharge into on-site playas. Stormwater from agricultural areas at the periphery of Pantex drain into off-site playas. From the various playas, water either evaporates or infiltrates the soil. Two principal subsurface water-bearing units exist beneath Pantex and adjacent areas: the Ogallala Aquifer and the underlying Dockum Group Aquifer. The perched aquifer lies within the vadose, or unsaturated zone above the Ogallala Aquifer. The vadose zone consists of as much as 500 ft of sediment that lies between the land surface and the Ogallala Aquifer.

1.6.1 Perched Aquifer

The perched aquifer sits within the Ogallala Formation. It is present in the vadose zone, above the main zone of saturation, and it is discontinuous. Perched aquifers form above clayey layers that have low permeability. Depths from the surface to the perched aquifer range from 209 to 279 ft. Data collected from wells at Pantex indicate that the zone of saturation in the perched aquifer varies in thickness by as much as 50 to 80 ft.

1.6.2 Ogallala Aquifer

The main Ogallala Aquifer lies beneath the perched aquifer. Depth to the main Ogallala Aquifer ranges from 335 to 500 ft. The saturated thickness varies from 39 to 400 ft (Panhandle Groundwater Conservation District 1980). The aquifer is defined as the basal water-saturated portion of the Ogallala Formation and is a principal water supply on the Southern High Plains. The regional gradient of the Ogallala Aquifer beneath Pantex trends from the southwest to the northeast, where the zone of saturation is thickest. Pantex's production wells are located in this northeast area. The City of Amarillo's Carson County Well Field is located north and northeast of Pantex's well field.

1.6.3 Dockum Group Aquifer

The Dockum Group Aquifer lies under the Ogallala Formation at Pantex. Water contained in sandstone layers within the Dockum Group supplies domestic and livestock wells south and southeast of Pantex. Other wells reaching the Dockum Group Aquifer are located 10 mi south and west of Pantex. The aquifer may be semi-confined with respect to the overlying Ogallala Aquifer because of lateral variations in the Ogallala and shale layers within the Dockum Group.

1.6.4 Water Use

The Canadian River flows into the man-made Lake Meredith located approximately 25 mi north of Pantex. Many local communities use water from Lake Meredith for domestic purposes, when the water depth is sufficient. The major groundwater source near Pantex is the Ogallala Aquifer. It is used as a domestic and industrial water source by numerous municipalities and industries in the High Plains. Historical groundwater withdrawals and long-term pumping from the Ogallala Aquifer in Carson County and the surrounding eight-county area have exceeded the natural recharge rate of the Ogallala Aquifer. These overdrafts have removed large volumes of groundwater from recoverable storage and have caused substantial water level declines.

The large demands of the Amarillo area, which are primarily agricultural, are responsible for the drop in the water table. From 1988 to 1997, the average change in “depth to water” from 1,209 Ogallala Aquifer observation wells in the Panhandle was 1.49 ft. Groundwater withdrawals from the Ogallala Aquifer in Carson County have averaged approximately 39 billion gal over the last several years. This groundwater withdrawal rate is more than 10 times greater than the estimated annual recharge rate of 358 million gal.

Groundwater withdrawal rates are expected to decline each decade to approximately 21 billion gal by 2060 (Crowell 2007).

The City of Amarillo is the largest municipal user of Ogallala Aquifer water in the area. It pumps water for public use from the Carson County Well Field, located north and northeast of Pantex. Pantex obtains water from five wells in the northeast corner of the site. In 2024, Pantex pumped approximately 122 million gal of water from the Ogallala Aquifer. Most of the water used at Pantex is for domestic purposes. Through an agreement with TTU, Pantex provides water to the adjacent TTU research farm properties for domestic and livestock uses.

Pantex reviews emerging contaminants to potentially add to sampling lists when a contaminant could be of concern and has a robust water monitoring program (Figure 1.6). Emerging contaminants have been detected in drinking water supplies around the U.S. and may pose a risk to the environment or human health; however, risk factors are not fully known. Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that have been in use since the 1940s, and are (or have been) found in many consumer products like cookware, food packaging, and stain repellants. PFAS manufacturing and processing facilities, airports, and military installations that use firefighting foams are some of the main sources of PFAS (U.S. Environmental Protection Agency 2023). Pantex currently has contracts with two labs for PFAS analysis capabilities. Development of PFAS regulations is being monitored, historical use of PFAS chemicals has been documented, and samples from the drinking water system have been analyzed by multiple external laboratories with the results indicating zero detections of PFAS.

Figure 1.6 Environmental sampling technician processing water sample

Photo by Michael Schumacher

1.7 SEISMOLOGY

Seismic events of low magnitude have occurred infrequently in the region. The stress conditions at the site are such that the possibility of high-order seismic events is extremely unlikely. A qualitative understanding of the present conditions at Pantex indicates that anticipated seismic activity is well below the level that is necessary to cause significant damage to structures at Pantex. The potential for local or regional earthquakes (with a magnitude great enough to damage structures at the site to the degree that hazardous materials would be released) is extremely low (McGrath 1995).

1.8 LAND USE AND POPULATION

The land around Pantex is used mainly for winter wheat and grain sorghum farming, ranching, and for oil and gas exploration. Although dryland farming is dominant, some fields are irrigated from the Ogallala Aquifer or, less commonly, from local playas. Ranching in the region consists of cow-calf and yearling operations. The economy of the rural Panhandle region depends primarily on agriculture, but diversification has occurred in the more populated counties of the region to include manufacturing, distribution, food processing, and medical services. Nationally known businesses that are major employers in the greater Amarillo area include Bell Helicopter; Tyson Foods (a single rail beef-slaughtering operation); Pantex; Owens-Corning Fiberglass (a fiberglass reinforcement plant); and Cactus Feeders (one of the largest cattle-feeding operations in the world). Conoco-Phillips Petroleum and Xcel Energy are also major industrial presences in the Panhandle region.

A land-use census of the residential population surrounding Pantex showed that most of the population is located west-southwest of Pantex in the Amarillo metropolitan area. Population data from the 2020 census were used to generate Figure 1.7 (U.S. Census Bureau 2022), showing the population distribution at 5-mi intervals within 50 mi of Pantex. According to the 2020 census, the total population within 50 mi of Pantex is 332,688 people.

The total population of the 20-county area (defined as the Texas Panhandle) surrounding Pantex is 398,904. The population of the City of Amarillo (200,904 in 2020) represents approximately 49% of the counties' population. Approximately 32% of the population lives in other incorporated cities, and approximately 19% reside in unincorporated areas.

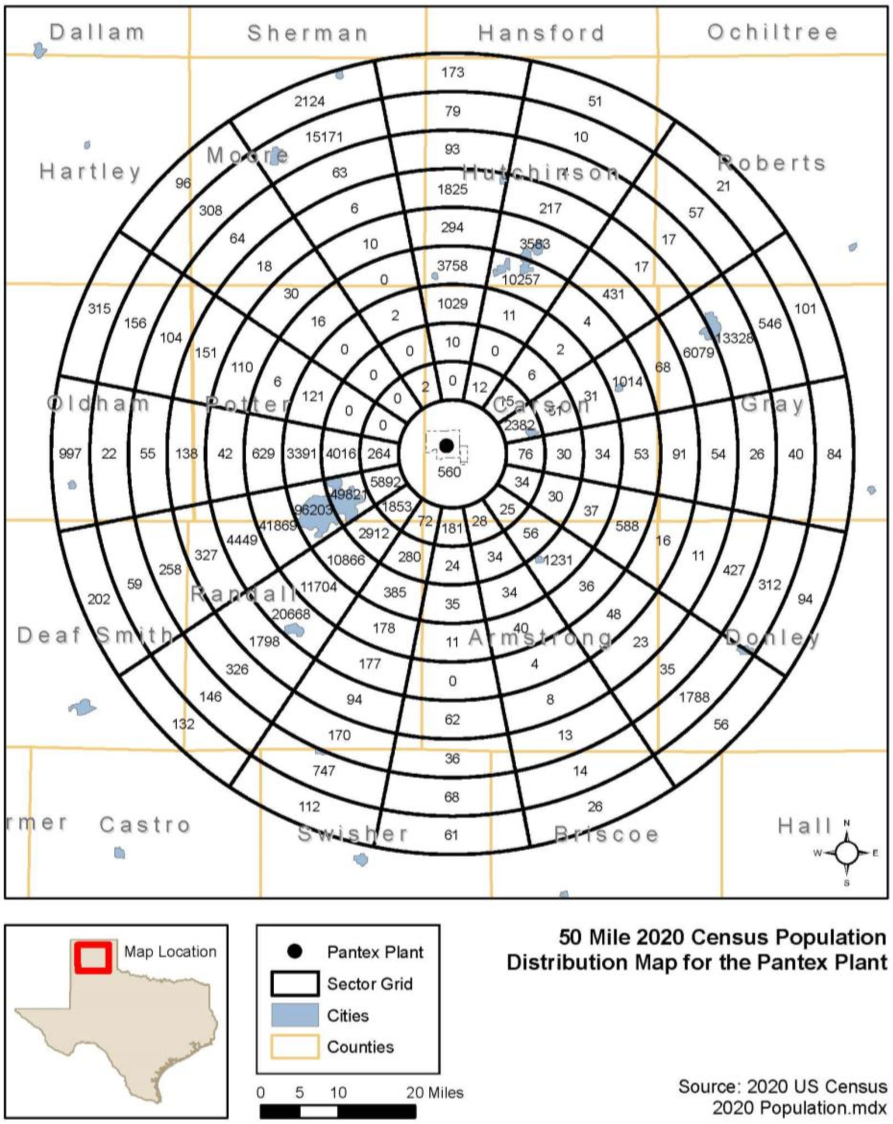

Figure 1.7 Population distribution within 50 miles of Pantex (2020)

The communities of Pampa, Borger, Hereford, Dumas, and Canyon each have populations between 13,000 and 18,000. The 20-county areas can be described as sparsely populated, with Potter and Randall counties being the exception. Excluding Potter and Randall counties, the general population density of each county ranges from 12 to 154 persons per square mile. Potter, Randall, Carson, and Armstrong counties make up the Amarillo Metropolitan Statistical Area. Hutchinson County (in which Borger is located) and Gray County (in which Pampa is located) are now classified as micropolitan statistical areas (U.S. Census Bureau 2022). Hartley, Moore, Roberts, Oldham, Deaf Smith, Donley, Dallam, Sherman, Hansford, Ochiltree, Lipscomb, Hemphill, Wheeler, and Collingsworth are the remaining counties of the defined area. The populations contained in the northerly portions of Castro, Swisher, and Briscoe Counties are also included in the 50 mi population estimate described above.

1.9 ORGANIZATION OF THE REPORT

The remainder of this report is organized into 12 chapters and nine appendixes as follows:

Chapter 2 discusses regulatory requirements for environmental compliance during 2024 and describes Pantex's compliance-related issues and activities. It presents results of various regulatory inspections and environmental activities and lists the environmental permits issued to Pantex.

Chapter 3 provides a brief summary of the environmental programs that are conducted at Pantex. Overviews are provided for the environmental management system (EMS), pollution prevention (P2), natural and cultural resources management, environmental restoration, and sustainability initiatives.

Chapter 4 describes the environmental radiological monitoring program, which deals with the potential exposure of the public and the environment to radiation resulting from Pantex operations. Also discussed are results of the environmental thermoluminescent dosimetry program and other radiological monitoring programs for various environmental media (e.g., air, groundwater, surface water, plants, and animals).

Chapters 5 through 11 discuss radiological and non-radiological monitoring and surveillance programs for individual environmental media. Chapter 5 discusses the air-monitoring program. The groundwater, drinking water, wastewater, and surface water monitoring programs are discussed in Chapters 6, 7, 8, and 9, respectively. Chapter 10 describes the soil monitoring program. Fauna and flora monitoring are discussed in Chapter 11. Each of these chapters includes a description of the monitoring program for the specific medium and an analysis of radiological and non-radiological data for the 2024 samples.

Chapter 12 reviews Pantex's Quality Assurance program for environmental monitoring efforts, as initiated in response to 10 Code of Federal Regulations (CFR) 830.120, *Nuclear Safety Management*, "Scope," and DOE O 414.1D, *Quality Assurance*. The chapter also includes an analysis of quality control (QC) samples collected during 2024 and a data validation summary.

Appendix A lists all the birds sighted at Pantex.

Appendix B provides drinking water sampling analytical results.

Appendix C lists all the analytes for which environmental analyses were conducted.

Appendix D provides soil sampling analytical results.

Appendix E is a glossary that lists and defines key terms used in this report.

Appendix F lists relevant elements and chemicals and the respective abbreviations and formulas.

Appendix G lists the relevant units of measure and the respective abbreviations.

Appendix H provides helpful conversion information.

Appendix I provides references.

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CHAPTER 2 - COMPLIANCE SUMMARY

Pantex policy is to conduct all operations in compliance with applicable environmental statutes, regulations, and the requirements of the various authorizations issued to Pantex. This chapter describes and reviews current issues, initiatives, and cleanup agreements in place, regulatory authorizations issued to Pantex, and measures to support DOE environmental performance indicators. It also summarizes the compliance status of Pantex for 2024.

Chapter Highlights

- Pantex tracked emissions from 30 different processes at specific locations and grouped sources across the site. Total Pantex emissions were less than 30% of the certified and authorized potential-to-emit levels for each of the pollutants tracked.
- Pantex is compliant with all provisions of the applicable regulations and issued permits.
- The annual Resource Conservation and Recovery Act waste site inspection was conducted by the Texas Commission on Environmental Quality (TCEQ) on May 29-31, 2024. It concluded with no findings or issues identified.

2.1 ENVIRONMENTAL REGULATIONS

Various government entities have regulatory authority over and environmental interests in the operations at Pantex. Table 2.1 presents environmental regulations applicable to operations at Pantex.

Table 2.1 Major Environmental Regulations Applicable to Pantex

Air Regulations			
Regulatory Description	**Authority**	**Regulations**	**Compliance Status**
Clean Air Act (CAA) CAA is the comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes the Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards to protect public health and public welfare and to regulate emissions of hazardous air pollutants.	Federal: EPA	Federal: 40 CFR 50-82	Pantex is subject to the applicable requirements codified in the Code of Federal Regulations (CFR) (including those dealing with emissions of radionuclides at Department of Energy facilities: 40 CFR 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities*).
CAA and the Texas Clean Air Act, through their implementing regulations, control the release of regulated emissions to the atmosphere and provide for the maintenance of ambient air quality.	State: TCEQ	State: 30 TAC 101–122; 30 TAC 305	Pantex maintains authorization through permits and Permits by Rule issued by the TCEQ for emissions released to the atmosphere. Pantex is a self-certified “Minor” emission source under the Federal Operating Permit

			Program.
CAA air toxics regulations specify work practices for asbestos to be followed during demolitions and renovations of all facilities, including, but not limited to, structures, installations, and buildings.	State: Texas Department of State Health Services (TDSHS)	State: 25 TAC 296 (Asbestos only)	Pantex establishes requirements for the safe removal and handling of asbestos-containing material. Notifications are made as required to the TDSHS for all asbestos-related activities.
Hazardous Material Regulations			
Regulatory Description	**Authority**	**Regulations**	**Status**
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.	Federal: EPA	Federal: 40 CFR 300, 302, 355, and 370	Pantex has been on the National Priorities List since 1994. The EPA, TCEQ, and National Nuclear Security Administration (NNSA) Pantex Field Office have signed an interagency agreement concerning the conduct of remediation at Pantex. A record of decision was issued and approved in 2008 which added Pantex to the Construction Completion List in 2010. Interested co-trustees have been involved in the planning and completion of the ecological risk assessment for Pantex and selection of the final remedy.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) FIFRA governs the manufacture and use of biocides, specifically the use, storage, and disposal of all pesticides, pesticide containers, and residues.	Federal: EPA State: Texas Department of Agriculture; Structural Pest Control Board	Federal: 40 CFR 170-171 State: 4 TAC 7.1-7.71; Structural Pest Control Act (Art. 135b-5)	State-licensed personnel apply pesticides in accordance with applicable regulations. Pantex implemented a land-applied chemical use plan in 1996. The plan was updated in 2022.
Medical Waste	Federal: U.S. Department of Transportation (DOT) State: Texas Department of State Health Services (TDSHS)	Federal: 49 CFR 173, *Shippers: Shippers—General Requirements for Shipments And Packagings* State: 30 TAC 326, *Environmental Quality*, "Medical Waste	Pantex manages medical waste in accordance with applicable regulations.

		Management"	
Resource Conservation and Recovery Act (RCRA) RCRA and the Texas Solid Waste Disposal Act govern the generation, storage, handling, treatment, and disposal of solid waste, including hazardous waste. These statutes and regulations also regulate underground storage tanks and spill cleanup.	Federal: EPA State: TCEQ	Federal: 40 CFR 260-280 State: 30 TAC 305, 327, and 335 State: 30 TAC 334	Pantex is defined as a large-quantity generator. Hazardous Waste Permit/Compliance Plan No. 50284 authorizes the management of hazardous wastes in various storage and processing units and addresses corrective action requirements at Pantex. Pantex operates five regulated underground storage tanks and one regulated aboveground storage tank.
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.	Federal: EPA	Federal: 40 CFR 700–766, and 10 CFR 850	Pantex manages polychlorinated biphenyl, asbestos, beryllium, and chemicals in compliance with applicable regulations.
General Environmental Regulations			
Regulatory Description	**Authority**	**Regulations**	**Status**
National Environmental Policy Act (NEPA) NEPA establishes a broad national policy to conduct federal activities in ways that promote the general welfare of 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.	Federal: DOE; Council for Environmental Quality	Federal: 10 CFR 1021, 40 CFR 1500–1508	In 2024, six standard NEPA review forms, 36 internal NEPA review forms, and 12 amendments were prepared.
Natural and Cultural Resources Regulations			
Regulatory Description	**Authority**	**Regulations**	**Status**
American Indian Religious Freedom Act (AIRFA) AIRFA was created in order to protect and preserve the traditional	Federal: DOE	Federal: 42 USC § 1996	A comprehensive Native American Treaty Search was conducted in 1999. This report documented a full search of all potential tribal interests in the lands that comprise the Pantex

religious rights and cultural practices of American Indians, Eskimos, Aleuts, and native Hawaiians. These rights include access to sacred sites, repatriation of sacred objects, among others.			Plant. The full document was circulated to tribes for their review and comment. No comments were received. No sacred artifacts have been found at the Pantex Plant and no tribes have expressed interest in the lands at Pantex as sacred sites.
Archaeological Resources Protection Act (ARPA) ARPA provides for the protection of archaeological resources and sites located on public and Native American lands.	Federal: Advisory Council on Historic Preservation (ACHP) State: Texas Historical Commission	Federal: 36 CFR Part 79 (39 CFR 79) 43 CFR 7	All archaeological surveys and testing at Pantex conformed to ARPA standards.
Endangered Species Act (ESA) The ESA prohibits any entity or person from taking any action that would jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat.	Federal: U.S. Fish and Wildlife Service (USFWS) State: Texas Parks and Wildlife Department (TPWD)	Federal: 50 CFR 10; 50 CFR 17; 16 USC 153, et seq. State: TPWD § 68	Ongoing and proposed actions are assessed as to their potential adverse effects on threatened and endangered species.
Executive Order (EO) 13287: Preserve America (2003) The Preserve America EO directs federal agencies to advance the protection, enhancement, and contemporary use of federal historic properties and to promote partnerships for the preservation and use of historic properties, particularly through heritage tourism.	Federal: DOE, ACHP	Federal: Volume 68 Federal Register, page 10635 (68 FR 10635), March 5, 2003	Ongoing and proposed actions are assessed as to their potential to affect historic properties through the NEPA process. Historic preservation at the Pantex Plant is governed by the Programmatic Agreement executed by DOE/NNSA and the Texas State Historic Preservation Office.
EO 13186: Responsibilities for Federal Agencies to Protect Migratory Birds (2001) Establishes commitment to	Federal: DOE	Federal; Volume 66 Federal Register, page 3853 (66 FR 3853), 2001	Actions being considered at Pantex are reviewed through the NEPA process, which considers impacts to migratory species. This EO adds additional language

migratory bird protection, management, research, and outreach on federal properties. The order reaffirms relationship between the U.S. Fish and Wildlife Service (USFWS) and other federal agencies.			beyond the Migratory Bird Treaty Act (MBTA) to consider impacts to habitat. It encourages partnerships, research, and outreach, dealing with migratory birds.
MBTA Under the MBTA, it is unlawful "by any means or manner to pursue, hunt, take, capture, or kill" any migratory birds except as permitted by regulation.	Federal: USFWS State: TPWD	Federal: 50 CFR 10 pursuant to 16 USC 704-707 and 712 State: TPWD § 64.002-64.005; TPWD § 64.007; TPWD § 26; TPWD § 27	Actions being considered at Pantex are reviewed through the NEPA process, which considers impacts to migratory species. Nuisance and other bird conditions are managed in compliance of the MBTA.
Native American Graves Protection and Repatriation Act	Federal: Department of the Interior (DOI)	Federal: 25 USC 3001-13	Actions being considered at Pantex are reviewed through the NEPA process, which considers the presence or possible presence of Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony.
National Historic Preservation Act (NHPA)	Federal: ACHP State: Texas Historical Commission	Federal: 36 CFR Part 800	Ongoing and proposed actions are reviewed through the NEPA process and monitored in order to consider potential impacts to historic properties. Pantex utilizes a program alternative to individual reviews for NHPA compliance.
Protection of Birds, Nongame Species, and Fur-Bearing Animals Requires the protection of all indigenous birds and ring-necked pheasants, nongame species, and fur-bearing animals except where exceptions are stated in the TPWD code.	Federal: USFWS State: TPWD	Federal: 50 CFR 10 State: Tex. Parks & Wildlife § 67 and Tex. Parks & Wildlife § 71	Actions being considered at Pantex are reviewed through the NEPA process, which considers impacts to all protected species.
Water Regulations			
Regulatory Description	**Authority**	**Regulations**	**Status**
Federal Water Pollution Control Act/Clean Water Act	Federal: EPA	Federal: 40 CFR 120-136, and 40 CFR 300 - 583	As currently defined, Pantex does not discharge its wastewaters to 'waters

The Texas Water Code, through its implementing regulations, regulates the quality of water discharged to waters of the State of Texas.	State: TCEQ	State: 30 TAC 205-299, 305, 309, 317, and 319	of the United States'. Pantex discharges its industrial wastewaters pursuant to Water Quality Permits No. WQ0002296000 and WQ0004397000; and Underground Injection Control Authorization No. 5W2000017. Pantex has coverage under the Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit for stormwater via Permit No. TXR150000. Pantex complies with the requirements of the permit whenever applicable to a project. Pantex operates under the TPDES Multi-Sector General Permit for Discharges of Stormwater from Industrial Sources via Permit No. TXR05GO12.
Safe Drinking Water Act Safe Drinking Water Act and the Texas Water Code govern public water supplies.	Federal: EPA State: TCEQ	Federal: 40 CFR 141–143 State: 30 TAC 290	Pantex operates a Non-transient, Non-community Public Water Supply System (No. 0330007). The system is recognized as a Superior Public Water System by the TCEQ.

2.2 CLEAN AIR ACT

Most requirements of the federal CAA in Texas are implemented under the Texas Clean Air Act, which is administered by the TCEQ, as approved by the EPA through the Texas State Implementation Plan. The exceptions to this delegation of authority from the EPA include 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants"; 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities"; 40 CFR 61, Subpart M, "National Emission Standard for Asbestos"; and regulations dealing with stratospheric ozone protection. The primary regulatory authority for 40 CFR 61, Subpart M, is delegated to the TDSHS.

2.2.1 Emissions of Radionuclides Other than Radon from DOE Facilities

According to the standard established in 40 CFR 61.92, "standard," emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem/yr or 0.10 mSv/yr. Based upon evaluations using the most conservative assumptions about the emissions of radionuclides from several Pantex locations that have the potential-to-emit (PTE) radioactive materials, Pantex has determined that the maximum effective dose equivalent that any member of the public received in 2024 was 1.60E-04 mrem/yr (1.600E-06 mSv/yr). Accordingly, Pantex is in compliance with the EPA standard. Continuous emission monitoring, as described in 40 CFR 61.93, "Emission Monitoring and Test Procedures," is not required of any source at Pantex, based on each source's emission potential. Pantex performs periodic confirmatory measurements and modeling to assure compliance with 40 CFR 61, Subpart H regulations.

In accordance with 40 CFR 61.96, "Applications to Instruct or Modify," all new construction projects and activities (or modifications to existing structures or activities) that have the PTE radioactive materials are evaluated to determine if the effective dose equivalent, caused by all emissions, is less than 1% of the 40 CFR 61.92 standard [i.e., is less than 0.1 mrem/yr (0.001 mSv/yr)]. During 2024, none of the evaluations resulted in the identification of exceedances of this reduced standard. Accordingly, there was no need to make an application for approval or notifications of startup to the EPA under the provisions of 40 CFR 61.96.

2.2.2 National Emissions Standard for Asbestos

Each year, Pantex files a Notification of Consolidated Small Operations Removing Asbestos-Containing Material with the TDSHS for maintenance activities to be conducted by Pantex in the next calendar year (CY). To verify that operations are consistent with the notification, Pantex keeps a log of all its affected maintenance activities to track quantities of material disturbed.

Subcontractors at Pantex are required to prepare separate notifications for work that qualifies as "demolition" or "renovation" as defined in 40 CFR 61, Subpart M, and 25 Texas Administrative Code (TAC) 296.251, *Health Services*, "Texas Asbestos Health Protection," "Notifications." Separate notifications are also required for jobs conducted by Pantex personnel that involve amounts that would require job-specific notifications. Pantex maintains the required certifications for the personnel who plan, oversee, and conduct these efforts.

2.2.3 Chemical Accident Prevention

Pantex maintains controls on the introduction of new chemicals to any area of the plant and tracks chemical inventories to ensure that the quantities of chemicals at any location are below the thresholds stated in 40 CFR 68, *Protection of the Environment*, "Chemical Accident Prevention Provisions." This inventory control exempts Pantex from having to perform risk management planning.

2.2.4 Ozone-Depleting Substances

At Pantex, licensed technicians install and maintain stationary and motor vehicle air conditioning systems. Technicians use approved recycling devices as needed when conducting these efforts. Pantex maintains records of training and maintenance activities to demonstrate compliance with federal regulations (40 CFR 82, "Protection of Stratospheric Ozone").

2.2.5 Air Quality Permits and Authorizations

Pantex operates under several TCEQ air quality authorizations for the processes and activities conducted at Pantex. These include New Source Review permits issued under 30 TAC 116, "Control of Air Pollution By Permits For New Construction Or Modification" (Permit No. 84802), De Minimis activities as authorized under 30 TAC 116.119, and authorizations issued under 30 TAC 106, "Permits by Rule" (PBR).

2.2.6 Federal Operating Permit Program

The Title V Federal Operating Permit Program is administered and enforced by the EPA Region 6 Office and the TCEQ. During 2024, Pantex maintained documentation demonstrating compliance as a Synthetic Minor Source, as defined by the Federal Operating Permit Program.

2.2.7 Air Quality Investigation

The TCEQ did not perform an air quality-related compliance inspection of Pantex during 2024.

2.2.8 Emission Tracking and Calculations

Pantex is subject to the federal CAA and the State of Texas regulations under 30 TAC Chapters 101, 106, 111, 112, 113, 116, 117, 118, and 122. The main scope or function of Pantex's air emission tracking system is to monitor and quantify process emissions to (a) maintain the facility's designation of "Synthetic Minor" under the federal Title V program and (b) demonstrate compliance with the National Ambient Air Quality Standards and with the authorizations issued to Pantex. Pantex initiated a comprehensive system for tracking emissions from specific sources (facilities) in September of 1999 and has continued to update the tracking process to comply with changing regulations and best management practices. Pantex processes that generate emissions are conducted under the authority of various regulations and authorizations (permits, standard exemptions, and PBR). Table 2.2 identifies the tracked emission sources at Pantex and their authorizations.

Table 2.2 Tracked Emission Sources at Pantex

Process:	Authorization/Permit #	Standard Exemption (SE)	Permit By Rule (PBR)
High Explosives (HE) Synthesis Facility	Permit 84802 and Standard Permit 174554		
HE Fabrication	Permit 84802		
Firing Site Activities	Permit 84802		
Boiler House	Permit 84802		
Boiler House, Diesel Storage	Permit 84802		
Burning Ground Activities	Permit 84802		
Hazardous Waste Storage	Permit 84802		
Hazardous Waste Processing	Permit 84802		
Welding and Cutting		SE 39	
Dual Chamber Incinerator	Permit 84802		
Plastics Shop	Permit 84802		
Machining		SE 41	PBRs 106.432 and 106.452
Vehicle Maintenance Facility Fueling Operations	Permit 84802		
Pantex Site-wide Cooling Towers	Permit 84802		
Hazardous Waste Treatment and Processing Facility Liquid Processing Facility	Permit 84802		
Stationary Standby Emergency Engines	Permit 84802		
HE Synthesis, Formulation, and Production Facility	Permit 175239		
Painting Facilities	Registration 32674, 52638, 167514	SE 75	PBR 106.433
Miscellaneous Chemical Operations: (e.g., emissions of hazardous air pollutants from laboratories, small coating operations and fugitive sources)		SE 34	PBRs 106.122, PBR 106.433, De Minimis
Chemical Transfer Operations	Registration 72373		PBRs 106.262, 106.472, and 106.473

Process:	Authorization/Permit #	Standard Exemption (SE)	Permit By Rule (PBR)
Drum Management Operations	Registration 92876		PBRs 106.261, 106.262, and 106.512
HE Pressing Facility	Registration 145558		PBRs 106.261 and 106.262
Emergency Water Pump	Registration 87270		PBR 106.512
Printed Wire Assembly	Registration 43702		PBR 106.227

2.2.9 Program Structure and Requirements

Pantex is categorized as a Synthetic Minor Air Emission Source. To remain in this category, the following threshold limits cannot be exceeded: 25 tons per year of any combination of hazardous air pollutants (HAPs); 10 tons per year of any single HAP; or 100 tons per year of any non-HAP air pollutant. Under this designation, a facility is not required to declare its emissions every year to the TCEQ; however, 30 TAC 122.122, *Environmental Quality*, “Permit Requirements,” “Potential-to-Emit,” requires a certification of PTE when significant changes of emissions take place. The PTE, once submitted to the TCEQ, becomes a federally enforceable document for allowable emissions. Essentially, the PTE establishes emission limits that are administratively set by Pantex and authorized/enforceable by the TCEQ and the EPA.

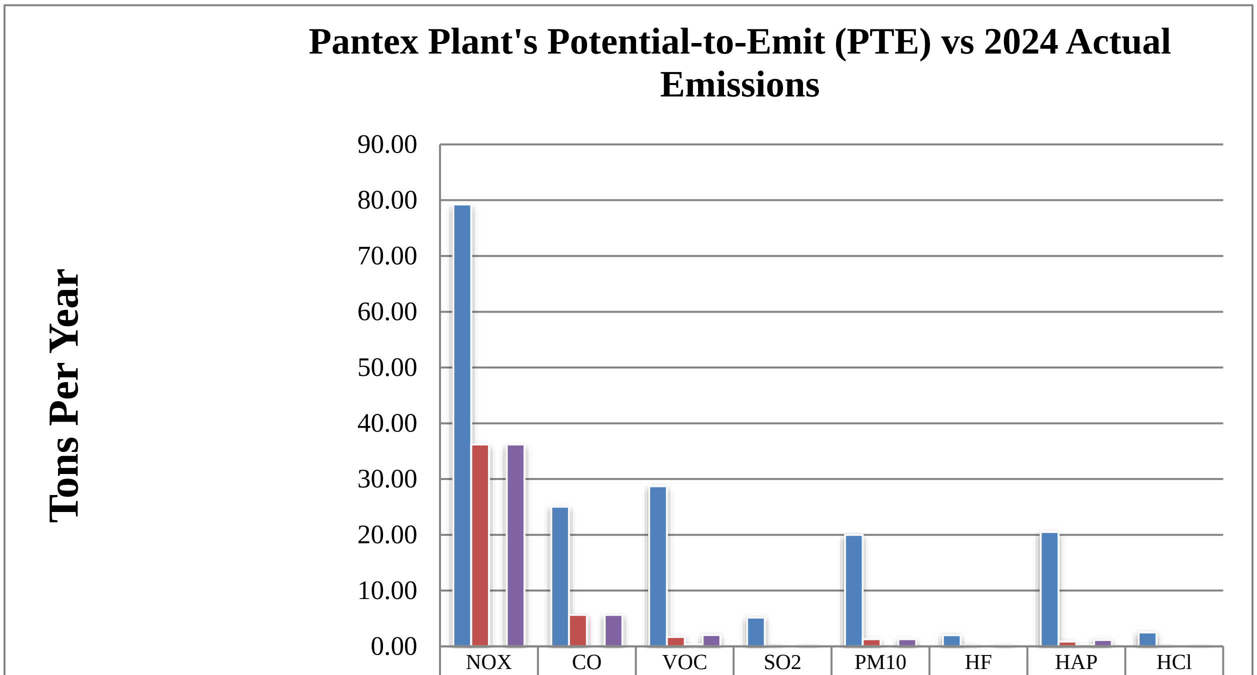
Pantex maintains a tracking process to verify compliance with certified emissions limits. This tracking process is implemented through air environmental compliance requirements (AECR) documents, which are placed into the everyday operational procedures/activities that have either point source or fugitive emissions. AECRs are management-driven documents that outline regulatory requirements for operators to follow based upon process activities and the requirements of the federal and state air emissions regulations. The approved AECRs incorporate sections of the authorization that outline the internal reporting and recordkeeping requirements for process operators. Operational data are gathered by process operators and then input on a monthly basis into commercial, off-the-shelf computer software. The software uses emission factors from source tests, manufacturer’s data, and EPA documentation to calculate hourly, CY, and rolling 12-month emissions.

2.2.10 Types and Tracking of Emissions

During 2024, Pantex tracked the emissions from 30 different processes at both specific locations and grouped sources across Pantex. Pantex personnel responsible for air program compliance gathered facility data on emissions of common air pollutants including nitrogen oxides (NOx), carbon dioxide (CO_2), volatile organic compounds (VOCs), sulfur oxides (SOx), particulate matter (PM), and HAPs. The data, once gathered, are compiled into a monthly report that compares the cumulative past 12-month emissions for Pantex to the annual limits set in the authorized PTE.

2.2.11 Conclusions of Air Emission Tracking for 2024

Over the 12 months of air emission tracking for 2024, operations at Pantex remained well below the certified and authorized PTE levels for each of the pollutants tracked. Figure 2.1 is a graphic presentation of the emission information gathered from January through December 2024, expressed in relation to the PTE certification in tons per year (TPY). The graph demonstrates that Pantex continues to meet the requirements of the Title V program for the designation as a Synthetic Minor Source.



	NOX	CO	VOC	SO2	PM10	HF	HAP	HCl
Registered PTE-Jul 23	79.25	25.03	28.71	5.16	19.99	2.00	20.52	2.50
Permit 84802 Emission Rates:	36.19	5.64	1.70	0.12	1.30	0.16	0.87	0.01
Exemption Authorization Emission Rates:	0.00	0.00	0.33	0.00	0.00	0.00	0.28	0.00
Plant Total Emission Rates:	36.19	5.64	2.03	0.12	1.30	0.16	1.15	0.01

Figure 2.1 Pantex's PTE vs January – December 2024 actual emissions

2.3 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

Because Pantex is listed on the National Priorities List, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 107 (Title 42 of the USC, Chapter 9607) is applicable. Section 107 provides for the designation of federal and state trustees who are responsible for assessing damages, injury to, destruction of, and loss of natural resources. As Pantex's primary Natural Resource Trustee [per 40 CFR 300.600(b)(3)], the DOE is responsible for encouraging the involvement of designated federal and state trustees. To meet this responsibility, DOE held meetings with state and federal agencies. DOE and EPA jointly issued an interagency agreement (IAG) in December 2007 in conclusion of negotiations between DOE, Pantex, EPA, and TCEQ. This agreement became effective in February 2008.

Pantex submitted the Site Management Plan (SMP), a primary document required by Article 7.2 of the IAG in November 2008. The SMP is a schedule with deadlines and timetables for completion of all primary documents and additional work identified pursuant to the IAG. The SMP is submitted annually to update schedules for the 5-year review and the Final Remedial Action Completion Report. No additional work has been identified for inclusion in the SMP.

Accordingly, Pantex was added to the Construction Completion List, signifying the start of the operation and maintenance (O&M) phase of the remedy. Progress reports are prepared and submitted to EPA and TCEQ quarterly to communicate the status and accomplishments of the remedial action systems. Also, an annual report is prepared to document a more thorough evaluation, and 5-year reviews are conducted to ensure periodic comprehensive analyses of the protectiveness of the selected remedy. The first and second 5-year reviews were completed in 2013 and 2018, respectively. The third 5-year review was completed in

September 2023. The results of the review indicate that the selected remedy is performing as intended and is protective of human health and the environment in the short-term. Remedy performance and controls that minimize or prevent contact with contaminated soils and groundwater provide short-term protection while the remedies continue to operate to meet long-term protective goals.

2.4 ENDANGERED SPECIES ACT

Pantex provides habitat for several species protected by federal and state endangered species laws. In 1992, Pantex began a program to assess its natural resources (see Chapter 3). Each year, wildlife observations are recorded and state and federal rare species lists are examined for changes. These observations include data collected by subcontractors working on wildlife projects at Pantex. The current status of endangered or threatened species, as well as species of concern, known to appear on or near Pantex (Carson and Potter counties) is summarized in Table 2.3. Pantex is in compliance with the applicable provisions of the Endangered Species Act.

Table 2.3 Endangered, Threatened and Candidate Species, and High-Priority Species of Concern Known to Appear on or Near Pantex[a]

Common Name		Scientific Name	Present in 2024	Federal Status	State Status
Birds	Bald eagle	*Haliaeetus leucocephalus*	Yes	Delisted	Concern
	Franklin's gull	*Leucophaeus pipixcan*	No	-	Concern
	Interior least tern	*Sterna antillarum athalassos*	No	Delisted	Endangered
	Lesser prairie chicken	*Tympanuchus pallidicinctus*	No	Threatened/ Endangered	Endangered
	Mountain plover	*Charadrius montanus*	No	-	Concern
	Western burrowing owl	*Athene cunicularia hypugea*	Yes	-	Concern
	White-faced ibis	*Plegadis chihi*	Yes	-	Threatened
	Whooping crane	*Grus americana*	No	Endangered	Endangered
Mammals	Black bear	*Ursus americanus*	No	-	Threatened
	Black-tailed prairie dog	*Cynomys ludovicianus*	Yes	-	Concern
	Plains spotted skunk	*Spilogale putorius interrupta*	No	-	Concern
	Prairie vole	*Microtus ochrogaster*	No	-	Concern
	Swift fox	*Vulpes velox*	No	-	Concern
Reptiles	Texas horned lizard	*Phrynosoma cornutum*	Yes	-	Threatened

[a] Texas Parks and Wildlife Department (S1/S2 ranking, recently proposed.)

Listed below are several species that are listed as Threatened or Endangered for Carson County or surrounding counties but are not included in Table 2.3 because of their dependence on habitat not found at Pantex.

Endangered

- N/A

Federal and State - Threatened

- Arkansas River shiner (*Notropis girardi*)
  - Only expected in streams on or flowing into the Canadian River floodplain

State - Threatened

- Palo Duro mouse (*Peromyscus truei comanche*)
  - Resident of slopes of steep-walled canyons and along escarpments, habitat not found on Pantex

- Common black-hawk (*Buteogallus anthracinus*)
  - Sightings in the High Plains are extremely rare
  - Nesting habitat is cottonwood-lined watercourses far to the south in South Texas and the Trans-Pecos region
- Peppered chub (*Macrhybopsis tetranema*)
  - Only expected in streams on or flowing into the Canadian River floodplain

2.5 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

The Federal Insecticide, Fungicide, and Rodenticide Act regulates the manufacture and use of pesticides. The EPA has federal jurisdiction pursuant to 40 CFR 150-189, and the Texas Department of Agriculture and the Structural Pest Control Board have state jurisdiction pursuant to Title 4 TAC 7. Regulations promulgated under the Federal Insecticide, Fungicide, and Rodenticide Act govern the use, storage, and disposal of pesticides and pesticide containers. State-licensed personnel, in accordance with federal and state regulations, apply pesticides needed for operations at Pantex.

2.5.1 Pesticide Use in 2024

Texas Tech Research Farm submitted eight agricultural spray requests during the 2024 growing season; due to inclement weather or other unforeseen circumstances only six applications were made. The eight agricultural spray requests were reviewed and approved by the Environmental Compliance Department and Safety & Industrial Hygiene Department. Multiple Pantex organizations and PFO reviewed the requests for information and awareness. Pantex's Maintenance Department made zero applications during 2024. Historically, the Pantex's Maintenance Department made the majority of these applications for weed control in Zone 4, Zone 11, Zone 12, and the associated Perimeter Intrusion Detection and Surveillance beds. Contractors submitted 41 spray requests to control or suppress weeds, insects, and prairie dogs, as specified in the contract work completed at Pantex in 2024. Table 2.4 shows the number of pesticide applications conducted at Pantex since 2017.

Table 2.4 Number of Pesticide Applications Conducted at Pantex

Year of Pesticide Applications	Texas Tech Research Farm	Maintenance Department	Contractors	Total
2017	18	59	0	77
2018	10	35	4	49
2019	17	27	9	53
2020	9	35	12	56
2021	8	29	19	56
2022	5	29	33	67
2023	5	5	46	56
2024	6	0	41	47

2.6 FEDERAL WATER POLLUTION CONTROL ACT AND TEXAS WATER CODE

Pantex does not discharge wastewaters into or adjacent to waters of the United States; thus, Pantex is not subject to the Federal Water Pollution Control Act (Clean Water Act). Pantex is subject to the requirements of the Texas Water Code. All discharges must be done in compliance with the requirements of the Texas Water Code and its implementing regulations.

During 2024, Pantex disposed of most of its treated industrial and domestic wastewaters via discharge to an on-site playa lake as authorized by Water Quality Permit No. WQ0002296000. Pantex is authorized by Water Quality Permit No. WQ0004397000 and underground injection control (UIC) Authorization No.

5W2000017 to discharge treated wastewater through surface or subsurface irrigation systems. Combined, these authorizations support the production of approximately 1,400 ac of crops. The UIC authorization allows the application of limited quantities of treated wastewater to the subsurface irrigation area during periods when the agricultural fields are fallow.

Pantex operates under the Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector General Permit (TXR05GO12) for the discharge of stormwater related to industrial activities. Pantex also obtains coverage as needed under the TPDES Stormwater General Permit for Construction Activities (Permit TXR150000). The notices of intent filed for large construction projects during 2024 are listed with other Pantex environmental authorizations and permits in Table 2.5.

At seven of its more remote buildings, Pantex operates on-site sewage facilities (OSSFs), or septic tank systems, to dispose of domestic wastewaters from these buildings. Newer OSSFs have been approved by the TCEQ via permits. However, several of the systems were installed prior to the promulgation of applicable regulations and are not currently registered. As unregistered OSSFs are replaced, permits authorizing the upgrading or installation of the new system will be acquired from the TCEQ.

Table 2.5 Permits Issued to Pantex

Building or Activity	Permit Number	Issuing Agency	Effective Date	Expiration Date
Air				
Air Quality New Source Review (NSR) Permit	84802	TCEQ	03/29/2019	03/29/2029
Air Quality NSR Permit	175239	TCEQ	11/08/2024	11/08/2034
Air Quality Standard Permit	174554	TCEQ	11/21/2023	11/21/2033
All other small sources	Standard Exemption, De Minimis, and Permit by Rule (PBR)	TCEQ	Various dates	When changes occur to the process that modify the character or nature of the air emission, or modify the process so that the PBR may no longer be used.
Clean Air Act Title V Declaration, 30 TAC 122	N/A	TCEQ	05/22/2000 (first filing)	None
Solid Waste				
Solid Waste Registration Number	TX4890110527 30459	Environmental Protection Agency (EPA) TCEQ	10/30/1980 10/30/1980	None None
Industrial and Solid Waste Management Site Permit; Resource Conservation and Recovery Act Compliance Plan	HW-50284	TCEQ	05/30/2014	05/30/2024 (pending renewal)
UIC - TLAP	5W2000017	TCEQ	11/29/2004	When cancelled
UIC- Environmental Restoration Program	5X2600215	TCEQ	10/23/2001	When cancelled
Water				
Texas Water Quality Permit	WQ0002296000	TCEQ	08/27/2020	08/26/2025
TLAP	WQ0004397000	TCEQ	08/11/2020	08/10/2030

Building or Activity	Permit Number	Issuing Agency	Effective Date	Expiration Date
Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector (Industrial) Stormwater Permit	TXR05GO12	TCEQ	08/14/2021	08/14/2026
TPDES Stormwater General Permit for Construction Activities	TXR150000	TCEQ	03/05/2023	03/05/2028
Natural Resources				
Scientific Permit	SPR-1221-206	Texas Parks and Wildlife Department (TPWD)	12/30/2024	12/30/2027
Letter of Authorization: Trap and Release Fur-bearing Animals	None	TPWD	07/28/2000 (Initial)	Renewed annually.

2.6.1 Wastewater Discharge Permit Inspection

The TCEQ did not conduct a wastewater compliance investigation at Pantex during 2024.

2.7 MEDICAL WASTE

Medical waste at Pantex is regulated by the Department of Transportation (DOT), the State of Texas, and associated Pantex requirements. Pantex remains in compliance with applicable requirements.

2.8 NATIONAL ENVIRONMENTAL POLICY ACT

NEPA establishes requirements that federal agencies must meet to make well-informed decisions on proposed activities. The decisions must be based on alternatives that consider detailed information concerning potential significant environmental impacts. To minimize environmental impacts from operations at Pantex, proposed activities are reviewed for NEPA requirements.

At Pantex, the NEPA process is initiated by completing a NEPA Review Form (NRF). The NRF includes a description of the proposed action. Subject matter experts (SMEs) review the actions for potential environmental concerns. NEPA documentation ranges from internal reviews that tier off previously approved NEPA documents, categorical exclusions, environmental assessments, and environmental impact statements (EIS). *Implementation Guidance for DOE Policy on Documentation and Online Posting of Categorical Exclusion Determinations: NEPA Process Transparency and Openness*, May 25, 2010, mandates that all determinations for categorical exclusions involving classes of actions listed in Appendix B, "Categorical Exclusions Applicable to Specific Agency Actions" to Subpart D, "Typical Classes of Actions" of the DOE's NEPA regulations, 10 CFR 1021, *National Environmental Policy Act Implementing Procedures*, be published online.

In 2024, six standard NRFs (Categorical Exclusion determinations), 36 internal NRFs, and 12 amendments were prepared and approved. Categorical Exclusion determinations for the six standard NRFs were posted on Pantex's website.

At least every five years, DOE is required to evaluate whether the *Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* [referred to as the Pantex Site-Wide Environmental Impact Statement (SWEIS)] remains adequate, if a new SWEIS is warranted, or if the existing SWEIS should be supplemented. NNSA performs this evaluation through the preparation of a supplemental analysis (SA) as provided in 10 CFR 1021.314, "Supplemental Environmental Statements." Previous analysis conducted in the 2018 SA indicated that continued operations at Pantex, including changes expected to occur through approximately 2024, would be similar in nature and would not be expected to differ significantly from those NNSA identified and analyzed in the SWEIS. At the time of this report, preparations for a new SWEIS were being conducted in accordance with 40 CFR 1021.330(d), *National Environmental Policy Act Implementing Procedures*, "Programmatic (including site-wide) NEPA documents."

2.9 NATIONAL HISTORIC PRESERVATION ACT, ARCHAEOLOGICAL RESOURCE PROTECTION ACT, AND NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT

In October 2004, PFO, the M&O contractor, State Historic Preservation Office (SHPO), and the President's Advisory Council on Historic Preservation (Advisory Council) completed execution of a Programmatic Agreement and Cultural Resource Management Plan. The 2004 agreement was reviewed, updated, and executed by all signatory parties in September 2023 (Pantex 2023). Revisions to the document include updates to federal regulation references, the inclusion of a timeline for review, and the removal of one piece of legacy equipment that has been determined to no longer be eligible for the National Register.

This PA/CRMP ensures compliance with Sections 106 and 110 of the National Historic Preservation Act (NHPA), providing for more efficient and effective review of Pantex projects having the potential to impact prehistoric, World War II-era, or Cold War-era properties. In addition, the PA/CRMP outlines a range of preservation activities planned for Pantex's compliance program. The PA/CRMP provides for the systematic management of all archaeological and historic resources at Pantex under a single document.

Compliance with the ARPA requirements for site protection and collections curation is addressed in the PA/CRMP. Even though Native American mortuary remains or funerary artifacts have not been found at Pantex, compliance with the Native American Graves Protection and Repatriation Act is also addressed in the plan. Both archaeological and natural resources at Pantex are closely concentrated around six playa lakes. These playa and floodplain areas have been reserved for comprehensive ecosystem management, resulting in preservation of many of Pantex's archaeological sites.

Fulfilling Pantex's cultural resource management obligations under Section 106 of the NHPA, 56 projects were evaluated in 2024 under the PA/CRMP. Of these projects, 54 did not involve either National Register-eligible properties or possible adverse effects. For the remaining two projects, a prior notification and a walkdown prior to startup were required to avoid impacts to the National-Register-eligible properties.

2.10 RESOURCE CONSERVATION AND RECOVERY ACT

2.10.1 Active Waste Management

The types of wastes generated at Pantex include the following:

- Hazardous waste
- Universal waste
- Non-hazardous industrial solid waste
- Waste regulated by the Toxic Substances Control Act (TSCA)
- Low-level radioactive waste
- Mixed low-level radioactive waste
- Sanitary waste

Table 2.6 summarizes wastes generated from the operation, maintenance, and environmental cleanup at Pantex in CY 2024. Overall, the amount of waste generated in 2024 increased 25.2% from 2023. This is due primarily to increased waste generation volumes in the environmental restoration projects, the deactivation and decommissioning of excess facilities, and construction projects.

During CY 2024, 1,226.7 m^3 of hazardous waste was generated at Pantex. The following were typical hazardous wastes generated:

- Explosives-contaminated solids,
- Spent organic solvents, and
- Solids contaminated with spent organic solvents, metals, and/or explosives.

Hazardous wastes were managed in satellite accumulation areas (SAA) (less than 55-gal waste accumulation sites), central accumulation areas, or permitted waste management units. Some hazardous wastes, such as explosives, were processed on-site before the process residues were shipped off-site for final treatment and disposal. Environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities contributed 13.3% of the total hazardous waste generated. For 2024, 163.1 m^3 of the wastes from environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities was hazardous scrap metal exempt from the Resource Conservation and Recovery Act (RCRA). Hazardous wastes and residues from hazardous waste processing are shipped to commercial facilities authorized for final treatment and disposal or, as applicable, recycling.

Pantex generated 11,401.7 m^3 of non-hazardous industrial solid waste in 2024. Generated non-hazardous industrial solid wastes were characterized as either Class 1 non-hazardous industrial solid waste or Class 2 non-hazardous industrial solid waste, as defined by 30 TAC 335, Environmental Quality, "Industrial Solid Waste and Municipal Hazardous Waste." Class 1 non-hazardous industrial solid wastes generated at Pantex were managed in a similar manner as hazardous waste, including shipment to off-site treatment and/or disposal facilities. Some Class 2 non-hazardous industrial solid wastes (inert and insoluble materials such as bricks, concrete, glass, dirt, and certain plastics and rubber items that are not readily degradable) were disposed in an on-site Class 2 non-hazardous industrial solid waste landfill. Other Class 2 non-hazardous industrial solid wastes, generally liquids, were shipped to commercial facilities for treatment and disposal.

Pantex's environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities contributed 64.8% of the total non-hazardous industrial solid waste generated during 2024. In addition, 946.4 m^3 of sanitary waste (cafeteria waste and general office trash) was generated at Pantex. Sanitary wastes were also characterized as Class 2 non-hazardous industrial solid wastes and disposed of at authorized off-site landfills.

Pantex generated 66.5 m^3 of waste regulated by TSCA during 2024. These wastes include asbestos, asbestos-containing material, and materials containing or contaminated by polychlorinated biphenyls (PCBs). During the year, environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities contributed to 92.5% of the total TSCA waste generated. All TSCA wastes were shipped off-site for final treatment and disposal.

During 2024, 14.2 m^3 of waste that were managed as universal wastes were generated at Pantex. Universal wastes are defined as hazardous wastes that are subject to alternative management standards in lieu of regulation, except as provided in applicable sections of the TAC. Universal wastes include batteries, pesticides, paint and paint-related waste, and fluorescent lamps. During the year, wastes from environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities were shipped off-site for final treatment, disposal, or, as applicable, recycling.

Pantex generated 21.9 m^3 of low-level radioactive waste during 2024. The low-level radioactive wastes were generated by weapons-related activities.

Table 2.6 Waste Volumes Generated at Pantex (in cubic meters)

Waste Type	1993	2021	2022	2023	2024	Percent Increase or (Decrease) from 1993	Percent Increase or (Decrease) from 2023
Non-hazardous Industrial Solid Waste	10,885	9,453.8	6,773.3	8,669.3	11,401.7	4.7	31.5
Sanitary Waste	612	927.3	927.3	908.4	946.4	54.6	4.2
Hazardous Waste	369.6	1,282.5	876.2	1,168.2	1,226.7	231.9	5.0
Low-Level Waste	287	12.1	31.7	20.2	21.9	(92.4)	8.4
Mixed Waste	37.5	0.23	0.23	0.32	0.55	(98.5)	71.9
Toxic Substances Control Act	112.9	148.0	16.9	145.8	66.5	(41.1)	(54.4)
Universal Waste[a]	-	12.1	13.8	9.97	14.2	-	42.4
Total	12,304	11,836.0	8,639.4	10,922.2	13,678.0	11.2	25.2

[a] In 2001, Pantex began managing some hazardous waste under the Universal Waste Rules.

Assembly and disassembly of weapons can result in some wastes that include both radioactive and hazardous constituents, which are referred to as "mixed waste." The hazardous portion of the mixed waste is regulated by the TCEQ pursuant to RCRA regulations. The radioactive portion is regulated pursuant to the Atomic Energy Act. During 2024, 0.55 m^3 of mixed waste was generated at Pantex.

2.10.2 Hazardous Waste Permit Modifications

Pantex Hazardous Waste Permit/Compliance Plan No. HW-50284 sometimes requires modification to address new information, changes in facilities or changes in regulatory requirements. The three classes of modifications consist of minor modifications (Class 1 and Class 2) and major modifications (Class 3).

On November 22, 2023, the Pantex Plant submitted an application to renew and modify the Pantex Hazardous Waste Permit/Compliance Plan No. HW-50284. The TCEQ declared the renewal application administratively complete on January 18, 2024, and technically complete on May 28, 2024. Final draft permit and issuance of a preliminary decision by the Executive Director of the TCEQ declaring the permit meets all statutory and regulatory requirements was still under review as of December 31, 2024.

Pantex requested a Class 1-1 modification to Hazardous Waste/Compliance Plan No. HW-50284 on October 28, 2024. The subject of this modification was the administrative transfer of responsibility to a new M&O contractor. As of December 31, 2024, the Class 1-1 request has not received formal approval from the TCEQ.

2.10.3 Annual Resource Conservation and Recovery Act Inspection

The annual RCRA waste site inspection was conducted by the TCEQ on May 29–31, 2024. This year the investigation concentrated on all SAA and universal waste sites in Zone 12 North, and all hazardous waste permitted facilities at Pantex. A total of 52 various waste sites were visually inspected during the investigation, including seven permitted facilities, and 10 non-permitted central accumulation areas. The inspection also included a comprehensive records review of all day-to-day waste management activities and DOT shipping documents. This year's inspection concluded with no findings or issues identified, and Pantex received a general compliance letter from the TCEQ dated June 24, 2024.

2.10.4 Release Site and Potential Release Site Investigation, Monitoring, and Corrective Action

Progress reports, required by Table VII of Pantex Hazardous Waste Permit/Compliance Plan HW-50284 and Article 16.4 of the Pantex IAG, were submitted to both the TCEQ and EPA in 2024. The annual report contained a full reporting of all monitoring information for 2024. Quarterly progress reports were also submitted in 2024 in accordance with the schedule in the approved sampling and analysis plan (SAP) and Table VII of the Pantex Hazardous Waste Permit/Compliance Plan HW-50284. These reports focused on continued operation of remedies and on monitoring results from key groundwater wells.

2.10.5 Petroleum Storage Tanks

Pantex operated six regulated petroleum storage tanks (PSTs) in accordance with applicable requirements of 30 TAC, Chapter 334 *Underground and Aboveground Storage Tanks* during 2024. Of these tanks, five are underground PSTs used for vehicle refueling and emergency generator fuel storage. One PST is incorporated into an aboveground emergency generator package. The fuel types stored on-site include gasoline, diesel, and a gasoline–ethanol mix (E-85). The TCEQ conducted no formal on-site inspections during 2024.

2.11 SAFE DRINKING WATER ACT

Pantex operates a non-community, non-transient public water system (PWS), which is registered with the TCEQ. This category of system supplies water to a small group of people (e.g., schools and factories). Pantex obtains its drinking water from the Ogallala Aquifer through five wells located at the northeast corner of the plant.

2.12 DRINKING WATER INSPECTION

In September 2024, a TCEQ contractor collected routine water samples from the Pantex PWS. The analytical results generated from this event indicated that Pantex met or exceeded all applicable water quality parameter requirements. The TCEQ did not conduct a comprehensive compliance investigation during 2024.

2.12.1 Drinking Water System Achievements

On December 17, 2009, the TCEQ notified Pantex that its PWS had achieved a "Superior Rating." Organizations receiving the Superior PWS rating are recognized for their overall excellence in all aspects of operating a PWS. Pantex maintained its Superior PWS rating during 2024.

2.13 TOXIC SUBSTANCES CONTROL ACT

The major objective of the TSCA is to ensure that the risk to humans and the environment posed by toxic materials has been characterized and understood before the chemicals are introduced into commerce. The goal is to regulate chemicals that present unreasonable risk to human health or the environment. Of the materials regulated by TSCA, those containing asbestos; beryllium; and materials and parts containing, contaminated by, or potentially contaminated by PCBs, are managed at Pantex.

As a user of chemical substances, Pantex complies with applicable regulations issued under the TSCA; refrains from using PCBs, except as allowed by EPA regulations; and refrains from using any chemical substance that Pantex personnel know, or have reason to believe, has been manufactured, produced, or distributed in violation of the Act. As of December 31, 1996, all new parts and equipment used at Pantex cannot contain PCBs that are in concentrations of higher than 50 ppm.

2.14 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT

The Emergency Planning and Community Right-to-Know Act, which was enacted as part of the Superfund

Amendment and Reauthorization Act of 1986 (SARA), 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. In order to accomplish these goals, the Emergency Planning and Community Right-to-Know Act and EO 12856 require that Pantex file several annual reports with the EPA (Table 2.7) and participate in Local Emergency Planning Committee activities. Pantex remains in compliance with provisions of this statute.

Table 2.7 2024 Activities for Compliance with the Emergency Planning and Community Right-to-Know Act

Requirement	Applicable	Comment
Planning Notification [Superfund Amendments and Reauthorization Act (SARA 302-303)]	Yes	Two chemicals defined as "Extremely Hazardous Substance" by SARA 302-303 were stored at Pantex in quantities above the threshold planning quantities in 2024.
Extremely Hazardous Substance Notification (SARA 304)	Yes	There were no accidental releases of "Extremely Hazardous Substance" as defined by SARA 304 that exceeded quantity limits in 2024.
Material Safety Data Sheet/Chemical Inventory (SARA 311-312)	Yes	This requirement was satisfied by the Texas Tier II Report[a]. Twenty-three chemicals were listed in the report for 2024.
Toxic Chemical Release Inventory Reporting (SARA 313)	Yes	A Toxic Chemical Release Inventory Report was required for Calendar Year 2024.

[a] Report submitted annually through the State of Texas Environmental Electronic Reporting System (STEERS), providing access to TCEQ, local emergency planning committees, and the local fire department as required by 30 TAC 325.3.

2.15 FLOODPLAINS/WETLANDS ENVIRONMENTAL REVIEW REQUIREMENTS

Floodplain management is taken into account when surface water or land-use plans are prepared or evaluated. The U.S. Army Corps of Engineers (USACE), Tulsa District, completed a floodplain delineation report in January 1995 (U.S. Army Corps of Engineers 1995), revising an earlier delineation. In CY 2024, all proposed activities at Pantex were evaluated during the NEPA process for potential impacts on floodplains and wetlands and other criteria required by 10 CFR 1022, *Energy*, "Compliance with Floodplain and Wetland Environmental Review Requirements."

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CHAPTER 3 - ENVIRONMENTAL MANAGEMENT INFORMATION

To implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources, a comprehensive Environmental Management System (EMS) has been implemented. The Pantex EMS is a major component of the Integrated Safety Management System and contributes to achieving operational excellence and mission deliver. The Integrated Safety Management/EMS applies to all personnel whether permanent or temporary and to subcontractors working within the boundaries of Pantex.

Chapter Highlights

- Pantex exceeded clean energy targets set forth by the Sustainability Performance Office of DOE.
- Water intensity at Pantex has decreased approximately 14.1% from the 2007 baseline year.
- Pantex diverted 726 metric tons of non-hazardous solid waste and 100% of construction and demolition debris from being disposed in landfills in 2024.

3.1 ENVIRONMENTAL MANAGEMENT SYSTEM

The Pantex EMS provides for systematic planning, integrated execution, and evaluation of programs for the following:

- Public health and environmental protection,
- Environmental sustainability,
- P2,
- Recycling, and
- Compliance with applicable environmental protection requirements.

The Pantex EMS includes policies, procedures, and required training to identify activities with significant environmental impacts; manage, control, and mitigate the impacts of these activities; and assess performance and implement corrective actions where needed. Environmental aspects and impacts are reviewed annually and measurable environmental objectives and specific targets are developed for implementation. The Site Sustainability Plan (SSP) is prepared annually and reports Pantex's performance status and planned actions for meeting DOE's SSP goals. The EMS business management system provides the following:

- Framework to ensure compliance with environmental regulations,
- Support for the achievement of DOE sustainability goals, and
- Controls that are set to accomplish effective waste management, natural and cultural resource management, P2/source reduction, recycling/reuse, environmental remediation, sustainable acquisition and design principles, energy management/efficiency, fleet management, and water conservation.

A team of senior management personnel at Pantex leads the review, approval, promotion, and provision of human and physical resources to support the EMS. The EMS Senior Management Team helps guide achievement of environmental objectives, DOE sustainability goals, continual improvement of Pantex's EMS, and conformance with ISO 14001. Through communication of the following Pantex commitments to pollution control, team members strive to increase awareness of the Pantex *Environmental Policy* (E-POL-1024) within organizations across Pantex through communication of the following Pantex's commitments to P2C2 as defined below:

- **P**rotect the environment,
- **P**revent pollution,

- **C**omply with environmental requirements, and
- **C**ontinually improve Pantex's environmental stewardship programs.

The environmental objectives for FY 2024 and past EMS objectives are listed below in Table 3.1. By using the DOE sustainability goals as the site's environmental aspects, Pantex is in the unique position to work on multiyear objectives and quantify the large projects in terms of environmental impacts. As a result, most of the initial objectives from FY 2020 have continued into following years.

Table 3.1 Pantex Objectives and Targets for 2024

Objective	Target(s)	Status/Comments
Reduce water consumption and intensity throughout Pantex	Continue to work on repairing leaking, old infrastructure to make the system more efficient and to reduce number of leaking areas	Ongoing
	Repair the high-pressure fire loop water leaks	Ongoing
Increase the amount of clean/renewable energy used from the Pantex Wind Farm production	Complete North Substation/Pantex Wind Farm Interconnection Project	Ongoing
Reduce Scope 1 and 2 (Direct) Greenhouse Gas emissions	Perform Energy Independence and Security Act energy audit evaluations	Ongoing
	Continue the installation of electric vehicle chargers for the fleet	Ongoing
	Begin the process to install building-level energy meters on covered buildings	Ongoing
Pollution Prevention	Continue installation of water bottle filler stations in the on-site cafeterias	Ongoing
Environmental Compliance	Submit Lead Service Line Inventory to TCEQ by October 2024	Completed
Environmental Awareness	Implement conversion to the International Organization for Standardization 14001:2015	Completed

3.1.1 Environmental Management System Accomplishments for 2024

Pantex continues to implement and maintain a formal EMS using the ISO 14001 Standard as the platform for site implementation. On five occasions, the Pantex EMS has been the subject of formal triennial audits conducted by qualified auditors, outside the control or scope of the EMS. Each audit resulted in the conclusion that the Pantex EMS conformed to the ISO 14001 Standard. The most recent audit occurred in FY 2022 and the next audit is scheduled to take place in the spring of 2025.

As part of the sustainability program at Pantex, opportunities for continuous improvement are the emphasis of regularly scheduled building environmental walkdown surveillances. These surveillances focus on EMS principles, energy and water conservation, environmental sustainability, recycling, safety, and P2. Notable accomplishments of the sustainability program at Pantex include, but are not limited to, the following:

- Continued promotion of sustainable acquisition and procurement to the maximum extent practicable, ensuring bio-preferred and bio-based provisions and clauses are included in 95% of applicable contracts,
- Received a Gold Level DOE Green Buy Award in 2024 for Pantex's efforts to purchase 12 Priority Products in six different categories,
- Purchase of 94% of electronics that have met criteria for being environmentally sustainable, and

- Diversion of approximately 42% of municipal solid waste and approximately 100% construction and demolition material/debris originally from landfills to alternate pathways for beneficial reuse.

3.1.2 Energy

In the remainder of this section, the goals established by the DOE Sustainability Performance Office (SPO) are expressed in FY performance from DOE determined baselines. Pantex reported progress toward meeting these goals in the SSP produced after the completion of FY 2024. For the purpose of this document, the progress during CY 2024 is also reported where applicable. Success in reducing energy use at Pantex has historically been realized from energy savings activities such as the following:

- Usage of the Energy Management Control System to implement and maintain night, weekend, and holiday setbacks,
- Installation of occupancy sensors to control lighting in areas in several facilities with low occupancy rates (conference rooms, break rooms, restrooms),
- Installation of new or retrofitted advanced meters that are integrated with a communication network and dedicated server that stores the meter readings for use with the Energy Star Portfolio Manager building benchmarking system,
- Procurement of equipment such as Energy Star products that are more energy efficient, and
- Continuous and retro-building commissioning.

In 2024, Pantex continued to use an alternate work schedule, which has helped reduce energy consumption for a large number of administrative personnel. Pantex has implemented a permanent teleworking procedure that varies by requirements of various departments and organizations. Another major source of reductions in energy intensity has been the installation of the Pantex Wind Farm (PWF) that consists of five 2.3-megawatt Siemens wind turbines (see Figure 3.1) in the summer of 2014.

Figure 3.1 The Pantex Wind Farm with a field of winter wheat in the foreground

Photo by Michael Schumacher

In 2016, the DOE SPO provided guidance requiring a 25% reduction in energy intensity by FY 2025 from a FY 2015 baseline. Pantex had a 6.9% increase in energy intensity from the 2015 baseline as the energy intensity increased from 164.9 kBtu/ft^2/year for FY 2015 to 176.3 kBtu/ft^2/year for FY 2024.

Like many other sites with aging infrastructure and evolving missions, Pantex is constructing new buildings and demolishing older, inefficient buildings to reduce and consolidate its footprint. Pantex continues to plan the demolition of aging and inefficient buildings while also building new facilities to meet mission needs.

Continued considerable downtime of the PWF in 2024 increased the amount of energy purchased for consumption at Pantex. The PWF supplied 20,920 MWh of electricity to Pantex and the local electrical grid.

3.1.3 Greenhouse Gases

Guidance from the SPO has expanded upon the energy reduction and environmental performance requirements by setting requirements in several areas, including the management of greenhouse gases (GHG). The guidance suggests a 50% reduction of electricity-related and natural gas GHG emissions and 25% reduction of other indirect GHG emissions by FY 2030 from site's respective FY 2008 baselines.

The largest component of the GHG emissions accredited to Pantex are those from federally owned or controlled sources such as the combustion of natural gas used to produce steam on-site and the use of petroleum fuels in fleet and other vehicles and equipment as well as fugitive emissions from refrigerants and wastewater treatment operations. These emissions and those generated through the purchase and use of electricity generated off-site yielded more than 73,971 metric tons of carbon dioxide equivalent ($MtCO_2e$) of GHG in 2008.

During FY 2024, the operation of Pantex resulted in the emission of a total of 75,906.9 $MtCO_2e$. Of this total, 19,298.8 $MtCO_2e$ of emissions were from the combustion of natural gas, 27,592.3 $MtCO_2e$ off-site electricity, and 29,015.8 $MtCO_2e$ were due to other indirect GHG emissions. These emissions are illustrated in Figure 3.2.

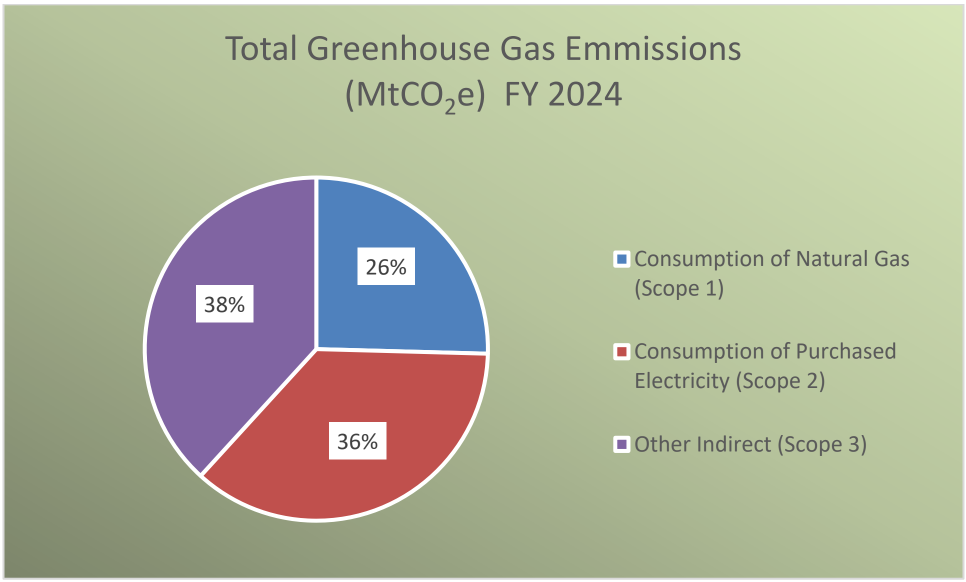


Figure 3.2 Total 2024 Greenhouse gas emissions

The operation of the PWF during CY 2024 reduced the amount of purchased electricity and the number of electricity-related GHG emissions at Pantex compared to baseline year (FY 2008) levels. In addition, reducing energy consumption by the means discussed in Section 3.1.2, Pantex has concurrently reduced the generation of electricity-related GHGs. Pantex also continued efforts to reduce GHG emissions by improving operations of its vehicle fleet, reducing petroleum fuel use, implementing zero-emission vehicle use, using alternative fuel vehicles, and ensuring the fleet is of a proper size for mission work. Future reductions in the generation of electricity-related GHGs are anticipated to occur as operation of the PWF continues.

Pantex saw an increase in other indirect GHG emissions compared to the FY 2008 baseline due to work-related travel restarting as well as a large increase in the number of new employees. During FY 2024, approximately 10% of the Pantex population continued to telework in some capacity. However, Pantex hired approximately 200 new employees and had more construction subcontractors than in previous years, all of which added to the increase in indirect emissions.

3.1.4 Water

Beginning in 2008, the DOE goal for Pantex is to reduce water use relative to the baseline of Pantex's water consumption in 2007 of approximately 129 million gal. Pantex continues to develop and implement initiatives to reduce annual use and meet sustainability goals integrated into the SSP. During 2024, water consumption was approximately 122 million gal. There was a 10.5% decrease in total square footage of buildings since the baseline year, and water use has decreased about 14.1% from the baseline year.

Five on-site water wells provide all of Pantex's potable water supply from the Ogallala Aquifer. There are approximately 50 mi of aging distribution lines suppling cooling towers, the steam plant, and domestic uses such as restrooms, showers, ice machines, and cafeterias. Some of Pantex's weapons processes require water for testing and quality control. In addition to the traditional distribution lines, there are over 17 mi of a high-pressure fire loop (HPFL) suppression system maintained for Pantex, with high-risk production areas prioritized. Fire suppression systems are tested on a rigorous schedule throughout the year, which is a main contributor to total water consumption. Pantex also provides water to adjacent and on-site TTU operations for domestic and livestock use through an agreement with TTU.

The majority of water lost from the system is through leaks in the aging distribution system. In FY 2024, several leaks in the distribution lines were identified and were repaired; however, as repairs were made, many lines developed new leaks due to the aging infrastructure. The domestic water distribution system is currently undergoing major renovations in a multiyear plan to greatly reduce the number of leaks.

Underneath Pantex, there is a perched aquifer that is currently the focus of on-site environmental restoration activities. Water from the perched aquifer is collected, treated, and transferred to an authorized on-site storage lagoon for the purpose of beneficial reuse. This treated groundwater can be combined with treated domestic and industrial wastewater resulting from Pantex's operations. The combined water is discharged via a permitted wastewater outfall to an on-site playa or beneficially reused for agricultural purposes via a subsurface or surface irrigation system.

3.2 OVERSIGHT

3.2.1 Federal Agencies

Chapter 2 of this document discusses the results of compliance inspections and/or other oversight activities conducted by the EPA in 2024.

3.2.2 State of Texas

Chapter 2 of this document discusses the results of compliance inspections and/or other oversight activities conducted by various state agencies in CY 2024. In 1989, the Secretary of Energy invited the host state of each DOE facility to oversee the evaluation of environmental impacts from facility operations as an additional oversight mechanism. As a result, the DOE entered into a five-year Agreement in Principle with the State of Texas in August 1990. It was renegotiated in 1995, 2000, 2005, 2010, 2015, and 2021. The current agreement is in effect through 2026. Six state agencies are involved: the Governor's Office (acting through the State Energy Conservation Office); the Texas Attorney General's Office; the TCEQ; the Texas Department of Public Safety, Division of Emergency Management; the TDSHS-Radiation Control; and the Texas Bureau of Economic Geology. The agreement focuses on general cooperation with all state agencies, with emphasis on emergency management and environmental sampling and surveillance. The agreement also provides for joint emergency planning with Carson, Armstrong, and Potter counties, and the City of Amarillo. Participation in joint exercises and drills is a significant component of the agreement and these actions facilitate readiness to respond to unplanned events and emergencies. Emergency planning, exercises and drills are scheduled and conducted throughout the year.

3.3 POLLUTION PREVENTION

Figure 3.3 Environmental Compliance staff celebrating success in sustainability

Photo by: Adam Baker

Activities in support of pollution prevention, also known as the P2 Program, are waste elimination, material substitution, waste minimization, recycling, and energy and water conservation. P2 Team members are continually seeking new and innovative initiatives to further the advancement of P2 principles.

Pantex has an established and award-winning sustainable acquisitions program. Figure 3.3 shows staff celebrating the award-winning sustainable acquisitions program at Pantex. The program maximizes, to the extent feasible, the procurement of sustainable products and services such as those recommended by the EPA, the U.S. Department of Agriculture, and the DOE Federal Energy Management Program. Pantex reviews purchase requisitions to maximize, to the extent feasible, the procurement of green products. In FY 2024, Pantex purchased over 11,700 bio-based certified products.

Additionally, the sustainable acquisitions requirements of DOE Acquisition Regulation clause 952.223-78 were incorporated into Pantex's procurement clauses and the terms and conditions include Federal Acquisition Regulation Clause 52.223-15. This clause requires that energy-efficient products meet DOE and EPA criteria for use of the Energy Star® trademark label, or that they are in the upper 25% of efficiency for all similar products as designated by DOE's Federal Energy Management Program. In FY 2024, 130 contract actions included the sustainable acquisitions clause.

The reuse principle is also a long-term practice implemented by using the proper management and disposition of all materials acquired by Pantex Plant for the entire life cycle of the item. Prior to purchasing items, Pantex employees can review the "Items Available for Reuse" section of the Property Accountability Tracking System on the internal website. This provides a list of non-consumables (e.g., equipment, tools, and furniture) available as the first source of supply. This ensures that the current inventories of items are used rather than purchasing new materials. Pantex also reutilized materials from other sites instead of purchasing new materials. This saves Pantex from having to procure various materials while supporting sustainable acquisition initiatives. The items received by Pantex in FY 2024 had an estimated acquisition value of more than $2.8 million.

Pantex has continued an active recycling program, which reduces the waste disposal volumes and saves taxpayers' money. Results of ongoing recycling initiatives in CY 2024 are shown in Table 3.2.

Table 3.2 Pantex Plant Site-Wide Recycling for CY 2024

Calendar Year 2024 Totals	
Recycled Material	**Metric Tons**
Batteries	44.4
Computers and Other Electronics	14.4
Concrete and Asphalt	3,363.6
Corrugated Cardboard	65.1
Engine Oils	6.2
Fluorescent Bulbs	2.4
Office and Mixed Paper	6.0

Calendar Year 2024 Totals	
Recycled Material	**Metric Tons**
Non-Suspension Scrap Metals	654.8
Oil Filters	0.6
Plastic	3.1
Tires/Scrap Rubber	23.4
Wooden Pallets	20.9
Total	**4,204.9**

In FY 2024, Pantex diverted 12,242.7 tons for a total of 100% of construction and demolition debris. Contracts have been maintained with off-site vendors to recycle concrete waste generated from construction projects. Pantex also diverted 726 metric tons of non-hazardous solid waste.

During 2024, Pantex continued a partnership with Y-12 National Security Complex to reuse and repurpose 74 metal containers received from the Oak Ridge facility. Transfer, reuse, and repurposing of these containers will continue throughout the remainder of a five-year P2 plan and beyond. Pantex continued to use non-lead bullets during Security Force live fire exercises, when possible, avoiding 0.698 metric tons of lead usage during FY 2024. Additionally, Pantex sent 485 metric tons of scrap metals including lead from industrial sources for recycling.

Pantex is continuing a proactive program to incorporate and instruct personnel in the essential need to institute a reliable sustainable acquisitions program. The sustainable acquisitions program continues to incorporate the purchase and acquisition of products that meet or exceed the sustainable acquisitions requirements. Through these ongoing efforts, Pantex has demonstrated an environmentally friendly approach to life-cycle management and stewardship of all processes while ensuring the protection of national security resources and assets entrusted to Pantex by the citizens of this country.

3.4 NATURAL RESOURCES

3.4.1 Flora and Fauna

Across most of the Southern High Plains, cultivation and other developments have reduced the acreage of native habitat and caused fragmentation of the habitat that does remain. These types of reductions and fragmentations have also occurred at Pantex. The remaining areas of near-native habitat at Pantex are small and include wetlands and shortgrass prairie uplands located near the playas.

A biological assessment at Pantex, completed in 1996, addressed the impacts to endangered or threatened species and species of concern that may occur in or migrate through the area from continuing Pantex operations. The U.S. Fish and Wildlife Service approved the assessment and concurred with the conclusion that continued Pantex operations would not be likely to adversely affect any federally listed threatened or endangered species (AL-PX-SW-005006, 1996). Lists of threatened and endangered species, species of concern, and information regarding designations of critical habitat are monitored regularly for changes in status. Results of animal and plant sampling are discussed in Chapter 11.

3.4.2 Mammals

When including feral cats (*Felis catus*), at least 14 species of mammals were recorded at Pantex in 2024 during field activities, spotlight surveys, and nuisance animal responses (Table 3.3). The all-time mammal list for Pantex includes 46 species; no previously unrecorded species sightings were reported for the year. In 2024, annual spotlight surveys continued and three surveys were performed approximately two to three weeks apart starting in mid-November.

Table 3.3 Mammals Identified at Pantex During 2024

Common Name	Scientific Name
Badger	*Taxidea taxus*
Black-tailed jackrabbit	*Lepus californicus*
Black-tailed prairie dog	*Cynomys ludovicianus*
Cottontail	*Sylvilagus spp*[a]
Coyote	*Canis latrans*
Domestic dog	*Canis familiaris*
Feral cat	*Felis sylvestris*
Gray fox	*Urocyon cinereoargentus*
Hispid cotton rat	*Sigmodon hispidus*
Mule deer	*Odocoileus hemionus*
Pronghorn	*Antelocapra americana*
Striped skunk	*Mephitis*
Virginia opossum	*Didelphis virginiana*
White-tailed deer	*Odocoileus virginianus*

[a] Desert (*S. audubonii*) and eastern (*S. floridanus*) cottontails could occur at Pantex

Figure 3.4 A coterie of prairie dogs

Photo by Katie Paul

Black-tailed prairie dogs continued to be prevalent at Pantex as shown in Figure 3.4. In 2024, a survey of black-tailed prairie dog colonies conducted with the assistance of global positioning system (GPS) equipment revealed that the colonies occupied about 753 ac at Pantex (Figure 3.5) and Pantex Lake (Figure 3.6). Prairie dogs are occasionally controlled where they have spread into operational areas of concern. Prairie dog control was conducted in landfill and security buffer areas just west of Zone 4, along the east side of Zone 5 where the colony was encroaching on landfill areas, and the area north of Zone 12 where the colony had started to encroach on a landfill.

3.4.3 Birds

Migratory birds are an important part of Pantex's natural resources. K. D. Seyffert compiled a bird checklist for Pantex. It indicates the species and their abundances expected in the Pantex area during various seasons of the year, based on habitat types and knowledge of migrations through the local area (Seyffert 1994). *The Integrated Plan for Playa Management at Pantex Plant and Wildlife Management at Pantex* provides for monitoring of birds across Pantex. The internally maintained all-time bird list for Pantex includes 212 species. The list is a result of systematic transect and plot surveys, intensive research projects by university collaborators, trail camera photos, casual observations, and nuisance animal (bird) response.

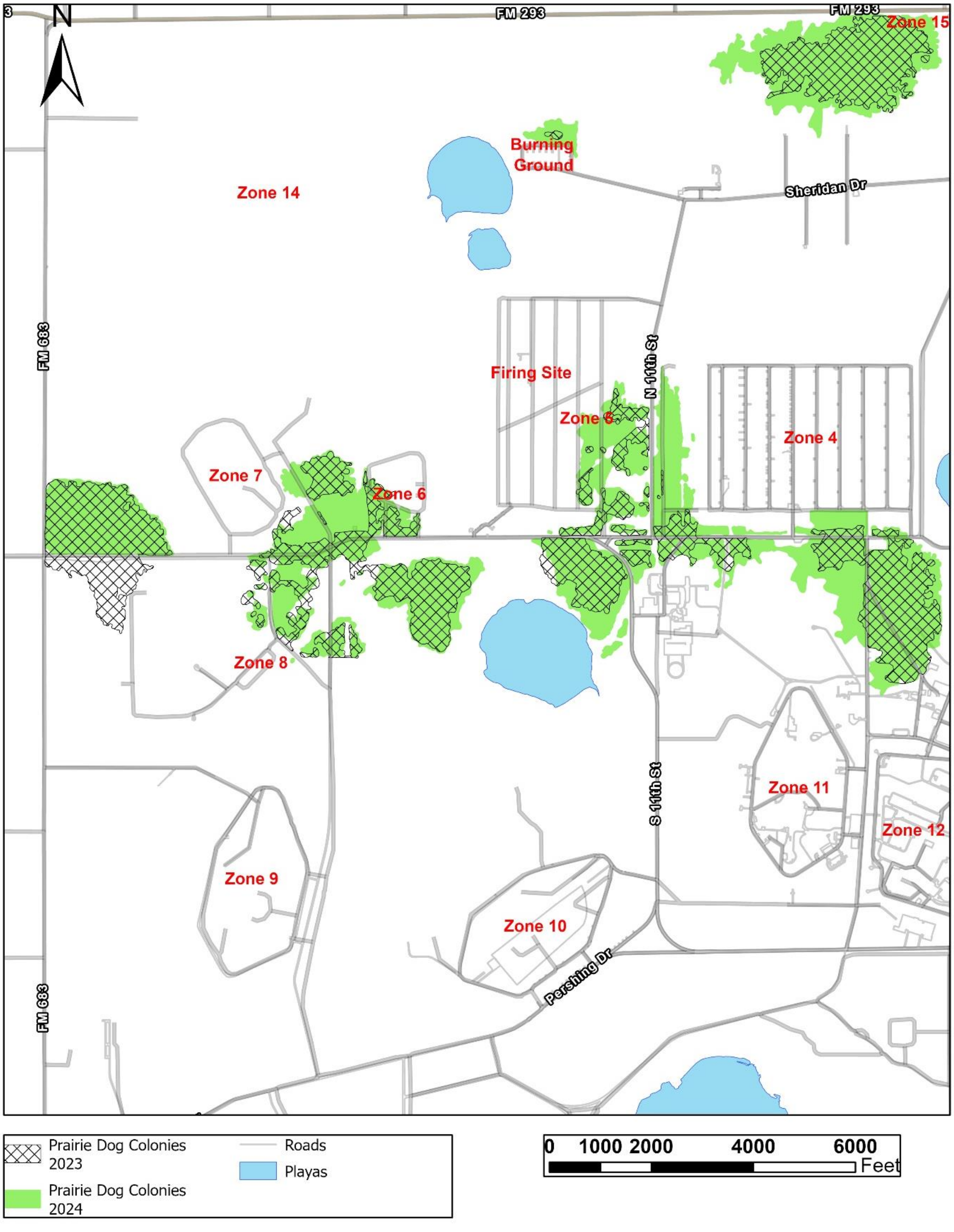


Figure 3.5 Locations of prairie dog colonies at Pantex, 2024

Figure 3.6 Location of prairie dog colonies at Pantex Lake, 2024

Currently, birds are recorded during work activities; thus, the distribution of sightings across Pantex is determined by staff field activity and work locations. During CY 2024, 81 species of birds were recorded across Pantex (Appendix A). American Avocets (*Recurvirostra americana)* and Black-necked Stilts (*Himantopus mexicanus)* continued to be abundant in CY 2024 with dozens of active nests and young being observed on-site as shown in Figure 3.7.

Figure 3.7 Black-necked Stilt and its young

Photo by Katie Paul

Pantex collaborates with York University, University of Manitoba, the Purple Martin Conservation Association, and a local master bird bander who maintains a study site for deployment of geolocator and GPS data-loggers on Eastern Purple Martins (*Progne subis subis*) as part of an international collaboration studying this declining songbird. GPS technology has confirmed roost locations and habitat throughout the migrations and winter.

During CY 2024, Pantex and collaborators continued research into purple martins. Results from studies are routinely shared through various journal articles, wildlife magazines, and presentations. These are acknowledged by DOE as important contributions to federal migratory bird initiatives.

3.4.4 Amphibians and Reptiles

Twelve species of reptiles and amphibians were recorded at Pantex in 2024 during field activities and nuisance animal responses (Table 3.4). The all-time amphibian and reptile list for Pantex includes 28 species.

Table 3.4 Amphibians and Reptiles Identified at Pantex During 2024

Common Name	Scientific Name
Bull frog	*Lithobates catesbeiana*
Bull snake	*Pituophis melanoleucus sayi*
Checkered garter snake	*Thamnophis marcianus*
Coachwhip	*Masticophis flagellum*
Plains black-headed snake	*Tantilla nigriceps*
Plains leopard frog	*Lithobates blairi*
Prairie rattlesnake	*Crotalus viridis*
Red-eared slider	*Trachemys scripta elegans*
Spotted chorus frog	*Psuedacris clarkii*
Texas horned lizard	*Phrynosoma cornutum*
Western hognose snake	*Heterodon nasicus*
Yellow mud turtle	*Kinosternon flavescens*

3.4.5 Pollinators

In 2024, Pantex staff identified and monitored various locations across Pantex property for vegetation beneficial to pollinators, primarily the several species of milkweeds found on the property. These plants provide key habitat for the monarch butterfly (*Danaus plexippus).* The butterfly will lay its eggs on the milkweed plants; when these eggs hatch the larvae will feed on the milkweed as they grow. The toxins from the milkweed are deposited into the tissues of the larvae which provide protection from predation as the toxins generally taste bad to most insectivores and will make them sick if they eat the monarch butterfly or its larvae. Due to the importance of these plant species in the life cycle of the monarch butterfly, which is an important pollinator species that is in decline, Pantex staff make efforts to protect these stands of milkweed whenever they are identified. While several healthy stands of milkweed were identified in CY

2024, very few monarchs were observed using milkweed patches in 2024 and no larvae or eggs were identified.

3.4.6 Nuisance Animal Management

In 2024, Pantex staff addressed 188 nuisance animal situations. These included over 44 wildlife species. An example of the nuisance animal management program is illustrated in Figure 3.8 as the plant's wildlife biologist observed a Pronghorn (*Antilocapra americana)* in the Playa 2 management unit. Ten striped skunks were trapped and released to Wild West Wildlife Rehabilitation Center (WWWRC) by ECD. WWWRC is a non-profit, licensed wildlife rehabilitator operating in the Amarillo area and serving the entire Texas Panhandle. The center monitors the skunks for rabies and other diseases, provides vaccines and necessary veterinary services, then relocates the animals to suitable habitats once cleared. WWWRC also assisted Pantex staff by providing assistance with an active Western Kingbird (*Tyrannus verticalis)* nest found on a security vehicle and an orphaned Mourning Dove (*Zenaida macroura)* fledgling that was found on Pantex property in 2024.

Figure 3.8 Observing Pronghorn nursery in Playa 2

Photo by Kevin Baird

3.5 CULTURAL RESOURCES

Cultural resources identified at Pantex include archaeological sites from prehistoric Native Americans; standing structures that were once part of the World War II (WWII)-era Pantex Ordnance Plant (1942 – 1945); and buildings, structures, and equipment associated with Pantex's Cold War operations (1951 – 1991). In addition, many artifacts and historical documents have been preserved which are valuable sources for interpreting prehistoric and historic human activities at Pantex. Some of these cultural resources are eligible for inclusion in the *National Register of Historic Places* (*National Register*), thus requiring protection and preservation under the NHPA and related cultural resource management requirements. Pantex's cultural resource management program ensures compliance with all applicable state and federal requirements.

The goal of the Cultural Resources Management (CRM) program is to manage Pantex's cultural resources efficiently and systematically, taking into account both Pantex's continuing mission and historic preservation concerns. This goal is achieved through coordination with Pantex's project review process for compliance with the NEPA, and through consultation with the SHPO and the Advisory Council. In September 2023, DOE, Pantex, the Texas SHPO, and the Advisory Council completed execution of a PA/CRMP (Pantex 2023). The PA/CRMP provides for the systematic management of all archaeological and historic resources at Pantex under a single document. It ensures compliance with Section 106 of the NHPA, providing for more efficient and effective review of Pantex projects having the potential to impact prehistoric, WWII-era, and Cold War-era properties, objects, artifacts, and records. In addition, the PA/CRMP outlines a range of preservation activities planned for Pantex's compliance program. No changes were made to the program in 2024. PFO and Pantex Cultural Resources staff completed the revision and updated process to the 2004 PA/CRMP. A signed and approved document is in place and will govern the CRM program until 2033.

3.5.1 Archaeology

Figure 3.9 Modern cattle vertebrae found at Pantex Lake

Photo by Kevin Baird

Pantex lies within the southern Great Plains archaeological province; specifically, it is within the High Plains Ecological Region of the Texas Panhandle. Approximately half of the DOE-owned and leased land at Pantex has been systematically surveyed for archaeological resources. Based upon those surveys, a site-location model was developed. In 1995, a 2,400-ac survey confirmed that prehistoric archaeological sites at Pantex are situated within approximately 0.25 mi of playas or their major drainage locations. Conversely, such sites do not occur in inter-playa upland areas (Largent 1995).

Sixty-nine archaeological sites have been identified at Pantex consisting of 57 Native American prehistoric sites, represented by lithic scatters of animal bone artifacts, and 12 Euro-American farmstead sites, represented by foundation remains and small artifact scatters. In consultation with the SHPO, Pantex determined that the 12 historic sites are not eligible for inclusion in the *National Register*. Pantex and the SHPO concluded that two of the 57 prehistoric sites (41CZ66 and 41CZ23) are potentially eligible for the *National Register* but that additional field work would be required to make a final eligibility determination. Pantex will continue to protect these two sites and monitor them on a regular basis, as though they are eligible. Regular monitoring of these sites has yielded only modern findings not associated with the prehistoric nature of the sites as shown in Figure 3.9. If additional features are exposed and found, excavation will proceed if they cannot be adequately protected in-situ. These exposed features will be analyzed, mapped, collected, and excavated by appropriate archaeological methods. All archaeological reports, records, photographs, maps, and artifacts will be archived at Pantex in accordance with applicable federal regulations. In addition, 22 of the prehistoric sites are protected within playa management units surrounding the four DOE-owned playas.

In the fall of 1996, Pantex personnel monitoring for erosion discovered a number of large bones belonging to a bison. An emergency excavation was completed under the supervision of a qualified archaeologist. The bones were identified, preserved, and placed in a permanent exhibit within the Pantex Access Control Facility.

In 2024, staff members monitored archaeological sites on four separate occasions. Staff members found no artifacts during the year.

3.5.2 World War II

In 1942, the U.S. Army Ordnance Department chose this site for construction of a bomb-loading facility. The 16,000-ac industrial Pantex Ordnance Plant, designed and constructed in only nine months, sprang up in the middle of a traditional rural farming and ranching community, bringing with it great social and demographic change. It was constructed by the USACE and operated by the Certain-teed Products Corporation to produce bombs and artillery shells.

The WWII-era historical resources of Pantex consist of 118 standing buildings and structures, all of which have been surveyed and recorded. In consultation with the SHPO, Pantex has determined that these properties are not eligible for inclusion in the *National Register* within a WWII context. The WWII-era buildings and structures have been preserved to some extent through survey documentation, photographs, individual site forms, and oral histories.

The Pantex Records Operation Center continues to maintain and store historical records and a variety of different media for preservation purposes. Records include facility maps, aerial maps and additional Cold War as-built drawings, as well as Pantex layout plans of former zones. In addition, a collection of Cold War-era photographs, written material, and other items have been collected and stored.

3.5.3 Cold War

The NHPA typically applies only to historic properties that are at least 50 years old unless they are of "exceptional importance" (NPS Bulletin 15, 1997). A total of 181 facilities used during the Cold War are eligible for inclusion in the *National Register* under the Cold War context. Many properties at Pantex are associated with the Cold War arms race and are of exceptional importance. As a final assembly, maintenance, surveillance, and disassembly facility for the nation's nuclear weapons arsenal, Pantex lies at the very heart of Cold War history (Figure 3.10).

Figure 3.10 Atomic Energy Merit Badge session in the 1960s

Photo Courtesy of Pantex Archives

The period of Cold War operations at Pantex date from 1951 to September 1991. In 1951, the AEC reclaimed Pantex as part of the expansion of the nuclear weapons complex. The Cold War-era historical resources of Pantex consist of approximately 590 buildings and structures and a large inventory of process-related equipment and documents. The historical resources of this period are among Pantex's most significant and offer a valuable contribution to the nation's cultural heritage.

Pantex 25-Year Master Site Plan (2021) specifically lists improvements and preservation of buildings listed in the PA/CRMP for in-situ preservation (Pantex 2023). The ten facilities designated for in-situ preservation are additionally included in all NEPA reviews. Pantex personnel review NEPA documentation to identify adverse effects on historical structures, objects, and archaeological sites. Historical equipment, tooling, trainers, and other components have been and continue to be acquired, inventoried, and moved into a historical facility. Preservation activities continue through the identification and evaluation of facilities; maintenance of an unclassified historical exhibit and railcar displays; collection of artifacts and records; monitoring of archaeological sites; educational outreach; and other preservation activities. Sixty-eight outreach activities for Pantex history occurred in CY 2024, including history presentations to newly hired staff members, students, and community leaders. A total of 4,630 artifacts related to the Cold War mission were added to the historical collection. These artifacts included photographs, slides, reports, physical objects, and manuals. Fourteen unclassified oral history interviews were conducted with current and former Pantex staff. These projects strengthen continued use of the historical facilities and confirm Pantex pledge for implementing preservation activities.

3.6 EDUCATIONAL RESOURCES AND OUTREACH OPPORTUNITIES

Pantexans donated their time and talent to area schools by speaking to students about the various careers available at Pantex. National Engineers Week and Introduce a Girl to Engineering in February help stimulate students' interest in science, technology, engineering, and math. For 33 years, the Pantex Regional Science Bowl has given middle school and high school students across the Texas Panhandle a chance to compete for the opportunity to advance to the National Science Bowl. Figure 3.11 shows a student team competing at the Regional Science Bowl. In addition, Pantex supported area schools with its robotics programs.

Pantexans are committed to helping their neighbors. During the United Way Day of Caring, over 40 employees came out and helped build ramps with the Texas Ramp Project as well as helping with some gardening at the Downtown Women's Shelter.

Figure 3.11 Lorenzo de Zavala Middle School at the Pantex Regional Middle School Science Bowl

Photo by Michael Schumacher

3.7 ENVIRONMENTAL RESTORATION

Historical waste management practices at Pantex resulted in impacts to on-site soil and perched groundwater. These historical practices included disposal of spent solvents in unlined pits and sumps, and discharge of high explosive (HE) containing wastewaters and other industrial wastewaters into unlined ditches and playas. As a result, HEs, solvents, and metals were found in the soil at solid waste management units (SWMUs) at Pantex and in the uppermost (perched) groundwater beneath Pantex. Pantex and regulatory agencies identified 254 units for further investigation and cleanup. Investigations that identified the nature and extent of contamination at SWMUs and groundwater were submitted to the TCEQ and EPA in the form of RCRA facility investigation reports. Those investigation reports closed many units through interim remedial actions and No Further Action determinations. Other units were evaluated in human health and ecological risk assessments to identify further remedial actions necessary to protect human health and the environment. Figure 3.12 depicts the location and status of the units. The 15 units still in active use will be closed in accordance with CERCLA requirements and RCRA permit provisions when they become inactive, are determined to be of no further use, and funding is obtained for investigation, cleanup, and closure of the site. One of these units is now inactive and funding has been requested to address the formerly active site. Pantex has recently discovered a new SWMU that will be closed under the new Texas Risk Reduction Program Remedy Standard B. That site is also depicted on Figure 3.12.

Those units requiring further remedial actions were assessed in a Corrective Measures Study to identify and recommend final remedial actions. A detailed summary of actions for the 254 units can be found in the *Record of Decision for Groundwater, Soil and Associated Media*, (Pantex Plant and Sapere 2008). The final approved remedial actions are detailed in the record of decision (ROD). Ongoing remedial actions focus on the following:

- Cleanup and removal of perched groundwater to protect the underlying drinking water aquifer,
- Removal of soil gas and residual non-aqueous phase liquid (NAPL) in the soil at the Burning Ground for future protection of groundwater resources,
- Institutional controls to protect workers, control perched groundwater use, and control drilling into and through perched groundwater, and
- Maintenance of soil remedies (ditch liner and soil covers) for groundwater protection.

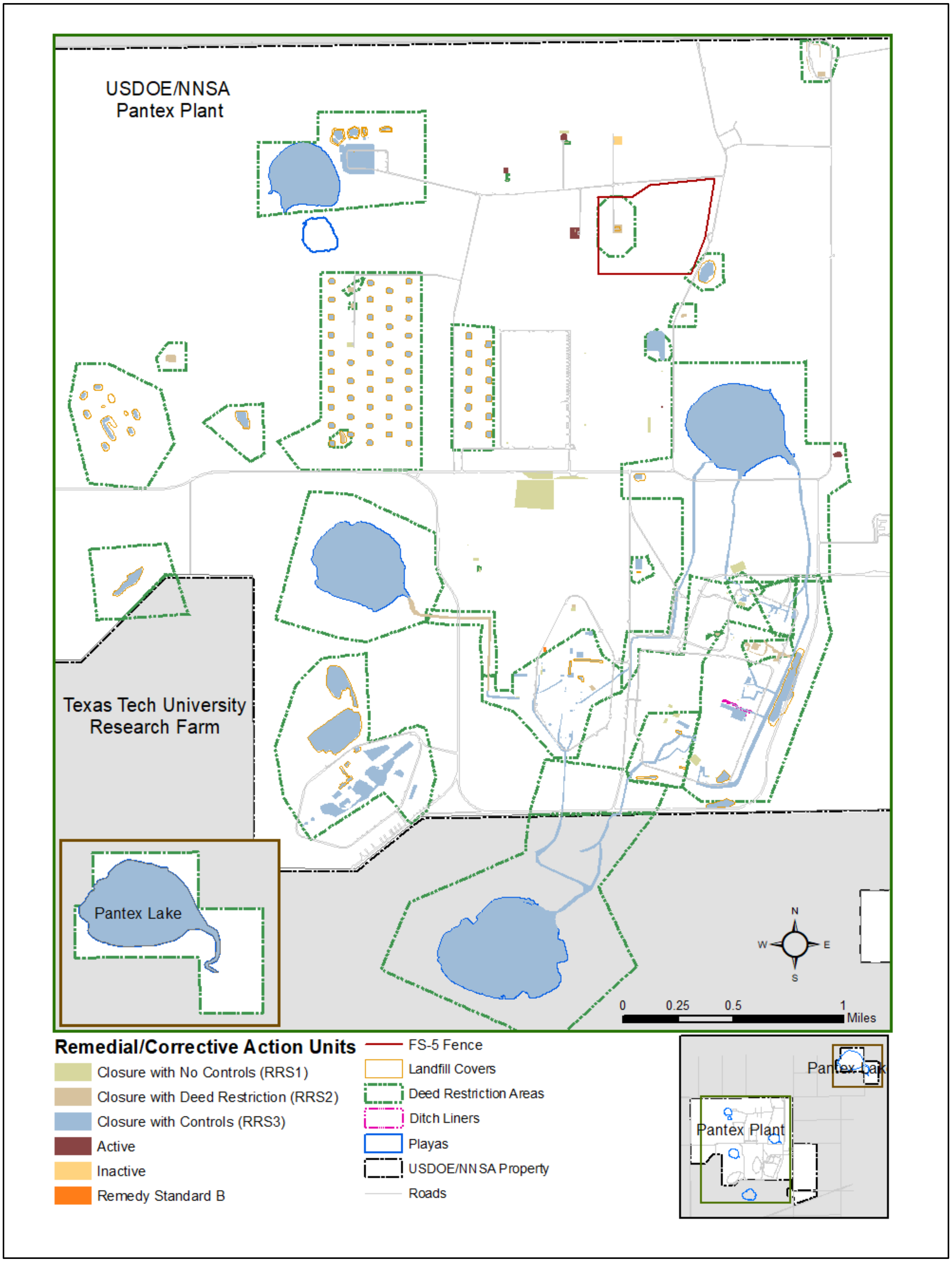


Figure 3.12 Location and status of solid waste management units

3.7.1 Environmental Restoration Milestones

During 2024, Pantex completed several milestones under the continued long-term stewardship (LTS) of environmental units. LTS includes the long-term operations and maintenance (O&M) of the remediation systems, monitoring of the systems to ensure that cleanup goals will be met, ensuring soil remedies and institutional controls are maintained, and reporting of that information to regulatory agencies and the public. Major milestones for the 2024 remedial actions are shown in Figure 3.13 and remedial action systems at Pantex are depicted in Figure 3.14.

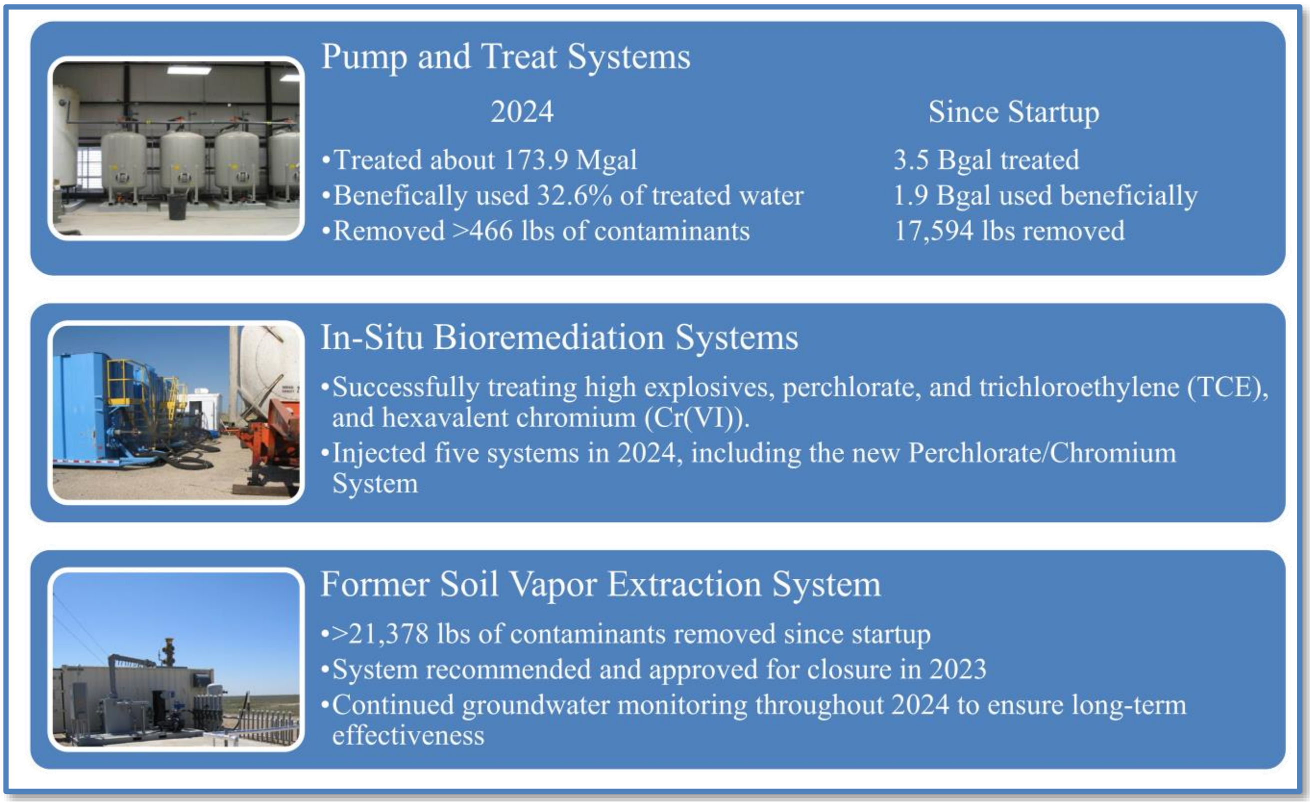
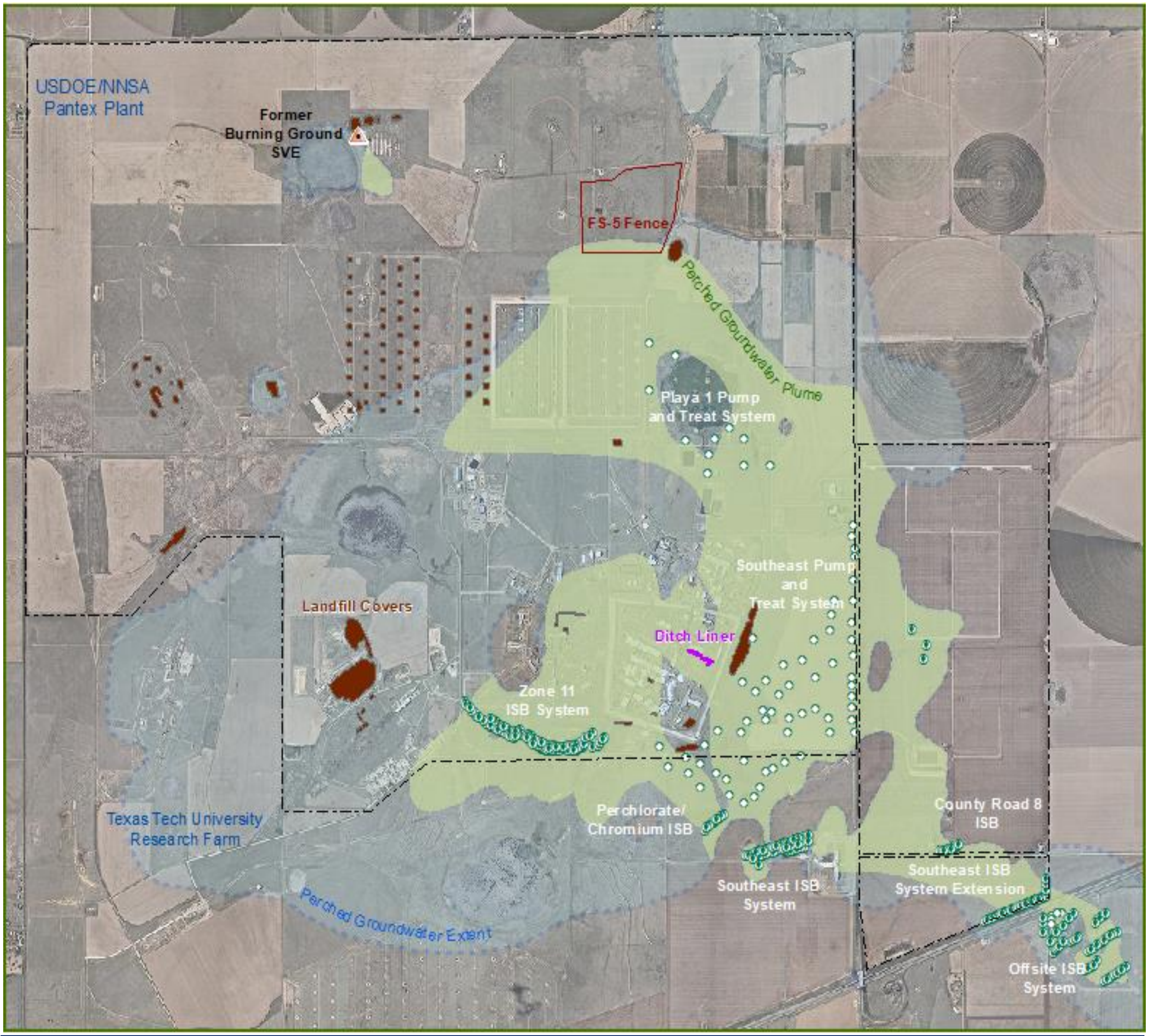


Figure 3.13 Major milestones for 2024 remedial actions

Pantex operates two pump-and-treat systems to achieve the goals outlined in the ROD, the Southeast Pump-and-Treat System (SEPTS) and the Playa 1 Pump-and-Treat System (P1PTS). The SEPTS was operated consistently to achieve those goals and more effectively capture and control plumes moving to the southeast. The P1PTS operated to primarily capture water that pushes the plumes to the southeast. Performance of the pump-and-treat systems for 2024 is depicted in Figures 3.15 and 3.16.

Pantex also operates five in-situ bioremediation (ISB) systems that are injected as needed to mitigate plumes in areas where contaminants are best treated with this technology, or in areas of thinner saturation where it is necessary to mitigate downward movement of contamination or where contamination is moving off-site.

A soil vapor extraction (SVE) system was operated from 2002 until its closure in 2023 to capture soil gas and residual NAPL in deeper soils. Mass removal at the SVE system is depicted in Figure 3.13. All of these systems operate to protect or clean up groundwater. Institutional controls are also implemented to protect people and the environment while clean up continues.



Groundwater Remedies:

- 2 Pump & Treat Systems
  - Playa 1 Pump and Treat
  - Southeast Pump and Treat
- 6 In-Situ Bioremediation (ISB) Systems
  - Zone 11 ISB
  - Southeast ISB
  - Southeast ISB Extension
  - Off-site ISB
  - Perchlorate/Chromium ISB
  - County Road 8 ISB
- Institutional Controls

Soil Remedies:

- Ditch Liner
- Soil Covers on Landfills
- Fencing at FS-5 to control use/access
- Institutional Controls
- Former SVE System

Figure 3.14 Remedial action systems at Pantex

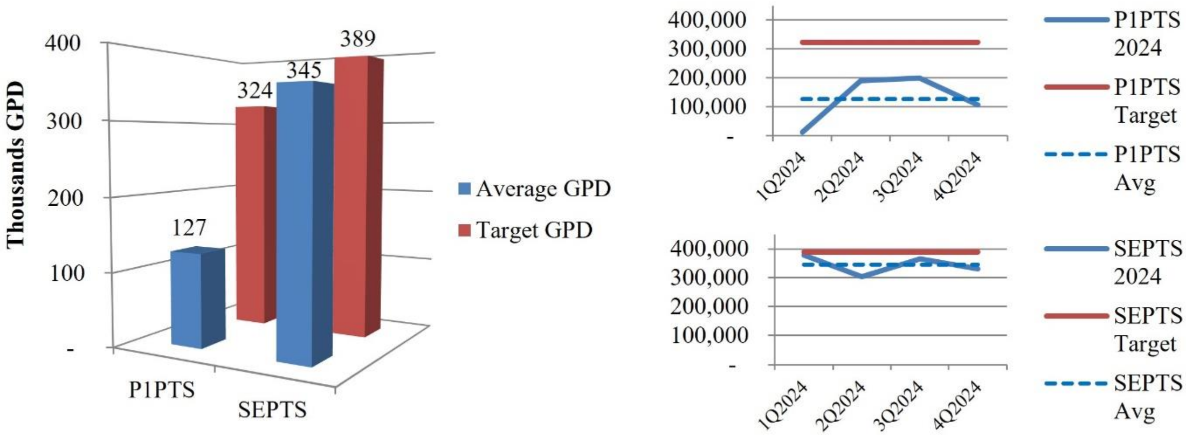
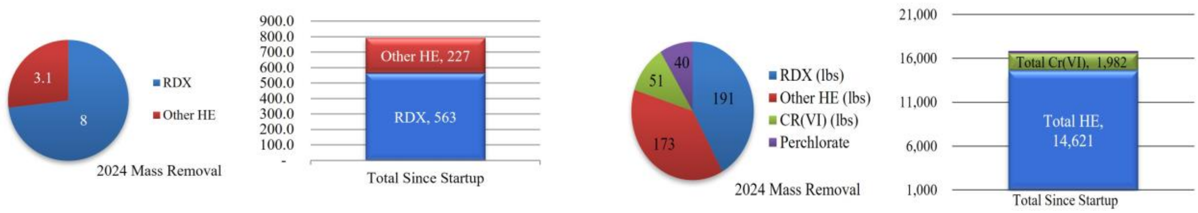


Figure 3.15 2024 Pump-and-treat systems performance



P1PTS Mass Removal **SEPTS Mass Removal**

Figure 3.16 2024 Pump-and-treat systems operation and mass removal

3.7.2 Pump-and-Treat System

To reach the goal of reducing saturated thickness, the pump-and-treat systems had a previous goal of operating 90% of the time and at 90% of treatment capacity if the wastewater treatment facility and subsurface irrigation system could receive all of the treated water. Pantex revised the goals during 2023 to prioritize treatment and use of the water to align operation with the goal of reducing saturated thickness and to address new water outlets that can be used to manage treated water. During 2024, 32.6% of the treated water was beneficially used despite the continued shutdown of the subsurface irrigation system. Pantex utilized the center-pivot irrigation system, shown in Figure 3.17, and ISB injection to optimize the amount of water beneficially used throughout the year. The two pump-and-treat systems were managed to maximize capture of the HE plumes to control movement of contaminated groundwater to the southeast. Pantex continues to discharge treated water to the WWTF lagoons that are currently managed to send water to Playa 1 due to the limited capacity of the wastewater ponds that are undergoing repair. Final repairs to the subsurface irrigation system were completed in March 2022, but it is currently experiencing communication failures and therefore was not used in 2024. When the pivot irrigation system was available, all water was discharged

Figure 3.17 Center-pivot irrigation sprinkler system at Pantex

to the pivot irrigation pond and to ISB injection. During times that ISB systems did not need water and irrigation was not available, treated water was discharged to Playa 1 and/or sent to the injection wellfield to be injected back into the perched aquifer. Due to expansion of the HE plume to the southeast, Pantex managed the two systems in 2024 to improve capture of the HE plume. P1PTS operations were affected by limited water outlets as WWTF lagoon repairs continued throughout the year and pivot irrigation was limited by weather or shutdown of the system. Operation of the SEPTS was mostly consistent throughout the year; however, throughput was adjusted as extraction wells intermittently came offline for maintenance and when water outlets were limited.

In addition to removing impacted water from the perched aquifer, the pump-and-treat systems remove contaminant mass from the groundwater that is extracted from the aquifer. The P1PTS primarily removes the HE hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and the SEPTS primarily removes RDX, perchlorate, and CR(VI). Figure 3.16 provides the mass removal for HEs, perchlorate, and CR(VI) for 2024, as well as totals since startup of the systems. The SEPTS has been operating longer, and the greatest concentrations of HEs are found in the SEPTS extraction well field, so mass removal is higher at that system. P1PTS throughput and mass removal was affected by adjusting operation in accordance with the new goals that prioritize the operation of the SEPTS when water outlets are limited.

3.7.3 In-Situ Bioremediation Systems

These systems are designed with closely spaced wells to set up a treatment zone in areas of the perched groundwater to control plumes migrating off-site, to TTU property south of Zone 11, or where the area is sensitive to vertical migration of contaminants of concern (COCs) to the underlying aquifer (Figure 3.18). Pantex drilled wells for two new ISB Systems in 2024, the Perchlorate/Chromium (PCR) ISB and the County Road 8 (CR8) ISB. The PCR ISB was fully injected in 2024; however, the CR8 ISB is awaiting installation of infrastructure and is anticipated to be injected in 2026.

Figure 3.18 In-situ bioremediation system well near Zone 11

Photo by Lucy Holt

To treat contaminants, amendment is injected into the treatment zone to provide a food source for naturally occurring bacteria that break down the COCs. Monitoring wells were installed downgradient of the groundwater flow from the treatment systems to monitor whether the system is effectively degrading the COCs. A discussion of treatment zone effectiveness and downgradient performance monitoring well information is included in Chapter 6.

3.7.4 Burning Ground Soil Vapor Extraction

The Former SVE system was installed and operated at the Burning Ground beginning in February 2002. After a large-scale system remediated a significant area at the Burning Ground, a small-scale activated carbon system was installed in late 2006 when the large-scale system became inefficient at continued removal of NAPL. The most recent system, consisting of a small-scale catalytic oxidizer and wet scrubber, was installed in early 2012 to replace the activated carbon system. The system was modified in 2017 to increase airflow through the soils to improve remediation and evaluate the system for closure. This system focused on treating residual soil gas and NAPL at a single well (SVE-S-20) where soil gas concentrations continued to remain high. Pantex began actively pulsing the system in 2020 to gain information relating to closure. Data collected in 2021 and 2022 indicated the NAPL source was nearly depleted and shutdown was recommended in 2023. By this time, the SVE system had effectively removed 21,378 lbs of VOCs.

Pantex requested closure of the system in the report *Draft Final Burning Ground Soil Vapor Extraction System Closure Report* (Pantex, 2023). The TCEQ and EPA approved the closure report for the SVE system in December and October 2024, respectively. Pantex has requested the removal of the SVE system in the application to renew and modify Hazardous Waste Permit/Compliance Plan No. HW-50284. As of 2024, Pantex no longer operates this system, although groundwater monitoring will continue for a period of time to evaluate the long-term effectiveness of the remedy.

3.7.5 Soil Remedies and Institutional Controls

Institutional controls are required as part of the LTS of soil remedial action units at Pantex. Deed restrictions have been placed on all soil units with the exception of the active units. All SWMUs at Pantex are restricted to industrial use. To support the deed restrictions, Pantex maintains long-term control of any type of soil disturbance in SWMUs to protect human health and to prevent spread of contaminated soils.

Institutional controls are also required for groundwater. Deed restrictions have been placed on DOE-owned and off-site property where impacted perched groundwater occurs. These restrictions do not allow for use of the perched groundwater and restrict drilling into or through the perched groundwater to protect the underlying drinking water aquifer.

Pantex also regularly inspects and maintains soil covers on landfills to prevent infiltration of water into the landfill contents and migration of impacted water to groundwater. Ditch liners are also regularly inspected and maintained to prevent infiltration of water through soils that have been impacted by past releases.

3.7.6 Third Five-Year Review

The five-year review is conducted to ensure that remedial actions for soils and groundwater at Pantex remain protective of human health and the environment. Pantex completed the *Third Five-Year Review Report Remedial Action Progress* in September 2023. The results of the review indicate that the selected remedy is performing as intended and is protective of human health and the environment in the short-term because there are no completed exposure pathways to human or environmental receptors for soil or perched groundwater. In order to achieve long-term protectiveness of human health and the environment, operation and maintenance of the remedial action systems must continue and enhancements to existing systems and institutional controls need to be evaluated, planned, and implemented. Pantex is actively pursuing changes to the systems and plans to have all recommendations for change implemented by the next review that is scheduled for completion in 2028. The five-year review report can be found at www.pantex.energy.gov.

3.7.7 Long-Term Groundwater Monitoring

Pantex transitioned to the LTM network in July 2009. The groundwater monitoring network was developed to evaluate the effectiveness of the remedial actions. The evaluation is conducted to ensure that the groundwater remedial systems are effective in stabilizing plumes and meeting cleanup goals, to detect any new COCs from source areas or in the drinking water aquifer, and to evaluate the presence and amount of natural attenuation that may be occurring in the groundwater plumes. The monitoring system also serves as an early detection system for the drinking water aquifer. The monitoring information collected is evaluated and reported in annual and quarterly progress reports and is summarized in Chapter 6 of this report. The quarterly and annual reports can be found at www.pantex.energy.gov.

3.8 ENVIRONMENTAL MONITORING

DOE O 458.1 requires the performance of monitoring that is integrated with the general environmental surveillance and effluent monitoring programs in order to do the following:

- Assess impacts,

- Characterize exposures and doses to individual members of the general public, to the population, and to biota in the vicinity of Pantex,
- Detect, characterize, and respond to releases from DOE activities, and
- Demonstrate compliance with applicable regulatory and permit limits.

The monitoring program with its associated planning, implementation, and assessment phases was designed based upon the system described in the EPA QA/G-1*, Guidance for Developing Quality Systems for Environmental Programs* (U.S. Environmental Protection Agency 2002). Another document useful in the continuous improvement of the design of Pantex monitoring program was Report No. 169, *Design of Effective Radiological Effluent Monitoring and Environmental Surveillance Programs*, published by the National Council on Radiation Protection and Measurements (2010). Although this document specifically addresses radiological effluent monitoring and surveillance, the authors note that many of the concepts described are appropriate for non-radiological contaminants that must also be monitored.

Planning for the environmental monitoring program begins with the development of (or revision of previously existing) monitoring requirements by the various environmental SMEs (for environmental media including but not limited to air, water, soil, and biota) by a process based upon that described in EPA QA/G4*, Guidance for Data Quality Objective Process* (2006).

When planning sample-collection locations and frequencies for various environmental media, the SME must consider several factors including the following:

- Purpose of the monitoring program,
- Trend of historical results from previous sampling,
- Predominant wind direction, and
- Presence of a sufficient quantity of a target species for analysis.

Through permits issued to Pantex, specifications for sampling locations and frequencies by a regulatory body (such as TCEQ or EPA) have also been used in the development of certain monitoring programs. When feasible, sample plans include taking samples at the same geographical location for several environmental media to allow an individual media scientist to compare results from other media and determine the usability of the data. Environmental monitoring and sample preparation is conducted in the building shown in Figure 3.19.

Figure 3.19 Environmental monitoring facility at Pantex

Photo bv Michael Schumacher

The implementation of these plans begins with the collection of samples by technicians using procedures contained within an environmental sampling and analysis manual. In addition to procedures common to all environmental media (such as those associated with completion of sampling logs and chain-of-custody forms), the manual contains procedures specific to each different environmental media. These specific procedures are based upon the collection protocols included in different national consensus standards. The majority of the analyses of Pantex environmental samples are completed by independent laboratories under a scope of work that requires the analysis of Pantex samples to be conducted using protocols that are equivalent to those in consensus standards. A limited number of analyses including those for preliminary analysis of certain water samples are performed on-site. In addition, Radiation Safety Department personnel perform analyses of the environmental thermoluminescent dosimeters (TLDs) discussed later in Chapter 4.

Data assessment processes were employed by Pantex to verify that the data collected for the monitoring programs met the specified data acceptance criteria. These processes included evaluation of sampling QA, laboratory technical performance, and data verification and validation. Chapter 12 in this document contains a discussion of the program used to ensure that the environmental monitoring data meet the appropriate data quality requirements.

Media-specific descriptions of the sampling locations and the results of the monitoring program for samples collected during 2024 are contained in Chapters 4-11 of this report.

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CHAPTER 4 - ENVIRONMENTAL RADIOLOGICAL PROGRAM

Pantex's environmental radiological monitoring program is conducted in accordance with DOE O 458.1, Radiation Protection of the Public and the Environment. The program involves measuring radioactivity in environmental samples in addition to calculating the potential radiological dose to the off-site public. The program monitors for the principal radionuclides in air, groundwater, drinking water, surface water, flora, and fauna samples associated with Pantex operations: tritium, uranium-234 (U-234), uranium-238 (U-238), and plutonium-239 (Pu-239). The radionuclides U-234, U-238, and Pu-239 emit primarily alpha particles although gamma radiation emissions from these radionuclides were also monitored and evaluated. Tritium and Nickel-63 emit beta particles.

Chapter Highlights

- Monitoring results for the environmental radiological pathways in 2024 indicated levels substantially below relevant standards, similar to results from previous years, and consistent with background conditions.
- There were no unplanned releases of radioactive material during 2024.

4.1 RADIOLOGICAL DISCHARGES AND DOSES

DOE O 458.1 requires radiological activities be conducted in a manner so that exposure to members of the public from ionizing radiation from all DOE sources and exposure pathways shall not cause, in a year, a total effective dose greater than 100 mrem [1 mSv]. At Pantex, demonstration of compliance with this limit is documented by a combination of measurements and calculations including the comparison of concentrations of radioactive material in air and water to Derived Concentration Standards (DCSs) listed in DOE-STD-1196-2022, *DOE Derived Concentration Technical Standard*. The DCS values are derived in accordance with dose limitation systems recommended by the International Commission on Radiological Protection in its several publications (2007). These standards are used by the EPA, the Nuclear Regulatory Commission, and other regulatory bodies including DOE in establishing regulatory limits for radiological protection. These regulatory limits are purposely set at levels well below those known to cause any adverse effects on the public and/or the environment.

4.1.1 External Radiation Pathways

DOE O 458.1 requires evaluations to demonstrate compliance with the dose limits described in Section 4.1, above. It is DOE and Pantex policy that radiological activities at Pantex are designed to ensure that any dose above background radiation is as low as reasonably achievable (ALARA). Evaluations consider several exposure pathways including direct external radiation from sources located on-site, external radiation from airborne radioactive material, and external radiation from radioactive material deposited on surfaces off-site. At Pantex, external gamma radiation is measured at several locations at or near the site to determine the magnitude of any dose from these pathways. Additionally, external radiation dose is measured at numerous locations around the perimeter of Pantex by the TDSHS Laboratory Services Section (TDSHS 2025). Measurements of external radiation, collected by Pantex and the State of Texas, continue to indicate that activities at Pantex do not contribute significantly to the exposure of workers, members of the public, or the environment to ionizing radiation.

4.1.2 Air Pathway

DOE O 458.1 further requires that internal doses to members of the public from inhalation of airborne effluents be evaluated using the EPA's CAA Assessment Package - 1988 (CAP88-PC) model (or another EPA-approved model or method) to demonstrate compliance with applicable subparts of 40 CFR Part 61, *Protection of the Environment*, "National Emission Standards for Hazardous Air Pollutants." Compliance with the limit for emissions to the airborne pathway of radionuclides, other than radon established by the EPA in 40 CFR 61.92, "Standard," is demonstrated at Pantex by calculating the effective dose equivalent received by a maximally exposed individual (MEI) using the CAP88-PC model (EPA 2019). The MEI is a theoretical person who resides near Pantex and who would receive, based on assumptions about lifestyle, the maximum exposure to radiological emissions and therefore the highest effective dose equivalent from Pantex operations.

Meteorological data used in this modeling effort was obtained from the meteorological towers from the Amarillo National Weather Service (NWS) station at the Rick Husband International Airport and the MesoNet site located at Pantex. The source term for releases to air was calculated based on process knowledge of the releases of radionuclides from the routine operations at Pantex (e.g., calibration of radiation detection instrumentation and operations at the Burning Ground and Firing Sites), the number of operations conducted during the year, and other modifying factors. In estimating the emissions, conservative assumptions concerning the form of the radioactive material and the presence or absence of engineering controls such as high-efficiency particulate air filters are made to ensure that maximum potential emissions are modeled. A small percentage (less than 0.001%) of these calculated emissions are due to emissions of U-238 and other radionuclides from various routine Pantex activities, while the balance are due to emissions of tritium. These emissions are summarized in Table 4.1 below.

Table 4.1 Pantex Radiological Atmospheric Emissions in Curies (Bq)

Tritium	Total Uranium	Total Plutonium	Total Other Actinides	Other (Nickel 63)
5.169E+00 (1.912E+11)	0.000E+00 (0.000E+00)	1.135E-12 (4.200E-02)	7.846E-09 (2.903E+02)	3.137E-12 (1.161E-01)

Based on the 2024 operational data, the results of the CAP88-PC modeling indicate that the MEI for 2024 located approximately 2.3 km northeast of Zone 12 would have received a dose of 1.60E-04 mrem/year (1.60E-06 mSv/yr). This dose is significantly below the EPA's maximum permissible exposure limit to the public of 10 mrem/yr specified in 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities." The indicated dose is also equivalent to 1.600E-04% of the DOE Public Dose Limit for air pathways. Based upon the same CAP88-PC modeling results, the collective population dose equivalent received by those living within 80 km (50 mi) of Pantex would have been 7.70E-04 person-rem/year (7.70E-06 person-Sv/year) in 2024. The majority radionuclide contribution to this collective population dose equivalent comes from tritium.

As in previous years, the effective dose equivalent for the MEI is substantially less than the regulatory limit. Effective dose equivalents for the last five years are shown in Table 4.2. Variation in the doses between years is due to changes in the emissions of tritium and isotopes of uranium associated with different operations such as instrument calibration, processing of certain HE components, and waste treatment operations during the different years.

Table 4.2 Effective Dose Equivalent for Maximally Exposed Individual Member of General Public during CYs 2020-2024

Year	Maximally Exposed Individual Dose (mrem)	Population Dose (Person-rem/yr)
2020	1.27E-07	7.23E-07
2021	4.11E-08	2.17E-07
2022	2.20E-04	1.10E-03
2023	1.301E-05	2.88E-05
2024	1.600E-04	7.70E-04

4.1.3 Water Pathways

In addition to promulgating the dose limit mentioned above, DOE O 458.1 requires operators of DOE facilities discharging or releasing liquids containing radionuclides from DOE activities to conduct such activities in such a manner as to:

- protect groundwater resources,
- not cause private or public drinking water systems to exceed the drinking water maximum contaminant limits outlined in 40 CFR 141, "National Primary Drinking Water Regulations", and
- comply with other limitations as applicable.

Current Pantex policy does not allow the discharge of radioactive material in liquid effluent discharges to groundwater or to sanitary sewers, thus eliminating any future potential impact to groundwater from those sources. Compliance with 40 CFR 141.66, "Maximum Contaminant Levels for Radionuclides," limitations for individual radionuclides potentially released from Pantex activities, with the exception of tritium, is demonstrated by comparing measured concentrations of radionuclides in drinking water to 4% of the DCS values for ingested water. The current average annual concentration of tritium tabulated in 40 CFR 141.66 which is assumed to produce the same four mrem dose equivalent is 20,000 pCi/L. The results of these measurements as well as those for other water monitoring programs did not indicate releases to any water pathway and thus no contribution to the total effective dose from Pantex activities during 2024.

4.1.4 Other Pathways

Pantex has considered doses to the public, which might arise from radioactive materials ingested with food from terrestrial crops, animal products, and aquatic food products (including plant and animal species). The results of the faunal monitoring measurements and monitoring of native vegetation and crops did not indicate releases to either pathway from Pantex activities during 2024.

As will be discussed in more detail below, the current program concerning the release of property containing residual material has been designed to ensure that such releases are ALARA. Public doses from this pathway are negligible.

4.1.5 Public Doses from All Pathways

The dose equivalent received by the MEI during 2024, the 2024 collective population dose, and the 2024 natural background population dose are presented in Table 4.3. Because there were no releases from Pantex to the water or other pathways, the air pathway dose represents the public dose from all pathways.

Table 4.3 Pantex Radiological Doses in 2024

Dose to Maximally Exposed Individual from Pantex Operations mrem (mSv)	Percent of DOE 100-mrem Limit	Estimated General Public Population Dose from Pantex Plant Operations person-rem (person-Sv)	Population within 80 km (50 mi)	Estimated Naturally Occurring Radiation Population Dose at Pantex (person-rem)
1.600E-04 (1.600E-06)	1.600E-04	7.70E-04 (7.70E-06)	360,000	100,800

4.2 RELEASE OF PROPERTY CONTAINING RESIDUAL RADIOACTIVE MATERIAL

DOE O 458.1 provides requirements for the clearance of potentially contaminated material and equipment (M&E) from Pantex to the public. The order distinguishes real property (land and structures) from personal or non-real property (any materials not land and structures) in its discussion of clearance. To implement the requirements of the order, DOE requires that the property that has been or is suspected of being contaminated with radioactive material be adequately surveyed (radiologically characterized) to ensure that the property meets pre-approved DOE-authorized limits prior to release to the public. DOE O 458.1 specifically indicates that previously approved guidelines and limits (such as those developed for compliance with DOE O 5400.5, *Radiation of the Public and the Environment*) may continue to be applied and used as pre-approved authorized limits until they are replaced or revised by pre-approved authorized limits issued under the new order. Clearance of potentially radioactive contaminated M&E to the public is managed with the consistent and appropriate application of one set of clearance criterion based upon the surface activity guidelines established in DOE O 5400.5.

Since 1993, Pantex's clearance process, as stated in MNL-RS0001 (2022), *Pantex Radiological Control Manual*, requires the Radiation Safety Department's evaluation of any potentially contaminated M&E using process and forms including;

- Radiation Safety Department's approval for M&E that is to be excessed,
- PX-4008, *Waste Operations Department Scrap Metal Disposition Form*, for disposition of any scrap metal (in compliance with former DOE Secretary Richardson's moratorium on recycling certain metals),
- PX-2643, *Material Evaluation Form*, for release of all waste,
- PX-691, *Shipment Request*, for release of outbound non-weapon shipments,
- PX-2189, *Radiation Safety Material Clearance*, for M&E not covered by one of the preceding methods, and/or
- PX-3134, *Process Knowledge*, for nonradioactive M&E having no potential for radioactive contaminated surfaces.

The application of the Pantex clearance process has resulted in no releases of personal property with surface contamination in excess of the indicated levels.

DOE O 458.1 requires that personnel independent of contractor personnel conducting property clearance activities perform verification. At Pantex, a Waste Certification Official who is independent from organizations producing, accumulating, transporting, or performing radiological characterizations and/or surveys of weapons components and certain categories of mixed low-level waste destined for burial at the Nevada National Security Site, performs the verification.

The volume of radiological waste generated at Pantex during 2024 is discussed in Chapter 2. As there were no releases of real property containing residual radioactive material during 2024 those values represent the quantities of personal property released from Pantex in 2024.

4.3 RADIATION PROTECTION OF BIOTA

DOE O 458.1 contains no specific limits for radiation doses to aquatic animals, terrestrial plants, and terrestrial animals. However, it requires the use of DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, or equivalent methodologies, to demonstrate that radiological activities are conducted in a manner that protects these populations from adverse effects due to radiation and radioactive material released from DOE operations. This requirement has the effect of limiting the dose to 1 rad/day (10 mGy/day) for aquatic animals and terrestrial plants and to 0.1 rad/day (1 mGy/day) for terrestrial animals (National Council on Radiation Protection and Measurements Report No. 109, International Atomic Energy Agency 1991).

During 2024, there was only sufficient precipitation in addition to discharge from the wastewater treatment facility for the collection of surface water and sediment samples from Playa 1. There was not adequate precipitation for water samples from Playa 3 and 4; however, sediment samples were collected. These samples were analyzed for tritium, U-234, U-235, U-238, and Pu-239/240. To implement the DOE-STD-1153-2019, the radionuclide concentrations obtained were entered into the DOE calculation tool (RAD-

BCG) with the standard and compared to biota concentration guide (BCG) limits for aquatic and terrestrial systems in the technical standard.

Estimated concentrations of the indicated radionuclides in the sediment were obtained by multiplying the measured aqueous concentrations by isotope-specific solid/solution distribution coefficients tabulated for the measured radionuclides in the standard. The value for each radionuclide was automatically divided by the BCG for that radionuclide to calculate a partial fraction for each nuclide for each medium. Partial fractions for each medium were added to produce a sum of fractions.

The dose limit for aquatic animals would not be exceeded if the sum of fractions for the water medium plus that for the sediment medium is less than 1.0. Similarly, the dose limits for both terrestrial plants and animals would not be exceeded if the sum of fractions for the water medium plus that for the soil medium is less than 1.0. The maximum site concentrations for each medium, applicable BCGs, partial fractions, and sums of fractions are listed in Tables 4.4a and 4.4b.

Table 4.4a Evaluation of Dose to Aquatic Biota in 2024

Nuclide	Measured Water Concentration (pCi/L)	BCG[a] (Water) (pCi/L)	Partial Fraction (Water)	Measured Sediment Concentration (pCi/g)	BCG (Sediment) (pCi/g)	Partial Fraction (Sediment)	Sum of Fractions (Water and Sediment)
Tritium	0.000	2.65 E+08	0.00E+00	0.452	3.74.E+05	1.21E-06	1.21E-06
U-234	0.375	2.02E+02	1.86E-03	1.574	5.27.E+03	2.99E-04	2.16E-03
U-235	0.005	2.17E+02	2.10E-05	0.005	3.73.E+03	1.23E-06	2.22E-05
U-238	0.390	2.23E+02	1.75E-03	0.390	2.49.E+03	1.57E-04	1.90E-03
Pu-239	0.000	1.87E+02	0.00E+00	0.016	5.86.E+03	2.74E-06	2.74E-06
Sum of Fractions			**3.63E-03**			**4.61E-04**	**4.09E-03**

[a]Biota Concentration Guides

Table 4.4b Evaluation of Dose to Terrestrial Biota in 2024

Nuclide	Measured Water Concentration (pCi/L)	BCG[a] (Water) (pCi/L)	Partial Fraction (Water)	Measured Sediment Concentration (pCi/g)	BCG (Soil) (pCi/g)	Partial Fraction (Soil)	Sum of Fractions (Water and Soil)
Tritium	0.000	2.31E+08	0.00E+00	0.452	1.71E+05	2.64E-06	2.64E-06
U-234	0.375	4.04E+05	9.27E-07	1.574	5.13E+03	3.07E-04	3.08E-04
U-235	0.005	4.19E+05	1.09E-08	0.005	2.83E+03	2.96E-05	2.96E-05
U-238	0.390	4.06E+05	9.61E-07	0.390	1.58E+03	2.47E-04	2.48E-04
Pu-239	0.000	2.00E+05	0.00E+00	0.016	6.11E+03	2.62E-06	2.62E-06
Sum of Fractions			**1.90E-06**			**5.89E-04**	**5.91E-04**

[a]Biota Concentration Guides

As the sum of fractions for the aquatic system and the terrestrial system are 4.09E-03 and 5.91E-04 respectively, applicable BCGs were met for both evaluations. Therefore, it can be concluded that populations of aquatic and terrestrial biota on and near Pantex are not being exposed to doses in excess of the existing DOE dose limits.

4.4 UNPLANNED RELEASES

No unplanned releases of radioactive material occurred at Pantex during 2024.

4.5 ENVIRONMENTAL RADIOLOGICAL MONITORING

With the exception of the environmental dosimetry program discussed in this chapter, media-specific descriptions, as well as the results of any radiological surveillance monitoring for samples collected during 2024, are contained in Chapters 5-11 of this report.

4.5.1 Environmental Dosimetry

The environmental dosimetry program uses TLDs to measure gamma radiation on and around Pantex. This program has been conducted at several locations in parallel with monitoring conducted by the TDSHS since the early 1980s. The TDSHS uses optically stimulated luminescence dosimeter devices similar in function to the TLDs used by Pantex. Figure 4.1 shows the locations of Pantex and the TDSHS dosimeters during 2024. Additionally, dosimeters are placed each quarter at multiple locations across the industrial portion of Pantex as part of the personnel dosimetry program. These dosimeters provide additional documentation that the dose from current operations is kept ALARA.

Pantex’s TLDs are generally placed at the same locations where Pantex operates air monitors, as discussed further in Chapter 5. Pantex's TLDs are analyzed and replaced at the end of each calendar quarter. This data provides the cumulative radiation exposure received while exposed to the environment over approximately 90 days of uninterrupted deployment at each location. This exposure includes ubiquitous background (i.e., cosmic radiation) as well as that from Pantex operations. The State of Texas has a robust QA/QC program, and historically State of Texas monitoring data has closely aligned with Pantex monitoring data.

Table 4.5 lists results for 2024 and reflects the dose that an individual would have received at the dosimeter location if the person were present continuously for a full quarter. The average quarterly dose for all Pantex on-site locations during 2024 was approximately 41 mrem. For TDSHS on-site locations, the average quarterly dose was approximately 42 mrem.

4.5.2 Future Radiological Monitoring

Media-specific SMEs periodically make revisions to the Pantex Environmental Monitoring Program based on technological advancements, process changes, and potential impacts. The SMEs develop or revise monitoring requirements using a process based upon EPA guidance documents and consider potential releases from current DOE activities at the site. However, the SMEs also consider planned new activities identified in the NEPA process discussed in Chapter 2. Based upon pathway analyses, the SMEs make adjustments to the monitoring program for their individual environmental media.

4.6 CONCLUSIONS

The environmental radiological monitoring program at Pantex continues to document the doses produced by current operations at Pantex are a small fraction of relevant limits set by EPA and DOE. Pantex’s monitoring results for the environmental radiological pathways in 2024 indicated levels below relevant standards, similar to results from previous years, and consistent with background conditions.

Measured and calculated doses to the public, workers, and the environment from Pantex operations are a minute fraction of the 320 mrem dose estimated to be received from naturally occurring sources each year.

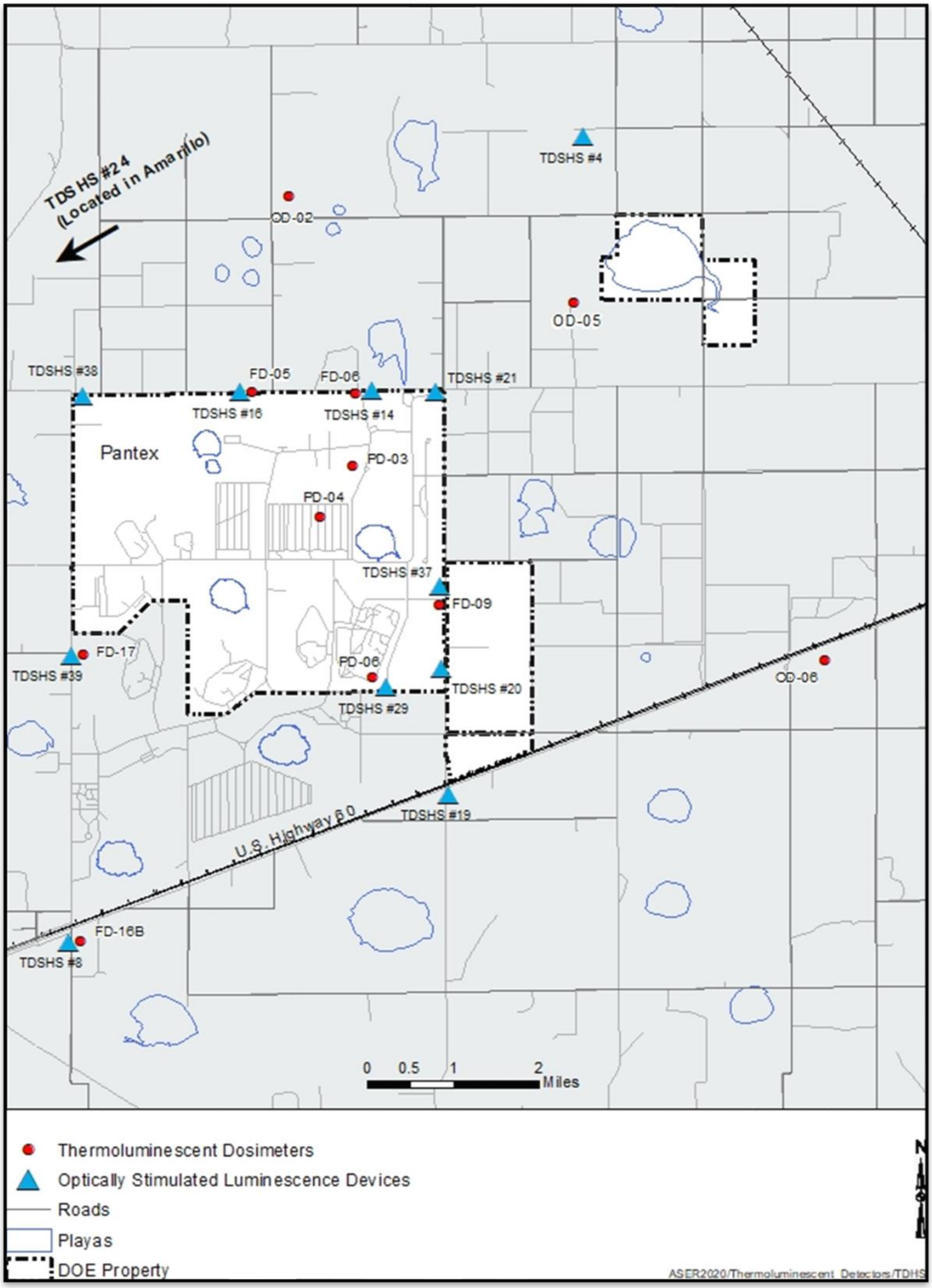


Figure 4.1 Locations of Pantex and TDSHS thermoluminescent dosimeters

Table 4.5 Average Quarterly Dose Measured in Millirem by Environmental Dosimeters

Location	Q1	Q2	Q3	Q4
Locations On or Near Pantex Operations				
On-site				
Pantex (PD-03, 04, & 06)	40	52	30	43
Texas Department of State health Services (TDSHS) (#20)	40	44	39	45
TDSHS (#29)	37	44	41	47
Fence Line				
Pantex (FD-05, 06, & 09)	58	34	42	33
TDSHS (#8, 14, 16, 19, 21, 37, 38, & 39)	39	44	40	53
Off-site				
Pantex (OD-02, 05, & 06)	45	37	30	35
TDSHS (#4)	37	43	40	47
Control Locations				
Pantex (FD-16B & 17)	42	30	31	35
TDSHS (#24)	36	42	38	42

CHAPTER 5 - AIR MONITORING

Some operations at Pantex are sources or potential sources of airborne emissions. Monitoring, sampling, and tracking to detect possible airborne emissions of radiological or hazardous pollutants at Pantex is conducted at on-site and off-site locations as a part of a comprehensive environmental surveillance program. Air monitors at fixed locations operate continually, sampling for radiological material to ensure operations are not having an impact on ambient air quality. Additionally, the TDSHS conducts air monitoring at a location on the northern boundary of Pantex.

Chapter Highlights

- All of the radiological air-monitoring data for 2024 indicated that results were below relevant Derived Concentration Standards (DCS) set by regulatory agencies.
- Data from radiological air monitoring conducted by Pantex indicate that operations are not releasing radiological material that would have detrimental effects on the on- or off-site environments, workers, or the public.

5.1 NON-RADIOLOGICAL AIR MONITORING

Emissions from Pantex operations are strictly limited by Air Quality Permit 84802, various Permits-By-Rule, Air Emission Registrations, State of Texas regulations, and the Clean Air Act. Emissions to the air from operations are tracked, documented, and reported based on the amounts of chemicals used and process knowledge.

5.2 RADIOLOGICAL AIR MONITORING

Current operations at Pantex involve various radioactive materials including tritium (a radioactive isotope of hydrogen), plutonium, uranium, and miscellaneous sources (e.g., thorium, cobalt, and cesium) that may be present in the components of nuclear weapons being managed. Rigorous operational controls, safety standards, and the physical form of the material reduce the potential for release of these radioactive materials to the environment, Pantex personnel, or the public. As mentioned in Chapter 4 (Table 4.1), the majority of radionuclide releases at Pantex are tritium. Very small amounts of tritium escape as gas or vapor during normal operations. Additionally, some tritium is released from the structural materials of a building where an accidental release of tritium occurred in 1989 [as described in the Environmental Information Document (1998)].

During 2024, Pantex operated eleven air-monitoring stations. The location of these monitoring stations is shown in Figures 5.1 and 5.2. Two monitoring stations are operated on-site, designated as PA-AR-XX; seven stations are operated along the boundary fence line, designated as FL-AR-XX; and two stations are operated at off-site locations, designated as OA-AR-XX.

On-site air-monitoring stations are located near operating areas (Figure 5.1). Station PA-AR-04-A is located in an area so that it is able to monitor the ambient air associated with shipping and receiving operations conducted at Pantex, since the predominant wind direction is from the southwest, south, and southeast. Station PA-AR-06-A is located near an operations area where nuclear material may be present.

Fence line monitoring stations are located along the perimeter of Pantex (Figure 5.1). The perimeter is defined as the perimeter that existed prior to the purchase of the property east of FM 2373 in the latter part of 2008. Two stations are located along the northern fence line, two stations are located along the eastern fence line, and two stations are located along the western fence line. An additional station was placed online along the south fence line. Stakeholders were considered in establishing the locations of the stations.

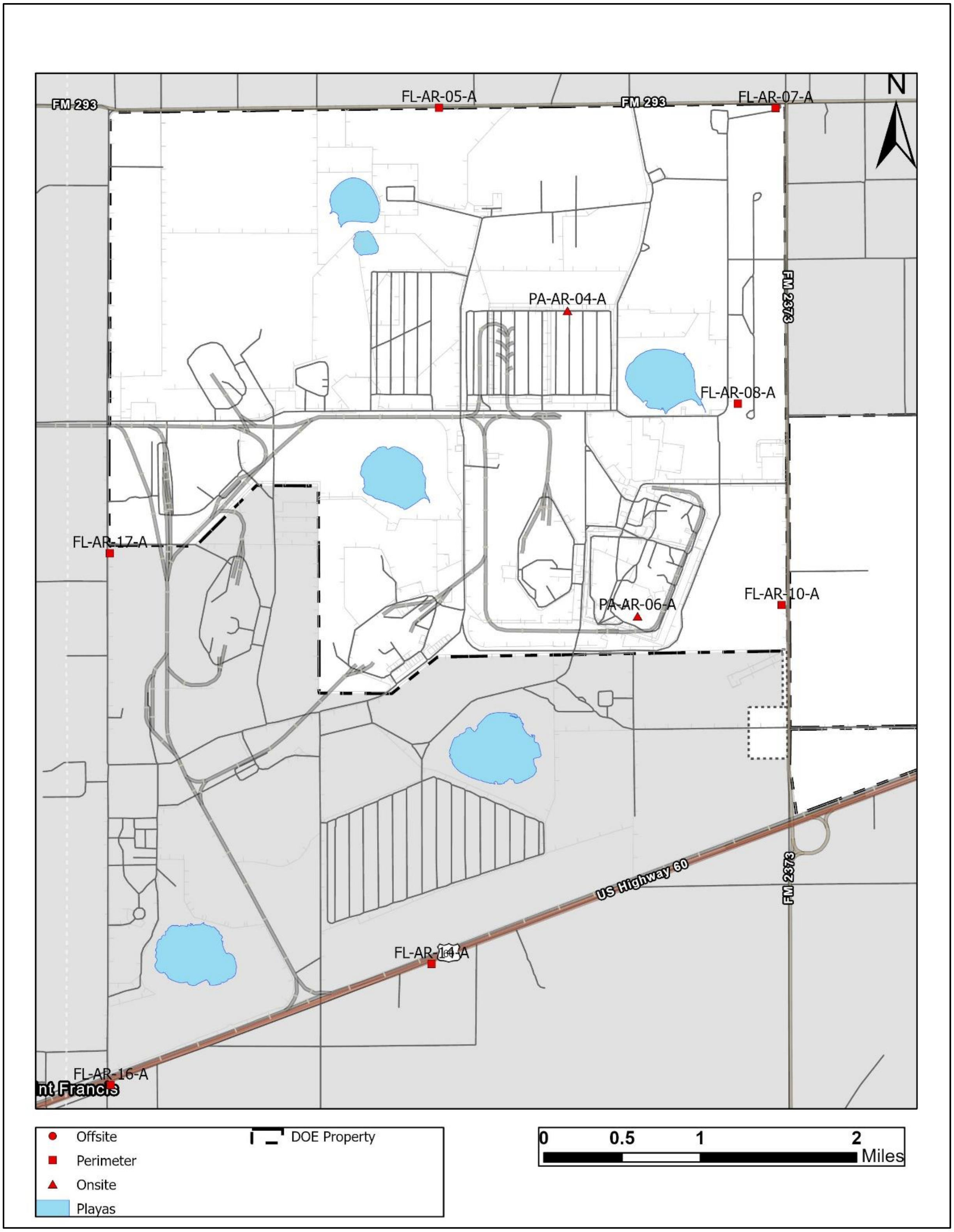


Figure 5.1 Locations of on-site and fence line air-monitoring stations

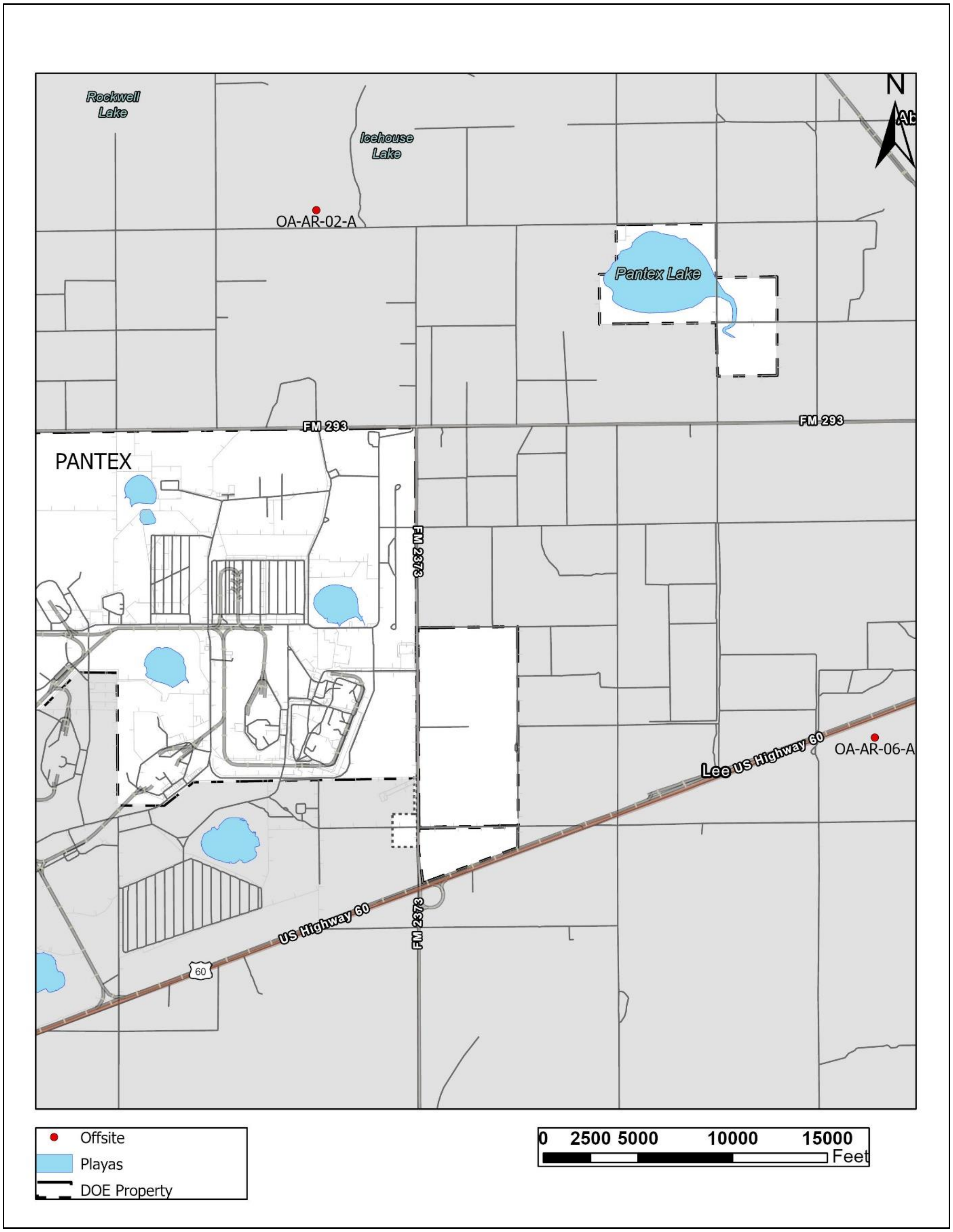


Figure 5.2 Locations of off-site air-monitoring stations

Off-site stations, OA-AR-02-A and OA-AR-06-A, are approximately five miles from the center of Pantex (Figure 5.2). Stations FL-AR-05-A, FL-AR-07-A, FL-AR-08-A, FL-AR-10-A, OA-AR-02-A, and OA-AR-06-A are all located in the predominant downwind direction from Pantex operations (i.e., the direction that radiological material would most likely be expected to travel). Monitoring stations FL-AR-14-A, FL-AR-16-A and FL-AR-17-A are located upwind of Pantex, opposite the predominant wind directions. Station FL-AR-16-A is used as a background location due to its distance from the center of Pantex and being located upwind of Pantex operations.

5.2.1 Collection of Samples

Original Station Configuration

Each air-monitoring station had a high-volume air sampler designed to collect solid particles on a filter and a low-volume air sampler designed to collect water vapor in silica gel. In Figure 5.3, the high-volume sampler is located on the left. These high-volume samplers collect solid particles by pulling air through a filter, much like a vacuum cleaner. The "doghouse" containing the low-volume sampler is on the right in Figure 5.3. Figure 5.4 shows the internal equipment for the low-volume air sampler; the U-shaped tube in the front of the equipment contains silica gel that collects water vapor from the air pulled through the tube. Samplers run continuously unless the equipment malfunctions or electric service is interrupted. Samplers are inspected, and filters or silica gel samples are scheduled to be collected on a weekly basis. Sampling technicians record sample-collection period, beginning and ending flow rates, sample run time, initial and final sample volume weights (for silica gel samples), as well as notes for any anomalies (loss of power, low sample run times, low sample weights, equipment replacement or failure, etc.,) in the associated sample log book.

The high-volume samplers operate at a flow rate of approximately 30 cfm. During a seven-day run period, particles from approximately 302,400 ft^3 of air are collected on 8×10-inch filters. Filters are collected approximately weekly, and all weekly filter samples for a given month are composited into one sample for analysis of U-234, U-238, and Pu-239 by an off-site radiological analysis laboratory.

Figure 5.3 Typical air-monitoring site

Airflow through the low-volume air samplers is 1.5 cfm. The silica gel in the U-shaped tube acts as a desiccant, removing water vapor from air as it flows through the sampler. The silica gel samples are collected at the same time as the individual particle filters from the high-volume samplers. Water vapor present in the sampled air and absorbed in the silica gel is recovered and analyzed for tritium by a radiological analysis laboratory.

Figure 5.4 Low-volume sampling apparatus

New Station Configuration

Due to the increasing age of the existing stations and increasing lack of availability of spare parts, the decision was made to reevaluate the station design. After extensive research and testing, a new design that is more aligned with how other DOE sites are performing this type of monitoring was purchased and implemented in March of 2024. Testing was performed for several months and the data of the test station was compared to two nearby stations to confirm accuracy of the data that was being obtained. The test data was in the same order of magnitude as the nearby stations with only minor variations which would be expected from varying locations.

Each new air monitoring station replaced the separate high-volume particulate samplers and low-volume air sampler with a unit designed to obtain dual samples using a single low-volume unit (see Figure 5.5). This new system uses a single pump motor to obtain samples from two separate media sampling ports that each have an independent flow rate adjustment.

The particulate monitoring sampler head uses 47mm glass fiber filters to collect particulate over a two-week monitoring period. The flow rate is set to approximately two cfm. Particles from a total of approximately 40,320 ft^3 of air are collected each sampling period, and filters over a one-month period are composited into one sample for analysis of U-234, U-238, and Pu-239 by an off-site radiological analysis laboratory.

Airflow through the second air sampling port is 350 ccm. The custom fabricated U-shaped silica gel tube was replaced with commercially available lab gas drying/purification tubes, which provide a much more readily available replacement and reduces the amount of leakage. The silica gel acts as a desiccant, removing water vapor from air as it flows through the sampler. Color-changing indicator silica gel is mixed with the normal silica gel to provide a visual determination of when the column is approaching saturation. The silica gel samples are collected at the same time as the individual particle filters. Water vapor present in the sampled air and absorbed in the silica gel is recovered and analyzed for tritium by a radiological analysis laboratory.

Figure 5.5 New station configuration

There are many advantages to the new configuration over the previous design. The new silica gel columns provide better resilience to temperature and humidity fluctuations, allowing for a more consistent collection of ambient moisture at each station. The lower flow rate ensures that the maximum amount of moisture is able to be collected from the air as it passes through the column and the slightly larger volume allows for the collection period to be expanded to two weeks, reducing overall costs and time associated with collecting and analyzing samples. Moving from the larger, separate high-volume particulate system to the smaller combined system has several advantages as well. The high-volume samplers that were in place are designed for facilities that are known to emit large quantities of radiation regularly to the atmosphere or during emergency situations where it is necessary to collect an adequate sample quickly to inform emergency response. The new system with lower flow rates still collects an adequate amount of sample but allows the sampling period between each composite sample to be increased to two weeks, without causing excessive loading on the filters. This reduces costs associated with collecting and analyzing samples. Additionally, there is a significant power savings due to the elimination of these higher volume samplers. The high-volume sampler enclosures were left in place at each station and the sampling equipment is kept in storage. In the unlikely circumstance of an emergency occurring, these samplers can be rapidly redeployed to assist with emergency response.

5.2.2 Sample Analysis Results

All analytical results obtained from the laboratory were converted to concentrations in air by dividing the quantity of radionuclides collected in the sample by the volume of air sampled. This quantity was calculated using the operational characteristics recorded. Table 5.1 summarizes the concentration values for tritium, U-234, U-238, and Pu-239 measured in samples collected from on-site, off-site, downwind, and upwind (control) monitoring stations. The values indicated are the mean plus-minus the standard deviation, the maximum value plus-minus its associated counting error, and the historical background concentration measured at a control location near Bushland, Texas during 2013, 2014, and 2015. This historical background value is the upper confidence limit for a population consisting of all data for the specified radionuclide from the control location during the period from 2013-2015.

Additionally, the mean and maximum concentrations are compared to the DCS. DCS values represent the concentration of a given radionuclide in either water or air that results in a member of the public receiving 100 millirem (mrem) effective dose following continuous exposure for one year for either the ingestion of water, submersion in air, or air inhalation pathways. The DCS value for each radionuclide is referenced from DOE-STD-1196-2022, *DOE Derived Concentration Technical Standard.* These comparison standard values are derived in accordance with dose limitation systems recommended by the International Commission on Radiological Protection in its several publications (International Atomic Energy Agency 1992) and used by the EPA, the Nuclear Regulatory Commission, and other regulatory agencies including DOE in establishing standards for radiological protection. These regulatory comparison standards are purposely set at levels well below those known to cause any adverse effects on the public and/or the environment.

Table 5.1 Concentrations of Radionuclides in Air for 2024 at On-site, Off-site, Downwind, and Upwind Locations

Radionuclide	Number of Samples Analyzed (Planned)	Mean[c] ±Std. Dev	Max ± Counting Error	Historical Background, at Control Location	DCS, Regulatory Comparison Value
On-site Locations, PA-AR-04-A and PA-AR-06-A					
Tritium[a]	56 (60)	0.56 ± 2.45	12.5 ± 7.14	1.32	130,000
U-234[b]	26 (26)	1.10 ± 0.69	3.16 ± 1.62	30.40	160,000
U-238[b]	26 (26)	1.25 ± 0.76	3.07 ± 1.48	28.96	180,000
Pu-239[b]	26 (26)	0.05 ± 0.16	0.32 ± 0.26	0.93	120,000
Off-site Locations, OA-AR-02-A and OA-AR-06-A					
Tritium[a]	58 (60)	-0.14 ± 1.56	4.02 ± 6.44	1.32	130,000
U-234[b]	26 (26)	1.38 ± 0.87	4.22 ± 1.74	30.40	160,000
U-238[b]	26 (26)	1.21 ± 0.74	2.93 ± 1.43	28.96	180,000
Pu-239[b]	26 (26)	-0.03 ± 0.22	0.23 ± 0.41	0.93	120,000
Downwind Locations, FL-AR-05-A, FL-AR-07-A, FL-AR-08-A, and FL-AR-10-A					
Tritium[a]	113 (120)	0.16 ± 1.49	7.74 ± 6.88	1.32	130,000
U-234[b]	51 (52)	1.25 ± 0.79	3.46 ± 1.64	30.40	160,000
U-238[b]	51 (52)	1.28 ± 0.75	2.97 ± 1.29	28.96	180,000
Pu-239[b]	51 (52)	0.08 ± 0.22	0.63 ± 1.24	0.93	120,000
Upwind Locations, FL-AR-14-A, FL-AR-16-A and FL-AR-17-A					
Tritium[a]	80 (90)	0.20 ± 1.99	15.98 ± 9.01	1.32	130,000
U-234[b]	37 (39)	1.40 ± 0.79	3.71 ± 1.82	30.40	160,000
U-238[b]	37 (39)	1.37 ± 0.81	3.34 ± 1.47	28.96	180,000
Pu-239[b]	37 (39)	0.02 ± 0.14	0.45 ± 0.99	0.93	120,000

[a] Units in all tables are × 10^{-18} µCi/mL (or yCi/mL) for tritium.
[b] Units in all tables are × 10^{-18} µCi/ft^3 (or yCi/ ft^3) for α-emitting radionuclides (U-233/234, U-238, and Pu-239/240)
[c] Negative values indicate that the average result of the analysis was below detectable levels

During 2024, air sampling equipment ran continuously collecting greater than 93% of the samples planned for all locations. Broken sample containers, intermittent power losses, or motor failures caused a few of high-volume and low-volume samples to be missed or resulted in non-representative sampling volumes.

5.2.3 Data Interpretation

During 2024, the maximum measurements for the U-234, U-238, and Pu-239 occurred at varying times of the year. The relative maxima were observed to be occurring both upwind and downwind of Pantex and are at such low levels as to be barely distinguishable. This indicates that many of the maximum measurements represent the collection of increased quantities of naturally occurring radioactive material in local soil during these periods.

Statistical comparisons of the 2024 U-234 and U-238 sample data for the location categories (on-site, upwind, and downwind) indicate that all results are of the same magnitude, thus indicating that areas potentially affected by Pantex operations are not distinguishable from background. The analysis laboratory indicated that less than 4% of the Pu-239 measurements were above the minimum detection activity (MDA). However, the concentrations were so close to the MDA that when the counting error is subtracted from these results, all samples would fall below the MDA. Average concentrations for all three alpha-emitting radionuclides are a minute fraction of levels that would cause a 100-mrem effective dose.

The ratio of the activities of U-234 and U-238 indicates radiological equilibrium between both radionuclides and suggests the absence of uranium discharges during Pantex operations. The ratio of measured values of Pu-239 to its DCS are indistinguishable from zero; thus, emissions of this isotope to ambient air are not indicated.

Variations in mission activities over the last several years may have resulted in various rates of emission of tritium and resulted in the apparent variations in measured concentrations of tritium during the period from 2018 through 2024. No tritium concentration in ambient air during 2024 (or any of the indicated years) exceeded the DCS. No measured concentration of tritium, uranium, or plutonium in ambient air exceeded the applicable DCS, or even 0.1% of this comparison value despite revised DCS values issued in 2022.

5.3 CONCLUSIONS

Data from radiological air monitoring conducted by Pantex continue to indicate that operations at Pantex are not releasing radiological material that would have detrimental effects on the on-site or off-site environments.

CHAPTER 6 - GROUNDWATER MONITORING

Groundwater monitoring at Pantex began in 1975 when the first investigative wells were installed. Pantex investigations resulted in the identification of contaminant plumes in the perched groundwater beneath Pantex and TTU property. Monitoring wells in the perched groundwater are being used to monitor two remedial actions: two pump-and-treat systems, with 70 operating extraction wells and four injection wells, and five active ISB systems consisting of 230 active treatment zone wells that are injected as needed. Pantex also monitors 29 wells in the deeper drinking water aquifer (Ogallala Aquifer) to verify the remedial actions remain protective of this resource.

Chapter Highlights

- Groundwater data collected in 2024 demonstrated that current remedial actions continue to progress toward cleanup of perched groundwater contaminants and that drinking water resources are safe. Four deeper wells in the drinking water aquifer were found to have HE constituents above the cleanup standards established for the Pantex Remedial Action. The wells are located away from drinking water sources, and other monitor wells indicate there is no concern for nearby drinking water resources or irrigation use in the area. Pantex is planning to install more wells in 2025 to investigate the extent of the plume.
- All major contaminants of concerns [trichloroethylene (TCE), hexavalent chromium, perchlorate, and the explosive RDX] have declining trends for areas under the influence of an active remedial action in perched groundwater.

6.1 GROUNDWATER AT PANTEX

Groundwater beneath Pantex and vicinity occurs in the Ogallala and Dockum Formations at two intervals (Figure 6.1). The first water-bearing unit below Pantex in the Ogallala Formation is a discontinuous zone of perched groundwater located at approximately 200 to 300 ft below ground surface and 100 to 200 ft above the drinking water aquifer. A zone of fine-grained sediment (consisting of sand, silt, and clay) that created the perched groundwater is found between the perched groundwater and the underlying drinking water aquifer. The fine-grained zone (FGZ) acts as a significant barrier to downward migration of contaminated water. The perched groundwater ranges in saturated thickness from less than a foot at the margins to more than 75 ft beneath Playa 1. Perched groundwater forms by surface water in the playa lakes that initially migrates down to the FGZ. It then flows outward in a radial manner away from the playas and becomes influenced by the regional south-to-southeast gradient. The largest area of perched groundwater beneath Pantex is associated with natural recharge from Playas 1, 2, and 4, treated wastewater discharge to Playa 1, historical releases to the ditches draining Zones 11 and 12, and stormwater runoff that drains to the unlined ditches and playas. Two hydraulically separate, relatively small, perched zones occur around Playa 3 (near the Burning Ground in the north central portion of Pantex) and near the old sewage treatment plant in the northeast corner of Pantex.

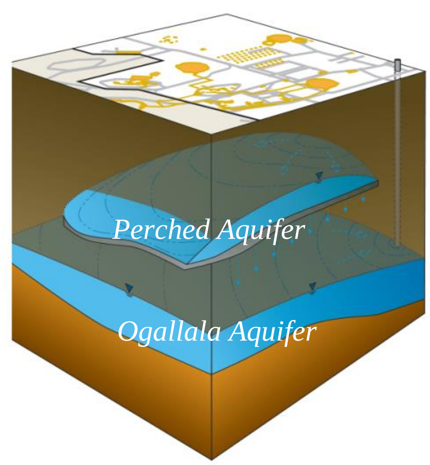


Figure 6.1 Groundwater beneath Pantex

The Ogallala Aquifer is the second water-bearing zone and is located below the FGZ in the Ogallala and Dockum Formations. The Ogallala Aquifer is a primary drinking and irrigation water source for most of the High Plains. The surface of groundwater in the Ogallala Aquifer beneath Pantex is approximately 400 to

500 ft below ground surface with a saturated thickness of approximately one to 100 ft in the southern regions of Pantex and approximately 250 to 400 ft in the northern regions. At Pantex, the primary flow direction of the Ogallala Aquifer is north to northeast due to the influence of the City of Amarillo's well field located to the north of Pantex and nearby irrigation wells.

Historical operations at Pantex resulted in contamination of much of the underlying perched groundwater. The contaminant plume has migrated past Pantex boundaries and beneath the adjacent property to the south and east. Most of the property to the east was purchased in 2008 to allow better access for monitoring, remediation and control of perched groundwater. The primary COCs in the perched aquifer are the explosives RDX and related breakdown products, perchlorate, hexavalent chromium, and TCE (Figure 6.2).

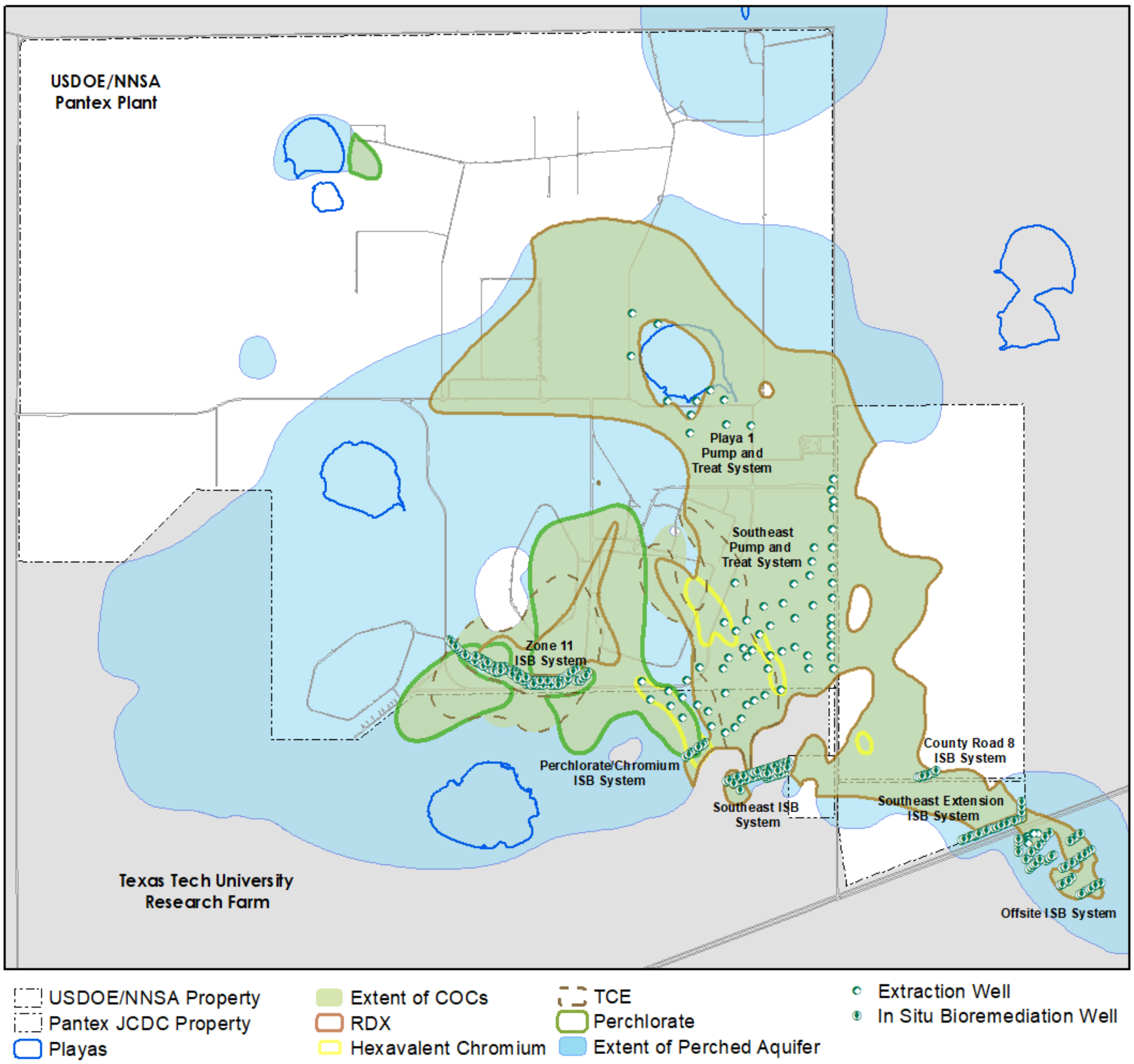


Figure 6.2 Major perched groundwater plumes and remediation systems

With the exception of one domestic well north of Pantex, no public or private water supply wells are completed in the perched groundwater in the immediate vicinity of Pantex. That domestic well is in an area that has not been impacted by historic operations.

Perched groundwater is not used for industrial purposes at Pantex; however, the treated perched groundwater is routed through the WWTF and is beneficially used for subsurface or surface irrigation of crops. Because concentrations of contaminants in the perched groundwater beneath Pantex's property and off-site to the south and east currently exceed drinking water standards, the water is not safe for domestic or industrial use. Pantex restricts on-site use of perched groundwater. TTU and three off-site property owners to the east have placed deed restrictions on their properties to control use of perched groundwater and restrict drilling through the perched groundwater in areas that are impacted. Due to the expansion of the plumes to the southeast, Pantex worked with landowners in 2022 to place two additional deed restrictions on use of groundwater beneath the property while remediation continues at those locations.

6.2 LONG-TERM MONITORING NETWORK

The purpose of the LTM network is to ensure that remedial action objectives (RAOs) are being achieved. The RAOs and the corresponding LTM Network Monitoring Objectives are provided in Table 6.1.

Table 6.1 Summary of Objectives

Remedial Action Objectives	Long Term Monitoring Network Monitoring Objectives
• Reduce risk of exposure to perched groundwater through contact prevention • Achieve cleanup standard for perched Contaminants of Concern • Prevent growth of perched groundwater contaminant plumes • Prevent Contaminants of Concern from exceeding cleanup standards in the drinking water aquifer	• Remedial–action–effectiveness • Plume stability • Uncertainty management • Early detection

To ensure the achievement of the RAOs, wells and monitoring information was chosen with respect to specific objectives developed for the LTM network. The objectives are applied to perched and drinking water aquifer monitoring wells, as appropriate.

Pantex developed AL-PX-SW-8419 (2019), *Long-Term Monitoring System Design Report* and AL-PX-SW-8418 (2019), *Sampling and Analysis Plan* to detail the LTM network and monitoring. The network monitoring information is evaluated quarterly, annually, and on a five-year basis.

6.3 THE SCOPE OF THE GROUNDWATER MONITORING PROGRAM

Groundwater is monitored at Pantex in accordance with requirements of the Pantex Hazardous Waste Permit/Compliance Plan No. HW-50284. Pantex is also subject to requirements in the IAG, signed jointly by the EPA and TCEQ, and issued effective in 2008. The *Long-Term Monitoring System Design Report* and a new SAP, approved by the EPA and TCEQ in July 2009, identified the final monitoring well network and the parameters to be monitored.

An update to the *Long-Term Monitoring System Design Report* and revised SAP were submitted in 2019 and approved by the TCEQ and EPA in early 2020. Table 6.2 summarizes the number of wells sampled in 2024 that were used in the monitoring of the remedial actions and the total number of analytes assessed. Appendix C provides the list of analytes that were sampled in the monitoring wells during 2024.

Table 6.2 Summary of Well Monitoring in 2024

Well Type	Drinking Water Aquifer		Perched Groundwater	
	# Wells	# Analytes Assessed	# Wells	# Analytes Assessed
Long-Term Monitoring Well	29	1,865	113	6,965
Other wells	3	117	--	--
Pump & Treat Extraction Well	--	--	61	1,917
ISB Treatment Zone Monitoring Wells	--	--	38	1,450
Total	32	1,982	212	10,332

In 2023, Pantex began evaluating perched groundwater for a new emerging group of contaminants (per- and polyfluoroalkyl substances [PFAS]). PFAS are of potential concern at Pantex due to the past use of firefighting foams and PFAS compounds in HE binders. Pantex began evaluating PFAS in the areas of the pump-and-treat systems. Pantex has discovered the presence of PFAS in the area of the pump-and-treat systems and has verified that our treatment processes remove PFAS to meet Texas Risk Reduction Program protective concentration levels. During 2024, Pantex collected samples from 72 wells and assessed 3,920 analytes for the presence of PFAS. Pantex also collected data at the pump-and-treat systems to verify treatment. The data were collected to help prepare a work plan for investigation of PFAS. The planned completion date of the investigation is 2026. Pantex is expanding evaluation of the perched groundwater for CY 2025 to gather more information. A full investigation of PFAS will occur as funding becomes available. Until that time, Pantex will continue to treat PFAS in groundwater in order to mitigate contaminant movement to off-site locations and to protect the drinking water aquifer.

6.4 REMEDIAL ACTION EFFECTIVENESS AND PLUME STABILITY

The purpose of the remedial action evaluation is to determine the effectiveness of remedial measures, indicate when RAOs for perched groundwater have been achieved, and validate groundwater modeling results or provide data that can be used to refine modeling. The expected conditions for the remedial–action–effectiveness wells are that indicators of the reduction in volume, toxicity, and mobility of constituents will be observed over time as remedial actions continue. These indicators include stable or decreasing concentrations of constituents, or declining water levels in areas where pump-and-treat remedies have been implemented.

The purpose of plume stability wells is to determine if impacted areas (plumes) of perched groundwater are expanding and affecting uncontaminated perched groundwater and to monitor the changes occurring within the perched groundwater plumes. The expected conditions for the plume stability wells are that, over time, a reduction in the toxicity and mobility of constituents will be observed.

6.4.1 Pump-and-Treat Systems

The two pump-and-treat systems (depicted in Figure 6.2) are designed to remove and treat perched groundwater, provide hydraulic control of plume movement away from Pantex, and reduce saturated thickness in the perched groundwater to lessen the potential for impacted perched groundwater to migrate to the drinking water aquifer below. The systems were designed to remove and treat perched groundwater and beneficially use the treated water. The SEPTS has the capability to inject the treated water back into the perched aquifer when beneficial use is not possible. Operational priorities for the pump-and-treat systems emphasize beneficial use of water. Pantex has focused on beneficial use of the treated water, to the extent possible, since the subsurface irrigation system operation began in May 2005 and ISB systems were brought online beginning in 2008.

The P1PTS 2024 annual average operational rate was approximately 45%. This system was heavily affected by ongoing construction of repairs at the WWTF, which prevented use of the subsurface irrigation system; limited operation of the pivot irrigation system because of a break at the wet well; freezing temperatures; harvest operations; and prioritization of operating SEPTS. The SEPTS annual average operation in 2024 was 95%.

Performance of the systems has been affected by a failure of the on-site subsurface irrigation system. Final repairs to the subsurface irrigation system were completed in March 2022, but Pantex continues to discharge WWTF wastewater to Playa 1 due to limited capacity of the wastewater ponds that are undergoing repair. The flow to Playa 1 is restricted by permit, so flow from the systems must also be restricted when the irrigation system is not fully operational. In August 2023, Pantex finished installing an irrigation alternative on the property east of FM 2373 to provide additional long-term beneficial use of the treatment system water. However, use of this system was limited in early 2024 because of a break at the wet well and freezing temperatures.

The SEPTS system was operated at a higher capacity using supply of ISB systems, injection into perched groundwater, release to Playa 1, and periodic shutdowns of the P1PTS to allow full operation of the system. The SEPTS operation's focus was on removing water in high-priority locations that help control migration of the plume to the southeast. Water levels are continuing to decline in the areas downgradient of the pump-and-treat systems, with declines exceeding one foot per year in several wells as depicted in Figure 6.3.

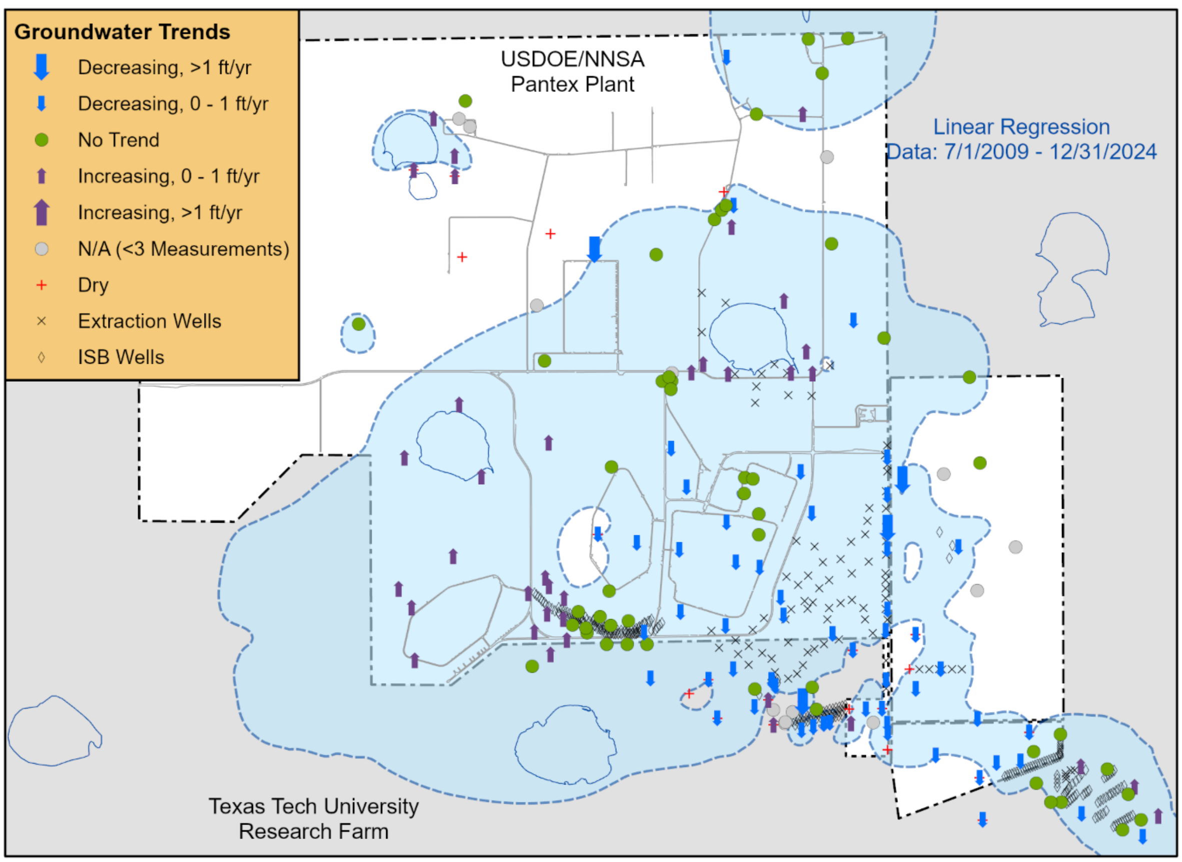


Figure 6.3 Water-level trends in the Perched Aquifer

RDX concentration trends since the start of remedial action in July 2009, depicted in Figure 6.4, generally indicate that RDX is below Groundwater Protection Standards (GWPS), decreasing, or does not demonstrate a trend at all monitoring points near source areas in Zone 12 and near the ditch along the eastern side of Zone 12. Some wells near Playa 1 are exhibiting increasing trends because of reduced system operations at the P1PTS, which have dramatically affected water levels and gradients in this region of perched groundwater. The SEPTS has affected the plume as the majority of COC concentrations are declining or not demonstrating a trend along the outer margins of the system. The off-site remediation system has affected many areas of the plume, with most wells demonstrating concentrations below GWPS. Wells upgradient of the Zone 11 ISB treatment zone are indicating a long-term increasing trend, but recent data have demonstrated a decreasing trend. PTX06-1153 is the only well downgradient of the Southeast ISB System that is not indicating effective treatment. A recommendation to inject the well was included in the Third Five-Year Review and Pantex is preparing for injection of that well after it is removed from the Pantex Hazardous Waste Permit/Compliance Plan No. HW-50284.

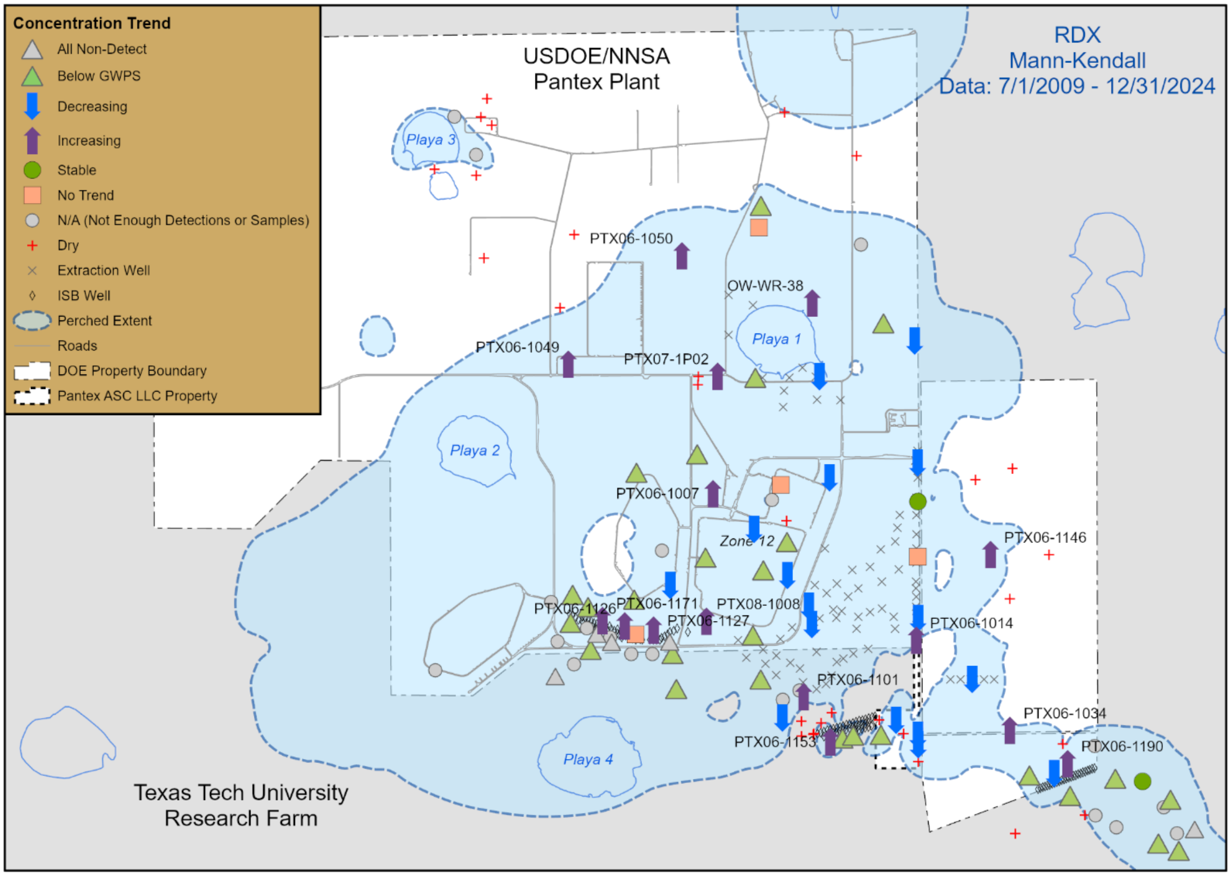
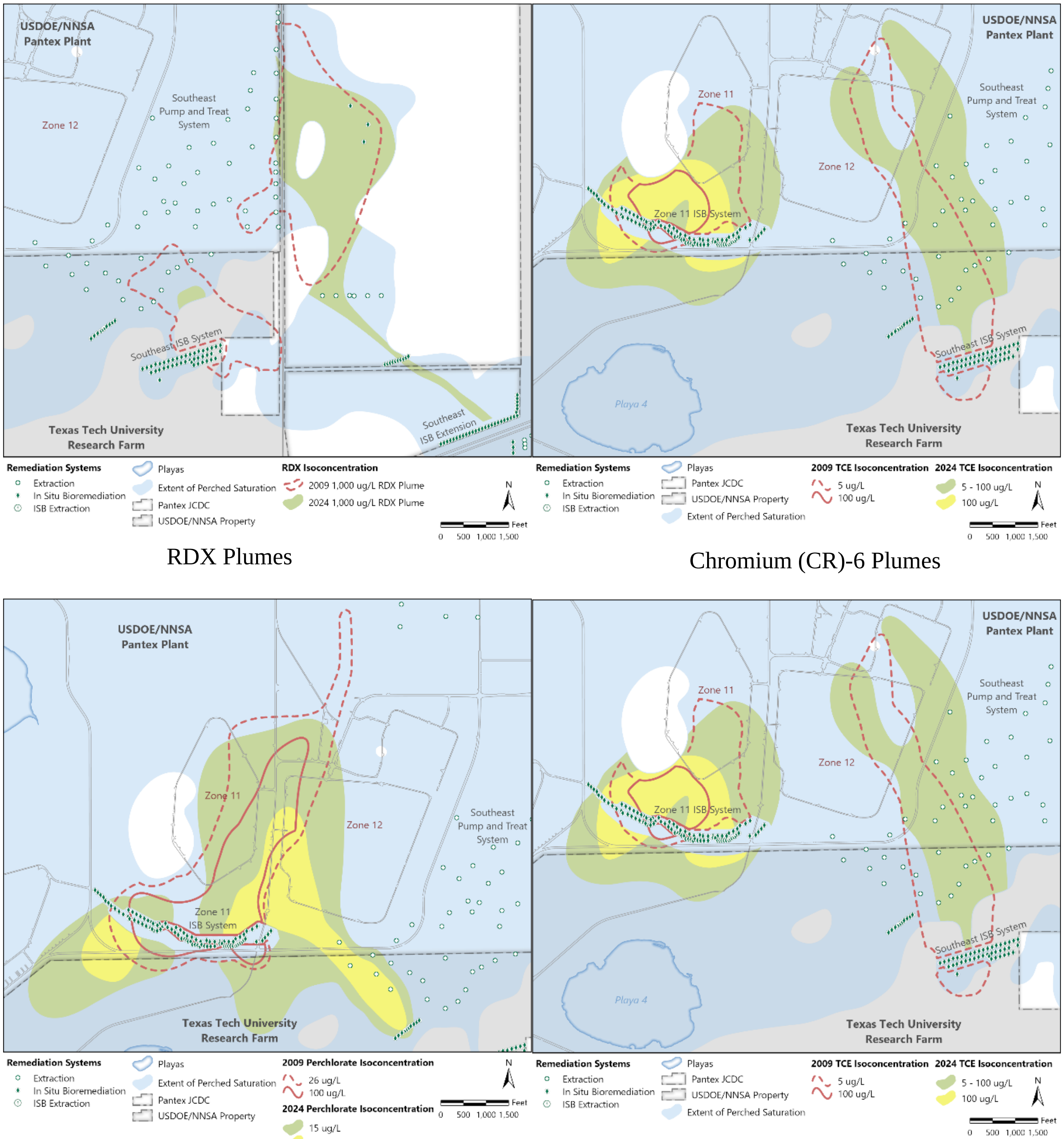


Figure 6.4 RDX concentration trends in the Perched Aquifer

Concentration trends for the remaining major COCs (perchlorate, TCE, and hexavalent chromium) are discussed in the *2024 Annual Progress Report*. Figure 6.5 shows plume movement of major COCs in perched groundwater for the time period of 2009 to 2024. Figure 6.6 shows the annual maximum concentration trends of the major COCs observed in the perched aquifer since 2009.

RDX and hexavalent chromium have demonstrated significant decreases over time, while perchlorate and TCE do not show significant decreases; however, they are trending downward. This indicates that sources are declining and where the plume is under the influence of a remediation system, the concentrations have dropped significantly. There is one well, PTX06-1146, located in the northeast area of the property east of FM 2373, at which the maximum concentration of RDX increased over the past two years. This well's maximum RDX concentration is known to fluctuate, and Pantex is currently installing the Northeast ISB system in that area to address the remediation of RDX. RDX concentrations are expected to decrease once injections at the Northeast ISB occur. Areas outside the influence of the remedial action systems are also monitored for HEs and TCE breakdown products to gather data regarding natural attenuation.



RDX Plumes

Chromium (CR)-6 Plumes

Perchlorate Plume

TCE Plume

Figure 6.5 2009 - 2024 Plume movement – perchlorate, hexavalent chromium, RDX, and TCE in the Perched Aquifer

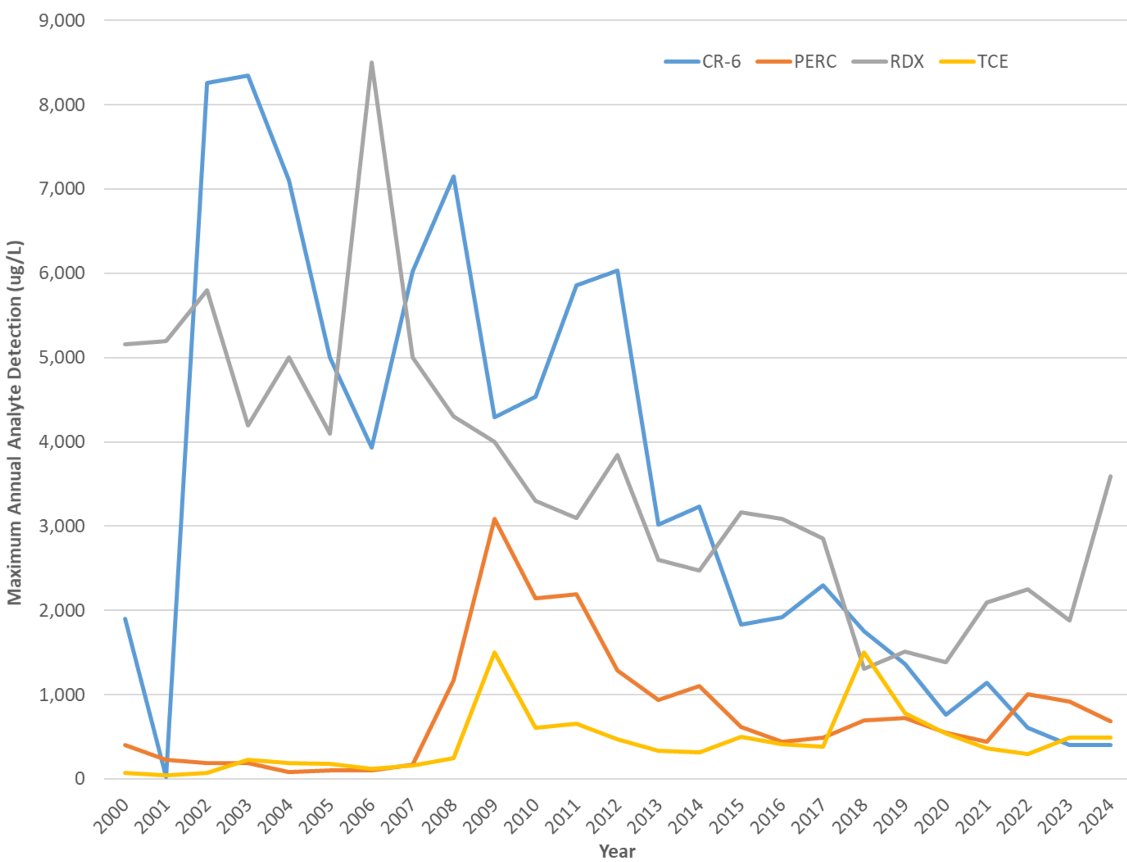


Figure 6.6 Annual maximum concentration trends in the Perched Aquifer

6.4.2 In-Situ Bioremediation Systems

The ISB systems (depicted in Figure 6.2) treat the impacted groundwater as it moves through the bioremediation zone with the goal of reducing concentrations below the GWPS established in the CERCLA ROD and provisions of Pantex Hazardous Waste Permit/Compliance Plan No. HW-50284. Creation of a bioremediation zone is achieved by injecting amendment and nutrients to stimulate resident bacteria. With complete reduction, the resident bacteria will reduce the COCs to less harmful substances.

Five ISB systems (Zone 11 ISB, Southeast ISB, Southeast ISB Extension, Offsite ISB, and the new Perchlorate/Chromium ISB) are installed at Pantex. Overall, the older Zone 11 and Southeast ISB have been effective in treating the primary COCs: RDX, hexavalent chromium, TCE, and perchlorate. Pantex continues to evaluate areas of the ISBs where an issue has been identified with treatment and has made adjustment to the treatment as needed based on the results of evaluation.

Monitoring of conditions within the treatment zone indicates that a reducing zone has been established at all ISB systems. Downgradient monitoring at the Southeast ISB demonstrates that the system has been effective at reducing concentrations of RDX and hexavalent chromium to levels below the GWPS across most of the treatment zone. Pantex will continue to monitor wells in the area to determine groundwater flow patterns, mass flux, and treatment conditions in the western side of the treatment zone where RDX concentrations persist above the GWPS. Pantex plans to inject one downgradient monitor well to effectively impact the area that is not demonstrating complete treatment. Water levels in the area of the Southeast ISB are declining as the pump-and-treat systems continue to remove water causing persistent low-water levels or dry conditions across the system. As a result, future need for injections at the Southeast ISB may be reduced or eliminated.

Evaluation of data collected downgradient of the Zone 11 ISB treatment zone indicates that a very mild to strong reducing zone has been established and maintained over time with conditions favorable for reduction of perchlorate and reductive dechlorination of TCE. Overall, perchlorate concentrations have been reduced to concentrations below the GWPS, and TCE concentrations in downgradient wells are either below GWPS or concentrations continue to trend downward.

The Southeast ISB Extension was installed at the southeast Pantex property boundary in 2017 as an extension for remediation for the southeast perched groundwater. This system was designed to arrest off-site movement of the HE plumes once the off-site system has completed treatment. Injections for this system began in 2019. Wells sampled within the treatment zone indicate that HEs are treated below the GWPS. The downgradient monitoring wells concentrations are near or below the GWPS for RDX.

The Offsite ISB was installed southeast of Pantex property boundary to address HE plumes that have moved off-site. This system is designed to completely arrest further movement of the plume downgradient and to achieve cleanup of the entire HE plume. Pantex began installation of the system in 2020 to stabilize the leading edge of the plume and begin treatment at the core of the plume. The system was expanded yearly, with the system completed in 2023. Wells have been injected each year after installation according to a schedule developed during design of the system. Portions of the system indicate that treatment conditions are establishing. As new wells are injected, the treatment zone will expand and the system is projected to completely treat all HE constituents that have moved off-site. The system will be injected every six months according to the optimized schedule. The downgradient monitoring well at this system continues to indicate that the HE concentrations remain below GWPS, indicating the system is arresting downgradient movement of the plumes.

Pantex has installed a new PCR ISB near the leading edge of the southeast perchlorate and hexavalent chromium plume to limit further migration of the southeastern plumes of chromium and perchlorate. Pantex fully injected the new PCR ISB system during fourth quarter 2024, but that system has not yet been fully sampled. Sampling for that system will be completed during 2025.

6.5 UNCERTAINTY MANAGEMENT AND EARLY DETECTION

The purpose of uncertainty management wells in perched groundwater is to confirm expected conditions identified in the RCRA Facility Investigations and ensure there are not any deviations, fill potential data gaps, and fulfill LTM requirements for soil units evaluated in the baseline risk assessment. The purpose of early detection wells is to identify breakthrough of constituents to the drinking water aquifer from overlying perched groundwater, if present, or from potential source areas in the unsaturated zone, before potential points of exposure have been impacted. Because the evaluation of uncertainty management and early detection well types are similar, they are evaluated together for unexpected conditions.

Figure 6.7 depicts the perched and Ogallala Aquifer wells used in this evaluation for 2024. Pantex monitors for the most widespread and leachable contaminants at the uncertainty management and early detection wells. The list of analytes sampled for these wells are included in Appendix C and consist of all HEs found in perched groundwater, degradation products of RDX, perchloroethylene (PCE), and TCE, as well as chloroform and boron. The data for each well in each aquifer were evaluated for unexpected conditions. Discussions of unexpected conditions are provided in the following sections.

6.5.1 Perched Groundwater Uncertainty Management and Unexpected Conditions

In perched groundwater, statistical trend analysis demonstrated source areas are below GWPS, stable or declining as expected in wells monitored for uncertainty management in 2024. Other wells downgradient of source sites show plume movement from previous source areas but no new sources have been detected.

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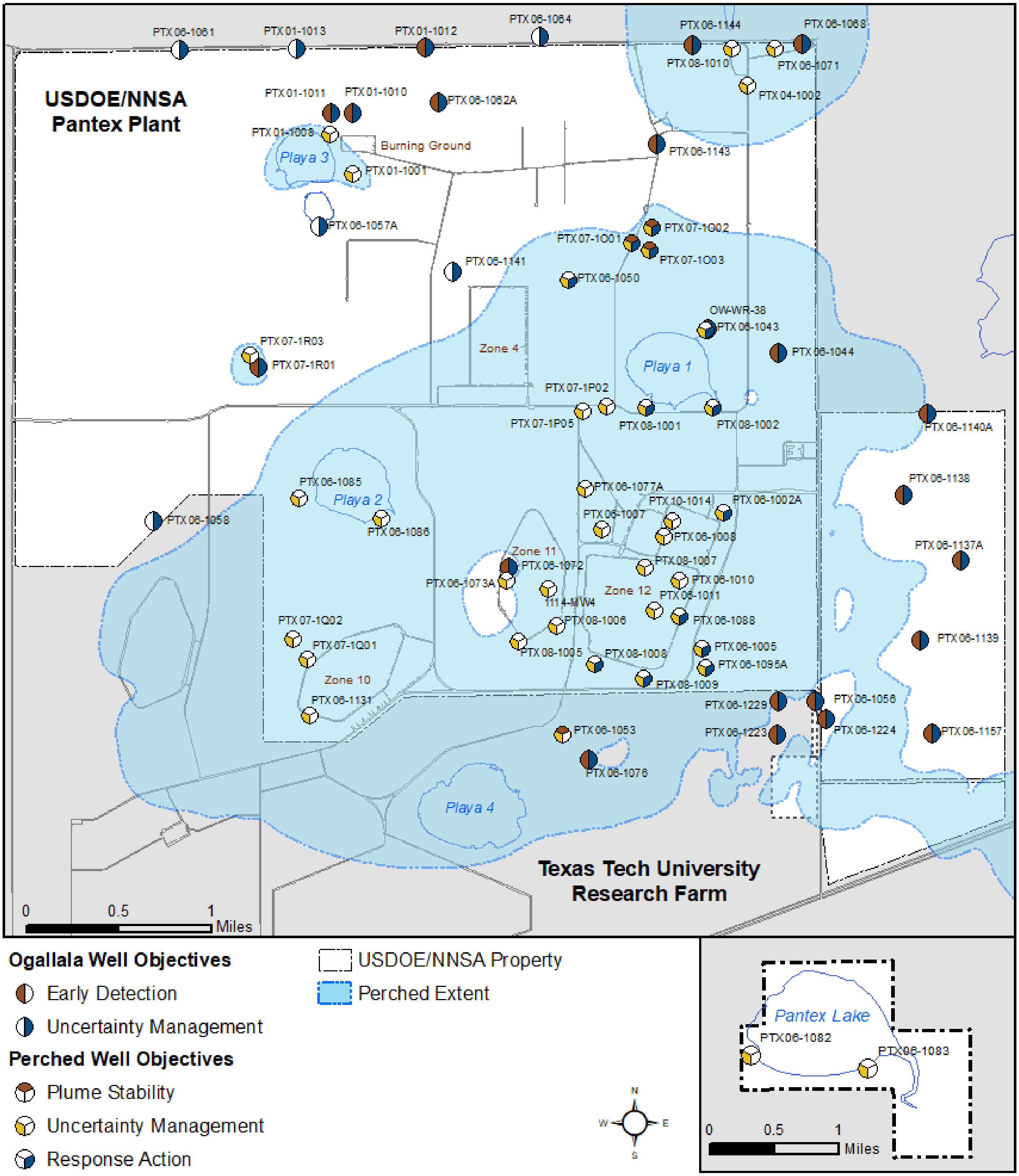


Figure 6.7 Uncertainty management and early detection wells

Perchlorate and TCE were detected at PTX01-1001, a perched monitor well located in the Burning Ground area. Perchlorate was detected at 68 µg/L, above the GWPS (15 µg/L), and TCE was detected at 1.11 µg/L, above the practical quantitation limit (PQL) (1 µg/L), but below the GWPS (5 µg/L). Previous detections in PTX01-1001 have been associated with releases from the wash rack at the southwest corner of the loop road inside the Burning Ground area. A documented leak from a water line on the south side of the loop road has occurred for a long period of time, as evidenced by the cattails growing in that area and increasing water level trends in PTX01-1001 while other locations at the Burning Ground do not demonstrate a similar trend. Pantex minimized the leak; however, the leak continued through 2024 and was not fully stopped until early 2025 when the maintenance crew received all needed parts for the repair. It appears likely that the water leak has affected deeper soil contamination that remains at the wash rack. It is expected that with the removal of water from the area, concentrations and water levels will decline with time, as observed in past data.

6.5.2 Ogallala Aquifer Uncertainty Management and Early Detection

Unexpected conditions in the Ogallala Aquifer primarily involve detection of indicator constituents above background, including boron, hexavalent chromium, perchlorate, and TCE that occurred in nine Ogallala wells in 2024. Boron frequently occurs at higher concentrations in wells that are located along the southern side of Pantex, due to the influence of the Dockum Aquifer. Detections of hexavalent chromium and perchlorate are likely the result of background variability.

TCE was detected at PTX01-1010, located just north of the Burning Ground. In the third quarter of 2024 TCE was detected (0.67 µg/L). This was below the GWPS (5 µg/L) and the PQL (1 µg/L). Although resampling is not required when the detection is less than the PQL, Pantex initiated a resampling event during the fourth quarter to validate this detection as a precaution. The verification sample was split and sent to two separate labs; both TCE verification samples support the initial detection results. In accordance with the Contingency Plan and requirements established in the approved *Draft Final Burning Ground Soil Vapor Extraction System Closure Report* (Pantex 2023). Pantex will continue to monitor this well and evaluate the data. Other than the detection of TCE at PTX01-1010, no Ogallala Aquifer uncertainty management wells indicated impacts from a soil source area in 2024.

HEs and VOCs were detected in five Ogallala wells beneath the southeast area in 2024; these detections are associated with cross-contamination of the Ogallala Aquifer from impacted perched groundwater in areas where the FGZ is more permeable. Three wells were installed in 2023 to evaluate the detections at PTX06-1056. Detection of HEs in two of these wells confirmed the presence of HEs in the Ogallala Aquifer. One well, PTX06-1229, indicated the presence of three HE constituents in the Ogallala Aquifer at concentrations above GWPS, including RDX at 307 ug/L.

Based on evaluation of potential plume movement, Pantex installed three wells in 2024, PTX06-1231, PTX06-1232, and PTX06-1233, shown in Figure 6.8, within the projected migration path of the plume and in areas where perched groundwater was absent to avoid potential cross-contamination from impacted perched groundwater. Sample results for downgradient well PTX06-1233 indicate that RDX and other HEs are defined at the farthest downgradient extent of the plume because all measured concentrations are below the GWPS. Sampling of the upgradient well, PTX06-1231, indicates RDX at higher concentrations than found in PTX06-1229, possibly indicating another area of impact from a more permeable area of the FGZ near that well. PTX06-1232, located downgradient between PTX06-1229 and PTX06-1233, indicated the presence of RDX at 27 µg/L, lower than observed at PTX06-1229 but above the GWPS of 2 µg/L. Pantex will continue to evaluate the wells as new samples are collected. Once enough data are gathered to fully define the extent of HEs, plume maps will be developed and provided in later progress reports and in the investigation reporting.

Pantex continues to plan for installation of new wells and to complete full investigation of nature and extent of the newly discovered plumes in the Ogallala Aquifer. Pantex is contracting support for the completion of the investigation and plans for installation of up to an additional eight new wells in 2025, as well as the development of an investigation work plan, in accordance with a recommendation provided in the *Third Five-Year Review* (HGL and Pantex, 2023). The investigation work plan is planned for completion in March 2026.

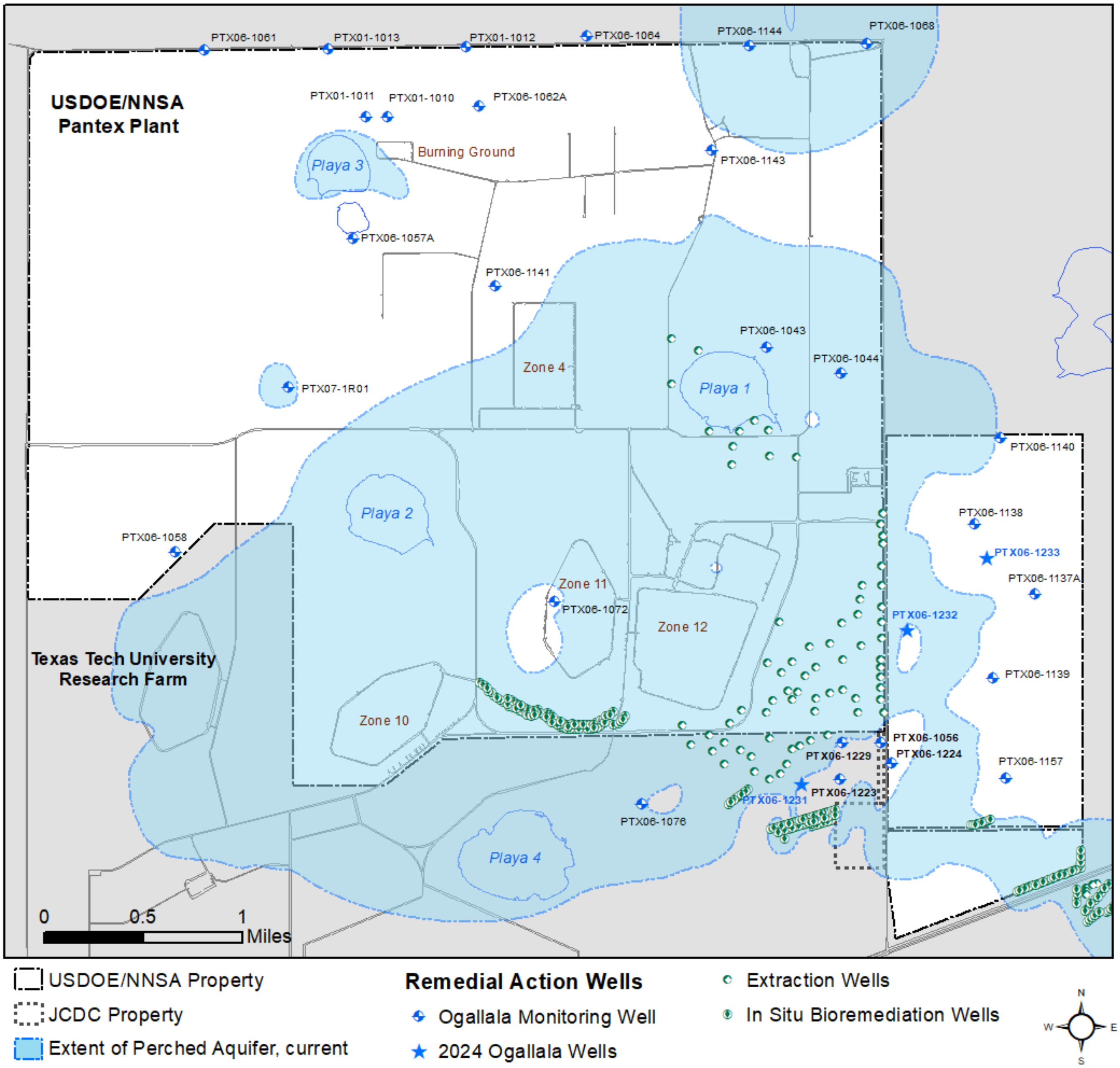


Figure 6.8 Location of new installed Ogallala wells in 2024

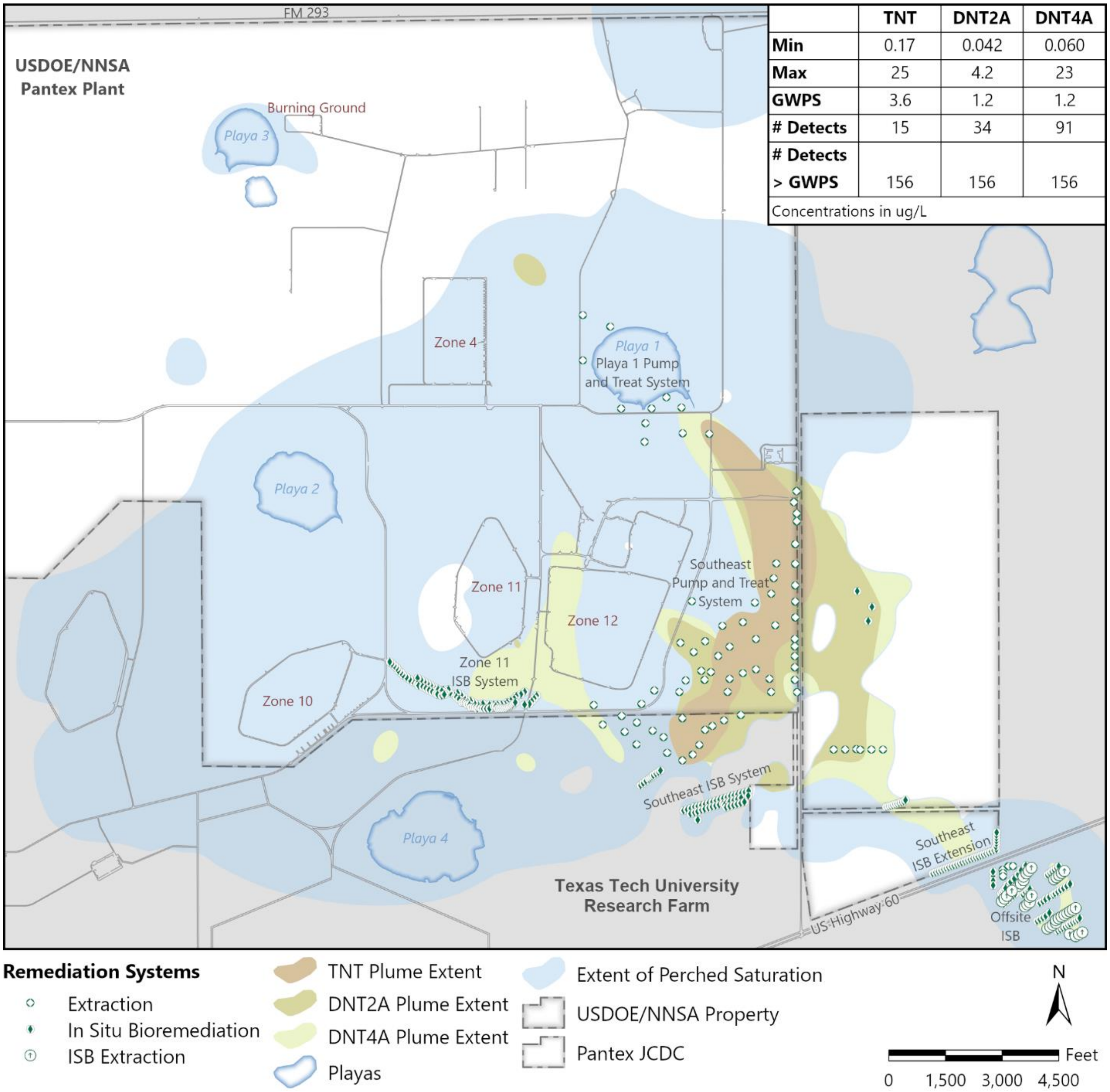
6.6 NATURAL ATTENUATION

Natural attenuation is the result of processes that naturally lower concentrations of contaminants over time. This process is monitored at Pantex to help determine where natural attenuation is occurring and under what conditions it is occurring. Pantex routinely monitors for breakdown products of the primary COCs. Groundwater conditions that may affect attenuation, such as dissolved oxygen and redox potential, are also monitored in each well. For example, RDX can degrade under aerobic and anaerobic conditions, but achieves faster reduction under anaerobic conditions. Trending of concentrations is also performed at each well to determine if concentrations are declining as expected.

Based on monitoring results for Trinitrotoluene (TNT) and its breakdown products (2-amino-4,6-DNT and 4-amino-2,6- DNT), TNT continues to naturally attenuate over time (Figure 6.9). TNT has been manufactured at Pantex since the 1950s yet is only present in the central portion of the overall southeastern plume within the SEPTS well field and near Playa 1. Its first breakdown product, 2-amino-4,6-DNT, occurs near the TNT plume and extends slightly beyond. The plume for the final breakdown product, 4-amino-2,6-DNT, extends to the eastern edge of the perched saturation at low concentrations. Only TNT breakdown products are present in perched groundwater beneath Zone 11 and north of Playa 1. Concentrations of the breakdown products are still above GWPS, but most wells with detections show a decreasing or stable trend over the past few years.

Perched groundwater sampling results for RDX and breakdown products [hexahydro-1-Nitroso-3,5-Dinitro-1,3,5-triazine (MNX), hexahydro-1,3-Dinitroso-5-Nitro 1,3,5-triazine (DNX), and hexahydro-1,3,5-Trinitroso-1,3,5-triazine (TNX)] indicate that the breakdown products are present throughout most of the RDX plume, with TNX being the most widespread. TNX, the final degradation product, is a better indicator of degradation because the other intermediate products (MNX, DNX) degrade rapidly and do not accumulate in the environment (SERDP 2006). If complete biodegradation of RDX were occurring, RDX and all breakdown products would be expected to decrease over time. As depicted in Figure 6.10, the RDX plume is similar in size and in extent to the TNX plume but at much lower concentrations. Pantex contracted for a project to evaluate lines of evidence for natural attenuation of RDX at Pantex. The study included both aerobic and anaerobic degradation with evidence of both occurring. Biodegradation rates of 0.016 to 0.168/year were calculated translating to RDX half-lives of approximately 5 to 50 years. The project found that the rates of RDX biodegradation are likely limited by the available labile organic carbon in the groundwater. The predominant attenuation process is aerobic biodegradation by bacterial strains. The study found several lines of evidence for natural attenuation of RDX as well as the potential to enhance aerobic biodegradation of RDX with introduction of low levels of labile organic carbon. Recommendations for further study were presented for additional treatability studies, bioaugmentation, and additional proteomics analyses for the degrading bacterial strains.

Pantex has monitored for breakdown products of TCE for many years; however, a strong indication of natural attenuation of TCE has not been observed in perched groundwater. TCE is degrading in the Zone 11 ISB treatment zone. The SEPTS and the ISB treatment zones are actively treating the TCE plumes at Pantex.



	TNT	DNT2A	DNT4A
Min	0.17	0.042	0.060
Max	25	4.2	23
GWPS	3.6	1.2	1.2
# Detects	15	34	91
# Detects > GWPS	156	156	156
Concentrations in ug/L			

Figure 6.9 TNT and degradation product plumes

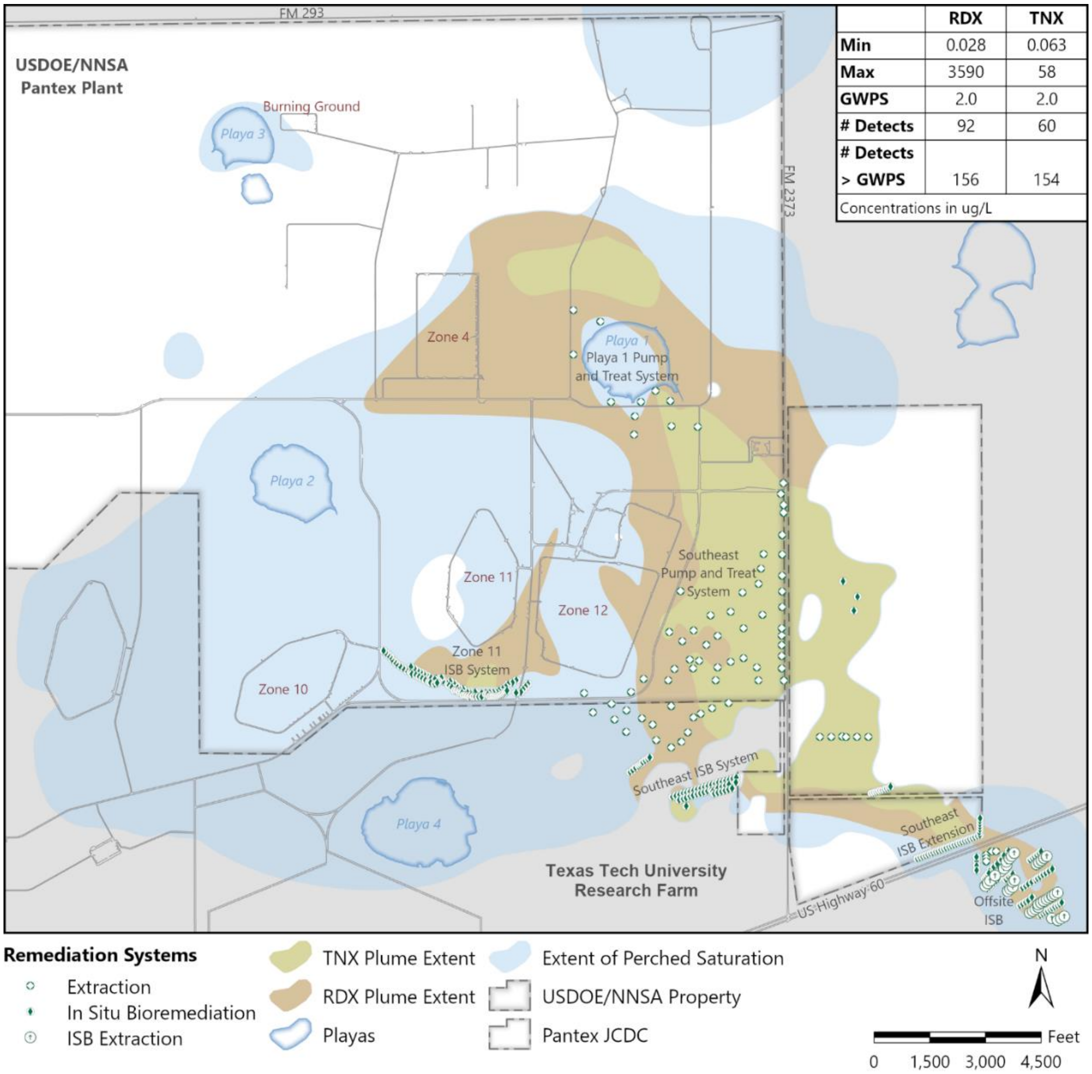


Figure 6.10 RDX and degradation product plume

6.7 CONCLUSIONS

Overall, the groundwater remedial actions continued to be effective in 2024. The remedial actions continue to operate and meet short-term expectations for cleanup of the perched groundwater in areas under the influence of the remediation systems. As a whole, perched water levels continue to decline. Perched aquifer wells near Playa 1 reported a slight increase in groundwater levels attributable to rainfall, infiltration, and release of treated water from the WWTF and pump-and-treat systems. COC mass is being removed or reduced and institutional controls provide protection for use of impacted groundwater, while the remedial actions continue to operate to meet long-term goals. The influence of both pump-and-treat systems will continue to expand as the saturated thickness is reduced in the perched aquifer. Treatment will expand at the ISBs over time as treated water moves downgradient, providing protection for off-site resources and the deeper drinking water aquifer.

Because of COC detections above the GWPS indicating possible migration of perched groundwater to the Ogallala Aquifer, Pantex has fully implemented the conditions specified in *Pantex Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex 2019). Six additional Ogallala monitoring wells were installed in 2023 and 2024 to help define extent of the contamination. HE above the GWPS was identified in three of those wells. However, downgradient Ogallala monitoring wells continue to indicate that drinking water resources at Pantex and the surrounding area are safe. Pantex continues to plan for installation of new wells and to complete full investigation of nature and extent of the newly discovered plumes in the Ogallala Aquifer.

Pantex evaluated lines of evidence for natural attenuation of RDX in perched groundwater beneath Pantex. The study included both aerobic and anaerobic degradation with evidence of both occurring. The project found that the rates of RDX biodegradation are likely limited by the available labile organic carbon in the groundwater.

CHAPTER 7 - DRINKING WATER

Pantex's drinking water system (State of Texas Public Water System [PWS] ID. No. 0330007) is considered a non-transient, non-community PWS under the Safe Drinking Water Act (SDWA) regulations. The EPA created this category to identify private systems that continuously supply water to small groups of people (for example, in schools and factories). The same group of people consume water supplied by such systems daily over long periods.

Chapter Highlights

- There was a decrease of 20 million gal produced/pumped from the Ogallala Aquifer compared to 2023.
- Results from the routine drinking water compliance samples collected by Pantex and a TCEQ contractor in September 2024 confirmed that the drinking water system at Pantex met all water-quality regulatory requirements.
- All analytical results for bacteria, chemical compounds, disinfection by-products (DBP), metals, pesticides, and volatile organic compounds were below regulatory limits, and adequate levels of disinfectant were maintained in the distribution system.
- Pantex PWS continues to be recognized by the TCEQ as a "Superior" supply system.

7.1 DRINKING WATER AT PANTEX

Drinking water at Pantex originates from the Ogallala Aquifer. The water is obtained via groundwater production wells. These wells supply all of Pantex's water needs. The water pumped from the Ogallala Aquifer is treated to provide disinfection protection and is then transferred to a distribution system which distributes water across Pantex. In addition, the system provides water to adjacent TTU-owned property for domestic and livestock use.

Samples from the drinking water system are collected by Pantex personnel and analyzed by contract laboratories monthly for biological contaminants. Similarly, the drinking water system is also sampled and analyzed annually and triennially for various chemical contaminants as required by the SDWA and its implementing regulations. Additionally, samples from the drinking water system are collected each year by TCEQ contractor personnel and analyzed for biological and chemical contaminants. Analytical results, from samples collected by both Pantex and the TCEQ contractor, were compared to regulatory guidelines for drinking water. Sampling locations were chosen to meet regulatory requirements and to provide system operators with data that would assist their evaluation of the system's integrity.

7.2 NEW REQUIREMENTS AND PROGRAM CHANGES

In 2024, the EPA issued the Lead and Copper Rule Improvements (LCRI) final rule. This rule requires drinking water systems across the nation to identify and replace lead pipes within a ten-year time frame. This rule also lowered the maximum contaminant level, requiring municipalities to take action when there is lead detection. In conjunction with the LCRI, the EPA requested all public water systems to develop an inventory prior to October 16, 2024. Pantex completed and submitted this task prior to that date.

7.3 WATER PRODUCTION AND USE

During 2024, Pantex produced/pumped approximately 122 million gal of water from the Ogallala Aquifer. This was a decrease of 20 million gal compared to water produced in 2023. The decrease was due to repairs being made to leaking components of the High-Pressure Fire Loop (HPFL) and domestic water systems. Pursuant to the requirements found in Chapter 16 of the Texas Water Code, Section 16.012(m) and Title 31

TAC, Chapter 358, Pantex submits an annual water use survey to the Texas Water Development Board to show water production and reuse.

Pantex remains committed to reducing the amount of produced water by implementing a water reuse and recycling program. Examples of the water conservation and reuse initiatives include the procurement of more efficient industrial cooling equipment (such as water re-circulating systems) and beneficial reuse of treated wastewater. Pantex's goal is to beneficially reuse 100% of its treated wastewater to grow crops in the northeast portion of the plant. In 2023, Pantex completed an additional wastewater land application project to further the beneficial reuse of treated wastewater. Pantex personnel continue to investigate other reuse opportunities.

7.4 SAMPLING

Pantex collected routine drinking water samples at 12 locations. Ten locations were sampled for biological indicators and residual disinfectant levels, and two locations were monitored for chemical and water-quality constituents. Sample locations are periodically changed to assure there is adequate Pantex coverage. The sampling locations are representative of drinking water at Pantex and are listed in Table 7.1. Routine drinking water sampling results are listed in Appendix B.

Table 7.1 Drinking Water Sampling Locations, 2024

Description	Location
Chemical and Water Quality Monitoring	Building 15-027 (entry point to the distribution system) Building 16-012 [Total Trihalomethanes (TTHM) second site[a]]
Biological and Disinfectant Level Monitoring	Building 12-103 Building 18-001 Building 12-15A Building 16-012 Building 12-070 Building 11-002 Building 15-027 Building 16-001 Building 10-009 Building 12-036

[a] The TTHM site is the second sampling location within the distribution system with the potential for high disinfection by-products [TTHM and haloacetic acids (HAA5)] formation. Samples were collected for TTHMs and HAA5s at the entry point to the distribution system, but these constituents are not regulated at this location. All sample results were below applicable regulatory limits.

7.5 RESULTS

In 2024, the TCEQ contractor sampled the water system at Pantex. Results for this drinking water sampling were within regulatory limits for chlorine (disinfectant) and below regulatory limits for DBPs, metals, microbial contaminants, inorganic contaminants, nitrate, pesticides, and VOCs. Table 7.2 shows the water-quality results from the Pantex water system as measured by the TCEQ contractor.

Table 7.2 Water-Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Inorganics (E300.0, Anions)			
Nitrate (as N)	1.39	10	mg/L
E524.2 Regulated (E524.2 Volatiles by GC/MS)			
Vinyl chloride	<0.500	2	ug/L
1,1-Dichloroethene	<0.500	7	ug/L
Methylene chloride	<0.500	5	ug/L
Trans-1,2-dichloroethene	<0.500	100	ug/L
Cis-1,2-dichloroethene	<0.500	70	ug/L
1,1,1-Trichloroethane	<0.500	200	ug/L
Carbon tetrachloride	<0.500	5	ug/L
1,2-Dichloroethane	<0.500	5	ug/L
Benzene	<0.500	5	ug/L
Trichloroethene	<0.500	5	ug/L
1,2-Dichloropropane	<0.500	5	ug/L
Toluene	<0.500	1000	ug/L
1,1,2-Trichloroethane	<0.500	5	ug/L
Tetrachloroethene	<0.500	5	ug/L
Chlorobenzene	<0.500	100	ug/L
Ethyl benzene	<0.500	700	ug/L
m,p-Xylene	<0.500	N/A	ug/L
Styrene	<0.500	100	ug/L
1,4-Dichlorobenzene	<0.500	75	ug/L
1,2-Dichlorobenzene	<0.500	600	ug/L
1,2,4-Trichlorobenzene	<0.500	70	ug/L
Xylene (total)	<0.500	10000	ug/L
E524.2 Unregulated (E524.2 Volatiles by GCIMS)			
Dichlorodifluoromethane	<0.500	N/A	ug/L
Chloromethane	<0.500	N/A	ug/L
Bromomethane	<0.500	N/A	ug/L
Chloroethane	<0.500	N/A	ug/L
4-Chlorotoluene	<0.500	N/A	ug/L
Trichlorofluoromethane	<0.500	N/A	ug/L
Acetone	<5.00	N/A	ug/L
Methyl iodide	<0.500	N/A	ug/L
Carbon disulfide	<0.500	N/A	ug/L
Acrylonitrile	<5.00	N/A	ug/L
Tert-butyl methyl ether	<0.500	N/A	ug/L
1,1-Dichloroethane	<0.500	N/A	ug/L
Vinyl acetate	<5.00	N/A	ug/L
2,2-Dichloropropane	<0.500	N/A	ug/L
2-Butanone	<5.00	N/A	ug/L
Bromochloromethane	<0.500	N/A	ug/L
Tetrahydrofuran	<5.00	N/A	ug/L

Table 7.2 Water-Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Chloroform	<1.00	N/A	ug/L
1,1-Dichloropropene	<0.500	N/A	ug/L
Methyl methacrylate	<5.00	N/A	ug/L
Dibromomethane	<0.500	N/A	ug/L
Bromodichloromethane	<1.00	N/A	ug/L
Cis-1,3-Dichloropropene	<0.500	N/A	ug/L
4-Methyl-2-pentanone	<5.00	N/A	ug/L
Trans-1,3-Dichloropropene	<0.500	N/A	ug/L
Ethyl methacrylate	<5.00	N/A	ug/L
1,3-Dichloropropane	<0.500	N/A	ug/L
2-Hexanone	<5.00	N/A	ug/L
Dibromochloromethane	<1.00	N/A	ug/L
1,1,1,2-Tetrachloroethane	<0.500	N/A	ug/L
o-Xylene	<0.500	N/A	ug/L
Bromoform	<1.00	N/A	ug/L
Isopropylbenzene	<0.500	N/A	ug/L
1,1,2,2-Tetrachloroethane	<0.500	N/A	ug/L
Bromobenzene	<0.500	N/A	ug/L
1,2,3-Trichloropropane	<0.500	N/A	ug/L
n-Propylbenzene	<0.500	N/A	ug/L
2-Chlorotoluene	<0.500	N/A	ug/L
1,3,5-Trimethylbenzene	<0.500	N/A	ug/L
Tert-butylbenzene	<0.500	N/A	ug/L
1,2,4-Trimethylbenzene	<0.500	N/A	ug/L
Sec-Butylbenzene	<0.500	N/A	ug/L
1,3-Dichlorobenzene	<0.500	N/A	ug/L
4-Isopropyltoulene	<0.500	N/A	ug/L
n-Butylbenzene	<0.500	N/A	ug/L
Hexachlorobutadiene	<0.500	N/A	ug/L
Naphthalene	<0.500	N/A	ug/L
1,2,3-Trichlorobenzene	<0.500	N/A	ug/L
Haloacetic Acids (552.2 Haloacetic Acids by GC)			
Bromochloroacetic acid	<1.00	N/A	ug/L
Dibromoacetic acid	<1.00	N/A	ug/L
Dichloroacetic acid	<1.00	N/A	ug/L
Monobromoacetic acid	<1.00	N/A	ug/L
Monochloroacetic acid	4.30	N/A	ug/L
Trichloroacetic acid	<1.00	N/A	ug/L
Total regulated HAA	4.30	60	ug/L
Volatiles (E524.2 Volatiles by GC/MS)			
Chloroform	2.01	N/A	mg/L
Bromodichloromethane	2.42	N/A	mg/L
Dibromochloromethane	1.88	N/A	mg/L

Table 7.2 Water-Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Bromoform	<1.00	N/A	mg/L
Total trihalomethanes	6.31	80	mg/L

Definitions:

maximum contaminant level (MCL): the highest level of a contaminant allowed in drinking water.

mg/L = milligrams per liter or parts per million

N/A = not applicable; there are no MCLs under the SDWA.

ug/L = micrograms per liter or parts per billion

umho/cm = micromhos per centimeter; this is a measurement of electrical conductivity in water.

7.5.1 Inorganic Contaminants

Monitoring for inorganic contaminants in the PWS is required by state and federal regulations. The State of Texas regulates the amount of these contaminants in drinking water to protect public health. Consumption of these contaminants may cause health problems if present in public water supplies in amounts greater than the drinking water standard set by the EPA. All inorganic contaminant results from monitoring conducted in 2024 were below regulatory levels.

7.5.2 Biological Monitoring

Water distribution systems may contain naturally occurring microorganisms and other organic matter that could enter a system through leaks, cross-connections, back-flow events, or disinfection system failures. Bacterial growth may occur within the water itself, at or near the pipe surfaces, or from suspended particulates. Factors that influence bacterial growth include water temperature, flow rate, and chlorination. During 2024, all microbial sample results were negative for coliform and Escherichia coli bacteria.

7.5.3 Radiological Monitoring

Radiological monitoring is not required for the non-transient, non-community PWS at Pantex. During 2024, no radiological monitoring was conducted.

7.5.4 Disinfection By-Products

All drinking water at Pantex is chlorinated prior to entry into the distribution system. Disinfection By-Products (DBPs) are produced by the reaction between the disinfectant (chlorine) and organic matter in the water. Reducing the amount of organic matter in the source water before disinfection can help control the quantity of DBPs produced. In addition, limiting the amount of disinfectant introduced in the system reduces the formation of these by-products. All PWSs where chlorine is used are required to maintain residual levels between 0.2 and 4.0 mg/L throughout the distribution system. These levels provide assurance that the water is safe from most water-borne pathogens while minimizing any adverse health risks to the population from DBPs or the higher concentrations of chlorine.

DBPs are broken into two groups: total trihalomethanes (TTHMs) and haloacetic acids (HAA5). TTHMs are reported as the sum of the chloroform, dibromochloromethane, bromodichloromethane, and bromoform concentrations in mg/L. Haloacetic acids are reported as the sum of the monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid concentrations in mg/L. All tests for DBPs were at or below SDWA MCLs.

7.5.5 Water-Quality Parameters

No water-quality parameter testing was conducted in 2024. Testing typically includes constituents such as metals. Typically, detection of these constituents does not indicate that the water is unsafe to drink; rather, they may have considerations of the water such as color, odor, and taste.

7.5.6 Synthetic Organic Contaminants

Synthetic organic chemicals are products derived from naturally occurring materials (petroleum, natural gas, and coal), which have undergone at least one chemical reaction, such as oxidation, hydrogenation, or other process. No testing for synthetic organic chemicals was performed in 2024.

7.5.7 Volatile Organic Contaminants

VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. VOCs are released by a wide array of products, numbering in the thousands. Organic chemicals are widely used as ingredients in household products such as fuels, paints, varnishes, waxes containing organic solvents, and many cleaning, disinfecting, cosmetic, degreasing, and hobby products. All of these products can release organic compounds while being used, and to some degree, while they are stored. Due to the vast number of products on the market that contain VOCs, it is possible that some of these constituents will find their way into drinking water supplies. The TCEQ monitored the water system for VOCs during 2024. All sample results were below any regulatory limits established in federal or state regulations and within the ranges observed in previous years.

7.5.8 Lead and Copper Monitoring

The Lead and Copper Rule under the SDWA requires that concentrations of lead and copper remain below action levels (0.015 and 1.3 mg/L, respectively) for the 90th percentile of the sampling locations. These regulations establish requirements for monitoring, reporting, corrosion-control studies and treatment, source-water treatment, lead service line replacement, and public education. PWSs must control the levels of lead and copper in drinking water by controlling the corrosiveness of the water. Pantex is on a triennial monitoring schedule for lead and copper. Compliance monitoring for lead and copper was conducted during 2024 and all results were within regulatory limits.

7.5.9 Contaminant Candidate Monitoring

The drinking water Contaminant Candidate List (CCL) is a list of contaminants that are currently not subject to national primary drinking water regulations but are known or anticipated to occur in PWSs. Contaminants listed on the CCL may require future regulation under the SDWA. The EPA is required to publish the CCL every five years. The SDWA directs the EPA to consider the health effects and occurrence information for unregulated contaminants as the agency makes decisions to place contaminants on the list. The SDWA further specifies that the EPA place those contaminants on the list that present the greatest public health concern related to exposure from drinking water. The EPA uses the CCL to identify priority contaminants for regulatory decision making and information collection.

The EPA published 86 FR 73131, *Revisions to the Unregulated Contaminant Monitoring Rule (UCMR 5) for Public Water Systems and Announcement of Public Meetings*, which was effective January 26, 2022. The Unregulated Contaminant Monitoring Rule will require Pantex to collect drinking water samples for 29 PFAS and one lithium analysis during a 12-month period between 2023 and 2025.

7.6 INSPECTIONS

The TCEQ monitors the water supply in accordance with the drinking water standards. A TCEQ contractor collected samples from Pantex PWS system in September 2024. The report generated from that event indicated that Pantex met or surpassed all water quality requirements. The TCEQ did not perform a Comprehensive Compliance Inspection of the Pantex PWS in 2024.

7.7 CONCLUSIONS

Results from the routine drinking water compliance samples collected by Pantex and a TCEQ contractor in August 2024 confirmed that the drinking water system at Pantex met all water quality regulatory requirements. No corrective actions, deficiencies, or violations were identified during the last routine drinking water compliance inspection that was conducted in November 2021. Monitoring results demonstrate that Pantex continues to provide safe drinking water while the water supply system maintains a “Superior Rating.”

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CHAPTER 8 - WASTEWATER

Pantex operates an on-site wastewater treatment facility (WWTF). The wastewater treatment system consists of a facultative lagoon and two wastewater storage lagoons. This system is permitted by the TCEQ to treat and dispose of domestic and industrial wastewater.

Chapter Highlights

- During 2024, Pantex discharged approximately 50 million gal of treated wastewater to Playa 1 and beneficially reused more than 53 million gal of remediated groundwater for agricultural purposes.

8.1 WASTEWATER AT PANTEX

Domestic and industrial wastewaters generated at Pantex are treated at an on-site WWTF. Industrial effluents from Pantex operations are generally pre-treated and directed into the WWTF for further treatment. All such effluents are collected in the sanitary sewer, managed in the WWTF, and can be discharged through permitted outfalls to either a subsurface irrigation system, a surface irrigation system, or Playa 1. The playa is an ephemeral lake and is not connected to any other lakes, rivers, or streams (Figure 8.1).

Figure 8.1 Playa 1

The WWTF (Figure 8.2) includes a clay-lined, facultative lagoon that covers approximately 3.94 ac and has a capacity of 11million gal. In addition, there are two storage lagoons (Figures 8.3 and 8.4) that are used for the storage and retention of treated wastewater. The east lagoon (Figure 8.3) is a storage lagoon that is lined with a polyethylene liner and has similar dimensions and capacity to the facultative lagoon. This lagoon receives treated domestic and industrial wastewater, as well as treated groundwater from environmental remediation projects. If necessary, the east lagoon can serve as a facultative lagoon.

Figure 8.2 Wastewater Treatment Facility, facultative lagoon

Figure 8.3 East wastewater storage lagoon

Figure 8.4 Wastewater storage lagoon

The treatment process in the facultative lagoon involves a combination of aerobic, anaerobic, and facultative bacteria. At the surface, aerobic bacteria and algae exist in a symbiotic relationship. Oxygen is provided by natural aeration processes, and algal photosynthesis. Bacteria utilize the oxygen for the aerobic degradation of organic matter, while algae utilize the nutrients and carbon dioxide released in the degradation process. Facultative bacteria within the water column are used in the treatment and degradation of organic matter. Anaerobic bacteria decompose organic matter that is deposited in a sludge layer at the bottom of the lagoon. The wastewater treatment process in a facultative lagoon is complex and nearly all treatment is accomplished by biological activity.

8.2 OPERATIONAL DESCRIPTION AND METRICS

During 2024, Pantex had three authorizations from TCEQ for wastewater disposal (Texas Land Application Permit WQ00002296000, Texas Water Quality Permit WQ0002296000, and Underground Injection Control [UIC] Authorization 5W2000017). Each required analytical monitoring and periodic reporting to the TCEQ. Under the Texas Land Application Permit (TLAP), WQ0004397000, Pantex is permitted to dispose of treated wastewater by means of surface and subsurface irrigation systems into agricultural fields for beneficial reuse (Figure 8.5). This permit was modified and reissued on August 11, 2020, and will expire on August 11, 2030. When discharging to the subsurface irrigation system, water is distributed through manifold pipes to individual zones located within four tracts of land that are each approximately 100 acres in size. Discharge via the surface irrigation system is distributed through five center-pivot sprinklers, each covering approximately 120 acres of agricultural land.

The irrigation areas consist of agricultural land owned by the DOE and farmed by TTU. Crops grown in this area may include winter wheat, sorghum, cotton, corn, oats, and opportunity wheat. Crops will vary from field to field, depending on the cropping needs of TTU. The surface irrigation system was used during 2024 with limited downtime. The subsurface irrigation system was not operational during 2024 due to ongoing repairs.

Figure 8.5 Irrigation Tract 101

During periods when the agricultural fields are fallow, Pantex is authorized to apply limited quantities of wastewater to select irrigation areas according to UIC Authorization 5W2000017. There is no expiration date on this authorization.

Pantex maintains a Texas Water Quality Permit WQ0002296000, which allows for the discharge of treated wastewater to Playa 1. This permit was renewed by the TCEQ on August 27, 2020, and will expire on August 27, 2025.

Through compliance with these three authorizations, Pantex manages and discharges treated effluent in a manner that is beneficial to the environment. Pantex began a lagoon liner refurbishment project to replace, repair, and refurbish the liners for the facultative and lower storage lagoons. This project is scheduled to be complete in July 2025.

8.3 SAMPLING LOCATIONS

Sampling was conducted at the incoming weir of the lagoon system (before treatment) and at the permitted discharge point for surface water discharge, Outfall 001A. Monitoring the water quality at the incoming weir was conducted to determine the effectiveness of the wastewater treatment system. Results of these efforts showed that the treatment system adequately treated the wastewater to comply with all effluent limitations. During 2024, no water was discharged through Outfall 031 to the subsurface drip irrigation system, and no samples were collected. Remediated groundwater was discharged through Outfall 032 to the pivot irrigation system and samples were collected during each month in which discharge occurred.

8.4 ANALYTICAL RESULTS

During 2024, Pantex discharged approximately 50 million gal of treated wastewater through Outfall 001A. Water-quality results from this outfall are shown in Table 8.1. More than 53 million gal of remediated groundwater was discharged through Outfall 032, measurements of all parameters were within permit limits.

Table 8.1 Water-Quality Results from Outfall 001A, 2024

Analyte	Maximum Discharge Limits[a] (mg/L)	Highest Daily Average Concentration (mg/L)	Maximum Detected Concentration (mg/L)	Permit Exceedance/ Violation[b]	Percent Compliance
Copper	1.0	<0.016	<0.020	0/0	100
Manganese	2.0	0.048	0.068	0/0	100
Zinc	2.0	<0.014	0.020	0/0	100
Octahydro-1,3,5,7-tetranitro 1,3,5,7-tetrazocine	Report	<0.0003	<0.013	0/0	100
Research Department Explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine)	Report	<0.013	<0.013	0/0	100
Pentaerythritol tetranitrate	Report	<0.027	<0.027	0/0	100
trinitrotoluene	Report	<0.013	<0.013	0/0	100
TATB [d]	Report	N/A	<0.054	0/0	100
Biochemical oxygen demand	70	15.2	33.8	0/0	100
Chemical oxygen demand [d]	150	N/A	61.5	0/0	100
Total suspended solids	90	65.0	74	1/0	83
Oil/Grease [d]	15	N/A	<10.4	0/0	100
pH[c]	6.0 Min. 10.0 Max.	6.6	9.0	0/0	100

[a] The maximum discharge limits are based on the daily maximum levels stated in the permit.
[b] An exceedance is defined as a measured value above or below a permit limit. A violation is defined as a missing permit parameter such as failure to obtain a sample required by the permit.
[c] pH is measured in standard units and not in mg/L.
[d] The permit does not require a daily average concentration for this analyte.

8.5 PERMIT COMPLIANCE VIOLATIONS

In September 2024, the Total Suspended Solids (TSS) daily average concentration was measured at 65.0 mg/L. The Daily Average limitation for TSS is 60.0 mg/L. However, the daily maximum concentration (90 mg/L) was not exceeded. All corrective actions for reporting and mitigating this exceedance were completed.

8.6 CONCLUSIONS

At Outfall 001A, the 2024 results for explosives, metals, biochemical oxygen demand, chemical oxygen demand, and oil/grease were all within expected ranges and did not exceed permit limits. However, the Daily Average permit limit for TSS was exceeded during the month of September due to excessive algae growth in the WWTF storage lagoons. All measured results from Outfall 032 were within permit limits.

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CHAPTER 9 - SURFACE WATER

To ensure outdoor operations at Pantex are not adversely affecting the environment, Pantex actively monitors the stormwater runoff from each industrial area and the surface-water quality of each on-site playa lake.

Chapter Highlights

- Data from the surface water monitoring program collected during 2024 were consistent with historical data from past monitoring activities, indicating that operations at Pantex did not adversely affect the water quality of the playa lakes.
- No significant changes were made to the surface-water monitoring program during 2024.

9.1 SURFACE WATER AT PANTEX

Pantex is located in a region with a semi-arid climate and a relatively flat topography. Surface water represented by rivers or streams does not exist around the site. All surface water drains to isolated playa lakes. Playa lakes are shallow, ephemeral lakes that have clay-lined basins that fill periodically with surface-water runoff. Playa basins consist of the ephemeral lakes themselves and their surrounding watersheds. There are approximately 20,000 of these playa lakes on the Southern High Plains. Playa lakes are extremely important hydrologic features that provide prime habitat for wildlife, especially waterfowl that winter in the Southern High Plains. Playa lakes are also believed by most authorities to be an important source of recharge for the Ogallala Aquifer, the area's primary source of groundwater.

There are six playa lakes located on DOE-owned or leased property. Two are located on property leased from TTU. Most surface drainage on DOE property flows via man-made ditches, via natural drainage channels, or by sheet flow to the on-site playa basins. Some stormwater flows to off-site playa lakes at the outer periphery of the site, which are a considerable distance from most Pantex operations. Figure 9.1 is a map of Pantex that shows the locations of the six playas with their respective drainage basins (watersheds).

Effluent from the WWTF and stormwater runoff from Zones 4, 12, and the northeastern portion of Zone 11 are permitted to discharge to Playa 1. Stormwater runoff from the northwestern portions of Zone 11 is channeled to Playa 2 via a ditch system. Stormwater runoff from the Burning Ground flows, primarily as sheet flow, into Playa 3. Stormwater runoff from the southern portions of Zones 10, 11, and 12 discharge into Playa 4 on TTU property. There are no discharges from Pantex to Pantex Lake or Playa 5. Pantex Lake is located on DOE property to the northeast of the main property, and Playa 5 is located on TTU property to the southwest. Both of these playas receive stormwater runoff from surrounding pastures and agricultural operations.

9.2 SAMPLING LOCATIONS AND MONITORING RESULTS

Surface water sampling occurs in response to precipitation or discharge events. During 2024, Pantex collected samples in accordance with the permits issued by the TCEQ and the data quality objective documents developed by Pantex media scientists. The TCEQ is the permitting authority for stormwater discharges in the State of Texas.

Stormwater runoff at Pantex is sampled in accordance with Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector General Permit (MSGP) TXR050000. General permits are typically active for five years with the most recent MSGP expiring in August 2026. Stormwater sampling locations, known as outfalls, are conveyances in which stormwater accumulates and discharges. Locations have been selected based on their proximity to Pantex operations.

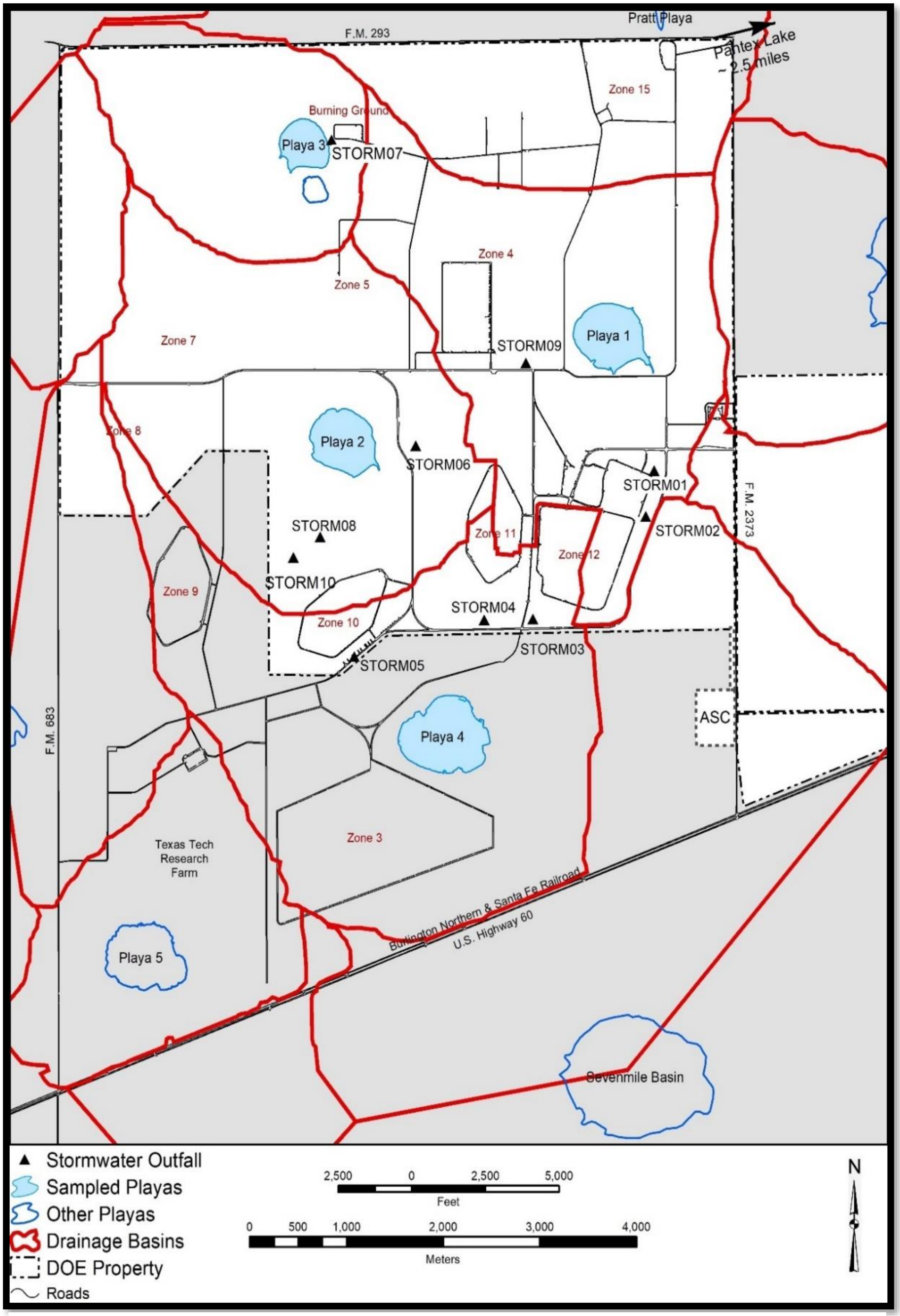

Figure 9.1 Drainage basins, playa lakes, and stormwater outfalls at Pantex

The TCEQ issued an additional five-year general permit, TPDES General Permit No. TXR150000, relating to stormwater discharges associated with construction activities. The most recent general permit expires in March 2028. There were seven construction projects filed under this general permit at the end of 2024 for Pantex. This permit does not require analytical monitoring but relies on best management practices, such as stormwater pollution prevention plans, soil stabilization controls, and routine field inspections.

Environmental surveillance monitoring is also conducted at the on-site playa lakes as a best management practice. Appendix C contains a list of the surface-water analytes that were monitored during 2024. In addition to the playa lake sampling program, Pantex also monitors stormwater quality at nine different outfalls (shown on Figure 9.1). The flow diagram in Figure 9.2 depicts how stormwater and treated industrial effluents discharge through the outfalls, and ultimately to the playa lakes or the subsurface drip irrigation system. During 2024, Pantex collected samples at one playa lake and nine stormwater outfalls. Based on data from the National Weather Service rainfall during 2024 was above average with approximately 20.9 in for the year. The average annual rainfall for Amarillo is typically 19.7 in.

Stormwater monitoring required by the TPDES MSGP in 2024 consisted of both visual monitoring and analytical monitoring. Both are required each year for the duration of the MSGP. Visual monitoring involves the examination of the physical properties of stormwater including color, clarity, odor, oil sheen, solids, and foam. Visual samples taken and examined in 2024 appeared to be of good quality, and none showed any abnormalities based on the criteria specified in the MSGP. Analytical monitoring consisted of metals [inland water-quality parameters (IWQPs)] listed in Title 30 of the Texas Administrative Code, Chapter 319 and sector-specific analytes required by the MSGP. Metal concentrations were compared with IWQPs, and sector-specific analytes were compared to benchmark levels listed in the MSGP. The 2024 stormwater outfall sample results for metals are listed in Table 9.1.

9.2.1 Playa 1 Basin

Playa 1 is approximately 79.3 ac in size and may receive treated wastewater effluent and stormwater runoff from several small drainages. One of the drainages to the playa lake is associated with Pantex operations (permitted Industrial Wastewater Outfall 001A). The other drainages receive stormwater runoff from agricultural and operational areas. Stormwater Outfalls 01 and 02 are located upstream in one of these drainages, which originates from some of the operational areas of Zone 12 North. The western edge of Playa 1 receives stormwater runoff from the Zone 4 area. Two additional drainages transport stormwater runoff from agricultural areas that are north of the playa. In 2024, Pantex collected samples at Playa 1 and within the Playa 1 basin at Stormwater Outfalls 01 and 02.

During the second and fourth quarters of 2024, samples were collected from Playa 1 for metals, radionuclides, and explosives. Metal analyses were consistent with historic levels found at the playa and all were below their respective IWQP. Isotopic radiological analyses for uranium were all below their respective DCS for ingested water. Tritium was also below the DCS for ingested water, as well as the more conservative MCL for drinking water standards. All explosive analyses were below laboratory-detection levels.

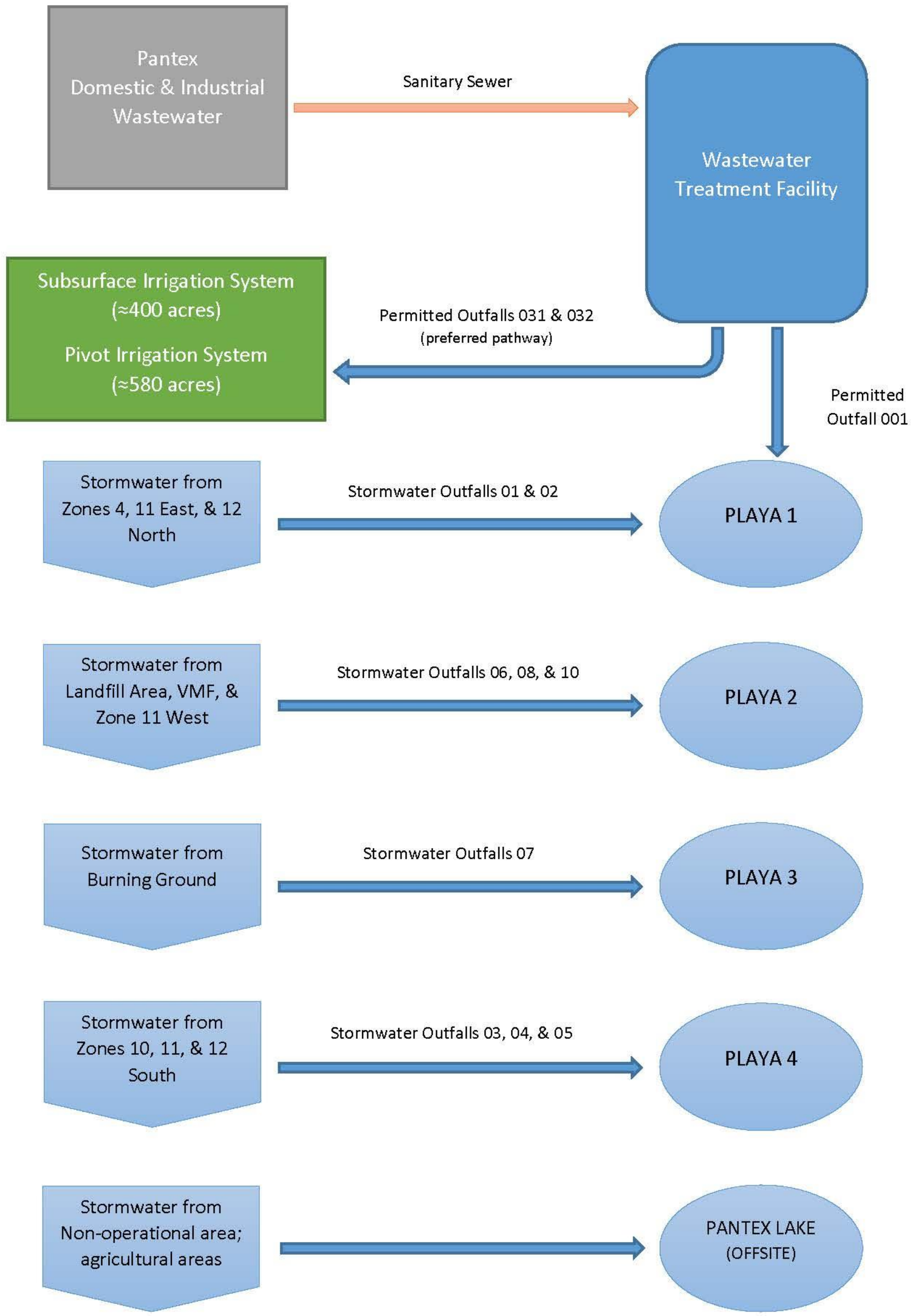

Figure 9.2 Pantex surface water schematic

Table 9.1. Annual Stormwater Results (metals), 2024 (mg/L)

	Outfall 01	Outfall 02	Outfall 03	Outfall 04	Outfall 05	Outfall 06	Outfall 07	Outfall 08	Outfall 10	IWQP[a]
Arsenic	0.008	0.004	0.007	0.002	0.001	0.005	0.002	0.002	0.004	0.3
Barium	0.522	0.196	0.381	0.082	0.040	0.397	0.509	0.105	0.181	4.0
Cadmium	0.001	0.0003	0.0004	<0.001	<0.001	0.0005	<0.001	<0.001	<0.001	0.2
Chromium	0.025	0.004	0.021	0.003	0.002	0.010	0.003	0.002	0.007	5.0
Copper	0.280	0.002	0.016	0.006	0.004	0.018	0.005	0.005	0.005	2.0
Lead	0.019	0.001	0.012	0.002	0.001	0.008	0.002	0.001	0.004	1.5
Manganese	0.433	0.072	0.287	0.041	0.020	0.258	0.041	0.034	0.097	3.0
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.01
Nickel	0.021	0.003	0.016	0.005	0.003	0.013	0.003	0.002	0.005	3.0
Selenium	<0.005	0.002	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.2
Silver	0.0002	0.0003	0.0001	<0.001	<0.001	0.0001	<0.001	<0.001	<0.001	0.2
Zinc	0.191	0.010	0.129	0.025	0.025	0.157	0.010	0.011	0.023	6.0

[a] IWQP = Inland Water Quality Parameter limits from 30 TAC 319.22

Note: The values above are the average concentration from all samples, if more than one sample was collected during the year.

9.2.2 Stormwater Outfall 01 – Zone 12 North at BN5A

BN5A is the designation for the parking lot located north of operational areas, south of Playa 1, and west of agricultural areas. Flow through this outfall consists entirely of stormwater that originates in the operational areas of Zone 12 North. The stormwater flows northward from the outfall through the BN5A ditch, and then northward to Playa 1 where it finally discharges.

Pantex performed permit-required monitoring at Stormwater Outfall 01 during the third and fourth quarters of 2024. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal (6.0 – 9.0 standard units), and all metal concentrations were below their respective IWQP limits.

9.2.3 Stormwater Outfall 02 – Zone 12 East at South 15th Street

Stormwater discharges that flow through Stormwater Outfall 02 originate from the eastern portions of Zone 12 South, which include some of the operational areas of Pantex. Stormwater from this outfall flows northward and combines with the discharge from Stormwater Outfall 01 as it flows to Playa 1.

Pantex performed permit-required monitoring at Stormwater Outfall 02 during the second and fourth quarters of 2024. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP limits.

9.2.4 Playa 2 Basin

Playa 2 is approximately 74 ac and only receives stormwater runoff. Playa 2 receives runoff from the northwest side of Zone 11, the north side of Zone 10, and an area of agricultural fields that includes both pasture and cultivated land. Three stormwater outfalls, Outfalls 06, 08, and 10, are within the Playa 2 basin. During 2024, Pantex collected samples from all three stormwater outfalls. However, monitoring was not conducted at Playa 2 due to insufficient water levels.

9.2.5 Stormwater Outfall 06 – Vehicle Maintenance Facility

Stormwater Outfall 06 receives stormwater runoff from an area that includes the VMF and portions of the parking lot around the VMF where vehicles awaiting maintenance are staged. Refueling stations for the Pantex fleet are also located in this drainage area. The drainage area is primarily a paved lot used for parking and staging vehicles on the south side of the VMF.

Pantex performed permit-required monitoring at Stormwater Outfall 06 during all four quarters of 2024. Activities included visual monitoring, pH testing, total petroleum hydrocarbons (TPHs) analysis, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP and pH was normal. All TPH results were below laboratory-detection limits, indicating that runoff from the VMF is not contributing significant hydrocarbon pollutants to the environment. All metal concentrations were below their respective IWQP limits.

9.2.6 Stormwater Outfalls 08 and 10 – Landfill

Stormwater outfalls 08 and 10 receive stormwater runoff from an area within Pantex's active landfill. Runoff from active open landfill cells is retained within each cell. Stormwater at these outfalls consists of runoff over the landfill area, including runoff over closed cells. Stormwater from this area eventually makes its way northward to Playa 2.

Pantex performed permit-required monitoring at Stormwater Outfalls 08 and 10 during the second, third, and fourth quarters of 2024. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP limits. Sector-specific monitoring is required at these locations and includes TSS and iron. TSS concentrations averaged 82.3 mg/L for the year, which is below the benchmark level of 100 mg/L. Iron concentrations averaged 3.1 mg/L for the year, which is above the benchmark level of 1.3 mg/L. However, background samples collected outside the landfill area have confirmed that iron is naturally occurring in the soils at Pantex and are not indicative of a contaminant problem. Depending on the lack of vegetative cover during drought conditions and the severity of each storm event, this naturally occurring analyte can be easily entrained in stormwater runoff at levels well above the benchmark limits from any area at the site. As a best management practice, Pantex continues to monitor the landfill area for erosion issues and implements stabilization controls as needed.

9.2.7 Playa 3 Basin

Playa 3, the smallest playa lake at Pantex, is approximately 54 ac and receives stormwater runoff from pastureland, cultivated fields, and portions of the Burning Ground. No well-defined ditches feed into the playa, and runoff occurs primarily as sheet flow. Stormwater Outfall 07 is located within the basin and is northeast of the playa, between the playa and the Pantex Burning Ground. During 2024, Pantex collected samples within the Playa 3 basin at Stormwater Outfall 07. However, monitoring was not conducted at Playa 3 due to insufficient water levels.

9.2.8 Stormwater Outfall 07 – Burning Ground

Stormwater Outfall 07 receives stormwater runoff from the Burning Ground operational area through a culvert that underlies a circumferential road around the Burning Ground, a relatively small land area. For this reason, sampling at the outfall can be a challenge.

Pantex performed permit-required monitoring at Stormwater Outfall 07 during the fourth quarter of 2024. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP limits.

9.2.9 Playa 4 Basin

Playa 4 is approximately 112.5 ac and is located on property owned by TTU. This playa lake receives runoff primarily from pasture areas, but it does receive stormwater runoff from portions of Zone 10 (through Stormwater Outfall 05), Zone 11 (through Stormwater Outfall 04), and Zone 12 South (through Stormwater Outfall 03). Discharges from Zone 12 are predominately stormwater runoff; however, Pantex Fire Department personnel periodically flush firewater storage tanks or test fire hydrants in sufficient volumes that can reach Stormwater Outfall 03. During 2024, Pantex collected samples at Stormwater Outfalls 03, 04, and 05. However, monitoring was not conducted at Playa 4 due to insufficient water levels.

9.2.10 Stormwater Outfall 03 – Zone 12 South

Surface water monitored at Stormwater Outfall 03 is primarily stormwater runoff from the west half of Zone 12 South. Stormwater flows southward through this outfall to Playa 4 where it finally discharges. Periodically, water from the fire protection system is discharged through this outfall during routine maintenance activities.

Pantex performed permit-required monitoring at Stormwater Outfall 03 during all four quarters of 2024. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP limits.

9.2.11 Stormwater Outfall 04 – Zone 11 South

Surface water monitored at Stormwater Outfall 04 is entirely stormwater runoff from the southern half of Zone 11. Stormwater from this area discharges southward through the outfall to Playa 4. The terrain in this area is very flat and all operations occur indoors.

Pantex performed permit-required monitoring at Stormwater Outfall 04 during the second, third, and fourth quarters of 2024. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP limits.

9.2.12 Stormwater Outfall 05 – Zone 10 South

Surface water monitored at Stormwater Outfall 05 is entirely stormwater runoff from the southern half of Zone 10. The terrain in this area is also very flat and includes several contractor laydown yards. Some of the laydown yards contain material staging areas, waste bins used primarily for scrap metal, and double-walled aboveground storage tanks used for equipment refueling.

Pantex performed permit-required monitoring at Stormwater Outfall 05 during all four quarters of 2024. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP limits.

9.2.13 Pantex Lake

Pantex Lake is the largest playa lake controlled by DOE and is approximately 337 ac in size. This playa lake is located approximately 2.5 miles to the northeast from the main Pantex site. Monitoring at Pantex Lake was discontinued in 2003, as it does not receive any runoff or discharges from Pantex.

9.3 CONCLUSIONS

Monitoring stormwater runoff at Pantex is performed as required by the TCEQ's general permit. Sampling results from the stormwater outfalls during 2024 showed no significant changes from the results of previous years. All monitoring results for metals were below their respective IWQP limits established by the State of Texas. Sample results continue to indicate that the stormwater discharges at Pantex are of good quality and that current operations are not degrading stormwater quality.

The playa lakes at Pantex are monitored as a best management practice, but monitoring is often limited due to the semi-arid climate of the Texas Panhandle. The playa lake sample results obtained during 2024 were very similar to past monitoring results. The playa lake data continues to support the premise that operations at Pantex are not negatively affecting the water quality of the playas.

CHAPTER 10 - SOILS

In accordance with the Pantex Hazardous Waste Permit/Compliance Plan No. HW-50284 and the Pantex Texas Land Application Permit (TLAP) WQ0004397000, surface and subsurface soil samples are collected and analyzed for various parameters.

Chapter Highlights

- Results of soil monitoring conducted at the subsurface irrigation site were consistent with historical and the previous year's results.
- Results of soil monitoring conducted at the surface irrigation site were consistent with baseline monitoring results.
- On-site Burning Ground surface soil monitoring results were below the concentration ranges of the established background levels.

10.1 SOIL SAMPLING AT PANTEX

Surface soil samples are collected at the Pantex Burning Ground and analyzed for metals and explosives in accordance with Provision VI.C of the Pantex Hazardous Waste Permit/Compliance Plan No. HW-50284. Subsurface soil samples are also collected from subsurface and surface irrigation tracts and analyzed for various parameters in accordance with Provision V.O and V.P of TLAP WQ0004397000. All samples are analyzed by off-site contract laboratories that meet EPA requirements as discussed in Chapter 12, "Quality Assurance." Specific analytes are listed in Appendix C.

10.2 BURNING GROUND SURFACE SOIL SAMPLING AND ANALYSIS

In 2024, surface soil samples were collected from two general landscape positions: playa lake bottoms and inter-playa lake uplands. The characteristic soil types for these landscape positions are Randall clay in playa lakes, and Pullman clay loam in the uplands. Soil was sampled at five on-site locations, representing three upland and two playa-sampling areas associated with the Burning Ground. Samples from each associated grid area (Figure 10.1) were collected from a depth of 0 to 2 in. and combined to form individual composite samples.

10.2.1 Surface Soil Data Comparisons

Background comparison levels were determined by obtaining samples during three consecutive calendar quarters in 2006 for each monitoring parameter required Pantex Hazardous Waste Permit/Compliance Plan No. HW-50284. If all analytical results of the background samples for a particular constituent at any location were less than the method detection limit (MDL) identified in the permit, the background value was set at the MDL or the PQL, whichever was greater. If less than 50% of the analytical results of the background samples for a particular constituent at any location were greater than the MDL, the background value was set at the highest detected value, the MDL, or the PQL, whichever was greater. If the analytical results of more than 50% of the background samples for a particular constituent at any location were greater than the MDL, the background value was calculated using a 95% upper tolerance limit with 99.9% coverage.

10.2.2 Surface Soil Metals Analysis

Soil samples collected from the Burning Ground and Playa 3 were analyzed for 10 metals (see the "Burning Ground Soil" column in Appendix C). All of the metal concentrations observed in 2024 were below the established permit background concentrations and are reported in Appendix D.

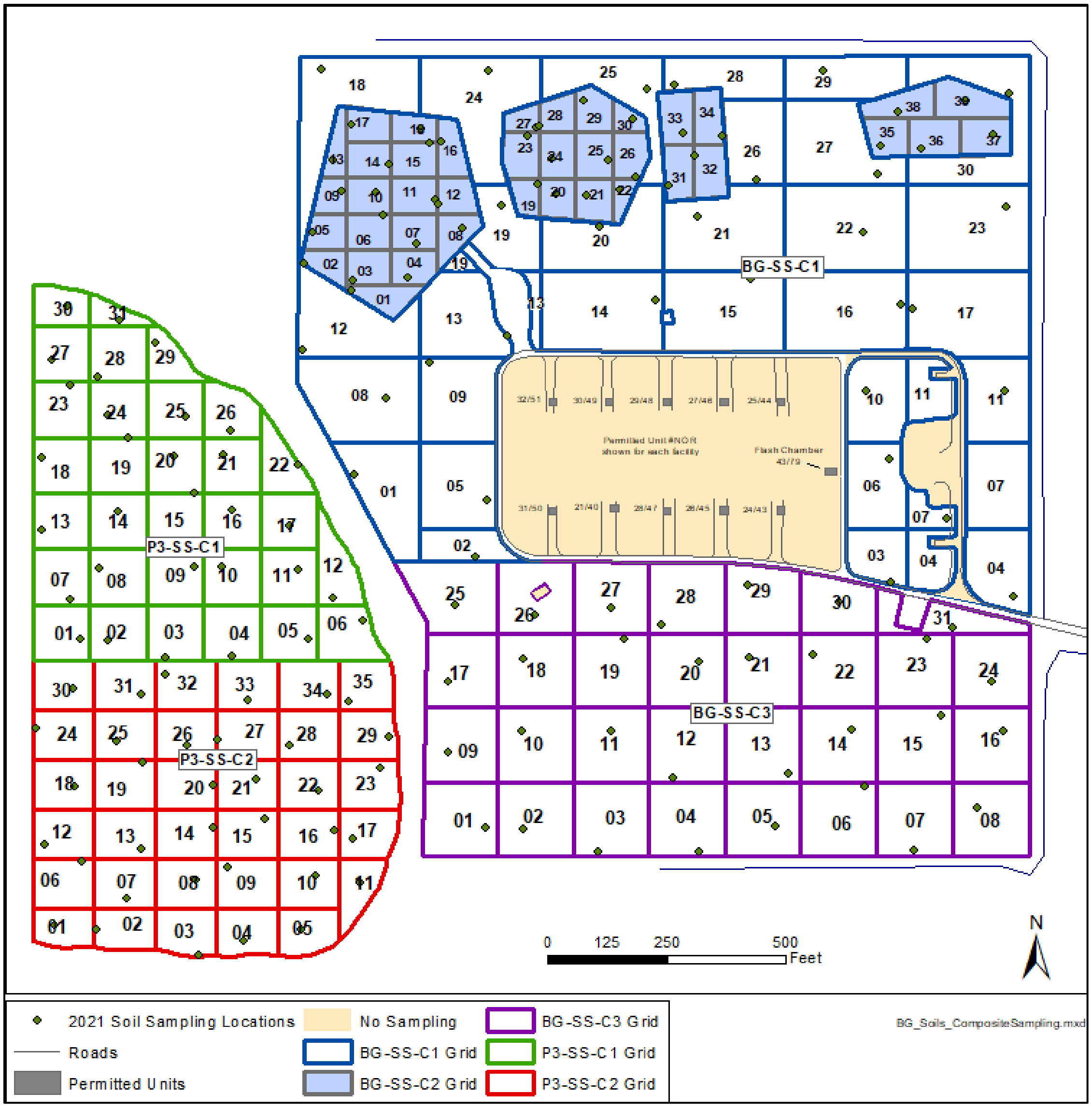

Figure 10.1 Burning Ground multi-incremental soil sampling locations for 2024

10.2.3 Surface Soil Explosives Analysis

Soil samples collected from the Burning Ground and Playa 3 were analyzed for eight explosive compounds (Appendix C). All sampling results for explosives in 2024 were below the established permit background concentrations as shown in Tables D1.1 through D1.5 in Appendix D.

10.3 SUBSURFACE DRIP IRRIGATION SYSTEM SOIL SAMPLING AND ANALYSIS

In 2024, the annual TLAP subsurface drip irrigation system soil samples were collected from three locations: Tract 101, Tract 201, and Tract 301, with each tract representing approximately 100 ac. Representative soil samples were collected using random sampling and composite techniques from the root zones of the irrigation areas. Each composite sample represented no more than 40 ac with no less than two soil cores representing each composite sample. Subsamples were composited by like sampling depth and soil type and collected individually at depths of 0 to 12 in. and 12 to 24 in. for analysis and reporting (Figure 10.2).

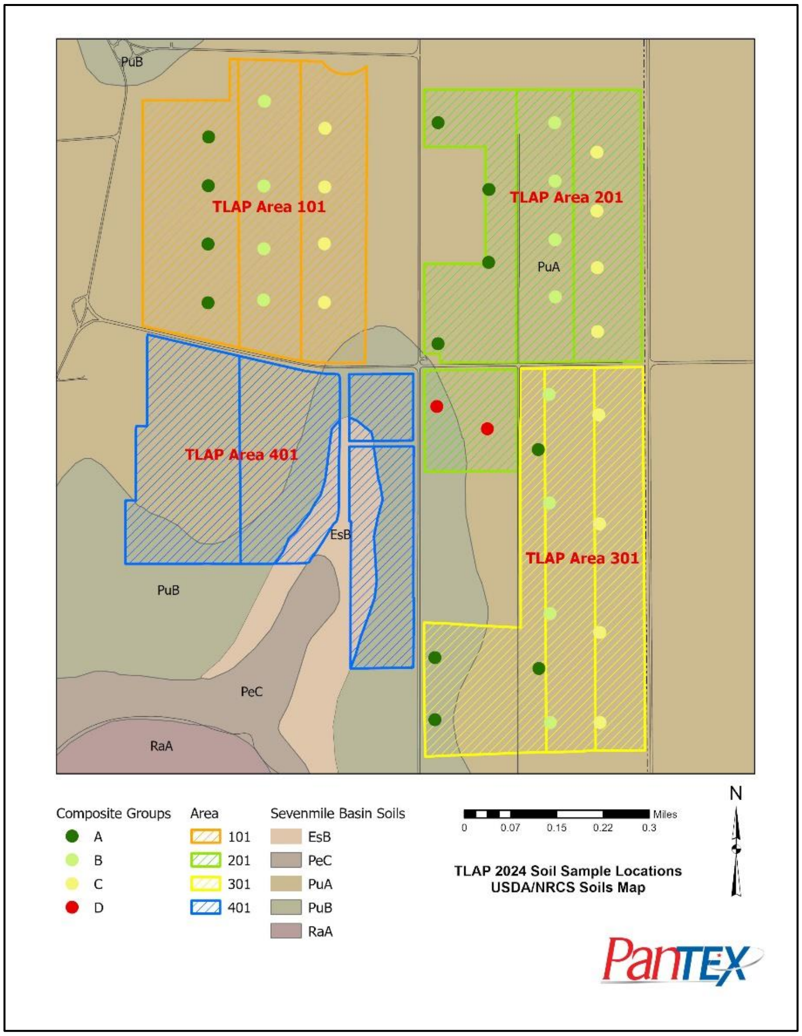

Figure 10.2 TLAP subsurface drip irrigation soil-sampling locations for 2024

These composite samples were analyzed for agricultural parameters, reactivity, two HEs, and one semi-volatile organic compound. See the "TLAP Soil" column in Appendix C for specific analytes.

10.3.1 Subsurface Drip Irrigation System Soil Sampling Results

The 2024 subsurface soil sampling results for HE, reactivity, and semi-volatile organic compound were all non-detects. The results of the agricultural parameters (nutrient parameters analyzed on a plant-available or extractable basis) are presented in Tables D1.6 through D1.8 in Appendix D. The TLAP subsurface soil sampling results are reported annually to the TCEQ as report-only information, with no comparison values. The agricultural parameters are also used for decision making regarding the addition of nutrient amendments to the agricultural soils.

10.4 SURFACE IRRIGATION SYSTEM SOIL SAMPLING AND ANALYSIS

In 2024, the annual TLAP surface irrigation system soil samples were collected from three locations: Pivot 3, Pivot 4, and Pivot 5. Each center pivot tract represents approximately 115 ac subdivided into north and south halves. Representative soil samples were collected from the root zones of the irrigation areas using random sampling and composite techniques. Each composite sample represented no more than 80 ac with no less than two soil cores representing each composite sample. Subsamples were composited by like sampling depth and soil type and individually at depths of 0 to 6 in., 6 to 18 in., and 18 to 30 in. for analysis and reporting (Figure 10.3). These composite samples were analyzed for agricultural parameters, reactivity, two HEs, and one semi-volatile organic compound. See the "TLAP Soil" column in Appendix C for specific analytes.

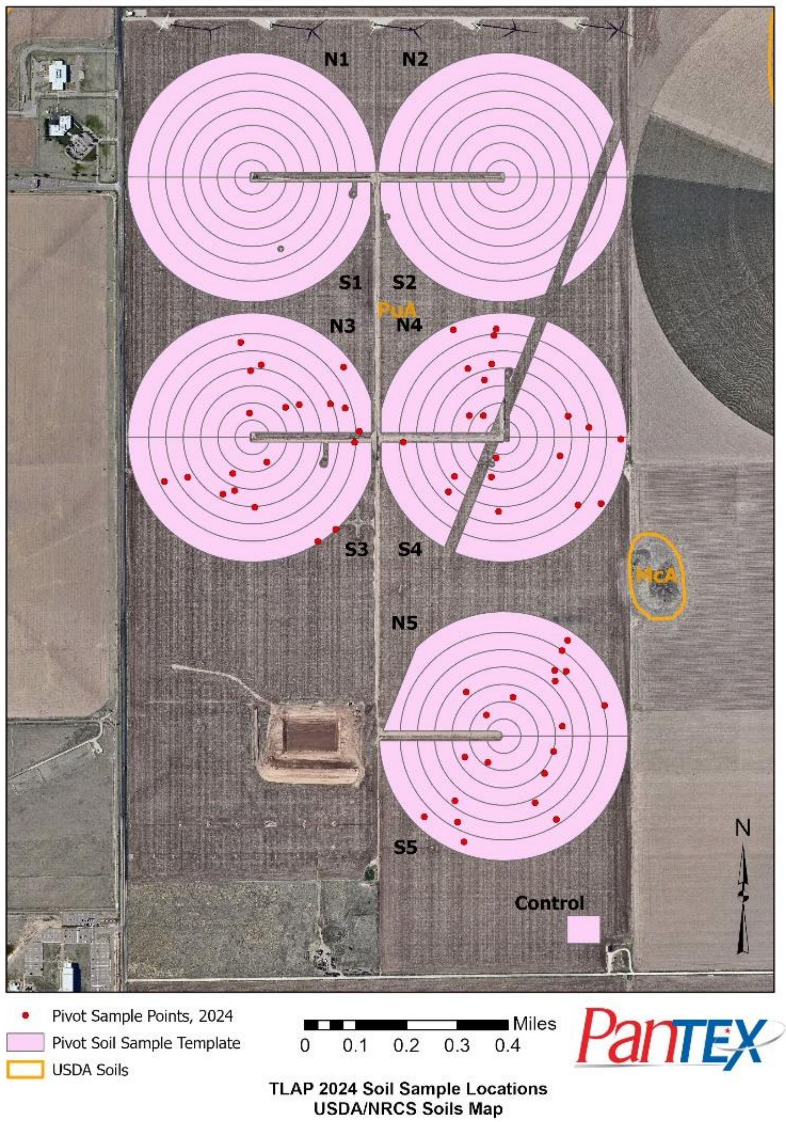

Figure 10.3 TLAP Center-Pivot irrigation soil-sampling locations for 2024

10.4.1 Surface Irrigation System Soil Sampling Results

The 2024 surface irrigation soil sampling results for HE, reactivity, and semi-volatile organic compounds were all non-detect. The results of the agricultural parameters (nutrient parameters analyzed on a plant-available or extractable basis) are presented in Tables D1.9 through D1.11 in Appendix D. The TLAP surface soil sampling results are reported annually to the TCEQ as report-only information, with no comparison values. The agricultural parameters are also used for decision making regarding the addition of nutrient amendments to the agricultural soils.

10.5 CONCLUSIONS

On-site Burning Ground surface soil monitoring results for 2024 were within the concentration ranges of the established background levels. Results of soil monitoring conducted at the surface and subsurface irrigation systems for 2024 were consistent with previous year's results and indicate operations are having no negative impact on the environment.

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Chapter 11 - FLORA AND FAUNA

The flora and fauna surveillance programs at Pantex are complementary to the air and water monitoring programs. These programs are designed to augment the assessment of potential short-term and long-term effects to the environment as a result of operations at Pantex. The program samples native vegetation, crops, and native animals for radionuclide analyses.

Chapter Highlights

- Radionuclide measurements in flora and fauna samples from on and near Pantex were similar to historical data and samples from the control location, indicating no influence from Pantex operations in 2024.

11.1 FLORA AND FAUNA SELECTION AT PANTEX

Figure 11.1 Checkered white butterfly on Frogfruit flowers

Photo by Katie Paul

Flora at Pantex consists of native vegetation and crops. Native vegetation species on the Southern High Plains consist primarily of prairie grasses and forbs. Crops are defined as any agricultural product harvested or gathered for animal or human food. Because vegetation species accumulate contaminants differently under varied growing conditions, data interpretation is complex, and results must be evaluated in concert with other environmental media (Figure 11.1).

Black-tailed prairie dogs were the primary species selected for sampling because of their place near the end of both the air and water pathways as well as their diet which consists of a wide variety of flora. Due to their regular proximity to potential sources of radionuclide contamination, cottontails residing in certain locations are regularly sampled as well.

Radionuclide concentrations in all samples were compared to historical and control location sample concentrations. Control locations are selected primarily due to their distance from Pantex. Distance and direction of prevailing winds in the area make it extremely unlikely that there has been any impact from Pantex operations past or present at these locations. Due to this separation, any detected concentration of radionuclides is assumed to be either naturally occurring materials or legacy fallout from Cold War-era nuclear weapons testing. Availability of routine access, lack of industrial activity, and the presence of typical Southern High Plains flora and fauna are also secondary factors considered when selecting background locations.

11.2 RADIOLOGICAL SURVEILLANCE IN FLORA

Surveillance of native vegetation at on-site and off-site locations is used to monitor any potential impacts from current Pantex operations. Samples are collected from locations on-site, at the perimeter of the property, and up to approximately five miles from the center point of Pantex (Figures 11.2 and 11.3). Rotational crops are also sampled (Figure 11.4) as available. Background samples of crop and native vegetation species were collected from control locations at the United States Department of Agriculture research farm in Bushland, Texas.

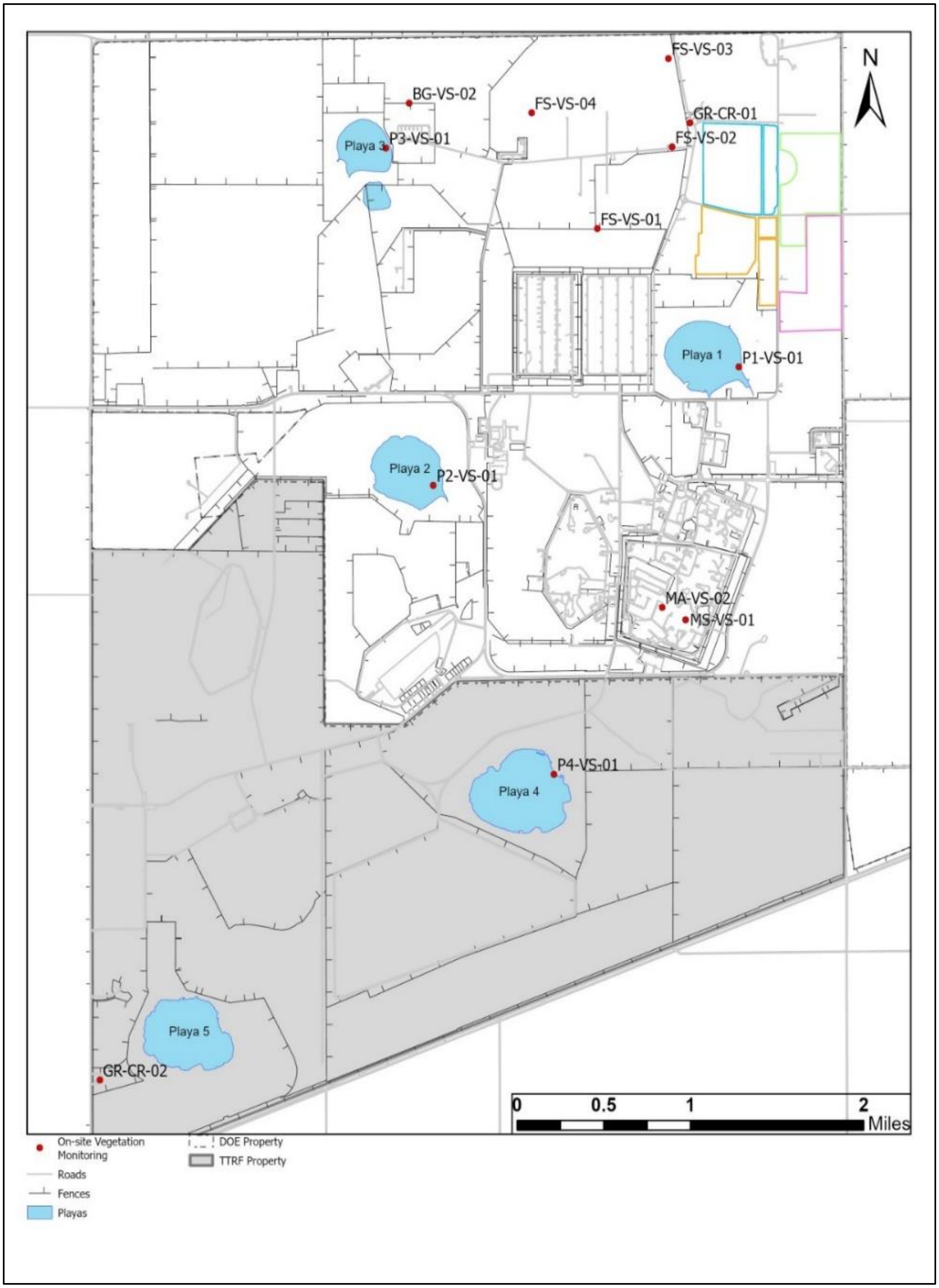

Figure 11.2 On-site vegetation-monitoring locations

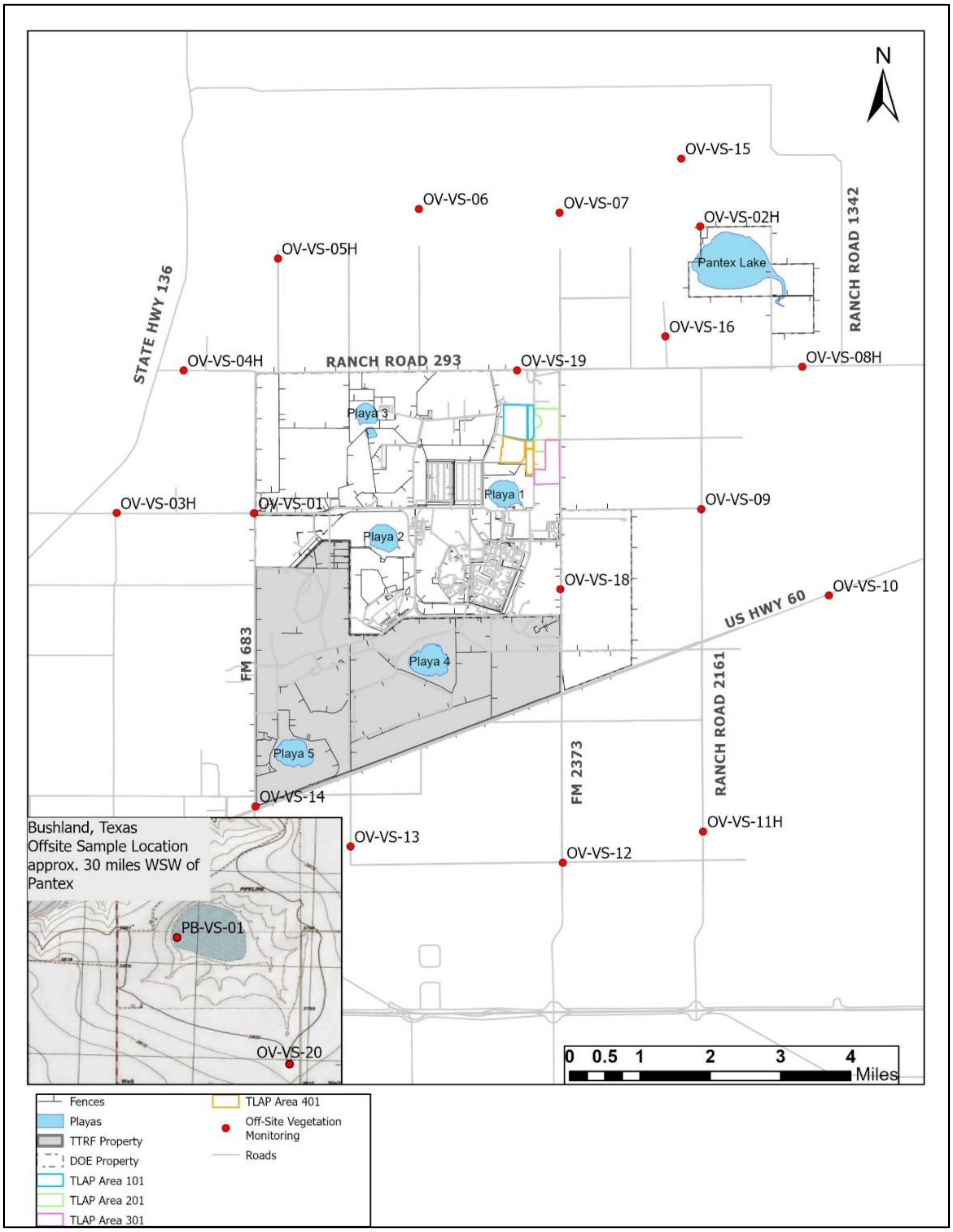

Figure 11.3 Off-site vegetation-monitoring locations

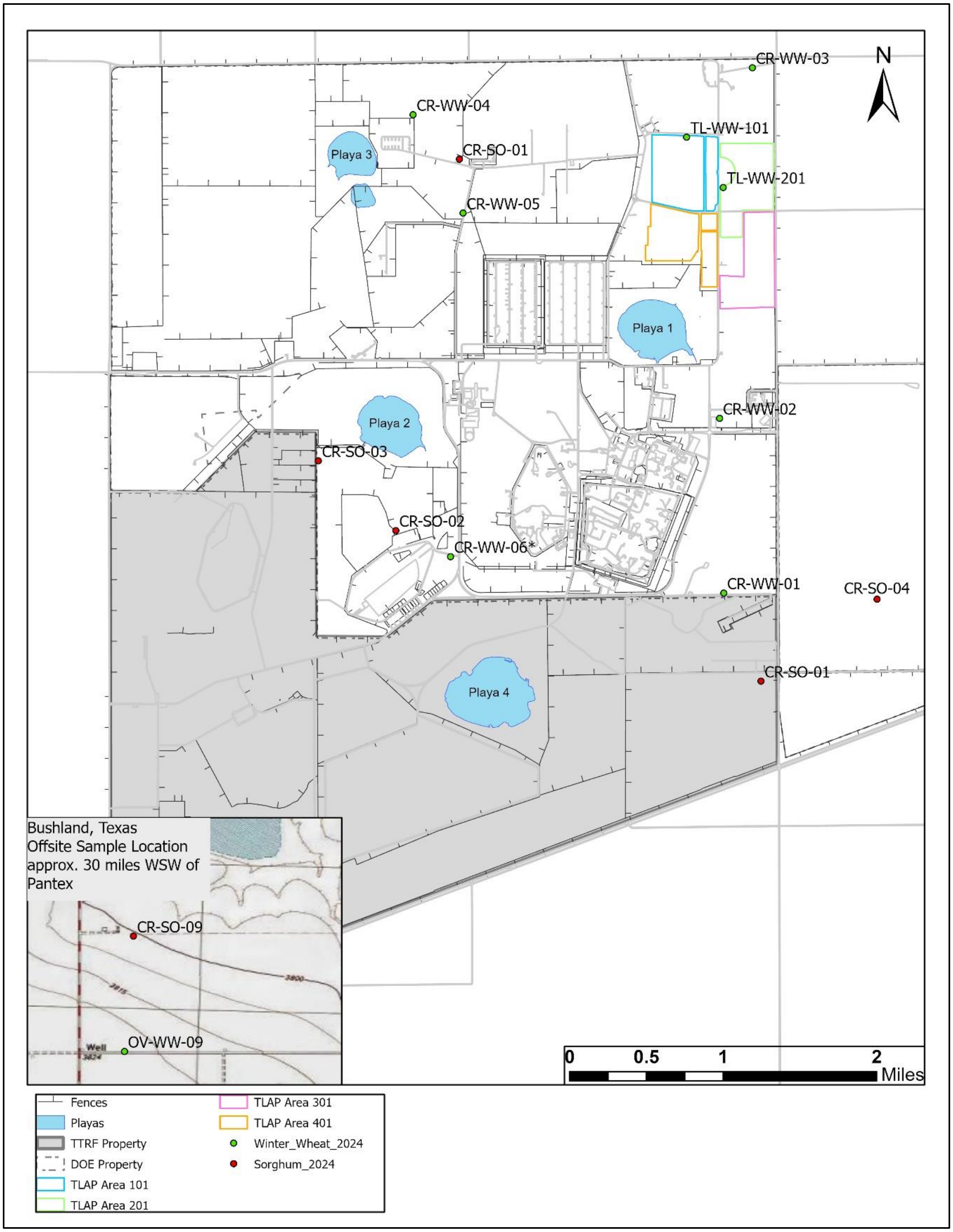

Figure 11.4 Crop-monitoring locations for 2024

NOTE: On Figures 11.2, 11.3, and 11.4, the following designations: B-Bushland, BG-Burning Ground, CR-crops, FS-Firing Sites, GR-garden produce, MA-Material Access Area, O-off-site, P-playa, S-sample, SO-grain sorghum, TL-Texas Land Application Permit, V-vegetation, and WW-winter wheat. Any sample location with H behind it is historical and is not currently being sampled.

Sampling locations are circles, approximately 33 ft in diameter, from which vegetation is collected, when it is available. Drought, cultivation, excessive grazing, prescribed burning and/or mowing may limit vegetation availability during certain parts of the growing season. Vegetation samples were analyzed for tritium, U-233/234, and U-238. Analytical data were corrected for moisture content and reported in pCi/g dry weight.

The on-site and off-site data were compared to those from the control locations and six-year mean values, where possible, to identify and interpret differences. Although the DOE limits the dose to terrestrial plants to one rad/day (see Chapter 4), there are currently no limiting concentrations for tritium or uranium in vegetation.

11.2.1 Native Vegetation

Native vegetation samples, consisting primarily of stem and leaves from grasses and forbs, were collected from two control locations, 10 on-site locations, and six off-site locations. Sampling occurred two times during the growing season, no more frequently than once per month.

Over 98% of tritium results from all on-site and off-site sample locations were at or below MDA levels; only one sample result from an off-site location had a detectable level of tritium. This is most likely due to natural seasonal variations or an off-site source not related to Pantex (Table 11.1).

Table 11.1 Vegetation Comparison of Tritium 2024, Control Location, and Highs for the Year

Sampling Location	Tritium pCi/g + Error
OV-VS-14	1.06±0.62
P4-VS-01	<Minimum Detectable Activity (MDA)
OV-VS-20 (control)	<MDA

The percentage of vegetation samples at or below the MDA level for U-233/234 and U-238 in all vegetation was 96% for U-233/234 and 93% for U-238. Usually, the percentage of vegetation samples at or below the MDA level is near 50%. The measured values in general for locations for the year were not significantly elevated and were comparable to the control location (Table 11.2). Results for all on-site and off-site locations were consistent with those found in previous years. Concentration of U-233/234 and U-238 in native vegetation indicates that no uptake of U-233/234 and U-238 into vascular plants has occurred.

Table 11.2 Native Vegetation Comparison of U-233/234 2024, Control Location and Highs

Sampling Location	U-233/234 pCi/g + Error
FS-VS-04	0.009±0.009
OV-VS-19	0.015±0.012
PB-VS-01 (control)	<Minimum Detectable Activity

11.2.2 Crops

Crop surveillance enables the evaluation of potential impacts to humans and livestock from Pantex operations. Samples of stems and leaves from dryland and irrigated grain sorghum were collected from on-site locations and from the Bushland, Texas control location.

Crop sampling locations vary annually according to crop rotation. Garden produce was sampled at two specially grown garden locations: one on the northeast side of Pantex property and one on the southwest side of the TTU property (Figure 11.2).

Six dryland grain sorghum samples, a duplicate sample, and a control sample were collected in September 2024 (Figure 11.4). There was adequate moisture to produce dryland winter wheat in 2024 and there were no issues collecting samples; eight samples, a duplicate, and a control sample were collected in April 2024. Fruits and leaves from garden plants were sampled in September 2024.

All crop and garden samples were analyzed for tritium, U-233/234, and U-238. All crop and garden produce analyzed in 2024 was at or below the MDA level for tritium. A vast majority of the crop and garden produce samples analyzed in 2024 were at or below MDA levels for U-233/234 and U-238 and were comparable to the off-site control location. All crop and garden results were similar to historical data. Results for crop and garden locations are in Table 11.3 and Table 11.4. Concentrations of U-233/234 and U-238 in crop and garden vegetation indicate no uptake of U-233/234 and U-238 into vascular plants has occurred due to activities at Pantex and that the radiological dose to terrestrial plant of one rad/day, as indicated in DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota,* has not been exceeded.

Table 11.3 Crop Comparison of Tritium 2024, High Locations and Control Location

Sampling Location	Tritium pCi/g + Error
CR-SO-03	<Minimum Detectable Activity (MDA)
GR-CR-02	< MDA
OV-WW-09 (control)	<MDA
OV-SO-09 (control)	<MDA

Table 11.4 Crop Comparison of U-233/234 and U-238 2024, High Locations and Control Location

Sampling Location	U-233/234 (pCi/g) + Error	U-238(pCi/g) + Error
CR-SO-04	0.008±0.007	<Minimum Detectable Activity (MDA)
TL-WW-101	0.013±0.012	<MDA
OV-WW-09 (control)	<MDA	<MDA
OV-SO-09 (control)	<MDA	<MDA

11.3 RADIOLOGICAL SURVEILLANCE IN FAUNA

Semi-annual radionuclide surveillance of fauna (prairie dogs and cottontails) at Pantex was scheduled at six on-site locations and one control location. The sites were as follows:

- Burning Ground
- Firing Site 4 (FS-4)
- West of Zone 4
- Playa 2
- Playa 3
- Zone 8
- Control site, Buffalo Lake National Wildlife Refuge near Umbarger, Texas

Buffalo Lake National Wildlife Refuge was chosen as the control site because fauna populations there are far enough from Pantex (41 miles) to be unaffected by Pantex operations and affords a dependable availability of prairie dogs and property access. Prairie dogs at Playa 3 and rabbits from Zone 12 south were not available in 2024.

Sample animals are live-trapped, humanely euthanized, and shipped to the analytical lab. Whole-body composites are prepared for determination of tritium, U-233/234, and U-238 activities. These radionuclides are associated with activities at Pantex but are also naturally occurring in soils at and around Pantex. Analytical results of the 2024 faunal sampling are presented in Table 11.5 and Table 11.6.

Twenty-four prairie dogs were sampled during 2024. Results were similar to or less than historic data, and all were below the MDA. Six cottontail rabbits were sampled in 2024. Results were similar to historic data, and all samples were below the MDA. None of the results exceeded any of the BCGs for the analyzed radionuclides and thus would not be expected to cause a dose exceeding 0.1 rad/day for terrestrial animals.

Table 11.5 Tritium, U-233/234, and U-238 in Prairie Dogs in 2024, in pCi/g Dry Weight

Location	No. of Samples (# ≤ MDA)	Maximum[a]	Minimum[a]	Mean ± Std.[b]
Tritium				
Zone 4 (W)	4(4)	<Minimum Detectable Activity (MDA)	<MDA	<MDA
Zone 8	4 (4)	<MDA	<MDA	<MDA
Playa 2	4 (4)	<MDA	<MDA	<MDA
Burning Ground	4 (4)	--	--	--
Playa 3	--[c]	--	--	--
FS-4	4 (4)	<MDA	<MDA	<MDA
Buffalo Lake	4 (4)	<MDA	<MDA	<MDA
U-233/234				
Zone 4 (W)	4(4)	<MDA	<MDA	<MDA
Zone 8	4 (4)	<MDA	<MDA	<MDA
Playa 2	4 (4)	<MDA	<MDA	<MDA
Burning Ground	4 (4)	--	--	--
Playa 3	--[c]	--	--	--
FS-4	4 (4)	<MDA	<MDA	<MDA
Buffalo Lake	4 (4)	<MDA	<MDA	<MDA
U-238				
Zone 4 (W)	4(4)	<MDA	<MDA	<MDA
Zone 8	4 (4)	<MDA	<MDA	<MDA
Playa 2	4 (4)	<MDA	<MDA	<MDA
Burning Ground	4 (4)	--	--	--
Playa 3	--[c]	--	--	--
FS-4	4 (4)	<MDA	<MDA	<MDA
Buffalo Lake	4 (4)	<MDA	<MDA	<MDA

[a] Counting error at 95% confidence level; the second of each paired set of values in the "Maximum" and "Minimum" columns
[b] Standard deviation
[c] Prairie dogs unavailable

Table 11.6 Tritium, U-233/234, and U-238 in Cottontail Rabbits in 2024 in pCi/g Dry Weight

Location	No. of Samples (# ≤ MDA)	Maximum[a]	Minimum[a]	Mean ± Std.[b]
Tritium				
Zone 4	4(4)	<Minimum Detectable Activity (MDA)	<MDA	<MDA
Zone 12 South	--[d]	<MDA	<MDA	<MDA
Buffalo Lake[c]	2 (2)	<MDA	<MDA	<MDA
U-233/234				
Zone 4	4(4)	<MDA	<MDA	<MDA
Zone 12 South	--[d]	<MDA	<MDA	<MDA
Buffalo Lake	2 (2)	<MDA	<MDA	<MDA
U-238				
Zone 4	4(4)	<MDA	<MDA	<MDA
Zone 12 South	--[d]	<MDA	<MDA	<MDA
Buffalo Lake	2 (2)	<MDA	<MDA	<MDA

[a] Counting error at 95% confidence level; the second of each paired set of values in the "Maximum" and "Minimum" columns is the "error"
[b] Standard deviation (see definition in glossary)
[c] Control site
[d] Rabbits unavailable

11.4 CONCLUSIONS

Radionuclide concentrations in vegetation samples were comparable to values observed in samples from control locations and historical data. These data indicate the uptake of radionuclides by vegetation on or near Pantex is similar to uptake occurring in vegetation at the control location.

Radionuclide concentrations in fauna samples were comparable to values observed in samples from control locations and historical data. The majority of radionuclide analyses in sampled prairie dogs was reported to be below the MDA. These results indicate that uptake of radionuclides by fauna on Pantex is similar to uptake by fauna at the control location.

CHAPTER 12 - QUALITY ASSURANCE

Due to its unique mission and service to the country, Pantex must operate as a High Reliability Organization. High reliability includes robust Quality Assurance (QA) that ensures all environmental monitoring data provides definitive evidence of regulatory compliance and protection of human health and the environment. The complexity of analytical chemistry and radiochemistry performed to support environmental monitoring programs necessitates that Pantex maintain an unparalleled QA and Quality Control (QC) program that meets the need for high reliability.

Chapter Highlights

- More than 99% of the 2024 analytical results were usable for making environmental decisions.
- All Pantex requirements for subcontract laboratories were met.

12.1 QUALITY ASSURANCE AT PANTEX

Pantex has an established a QA/QC program designed to ensure the reliability of analytical data used to support all site environmental programs. This program also satisfies the quality requirements implemented under the following:

- CERCLA ROD,
- TCEQ authorizations,
- DOE O 414.1D, *Quality Assurance, and*
- ISO 14001:2015, *Environmental Management Systems – Requirements with Guidance for Use.*

During 2024, the QA/QC program enhanced the reliability of data acquired for environmental monitoring, which includes air, soil, groundwater, surface water, flora, and fauna programs.

The ultimate goal of the Pantex environmental monitoring QA/QC program is to consistently generate reliable, high-quality environmental monitoring data. One measure of success for this QA/QC program is the amount of usable environmental data based on technical acceptance criteria for chemical and radiochemical measurements. By providing consistently usable data, Pantex fosters a high degree of confidence for regulatory compliance and protection of human health and the environment with stakeholders. This approach also allows Pantex to provide maximum value for the resources used to acquire environmental monitoring data.

12.2 ENVIRONMENTAL DATA ACQUISITION, PLANNING AND EXECUTION

Acquisition of environmental monitoring data is planned with its end use in mind. Each media scientist or subject matter expert defined the data collection requirements based on program needs and used guidance, such as EPA *QA/G4 Guidance for Data Quality Objective Process* (2006), in developing data quality objectives (DQOs) for data collection. The media scientists prepared the DQOs based on the overall data collection needs, regulatory requirements, stakeholder concerns, technical factors, quality requirements, and historical data in their respective areas of expertise.

The approved DQO for a specific monitoring program was scheduled and executed by using technical specifications in the DQO. This included sample location, sampling frequency, analytical method, and data acceptance criteria. During 2024, each DQO was associated with a procedure, defining requirements for sample collection, and data management. Procedures were reviewed and updated, as necessary, to reflect new requirements in associated DQOs or enhancements to the sample collection and data management process.

12.3 ENVIRONMENTAL DATA QUALITY ASSURANCE AND CONTROL

Pantex relies on a robust quality system. The intent of this system is to integrate and manage quality elements for field sampling, laboratory analysis, data management, and to monitor and control factors that affect overall data quality. Components of this quality system are described below.

12.3.1 Field Assessments/Surveillances

Internal assessments/surveillances are conducted annually, at a minimum, on representative field operations. These assessments are used to assure the reliability and defensibility of analytical data acquired to support environmental monitoring programs. They are also a tool for continuous improvement of sampling operations, administrative functions, control procedures, and quality systems. Activities reviewed in the field assessment may include calibration and documentation for field equipment, proper field sampling procedures, provisions for minimization of potential sample contamination, compliance with chain-of-custody procedures, sample documentation, and sample transfer to the laboratory.

12.3.2 Recordkeeping

All environmental records and documents are issued, revised, controlled, stored, and archived in accordance with the requirements of Pantex.

12.3.3 Quality Plan Requirements for Subcontract Laboratories

Subcontract laboratories are accredited by The National Environmental Laboratory Accreditation Conference Institute in accordance with Title 30 of the TAC, Chapter 25, for all parameters within the scope of work provided by Pantex. Exceptions might be made when National Environmental Laboratory Accreditation Conference Institute accreditation is not available.

Each subcontracted laboratory must be qualified by Pantex prior to receiving samples for analysis. The prequalification process includes a review of the technical proposal submitted by the prospective laboratory, successful analysis of performance evaluation (PE) samples, and a systems audit performed by a DOE Consolidated Audit Program (DOECAP) accrediting agency.

In addition to the initial systems audit, all subcontract laboratories must submit to a systems' audit every two years in order to maintain status as a qualified subcontract laboratory. These audits are technical and programmatic and are performed by a DOECAP accrediting agency. Their purpose is to ensure that all existing subcontract laboratories are qualified to provide high-quality analytical laboratory services.

A data package assessment is conducted annually at subcontract laboratories. In this type of assessment, random analytical deliverables are selected, and all the supporting documentation, such as calibration records, method detection limits, and QA/QC reports are reviewed. The subcontracted laboratory is also required to conduct internal audits at least annually to assure they are compliant with the laboratory's quality systems and with the requirements set out in *Pantex Statement of Work for Analytical Laboratories* (Pantex 2020).

Qualified subcontracted laboratories must successfully analyze PE samples semiannually in order to maintain qualified status, and they may be subject to submission of PE samples from Pantex at any time. PE sample analyses are designed to evaluate normal laboratory operations, and evaluation of the PE sample results must consider factors such as identification of false positives, false negatives, large analytical errors, and indications of calibration or dilution errors.

Non-compliance reports are submitted by the laboratory if unacceptable PE results are reported. PE sample requirements may be waived for any analysis in which a suitable PE sample is not available. Sample shipments to a subcontract laboratory may be suspended if it is determined that the laboratory is not capable of meeting the analytical, QA, and deliverable requirements of the statement of work (SOW).

12.4 LABORATORY QUALITY ASSURANCE

During 2024, Pantex used qualified laboratory auditors to participate in data package assessments. All Pantex requirements for the subcontracted laboratories were met. All of the subcontracted laboratories had the proper certifications for analyzing environmental samples from Pantex. They performed the necessary internal audits and participated in the appropriate PE programs. Annual DOECAP audits were also conducted by accrediting agencies. A technical and contractual verification of the laboratory deliverables, performed by staff scientists as analytical results were received from the laboratories, ensured that contractual deliverable specifications, technical content, and QC deliverables complied with statement of work requirements consistent with industry standards.

12.4.1 Data Review and Qualification

Historically, the vast majority of analytical results are usable unless there is a catastrophic QA/QC failure (such as no surrogate or radiotracer recovery) during the analytical process that causes the results to be rejected (declared not usable). Based on industry standard conventions, sample results are qualified as usable by means of various data qualifier flags to alert the end user to any limitations in using the result. This approach was taken to make use of as many sample results as possible without sacrificing quality. Sample results that were completely unusable were rejected and not made available for use in data calculations. Several criteria were used during the verification process so that analytical results could be appropriately qualified. Some of the criteria that caused data to be rejected during the verification process are described below:

- Missed Holding Times: The analysis was not initiated, or the sample was not extracted/prepared, within the time frame required by the EPA method and the SOW.
- Control Limits: A QC parameter, such as a surrogate, spike recovery, response factor, or tracer recovery associated with a sample failed to meet the limits of acceptability.
- Not Confirmed: Analytical methods for HEs and perchlorate may employ enhanced confirmation techniques, such as mass spectral or diode array detectors. This information is used to qualify data obtained from traditional techniques, such as use of a second chromatographic column, which may be prone to matrix interference. Second column confirmation is especially susceptible to false positives when the constituent of interest is at or near the MDL.
- Sample or Blank Contamination: The sensitivity of modern analytical techniques can make it difficult to have a blank sample that is truly analyte-free. This is especially true for inorganic parameters such as metals. When the laboratory either accidentally contaminates the actual sample or the lab blank contains parameters of interest above a control limit, the associated sample results may be rejected.
- Other: This category includes, but is not limited to, the issues listed below:
    - Broken chain-of-custody: There was a failure to maintain proper custody of samples, as documented on chain-of-custody forms and laboratory sample login records.
    - Instrument failure: Either the instrument failed to attain minimum method performance specifications or the instrument or a piece of equipment was not functioning.
    - Preservation requirements: The requirements, as identified by the EPA or a specific method, were not met and/or properly documented.
    - Incorrect test method: The analysis was not performed according to a method contractually required by Pantex.
    - Incorrect or inadequate detection or reporting limit: The laboratory is required to attain specific levels of sensitivity when reporting target analytes, unless matrix effects prevent adequate detection and quantitation of the compound of interest.

Pantex media scientist are alerted to any limitations in the use of the data, based on the DQO requirements. Of the 32,563 individual results obtained in 2024 from all laboratory analyses, 99.28% were deemed to be of suitable quality for the intended end use of the data. Figure 12.1 graphically summarizes the causes for the 0.72% of data rejected.

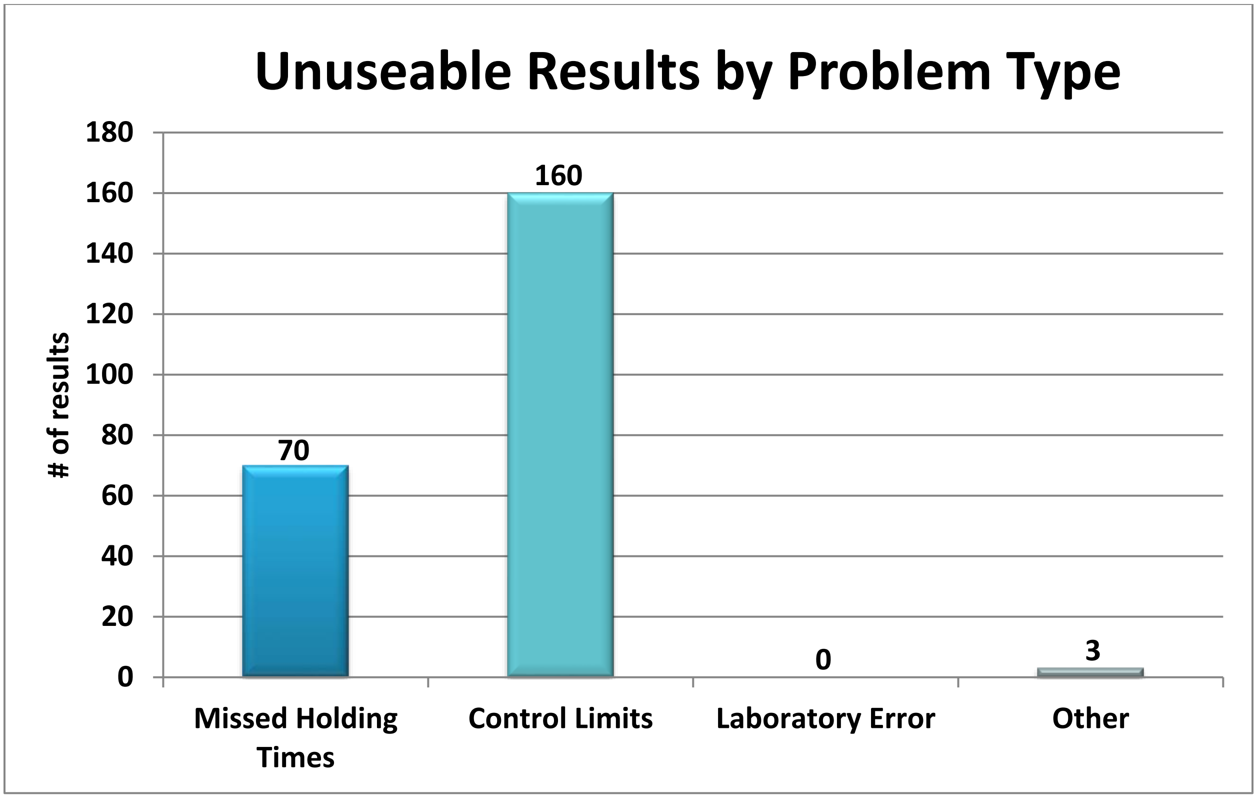

Figure 12.1 2024 Data rejection summary

12.4.2 Laboratory Technical Performance

All subcontract laboratories were required to participate in inter–laboratory–comparison studies administered by a National Environmental Laboratory Accreditation Program and/or DOE-approved provider. In 2024, Pantex off-site subcontract laboratories participated in the Multimedia Radiochemistry (MRaD) PE sample analysis, sponsored by Environmental Resource Associates.

The MRaD samples include radiological compounds in matrices including water, soil, air filters, and vegetation. MRaD results, particularly the results for MRaD Series 40 and 41, for all participating subcontract laboratories used by Pantex in 2024 (GEL and Eurofins TestAmerica) are presented in Figure 12.2. Both subcontract laboratories had acceptable MRaD results in 2024.

The primary purpose of the PE programs is to measure a laboratory's implementation of methods to obtain accurate results and serve as a comparison between laboratories.

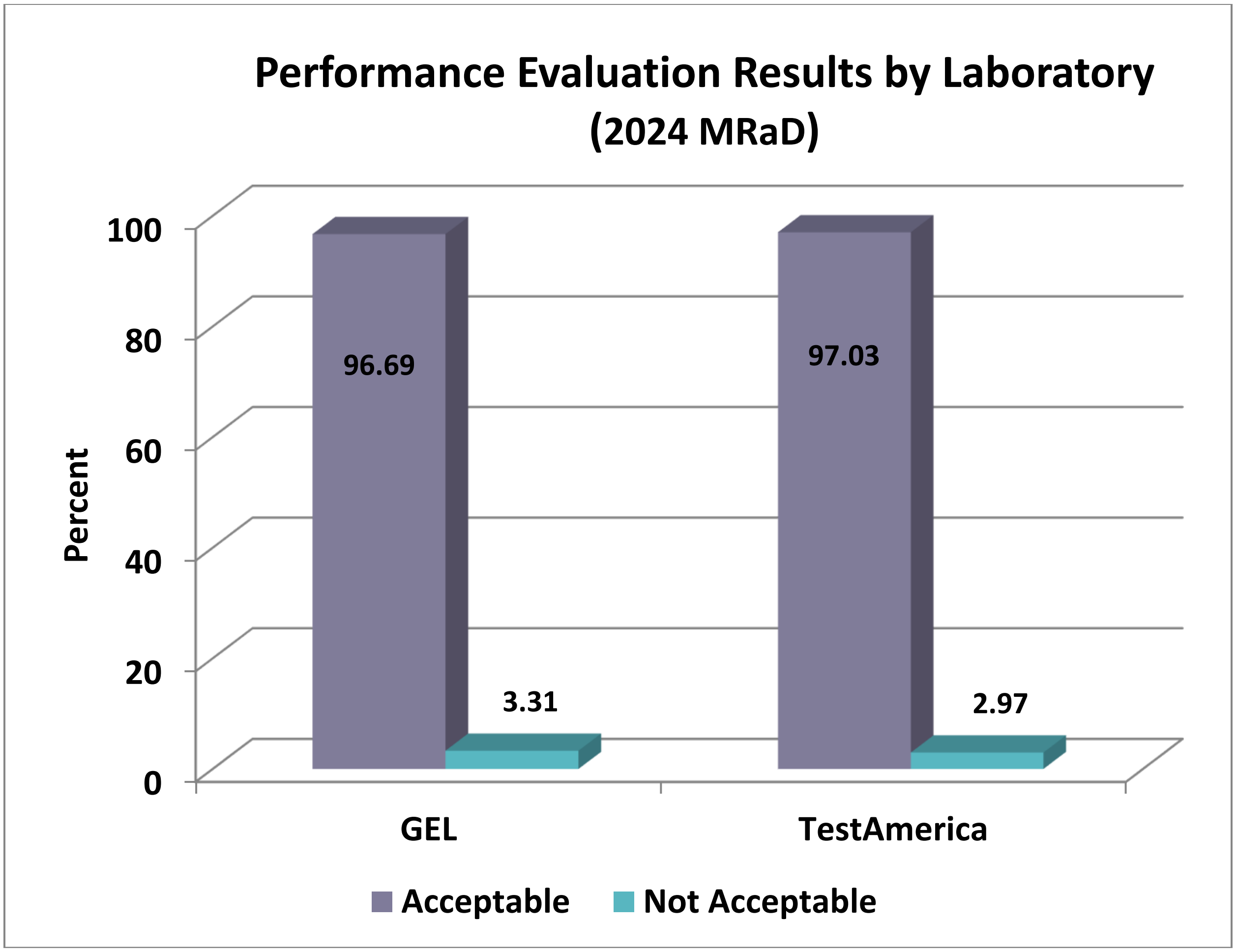

Figure 12.2 2024 Multimedia Radiochemistry results

12.5 FIELD OPERATIONS QUALITY ASSURANCE

QA samples, such as duplicates, replicates, blanks, and equipment rinsates, were collected at intervals specified in the DQOs. This was initiated to allow the media scientists to evaluate the data for potential bias or variability originating from either the sampling or the analytical process.

12.5.1 Duplicate and Replicate Analyses

During 2024, Pantex continued to collect and analyze field duplicate and replicate samples. A true field duplicate sample set consists of a thoroughly homogenized sample collected from one desired location. The sample is split into two discrete samples and may even be labeled as representing two separate sampling locations. When the laboratory is not informed that the two samples are subsamples from a single sampling location, these samples are referred to as blind duplicate samples. When samples are collected from the same site at the same time, the samples are considered field replicates. For comparison purposes, field duplicates and field replicates are evaluated by the same criteria. Random replicate samples were collected for all media except air and fauna. These exceptions are based upon the uniqueness of the sample type and the inability to replicate the sample.

The vegetation program's isotopic uranium data were analyzed to compare actual sample values to field replicate values. This program was chosen for statistical analysis because of the relatively high number of replicates required during the sample-collection process. The replicate error ratio (RER) was used to perform the replicate analysis. The ratio takes into account the sample and replicate uncertainty to determine data variability. The RER is given by:

RER = | S – R | / (σ95S + σ95R) where
RER = replicate error ratio,
S = sample value (original),
R = replicate sample value,
σ95S = sample uncertainty (95%), and
σ95R = replicate uncertainty (95%).

An RER of less than or equal to 1 indicates that the replicates are comparable within the 95% confidence interval. For 2024, the average RER value for vegetation data was 0.232 with an associated standard deviation of 0.178. The 2024 vegetation sample RER analysis indicated that field replicate sample precision accurately reflects the actual sample value. Figure 12.3 summarizes the RER data.

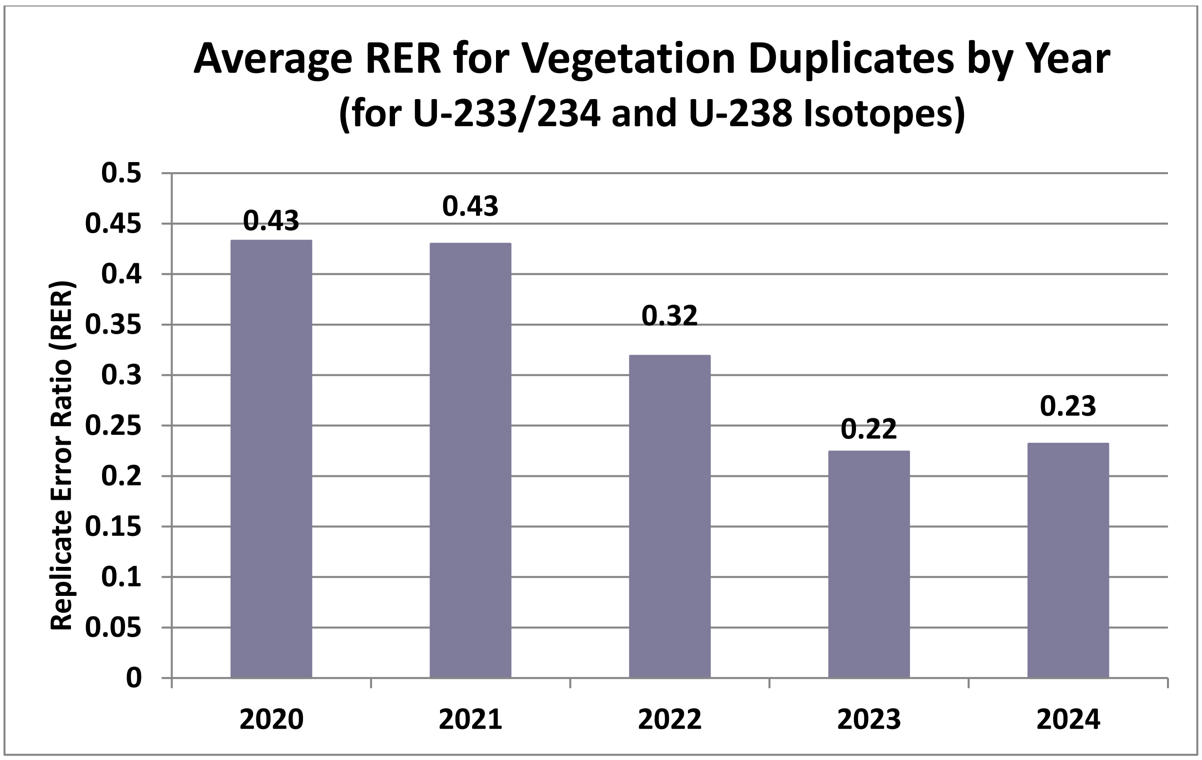

Figure 12.3 Five-year average replicate error ratio for vegetation duplicates

12.5.2 Blanks and Rinsates

During 2024, trip blanks, field blanks, and/or rinsate samples were collected for all applicable media programs. Blank samples were used to evaluate contamination that may have occurred during sampling, sample shipment, or laboratory operations. Trip blank and field blank values were used to flag detections found in sample values. The detections found were used to flag associated sample detects as "U" (undetected).

A rinsate (equipment) blank is a sample of analyte-free water poured over or through decontaminated sampling equipment. The rinse solution is collected to show that there is no contamination from the sampling tool or cross-contamination between samples.

Field blanks are analyte-free water samples that are taken to the field and opened for the duration of the sampling event and then closed and sent to the lab. Field blanks assess if airborne contamination exists at the sampling site.

Trip blanks are provided for each shipping container (cooler) containing VOC vials to evaluate potential contamination of the sample bottles during shipment from the manufacturer, storage of the bottles, shipment to the laboratory, or analysis at the laboratory. These compounds are indicative of common laboratory solvents. The frequency of VOC detection in trip blanks in 2024 was less than 0.1%.

12.6 ON-SITE ANALYTICAL LABORATORIES

A limited number of samples were analyzed on-site during 2024, using approved EPA or standard industry methods. On-site analyses by Pantex Materials and Analytical Service Laboratory included samples for alkalinity, nitrate, and hexavalent chromium.

The on-site laboratories followed an internal QC program similar to the program outlined in the SOW. The on-site laboratories were audited by Pantex internal quality audit program. Sampling technicians performed field measurements of certain samples for residual chlorine, dissolved oxygen, turbidity, conductivity, hydrogen sulfide, temperature, oxidation reduction potential, and pH.

12.7 CONTINUOUS IMPROVEMENT

During 2024, Pantex acquired analytical data to support several aspects of the environmental monitoring program as required by permits, regulations, and DOE orders. The QA/QC program described in this chapter was implemented to ensure the programmatic and technical elements required to meet these criteria were executed. In addition, this program functioned to provide cost-efficient analytical data of known and defensible quality.

Overall, programmatic data quality has continued to improve because of improved analytical methods, QA/QC practices, and refinement of DQOs, which can be quantified by trending the amount of usable data acquired over the past 20-plus years (Figure 12.4). Using 1996 as the base year, a 95% lower performance target was established to trend data usability. As with any data collection process, improvements are continually being made in defining technical specifications and improving sample-collection methodology, laboratory instrumentation, and QC practices. It is important to remember that any viable quality system undergoes continuous improvement by the very nature of the quality elements employed. This is the QA/QC program perspective used to review data critically for this report.

A well-established quality framework exists at Pantex that supports the environmental monitoring program. The acquisition and review of analytical data is based on procedurally controlled sampling, analysis, data management (validation), and standardized technical specifications governing analytical measurements. The integration of each of these elements ensures environmental data collection and monitoring requirements are achieved for meeting all site and stakeholder requirements for quality and reliability.

12.8 CONCLUSIONS

During 2024, the QA/QC program enhanced the reliability of data acquired for environmental monitoring, which includes air, soil, groundwater, surface water, flora, and fauna programs. Pantex obtained 32,563 individual analysis results in 2024, with 99.28% deemed to be of suitable quality for the intended end use of the data.

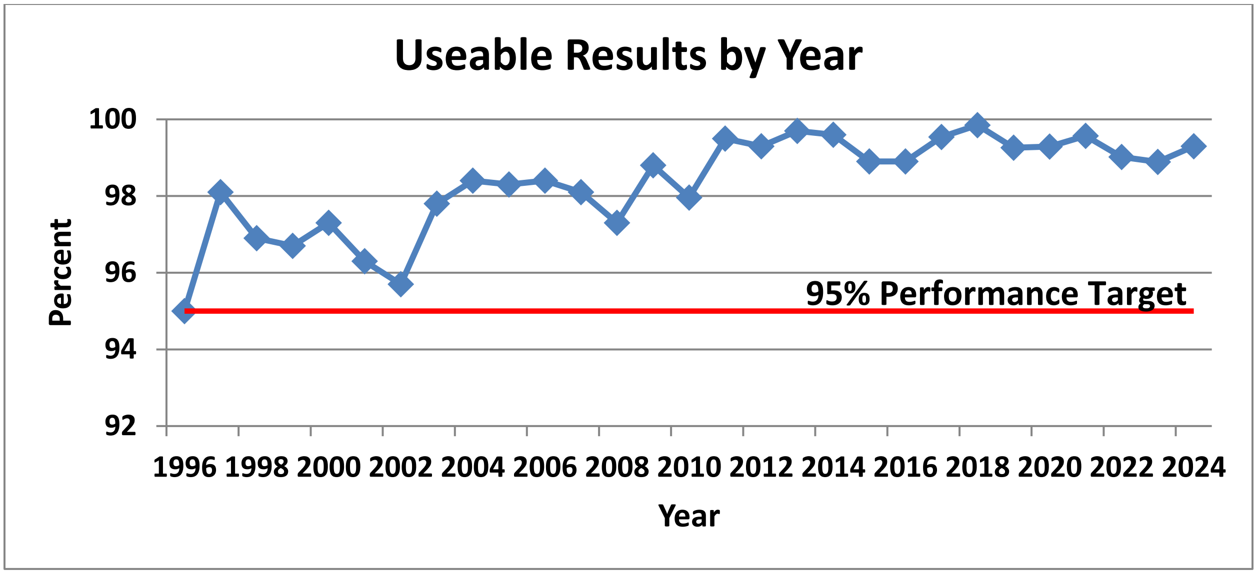

Figure 12.4 History of usable results data

APPENDIX A – BIRDS IDENTIFIED AT PANTEX IN 2024

Table A.1 Birds Identified at Pantex in 2024

Common Name	Scientific Name
American Avocet	*Recurvirostra americana*
American Coot	*Fulica americana*
American Green-winged Teal	*Anas crecca*
American Kestrel	*Falco sparverius*
American Wigeon	*Anas americana*
Bald Eagle	*Haliaeetus leucocephalus*
Barn Swallow	*Hirundo rustica*
Black-crowned Night Heron	*Nycticorax*
Black-necked Stilt	*Himantopus mexicanus*
Blue-winged Teal	*Anas discors*
Brown-headed Cowbird	*Molothrus ater*
Bufflehead	*Bucephala albeola*
Burrowing Owl	*Athene curnicularia hypugea*
Cackling Goose	*Branta hutchinsii*
Canada Goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Chihuahuan Raven	*Corvus crytoleucus*
Chippping Sparrow	*Spizella passerina*
Cinnamon Teal	*Anas cyanoptera*
Clay-colored Sparrow	*Spizella pallida*
Cliff Swallow	*Hirundo pyrrhonota*
Common Goldeneye	*Bucephala clangula*
Common Grackle	*Quiscalus quiscula*
Curve-billed Thrasher	*Toxostoma curvirostre*
Dickcissel	*Spiza americana*
Eared Grebe	*Podiceps nigricollis*
Eastern Kingbird	*Tyrannus*
Eurasian Collared Dove	*Streptopelia decaocto*
European Starling	*Sturnus vulgaris*
Feral Pigeon	*Columba livia*
Ferrugionus Hawk	*Buteo regalis*
Gadwall	*Anas strepera*
Grasshopper Sparrow	*Ammodramus savannarum*
Great Blue Heron	*Ardea herodias*
Great Horned Owl	*Bubo virginianus*
Greater White-fronted Goose	*Anser albifrons*
Greater Yellowlegs	*Tringa melanoleuca*
Horned Lark	*Eremophila alpestris*
House Finch	*Carpodacus mexicanus*

Common Name	Scientific Name
House Sparrow	*Passer domesticus*
Killdeer	*Charadrius vociferus*
Lark Bunting	*Calamospiza melanocorys*
Lark Sparrow	*Chondestes grammacus*
Least Sandpiper	*Calidris minutilla*
Lesser Scaup	*Athya affinis*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Mallard	*Anas platyrhyncos*
McCown's Longspur	*Calcarius mcccownii*
Mourning Dove	*Zenaida macroura*
Northern Bobwhite	*Colinus virginianus*
Northern Flicker	*Colaptes auratus*
Northern Harrier	*Circus cyaneus*
Northern Mockingbird	*Mimus polyglottos*
Northern Pintail	*Anas acuta*
Northern Shoveler	*Anas clypeata*
Prairie Falcon	*Falco mexicanus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Ring-billed Gull	*Larus delawarensis*
Ring-necked Pheasant	*Phasianus colchicus*
Ross' Goose	*Chen rossii*
Ruddy Duck	*Oxyura jamaicensis*
Say's Phoebe	*Sayornis saya*
Scissor-tailed Flycatcher	*Tyrannus forticatus*
Semipalmated Sandpiper	*Calidris pusilla*
Snow Goose	*Chen caerulescens*
Spotted Sandpiper	*Actitis macularia*
Swainson's Hawk	*Buteo swainsoni*
Tree Swallow	*Tachycineta bicolor*
Upland Sandpiper	*Bartramia longicauda*
Vesper Sparrow	*Pooecetes grammacus*
Western Kingbird	*Tyrannus verticalis*
Western Meadowlark	*Sturnella neglecta*
Western Sandpiper	*Calidris mauri*
White-crowned Sparrow	*Zonotrichia leucophrys*
Wilson's Phalarope	*Phalaropus tricolor*
Wilson's Snipe	*Gallinago delicata*
Wood Duck	*Aix sponsa*
Yellow-headed Blackbird	*Xanthocephalus*
Yellow-rumped Warbler	*Dendroica coronata*

APPENDIX B – 2024 DRINKING WATER ANALYTICAL RESULTS

Table B.1 Water-Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Inorganics (E300.0, Anions)			
Nitrate (as N)	1.39	10	mg/L
E524.2 Regulated (E524.2 Volatiles by GC/MS)			
Vinyl chloride	<0.500	2	ug/L
1,1-Dichloroethene	<0.500	7	ug/L
Methylene chloride	<0.500	5	ug/L
trans-1,2-Dichloroethene	<0.500	100	ug/L
cis-1,2-Dichloroethene	<0.500	70	ug/L
1,1,1-Trichloroethane	<0.500	200	ug/L
Carbon tetrachloride	<0.500	5	ug/L
1,2-Dichloroethane	<0.500	5	ug/L
Benzene	<0.500	5	ug/L
Trichloroethene	<0.500	5	ug/L
1,2-Dichloropropane	<0.500	5	ug/L
Toluene	<0.500	1000	ug/L
1,1,2-Trichloroethane	<0.500	5	ug/L
Tetrachloroethene	<0.500	5	ug/L
Chlorobenzene	<0.500	100	ug/L
Ethyl Benzene	<0.500	700	ug/L
m,p-Xylene	<0.500	N/A	ug/L
Styrene	<0.500	100	ug/L
1,4-Dichlorobenzene	<0.500	75	ug/L
1,2-Dichlorobenzene	<0.500	600	ug/L
1,2,4-Trichlorobenzene	<0.500	70	ug/L
Xylene (total)	<0.500	10000	ug/L
E524.2 Unregulated (E524.2 Volatiles by GC/MS)			
Dichlorodifluoromethane	<0.500	N/A	ug/L
Chloromethane	<0.500	N/A	ug/L
Bromomethane	<0.500	N/A	ug/L
Chloroethane	<0.500	N/A	ug/L
4-Chlorotoluene	<0.500	N/A	ug/L
Trichlorofluoromethane	<0.500	N/A	ug/L
Acetone	<5.00	N/A	ug/L
Methyl iodide	<0.500	N/A	ug/L
Carbon disulfide	<0.500	N/A	ug/L
Acrylonitrile	<5.00	N/A	ug/L
Tert-Butyl methyl ether	<0.500	N/A	ug/L
1,1-Dichloroethane	<0.500	N/A	ug/L
Vinyl acetate	<5.00	N/A	ug/L
2,2-Dichloropropane	<0.500	N/A	ug/L
2-Butanone	<5.00	N/A	ug/L

Table B.1 Water-Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Bromochloromethane	<0.500	N/A	ug/L
Tetrahydrofuran	<5.00	N/A	ug/L
Chloroform	<1.00	N/A	ug/L
1,1-Dichloropropene	<0.500	N/A	ug/L
Methyl methacrylate	<5.00	N/A	ug/L
Dibromomethane	<0.500	N/A	ug/L
Bromodichloromethane	<1.00	N/A	ug/L
Cis-1,3-Dichloropropene	<0.500	N/A	ug/L
4-Methyl-2-pentanone	<5.00	N/A	ug/L
Trans-1,3-Dichloropropene	<0.500	N/A	ug/L
Ethyl methacrylate	<5.00	N/A	ug/L
1,3-Dichloropropane	<0.500	N/A	ug/L
2-Hexanone	<5.00	N/A	ug/L
Dibromochloromethane	<1.00	N/A	ug/L
1,1,1,2-Tetrachloroethane	<0.500	N/A	ug/L
o-Xylene	<0.500	N/A	ug/L
Bromoform	<1.00	N/A	ug/L
Isopropylbenzene	<0.500	N/A	ug/L
1,1,2,2-Tetrachloroethane	<0.500	N/A	ug/L
Bromobenzene	<0.500	N/A	ug/L
1,2,3-Trichloropropane	<0.500	N/A	ug/L
n-Propylbenzene	<0.500	N/A	ug/L
2-Chlorotoluene	<0.500	N/A	ug/L
1,3,5-Trimethylbenzene	<0.500	N/A	ug/L
Tert-Butylbenzene	<0.500	N/A	ug/L
1,2,4-Trimethylbenzene	<0.500	N/A	ug/L
Sec-Butylbenzene	<0.500	N/A	ug/L
1,3-Dichlorobenzene	<0.500	N/A	ug/L
4-Isopropyltoulene	<0.500	N/A	ug/L
n-Butylbenzene	<0.500	N/A	ug/L
Hexachlorobutadiene	<0.500	N/A	ug/L
Naphthalene	<0.500	N/A	ug/L
1,2,3-Trichlorobenzene	<0.500	N/A	ug/L
Haloacetic Acids (552.2 Haloacetic Acids by GC)			
Bromochloroacetic Acid	1.80	N/A	ug/L
Dibromoacetic Acid	1.40	N/A	ug/L
Dichloroacetic Acid	1.60	N/A	ug/L
Monobromoacetic Acid	<1.00	N/A	ug/L
Monochloroacetic Acid	2.60	N/A	ug/L
Total Regulated HAA	5.60	60	ug/L
Trichloroacetic acid	<1.00	N/A	ug/L
Volatiles (E524.2 Volatiles by GC/MS)			
Chloroform	4.77	N/A	mg/L

Table B.1 Water-Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Bromodichloromethane	7.00	N/A	mg/L
Dibromochloromethane	7.14	N/A	mg/L
Bromoform	3.39	N/A	mg/L
Total Trihalomethanes	22.3	80	mg/L

Definitions:

Maximum contaminant level (MCL): The highest level of a contaminant allowed in drinking water.

mg/L = milligrams per liter or parts per million

N/A = Not applicable; there are no MCLs under the SDWA.

ug/L = micrograms per liter or parts per billion

umho/cm = micromhos per centimeter; this is a measurement of electrical conductivity in water.

APPENDIX C – ANALYTES MONITORED IN 2024

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Radionuclides											
Gross alpha, total	12587-46-1	-	-	-	-	-	-	-	-	-	-
Gross beta, total	12587-47-2	-	-	-	-	-	-	-	-	-	-
Plutonium-238	12059-95-9	-	-	-	-	-	-	-	-	-	-
Plutonium-239/240	10-12-8	+	-	-	-	-	-	-	-	-	-
Tritium	10028-17-8	+	-	-	+	-	-	-	+	-	+
Uranium-233/234	11-08-5	+	-	-	-	-	-	-	+	-	+
Uranium-235/236	15117-96-1	-	-	-	+	-	-	-	-	+	-
Uranium-238	7440-61-1	+	-	-	+	-	-	-	+	+	+
Metals											
Aluminum	7429-90-5	-	+	+	-	-	-	-	-	-	-
Antimony	7440-36-0	-	-	+	-	-	-	-	-	+	-
Arsenic	7440-38-2	-	+	+	+	-	-	-	-	+	-
Barium	7440-39-3	-	+	+	+	-	-	-	-	+	-
Beryllium	7440-41-7	-	-	+	-	-	-	-	-	+	-
Boron	7440-42-8	-	+	-	-	+	+	+[i]	-	-	-
Cadmium	7440-43-9	-	-	+	+	-	+	-	-	+	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Calcium	7440-70-2	-	+	+	-	-	-	+[i]	-	-	-
Chromium	7440-47-3	-	+	+	+	-	+	-	-	+	-
Chromium (hexavalent)	18540-29-9	-	+	-	-	-	-	-	-	-	-
Cobalt	7440-48-4	-	-	-	-	-	+	-	-	-	-
Copper	7440-50-8	-	-	+	+	+	+	+[i]	-	+	-
Iron	7439-89-6	-	+	+	+	-	-	+[i]	-	-	-
Lead	7439-92-1	-	-	+	+	-	+	-	-	+	-
Magnesium	7439-95-4	-	+	-	-	-	-	+[i]	-	-	-
Manganese	7439-96-5	-	+	+	+	+	-	+[i]	-	+	-
Manganese, divalent	16397-91-4	-	-	-	-	-	-	-	-	-	-
Mercury	7439-97-6	-	-	+	+	-	+	-	-	+	-
Molybdenum	7439-98-7	-	+	-	-	-	-	-	-	-	-
Nickel	7440-02-0	-	+	-	+	-	+	-	-	+	-
Potassium	7440-09-7	-	+	-	-	-	-	+[i]	-	-	-
Selenium	7782-49-2	-	-	+	+	-	-	-	-	+	-
Silver	7440-22-4	-	-	+	+	-	+	-	-	+	-
Sodium	7440-23-5	-	+	+	-	-	-	+[i]	-	-	-
Strontium	7440-24-6	-	-	-	-	-	-	-	-	-	-
Thallium	7440-28-0	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Tin	7440-31-5	-	-	-	-	-	-	-	-	-	-
Titanium	7440-32-6	-	-	-	-	-	-	-	-	-	-
Uranium, Total	11-09-6	-	-	-	-	-	-	-	-	-	-
Vanadium	7440-62-2	-	+	-	-	-	-	-	-	-	-
Zinc	7440-66-6	-	-	+	+	+	+	+[i]	-	+	-
Explosives											
1,3-dinitrobenzene	99-65-0	-	+	-	+	-	-	-	-	-	-
1,3,5-trinitrobenzene	99-35-4	-	+	-	+	-	+	-	-	-	-
2-amino-4,6-dinitrotoluene	35572-78-2	-	+	-	+	-	-	-	-	-	-
2-nitrotoluene	88-72-2	-	-	-	+	-	-	-	-	-	-
2,4-dinitrotoluene	121-14-2	-	+	-	+	-	+	+	-	-	-
2,6-dinitrotoluene	606-20-2	-	+	-	+	-	+	-	-	-	-
3-nitrotoluene	99-08-1	-	-	-	+	-	-	-	-	-	-
4-amino-2,6-dinitrotoluene	19406-51-0	-	+	-	+	-	-	-	-	-	-
4-nitrotoluene	99-99-0	-	-	-	+	-	-	-	-	-	-
HMX	2691-41-0	-	+	-	+	+	+	-	-	+	-
Nitrobenzene	98-95-3	-	-	-	+	-	-	+	-	-	-
PETN	78-11-5	-	-	-	+	+	+	-	-	+	-
RDX	121-82-4	-	+	-	+	+	+	-	-	+	-
										+	

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
TATB	3058-38-6	-	-	-	+	+	+	-	-		-
Tetryl	479-45-8	-	-	-	+	-	-	-	-	-	-
TNT	118-96-7	-	+	-	+	+	+	-	-	+	-
MNX	5755-27-1	-	+	-	-	-	-	-	-	-	-
DNX	80251-29-2	-	+	-	-	-	-	-	-	-	-
TNX	13980-04-6	-	+	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls (PCBs)											
Aroclor 1016	12674-11-2	-	-	+	-	-	-	-	-	-	-
Aroclor 1221	1104-28-2	-	-	+	-	-	-	-	-	-	-
Aroclor 1232	11141-16-5	-	-	+	-	-	-	-	-	-	-
Aroclor 1242	53469-21-9	-	-	+	-	-	-	-	-	-	-
Aroclor 1248	12672-29-6	-	-	+	-	-	-	-	-	-	-
Aroclor 1254	11091-69-1	-	-	+	-	-	-	-	-	-	-
Aroclor 1260	11096-82-5	-	-	+	-	-	-	-	-	-	-
PCB, Total	1336-36-3	-	-	+	-	-	-	-	-	-	-
Pesticides											
Alachlor	15972-60-8	-	-	+	-	-	-	-	-	-	-
Aldrin	309-00-2	-	-	+	-	-	-	-	-	-	-
Atrazine	1912-24-9	-	-	+	-	-	-	-	-	-	-
										-	

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Bromacil	314-40-9	-	-	+	-	-	-	-	-		-
alpha-Chlordane	57-74-9	-	-	+	-	-	-	-	-	-	-
Chlordane	12789-03-6	-	-	+	-	-	-	-	-	-	-
gamma-Chlordane	5566-34-7	-	-	+	-	-	-	-	-	-	-
Dieldrin	60-57-1	-	-	+	-	-	-	-	-	-	-
Endrin	72-20-8	-	-	+	-	-	-	-	-	-	-
Heptachlor	76-44-8	-	-	+	-	-	-	-	-	-	-
Heptachlor epoxide	1024-57-3	-	-	+	-	-	-	-	-	-	-
Lindane (gamma-BHC)	58-89-9	-	-	+	-	-	-	-	-	-	-
Methoxychlor	72-43-5	-	-	-	-	-	-	-	-	-	-
Methyl n,n-dimethyl-n-{(methlycarbamoyl)oxy}-1	23135-22-0	-	-	-	-	-	-	-	-	-	-
s-Methyl-n-((Methylcarb amoyl)-oxy)-thioacetimidate	16752-77-5	-	-	-	-	-	-	-	-	-	-
Metribuzin	21087-64-9	-	-	+	-	-	-	-	-	-	-
Prometon	1610-18-0	-	-	-	-	-	-	-	-	-	-
Propachlor	1918-16-7	-	-	+	-	-	-	-	-	-	-
Sevin (carbaryl)	63-25-2	-	-	-	-	-	-	-	-	-	-
Simazine	122-34-9	-	-	+	-	-	-	-	-	-	-
Toxaphene	8001-35-2	-	-	+	-	-	-	-	-	-	-
trans-Nonachlor-chlordane	57-74-9	-	-	+	-	-	-	-	-	-	-
Herbicides											
										-	

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
2,4-D	94-75-7	-	-	-	-	-	-	-	-		-
Miscellaneous											
Alkalinity	T-005	-	+	+	-	-	-	-	-	-	-
Ammonia (as N)	7664-41-7	-	-	-	-	+	-	-	-	+	-
Biochemical oxygen demand	10-26-3	-	-	-	-	+	-	-	-	+	-
Bromide	24959-67-9	-	-	-	-	-	-	-	-	-	-
Carbonaceous biochemical oxygen demand	10078	-	-	-	-	-	-	-	-	-	-
Chemical oxygen demand	C-004	-	-	-	-	+	-	-	-	+	-
Chlorate	14866-68-3	-	-	-	-	-	-	-	-	-	-
Chloride	16887-00-6	-	-	+	-	-	-	-	-	-	-
Chlorine residual	7782-50-5	-	-	+	-	-	-	-	-	-	-
Color	M-002	-	-	-	-	-	-	-	-	-	-
Corrosivity	10-37-7	-	-	-	-	-	-	-	-	-	-
Cyanide, free	10-71-9	-	-	-	-	-	-	-	-	-	-
Cyanide, total	57-12-5	-	-	+	-	-	-	-	-	-	-
Dissolved Organic Carbon	11-59-6	-	+	-	-	-	-	-	-	-	-
Dissolved Oxygen	NA	-	+	-	-	-	-	-	-	-	-
Electrical Conductivity-Paste	NA	-	-	-	-	-	-	+ [i]	-	-	-
Fluoride	7782-41-4	-	+	+	-	-	-	-	-	-	-
Foaming agents (surfactants)	NA	-	-	-	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Ignitability	NA	-	-	-	-	-	-	+	-	-	-
Nitrate (as N)	14797-55-8	-	+	+	-	-	-	+	-	-	-
Nitrate/nitrite (as N)	1-005	-	-	-	-	+	-	-	-	-	-
Nitrite (as N)	14797-65-0	-	+	-	-	-	-	-	-	-	-
Oil and grease	10-30-0	-	-	-	-	+	-	-	-	+	-
Ortho Phosphate	14265-44-2	-	-	-	-	-	-	+ [i]	-	-	-
Oxidation – Reduction Potential		-	+	-	-	-	-	-	-	-	-
Perchlorate	14797-73-0	-	+	-	-	-	-	-	-	-	-
pH	10-29-7	-	+	+	+	+	-	-	-	+	-
pH (1:1 ratio soil pH)	NA	-	-	-	-	-	-	+ [i]	-	-	-
pH (2:1 ratio soil pH)	NA	-	-	-	-	-	-	+ [i]	-	-	-
Phosphorus, Total (As P)	7723-14-0	-	+	-	-	-	-	-	-	-	-
Reactivity	NA	-	-	-	-	-	-	+	-	-	-
Sodium Adsorption Ratio	NA	-	-	-	-	-	-	+ [i]	-	-	-
Specific conductance	10-34-4	-	-	-	-	-	-	-	-	+	-
Sulfate	14808-79-8	-	+	+	-	-	-	-	-	+	-
Sulfide	18496-25-8	-	+	-	-	-	-	-	-	-	-
Sulfur	NA	-	-	-	-	-	-	+ [i]	-	-	-
Temperature	NA	-	+	+	+	+	-	-	-	+	-
										+	

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Total dissolved solids	10-33-3	-	+	+	-	-	-	-	-		-
Total hardness (as $CaCO_3$)	11-02-9	-	-	+	-	-	-	-	-	+	-
Total Kjeldahl Nitrogen	NA	-	-	-	-	-	-	+ [i]	-	+	-
Total Nitrogen	NA	-	-	-	-	-	-	+ [i]	-	+	-
Total organic carbon	C-012	-	+	-	-	-	-	-	-	+	-
Total petroleum hydrocarbons	10-90-2	-	-	-	+	-	-	-	-	-	-
Total suspended solids	10053	-	-	-	+	-	-	-	-	+	-
Turbidity	G-019	-	+	-	-	-	-	-	-	-	-
Volatile Organics											
1,1,1,2-tetrachloroethane	630-20-6	-	-	+	-	-	-	-	-	-	-
1,1,2,2-tetrachloroethane	79-34-5	-	-	+	-	-	-	-	-	-	-
1,1,1-trichloroethane	71-55-6	-	-	+	-	-	-	-	-	-	-
1,1,2-trichloroethane	79-00-5	-	-	+	-	-	-	-	-	-	-
1,2,3-tricholorobenzene	87-61-6	-	-	+	-	-	-	-	-	-	-
1,2,3-trichloropropane	96-18-4	-	-	+	-	-	-	-	-	-	-
1,2,4-trimethylbenzene	95-63-6	-	-	+	-	-	-	-	-	-	-
1,3,5-trimethylbenzene	108-67-8	-	-	+	-	-	-	-	-	-	-
1,1-dichloroethane	75-34-3	-	-	+	-	-	-	-	-	-	-
1,1-dichloroethene	75-35-4	-	+	+	-	-	-	-	-	-	-
										-	

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
1,1-dichloropropene	563-58-6	-	-	+	-	-	-	-	-		-
1,2-dibromo-3-chloropropane	96-12-8	-	-	+	-	-	-	-	-	-	-
1,2-dibromoethane	106-93-4	-	-	+	-	-	-	-	-	-	-
1,2-dichlorobenzene	95-50-1	-		+	-	-	-	-	-	-	-
1,2-dichloroethane	107-06-2	-	+	+	-	-	-	-	-	-	-
1,2-dichloroethene	156-60-5	-		-	-	-	-	-	-	-	-
cis-1,2-dichloroethene	156-59-2	-	+	+	-	-	-	-	-	-	-
trans-1,2-dichloroethene	156-60-5	-	+	+	-	-	-	-	-	-	-
1,2-dichloropropane	78-87-5	-		+	-	-	-	-	-	-	-
1,3-dichlorobenzene	541-73-1	-		+	-	-	-	-	-	-	-
1,3-dichloropropane	142-28-9	-	-	+	-	-	-	-	-	-	-
cis-1,3-dichloropropene	10061-01-5	-		+	-	-	-	-	-	-	-
trans-1,3-dichloropropene	10061-02-6	-		+	-	-	-	-	-	-	-
trans-1,4-dichloro-2-butene	110-57-6	-		-	-	-	-	-	-	-	-
1,4-dichlorobenzene	106-46-7	-	-	+	-	-	-	-	-	-	-
2,2-dichloropropane	594-20-7	-	-	+	-	-	-	-	-	-	-
2-butanone (methyl ethyl ketone)	78-93-3	-	-	+	-	-	-	-	-	-	-
2-chloro-1,3-butadiene	126-99-8	-	-	-	-	-	-	-	-	-	-
2-chlorotoluene	95-49-8	-	-	+	-	-	-	-	-	-	-
2-hexanone	591-78-6	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
4-chlorotoluene	106-43-4	-	-	+	-	-	-	-	-	-	-
4-isopropyltoluene	99-87-6	-	-	+	-	-	-	-	-	-	-
Acetone	67-64-1	-	-	+	-	-	-	-	-	-	-
Acetonitrile	75-05-8	-	-	-	-	-	-	-	-	-	-
Acetylene	74-86-2	-	-	-	-	-	-	-	-	-	-
Acrolein	107-02-8	-	-	-	-	-	-	-	-	-	-
Acrylonitrile	107-13-1	-	-	+	-	-	-	-	-	-	-
Allyl Chloride	107-05-1	-	-	-	-	-	-	-	-	-	-
Benzene	71-43-2	-	-	+	-	-	-	-	-	-	-
Bromobenzene	108-86-1	-	-	+	-	-	-	-	-	-	-
Bromochloromethane	74-97-5	-	-	+	-	-	-	-	-	-	-
Bromodichloromethane	75-27-4	-	-	+	-	-	-	-	-	-	-
Bromoform	75-25-2	-	-	+	-	-	-	-	-	-	-
Bromomethane	74-83-9	-	-	+	-	-	-	-	-	-	-
sec-Butylbenzene	135-98-8	-	-	+	-	-	-	-	-	-	-
tert-Butylbenzene	98-06-6	-	-	+	-	-	-	-	-	-	-
Carbon disulfide	75-15-0	-	-	+	-	-	-	-	-	-	-
Carbon tetrachloride	56-23-5	-	-	+	-	-	-	-	-	-	-
Chlorobenzene	108-90-7	-	-	+	-	-	-	-	-	-	-
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Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Chloroethane	75-00-3	-	-	+	-	-	-	-	-		-
Chloroform	67-66-3	-	+	+	-	-	-	-	-	-	-
Chloromethane	74-87-3	-		+	-	-	-	-	-	-	-
Dibromochloromethane	124-48-1	-		+	-	-	-	-	-	-	-
Dibromomethane	74-95-3	-		+	-	-	-	-	-	-	-
Dichlorodifluoromethane	75-71-8	-	-	+	-	-	-	-	-	-	-
Ethylbenzene	100-41-4	-	-	+	-	-	-	-	-	-	-
Ethyl methacrylate	97-63-2	-	-	+	-	-	-	-	-	-	-
Freon 113	76-13-1	-	-	-	-	-	-	-	-	-	-
Iodomethane	74-88-4	-	-	-	-	-	-	-	-	-	-
Isobutyl alcohol	78-83-1	-	-	-	-	-	-	-	-	-	-
Isopropylbenzene	98-82-8	-	-	+	-	-	-	-	-	-	-
Methylacrylonitrile	126-98-7	-	-	-	-	-	-	-	-	-	-
Methylene chloride	75-09-2	-	-	+	-	-	-	-	-	-	-
Methyl isobutyl ketone	108-10-1	-	-	-	-	-	-	-	-	-	-
Methyl methacrylate	80-62-6	-	-	+	-	-	-	-	-	-	-
n-Butylbenzene	104-51-8	-	-	+	-	-	-	-	-	-	-
n-Propylbenzene	103-65-1	-	-	+	-	-	-	-	-	-	-
Pentachloroethane	76-01-7	-	-	-	-	-	-	-	-	-	-
Propionitrile	107-12-0	-	-	-	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Styrene	100-42-5	-	+	+	-	-	-	-	-	-	-
tert-Butyl methyl ether	1634-04-4	-	-	+	-	-	-	-	-	-	-
Tetrachloroethylene	127-18-4	-	+	+	-	-	-	-	-	-	-
Tetrahydrofuran	109-99-9	-	-	+	-	-	-	-	-	-	-
Toluene	108-88-3	-	-	+	-	-	-	-	-	-	-
Trichloroethene (Trichloroethylene)	79-01-6	-	+	+	-	-	-	-	-	-	-
Trichlorofluoromethane	75-69-4	-	-	+	-	-	-	-	-	-	-
Vinyl acetate	108-05-4	-	-	+	-	-	-	-	-	-	-
Vinyl chloride	75-01-4	-	-	+	-	-	-	-	-	-	-
Xylene, m	108-38-3	-	-	+	-	-	-	-	-	-	-
Xylene, o	95-47-6	-	-	+	-	-	-	-	-	-	-
Xylene, p	106-42-3	-	-	+	-	-	-	-	-	-	-
Xylenes, Total	1330-20-7	-	-	+	-	-	-	-	-	-	-
Semi-Volatile Organic Compounds											
1,2,4,5-tetrachlorobenzene	95-94-3	-	-	-	-	-	-	-	-	-	-
1,2,4-trichlorobenzene	120-82-1	-	-	+	-	-	-	-	-	-	-
1,2-diphenylhydrazine	122-66-7	-	-	-	-	-	-	-	-	-	-
1,4-dioxane	123-91-1	-	+	-	-	-	-	-	-	-	-
1,4-naphthoquinone	130-15-4	-	-	-	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
2,3,4,6-tetrachlorophenol	58-90-2	-	-	-	-	-	-	-	-	-	-
2,4,5-trichlorophenol	95-95-4	-	-	-	-	-	-	-	-	-	-
2,4,6-trichlorophenol	88-06-2	-	-	-	-	-	-	-	-	-	-
2,4-dichlorophenol	120-83-2	-	-	-	-	-	-	-	-	-	-
2,4-dimethylphenol	105-67-9	-	-	-	-	-	-	-	-	-	-
2,4-dinitrophenol	51-28-5	-	-	-	-	-	-	-	-	-	-
2-chloronaphthalene	91-58-7	-	-	-	-	-	-	-	-	-	-
2-chlorophenol	95-57-8	-	-	-	-	-	-	-	-	-	-
2-methylnaphthalene	91-57-6	-	-	-	-	-	-	-	-	-	-
2-methylphenol (o-Cresol)	795-48-7	-	-	-	-	-	-	-	-	-	-
4,6-dinitro-2-methylphenol	534-52-1	-	-	-	-	-	-	-	-	-	-
4-chloroaniline	106-47-8	-	-	-	-	-	-	-	-	-	-
4-chlorophenyl phenyl ether	7005-72-3	-	-	-	-	-	-	-	-	-	-
4-methylphenol (p-Cresol)	106-44-5	-	-	-	-	-	-	-	-	-	-
Acenaphthene	83-32-9	-	-	-	-	-	-	-	-	-	-
Acenaphthylene	208-96-8	-	-	-	-	-	-	-	-	-	-
Acetophenone	98-86-2	-	-	-	-	-	-	-	-	-	-
Anthracene	120-12-7	-	-	-	-	-	-	-	-	-	-
Benzidine	92-87-5	-	-	-	-	-	-	-	-	-	-
										-	

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Benzo[*a*]anthracene	56-55-3	-	-	-	-	-	-	-	-		-
Benzo[*a*]pyrene	50-32-8	-	-	+	-	-	-	-	-	-	-
Benzo[*b*]fluoranthene	205-99-2	-	-	-	-	-	-	-	-	-	-
Benzo[*g*,*h*,*i*]perylene	191-24-2	-	-	-	-	-	-	-	-	-	-
Benzo[*k*]fluoranthene	207-08-9	-	-	-	-	-	-	-	-	-	-
Benzoic acid	65-85-0	-	-	-	-	-	-	-	-	-	-
Benzyl alcohol	100-51-6	-	-	-	-	-	-	-	-	-	-
bis(2-chloroethyl) ether	111-44-4	-	-	-	-	-	-	-	-	-	-
bis(2-chloroisopropyl) ether	39638-32-9	-	-	-	-	-	-	-	-	-	-
bis(2-ethylhexyl)adipate	103-23-1	-	-	+	-	-	-	-	-	-	-
bis(2-ethylhexyl) phthalate	117-81-7	-	-	+	-	-	-	-	-	-	-
Butachlor	23184-66-9	-	-	+	-	-	-	-	-	-	-
Butyl benzyl phthalate	85-68-7	-	-	-	-	-	-	-	-	-	-
Carbazole	86-74-8	-	-	-	-	-	-	-	-	-	-
Cresol, m	108-39-4	-	-	-	-	-	-	-	-	-	-
Chrysene	218-01-9	-	-	-	-	-	-	-	-	-	-
Dibenz[*a*,*h*]anthracene	53-70-3	-	-	-	-	-	-	-	-	-	-
Dibenzofuran	132-64-9	-	-	-	-	-	-	-	-	-	-
Dibromoacetic acid	631-64-1	-	-	+	-	-	-	-	-	-	-
Dichloroacetic acid	79-43-6	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Diethyl phthalate	84-66-2	-	-	-	-	-	-	-	-	-	-
Dimethyl phthalate	131-11-3	-	-	-	-	-	-	-	-	-	-
Di-n-butyl phthalate	84-74-2	-	-	-	-	-	-	-	-	-	-
Di-n-octyl phthalate	117-84-0	-	-	-	-	-	-	-	-	-	-
Diphenylamine	122-39-4	-	-	-	-	-	-	-	-	-	-
Fluoranthene	206-44-0	-	-	-	-	-	-	-	-	-	-
Fluorene	86-73-7	-	-	-	-	-	-	-	-	-	-
Hexachlorobenzene	118-74-1	-	-	+	-	-	-	-	-	-	-
Hexachlorobutadiene	87-68-3	-	-	-	-	-	-	-	-	-	-
Hexachlorocyclopentadiene	77-47-4	-	-	+	-	-	-	-	-	-	-
Hexachloroethane	67-72-1	-	-	-	-	-	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	193-39-5	-	-	-	-	-	-	-	-	-	-
Isophorone	78-59-1	-	-	-	-	-	-	-	-	-	-
Monobromoacetic acid	79-08-3	-	-	+	-	-	-	-	-	-	-
Monochloroacetic acid	79-11-8	-	-	+	-	-	-	-	-	-	-
Methyl iodide	74-88-4			+		-				-	
Naphthalene	91-20-3	-	-	+	-	-	-	-	-	-	-
N-nitrosodiethylamine	55-18-5	-	-	-	-	-	-	-	-	-	-
N-nitrosodimethylamine	62-75-9	-	-	-	-	-	-	-	-	-	-
										-	

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
N-nitrosodiphenylamine	86-30-6	-	-	-	-	-	-	-	-		-
N-nitrosodi-n-propylamine	621-64-7	-	-	-	-	-	-	-	-	-	-
N-nitrosopyrrolidine	930-55-2	-	-	-	-	-	-	-	-	-	-
Parathion, ethyl	56-38-2	-	-	-	-	-	-	-	-	-	-
Parathion, methyl	298-00-0	-	-	-	-	-	-	-	-	-	-
Pentachlorophenol	87-86-5	-	-	-	-	-	-	+	-	-	-
Phenanthrene	85-01-8	-	-	-	-	-	-	-	-	-	-
Phenol	108-95-2	-	-	-	-	-	-	-	-	-	-
Pronamide	23950-58-5	-	-	-	-	-	-	-	-	-	-
Pyrene	129-00-0	-	-	-	-	-	-	-	-	-	-
Pyridine	110-86-1	-	-	-	-	-	-	-	-	-	-
Trichloroacetic acid	76-03-9	-	-	+	-	-	-	-	-	-	-
Biological											
Complete blood count	NA	-	-	-	-	-	-	-	-	-	+
Histopathology	NA	-	-	-	-	-	-	-	-	-	+
Necropsy	NA	-	-	-	-	-	-	-	-	-	+
Total coliform bacteria	10-46-8	-	-	+	-	-	-	-	-	-	-
Escherichia coli	NA	-	-	+	-	-	-	-	-	-	-
Eastern encephalitis	NA	-	-	-	-	-	-	-	-	-	+
Western encephalitis	NA	-	-	-	-	-	-	-	-	-	+

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Hantavirus	NA	-	-	-	-	-	-	-	-	-	+
Plague bacteria	NA	-	-	-	-	-	-	-	-	-	+
Pseudorabies	NA	-	-	-	-	-	-	-	-	-	+
Tuleremia	NA	-	-	-	-	-	-	-	-	-	+
Dissolved Gases[h]											
Ethane	74-84-0	-	+	-	-	-	-	-	-	-	-
Ethene	74-85-1	-	+	-	-	-	-	-	-	-	-
Methane	74-82-8	-	+	-	-	-	-	-	-	-	-

[a] Groundwater
[b] Drinking water
[c] Stormwater and playas
[d] Irrigation water
[e] Burning Ground soils & sediment
[f] Texas Land Application Permit (TLAP) soils
[g] Vegetation
[h] Only applicable to ISB and ISPM wells to monitor performance of the ISB Systems
[i] TLAP nutrient parameters analyzed on a plant-available or extractable basis
[j] Wastewater
\+ = Sampled for
\- = Not sampled
NA = Not available

APPENDIX D – 2024 SOIL SAMPLING MONITORING RESULTS

Table D1.1 Sampling Location: BG-SS-C1

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	2.71	8.42	No
Boron (B)	12.60	50.00	No
Cadmium (Cd)	0.539	1.00	No
Cobalt (Co)	6.60	17.55	No
Chromium (Cr)	15.10	19.93	No
Copper (Cu)	20.70	67.34	No
2,4-Dinitrotoluene (2,4-DNT)	<0.0948	0.50	No
2,6-Dinitrotoluene (2,6-DNT)	<0.0948	0.50	No
Mercury (Hg)	0.197	0.29	No
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	84.20	858.24	No
Nickel (Ni)	14.70	29.76	No
Lead (Pb)	17.80	54.76	No
Pentaerythritol tetranitrate (PETN)	<0.0948	5.00	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.0477	2.60	No
Triaminotrinitrobenzene (TATB)	2.27	23.25	No
1,3,5-Trinitrobenzene (TNB135)	<0.0948	10.00	No
Trinitrotoluene (TNT)	<0.0948	10.00	No
Zinc (Zn)	73.50	160.58	No

Table D1.2 Sampling Location: BG-SS-C2

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	0.409	1.00	No
Boron (B)	8.22	50.00	No
Cadmium (Cd)	0.503	1.00	No
Cobalt (Co)	7.03	8.77	No
Chromium (Cr)	15.10	16.23	Yes
Copper (Cu)	27.40	75.38	No
2,4-Dinitrotoluene (2,4-DNT)	<0.0961	0.50	No
2,6-Dinitrotoluene (2,6-DNT)	<0.0961	0.50	No
Mercury (Hg)	0.0657	0.20	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	<0.0961	1.00	No
Nickel (Ni)	15.30	24.53	No
Lead (Pb)	15.80	77.82	No
Pentaerythritol tetranitrate (PETN)	<0.0961	5.00	No

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	<0.115	1.00	No
Triaminotrinitrobenzene (TATB)	0.9810	3.00	No
1,3,5-Trinitrobenzene (TNB135)	<0.0961	10.00	No
Trinitrotoluene (TNT)	<0.0961	10.00	No
Zinc (Zn)	87.90	317.32	No

Table D1.3 Sampling Location: BG-SS-C3

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	0.410	1.00	No
Boron (B)	11.10	50.00	No
Cadmium (Cd)	0.537	1.00	No
Cobalt (Co)	6.71	18.68	No
Chromium (Cr)	14.90	28.96	No
Copper (Cu)	16.90	53.84	No
2,4-Dinitrotoluene (2,4-DNT)	<0.0923	0.50	No
2,6-Dinitrotoluene (2,6-DNT)	<0.0923	0.50	No
Mercury (Hg)	0.0600	0.20	No
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	51.7	367.10	No
Nickel (Ni)	14.10	30.88	No
Lead (Pb)	20.20	54.88	No
Pentaerythritol tetranitrate (PETN)	<0.0923	5.00	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.405	1.80	No
Triaminotrinitrobenzene (TATB)	1.68	26.86	No
1,3,5-Trinitrobenzene (TNB135)	<0.0923	10.00	No
Trinitrotoluene (TNT)	<0.0923	10.00	No
Zinc (Zn)	75.60	168.00	No

Table D1.4 Sampling Location: P3-SS-C1

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	0.0976	1.00	No
Boron (B)	8.02	50.00	No
Cadmium (Cd)	0.441	1.00	No
Cobalt (Co)	5.47	35.78	No
Chromium (Cr)	15.30	36.35	No
Copper (Cu)	15.00	44.21	No
2,4-Dinitrotoluene (2,4-DNT)	<0.0966	0.50	No
2,6-Dinitrotoluene (2,6-DNT)	<0.0966	0.50	No

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Mercury (Hg)	0.0481	0.20	No
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	<0.0966	1.00	No
Nickel (Ni)	13.50	43.38	No
Lead (Pb)	16.60	54.13	No
Pentaerythritol tetranitrate (PETN)	<0.0966	5.00	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	<0.116	1.00	No
Triaminotrinitrobenzene (TATB)	<0.386	3.00	No
1,3,5-Trinitrobenzene (TNB135)	<0.0966	10.00	No
Trinitrotoluene (TNT)	<0.0966	10.00	No
Zinc (Zn)	69.20	129.75	No

Table D1.5 Sampling Location: P3-SS-C2

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	0.0950	1.00	No
Boron (B)	<47.00	50.00	No
Cadmium (Cd)	0.418	1.00	No
Cobalt (Co)	7.78	37.21	No
Chromium (Cr)	17.40	49.34	No
Copper (Cu)	17.00	43.93	No
2,4-Dinitrotoluene (2,4-DNT)	<0.0985	0.50	No
2,6-Dinitrotoluene (2,6-DNT)	<0.0985	0.50	No
Mercury (Hg)	0.0464	0.20	No
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	<0.0985	1.00	No
Nickel (Ni)	17.20	53.18	No
Lead (Pb)	18.00	24.41	No
Pentaerythritol tetranitrate (PETN)	<0.0985	5.00	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	<0.118	1.00	No
Triaminotrinitrobenzene (TATB)	<0.394	3.00	No
1,3,5-Trinitrobenzene (TNB135)	<0.0985	10.00	No
Trinitrotoluene (TNT)	<0.0985	10.00	No
Zinc (Zn)	73.20	139.91	No

Table D1.6 Sampling Location: TLAP Tract 101 (Subsurface)

Analyte (Agricultural Parameters)	Tract 101A Measured Value		Tract 101B Measured Value		Tract 101C Measured Value		Unit of Measurement
	Depth (in.)		Depth (in.)		Depth (in.)		
	12	24	12	24	12	24	
pH (2:1 ratio soil pH)	7.3	8.2	7.8	8.2	7.9	8.3	pH Units

Analyte (Agricultural Parameters)	Tract 101A Measured Value		Tract 101B Measured Value		Tract 101C Measured Value		Unit of Measurement
	Depth (in.)		Depth (in.)		Depth (in.)		
	12	24	12	24	12	24	
Total nitrogen	972.2	574.3	1025.9	578.5	866.0	512.5	mg/kg
Nitrate (as nitrogen)	25.2	3.3	15.9	3.5	8.0	2.5	mg/kg
Total kjeldahl nitrogen	947	571	1010	575	858	510	mg/kg
Orthophosphate (plant-available)	42	6	18	4	14	4	mg/kg
Calcium (plant-available)	3225	6433	5742	5957	3739	6572	mg/kg
Magnesium (plant-available)	712	894	779	807	689	916	mg/kg
Sodium (plant-available)	106	214	130	189	122	200	mg/kg
Sodium absorption ratio (SAR)	1.3	2.9	1.7	3.0	1.8	2.7	Percent
Potassium (plant-available)	642	434	593	355	483	399	mg/kg
Conductivity [saturated paste (ECe)]	0.85	0.53	0.80	0.61	0.61	0.47	µmho/cm
Calcium (water-soluble)	97	36	76	38	55	29	mg/L
Magnesium (water-soluble)	28	11	24	12	16	11	mg/L
Sodium (water-soluble)	55	78	68	84	60	67	mg/L
Sulfur (plant-available)	42	45	41	38	27	45	mg/kg

Table D1.7 Sampling Location: TLAP Tract 201 (Subsurface)

Analyte (Agricultural Parameters)	Tract 201A Measured Value		Tract 201B Measured Value		Tract 201C Measured Value		Tract 201D Measured Value		Unit of Measurement
	Depth (in.)		Depth (in.)		Depth (in.)		Depth (in.)		
	12	24	12	24	12	24	12	24	
pH (2:1 ratio soil pH)	7.5	8.3	7.4	8.3	7.6	8.5	7.7	8.3	pH Units
Total nitrogen	945.8	532.9	923.3	493.9	704.6	575.0	883.2	582.6	mg/kg
Nitrate (as nitrogen)	16.8	2.9	15.3	2.9	10.6	3.0	10.2	2.6	mg/kg
Total kjeldahl nitrogen	929	530	908	491	694	572	873	580	mg/kg
Orthophosphate (plant-available)	21	3	15	5	10	5	25	6	mg/kg
Calcium (plant-available)	3457	5334	2982	6098	3503	6663	4329	6646	mg/kg
Magnesium (plant-available)	749	840	684	807	658	897	617	771	mg/kg
Sodium (plant-available)	110	207	113	202	120	223	99	187	mg/kg
Sodium absorption ratio (SAR)	1.3	3.5	1.8	3.1	1.6	3.0	1.5	3.0	Percent
Potassium (plant-available)	681	393	620	406	509	459	570	414	mg/kg
Conductivity [saturated paste (ECe)]	0.59	0.44	0.68	0.39	0.66	0.44	0.70	0.47	µmho/cm
Calcium (water-soluble)	61	26	66	23	67	30	81	34	mg/L
Magnesium (water-soluble)	17	9	19	7	19	9	20	9	mg/L
Sodium (water-soluble)	46	81	65	66	60	72	57	77	mg/L
Sulfur (plant-available)	26	35	23	39	24	43	29	42	mg/kg

Table D1.8 Sampling Location: TLAP Tract 301 (Subsurface)

Analyte (Agricultural Parameters)	Tract 301A Measured Value		Tract 301B Measured Value		Tract 301C Measured Value		Unit of Measurement
	Depth (in.)		Depth (in.)		Depth (in.)		
	12	24	12	24	12	24	
pH (2:1 ratio soil pH)	7.7	8.3	7.5	8.3	7.7	8.3	pH Units
Total nitrogen	765.1	557.7	913.3	593.0	829.0	567.5	mg/kg
Nitrate (as nitrogen)	18.1	2.7	20.3	3.0	9.0	2.5	mg/kg
Total kjeldahl nitrogen	747	555	893	590	820	565	mg/kg
Orthophosphate (plant-available)	24	3	30	9	17	6	mg/kg
Calcium (plant-available)	3366	6343	3852	7380	4023	6797	mg/kg
Magnesium (plant-available)	649	776	736	896	822	802	mg/kg
Sodium (plant-available)	95	183	125	232	107	164	mg/kg
Sodium absorption ratio (SAR)	1.5	2.8	1.3	2.8	1.3	2.5	Percent
Potassium (plant-available)	449	326	656	476	595	402	mg/kg
Conductivity [saturated paste (ECe)]	0.81	0.36	0.87	0.37	0.54	0.36	µmho/cm
Calcium (water-soluble)	90	24	94	26	59	27	mg/L
Magnesium (water-soluble)	26	8	25	7	18	8	mg/L
Sodium (water-soluble)	63	62	56	63	44	57	mg/L
Sulfur (plant-available)	24	39	30	49	27	41	mg/kg

Table D1.9 Sampling Location: TLAP Pivot 3 (Surface)

Analyte (Agricultural Parameters)	Pivot 3 North Measured Value			Pivot 3 South Measured Value			Unit of Measurement
	Depth (in.)			Depth (in.)			
	6	18	30	6	18	30	
pH (2:1 ratio soil pH)	6.6	7.8	8.3	6.8	7.8	8.3	pH Units
Total nitrogen	1057.9	709.1	505.5	975.2	730.9	507.4	mg/kg
Nitrate (as nitrogen)	7.9	4.1	2.5	7.2	3.9	3.4	mg/kg
Total kjeldahl nitrogen	1050	705	503	968	727	504	mg/kg
Orthophosphate (plant-available)	47	5	10	23	6	10	mg/kg
Calcium (plant-available)	2725	4313	5875	2813	4425	6435	mg/kg
Magnesium (plant-available)	566	753	841	571	731	798	mg/kg
Sodium (plant-available)	65	103	216	62	106	211	mg/kg
Sodium absorption ratio (SAR)	1.3	1.0	3.5	1.1	1.2	2.4	Percent
Potassium (plant-available)	661	487	454	522	472	443	mg/kg
Conductivity [saturated paste (ECe)]	0.57	0.55	0.48	0.54	0.58	0.71	µmho/cm
Calcium (water-soluble)	50	105	28	55	64	97	mg/L
Magnesium (water-soluble)	13	15	8	13	15	13	mg/L
Sodium (water-soluble)	41	43	81	35	42	96	mg/L
Sulfur (plant-available)	24	30	44	22	32	49	mg/kg

Table D1.10 Sampling Location: TLAP Pivot 4 (Surface)

Analyte (Agricultural Parameters)	Pivot 4 North Measured Value Depth (in.)			Pivot 4 South Measured Value Depth (in.)			Unit of Measurement
	6	18	30	6	18	30	
pH (2:1 ratio soil pH)	6.7	7.7	8.2	7.1	8.0	7.8	pH Units
Total nitrogen	967.1	674.3	549.9	1025.4	674.2	558.2	mg/kg
Nitrate (as nitrogen)	5.1	3.3	2.9	5.4	5.2	4.2	mg/kg
Total kjeldahl nitrogen	962	671	547	1020	669	554	mg/kg
Orthophosphate (plant-available)	42	7	14	33	5	11	mg/kg
Calcium (plant-available)	3064	5871	6117	3565	6507	6604	mg/kg
Magnesium (plant-available)	575	801	748	646	695	719	mg/kg
Sodium (plant-available)	57	87	155	60	80	124	mg/kg
Sodium absorption ratio (SAR)	0.4	0.5	1.1	0.5	0.9	1.8	Percent
Potassium (plant-available)	638	500	412	726	448	407	mg/kg
Conductivity [saturated paste (ECe)]	0.54	0.60	0.44	0.64	0.61	0.52	µmho/cm
Calcium (water-soluble)	319	300	228	340	232	56	mg/L
Magnesium (water-soluble)	23	19	11	22	16	10	mg/L
Sodium (water-soluble)	27	35	61	34	50	57	mg/L
Sulfur (plant-available)	25	39	44	27	46	45	mg/kg

Table D1.11 Sampling Location: TLAP Pivot 5 (Surface)

Analyte (Agricultural Parameters)	Pivot 5 North Measured Value Depth (in.)			Pivot 5 South Measured Value Depth (in.)			Unit of Measurement
	6	18	30	6	18	30	
pH (2:1 ratio soil pH)	6.5	7.6	8.0	7.0	7.8	8.1	pH Units
Total nitrogen	1037.3	736.4	466.1	977.9	595.7	460.5	mg/kg
Nitrate (as nitrogen)	7.3	5.4	3.1	9.9	6.7	2.5	mg/kg
Total kjeldahl nitrogen	1030	731	463	968	589	458	mg/kg
Orthophosphate (plant-available)	41	8	9	22	5	12	mg/kg
Calcium (plant-available)	2916	5800	7896	3089	5755	6252	mg/kg
Magnesium (plant-available)	628	864	960	684	784	952	mg/kg
Sodium (plant-available)	47	83	179	44	94	223	mg/kg
Sodium absorption ratio (SAR)	0.5	0.8	0.6	0.5	1.2	2.3	Percent
Potassium (plant-available)	769	555	499	608	405	475	mg/kg
Conductivity [saturated paste (ECe)]	0.56	0.49	0.43	0.60	0.44	0.42	µmho/cm
Calcium (water-soluble)	70	61	693	129	45	47	mg/L
Magnesium (water-soluble)	19	15	15	20	12	8	mg/L
Sodium (water-soluble)	18	28	55	22	35	66	mg/L

Analyte (Agricultural Parameters)	Pivot 5 North Measured Value Depth (in.)			Pivot 5 South Measured Value Depth (in.)			Unit of Measurement
	6	18	30	6	18	30	
Sulfur (plant-available)	25	40	57	24	39	51	mg/kg

APPENDIX E ‑ GLOSSARY

Activity – The rate of disintegration or transformation of radioactive material, generally expressed in units of curie (Ci). The official Système International d'Unités (SI) unit is the becquerel (Bq). One Bq (one disintegration or transformation per second) is equivalent to 2.7 X 10^{-11} Ci.
ALARA – An acronym and phrase, "as low as reasonably achievable," used to describe an approach to radiation exposures and emission control or management whereby the exposures and resulting doses to the public are maintained as far below the specified limits as economic, technical, and practical considerations will permit. ALARA is not a dose limit.
Alpha particle – Type of particulate radiation (identical to the nucleus of the helium atom) consisting of two protons and two neutrons
Anion – A negatively charged ion that migrates to an anode, as in electrolysis
Aquifer – Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs
Archaeology – Scientific discipline responsible for the recovery, analysis, interpretation, and explanation of the unwritten portion of the prehistoric and historic past
Artifact – Any object manufactured or modified by human beings
Asbestos – Group of naturally occurring minerals that separate into fibers. The asbestos family includes actinolite, anthophyllite, chrysotile, crocidolite, and tremolite.
Assembly – The process of putting together a nuclear weapon or nuclear weapon component. This process takes place at Pantex.
Background or control samples – Samples obtained from a background sampling location for comparison with samples obtained at or near Pantex. Background or control samples are not expected to be affected by Pantex operations. The U.S. Department of Agriculture Research Station and the Texas Agri-Life Bush Research Farm at Bushland, Texas, have often been used as a control or background location.
Background radiation – Ionizing radiation which is in the natural environment, including cosmic rays and radiation from the naturally radioactive elements, both outside and inside the bodies of humans and animals
Becquerel (Bq) – The SI unit of radioactivity defined as one nuclear disintegration per second; therefore, one curie (Ci) is equivalent to 3.7 X 10^{10} Bq.
Best Management Practices – Practices that are not required by law, regulation, or permit but are designed to help ensure that Pantex produces the highest quality services and products
Beta particle – Type of particulate radiation emitted from the nucleus of an atom that has a mass and charge equal in magnitude to that of the electron
Biota – Living organisms
Biota Concentration Guide – The limiting concentration of a radionuclide in soil, sediment, or water that would not cause dose limits for protection of aquatic and terrestrial biota to be exceeded. An analog to the derived concentration standard used for human exposure
Blackwater Draw Formation – Quaternary formation consisting primarily of pedogenically modified eolian sands and silts interbedded with numerous caliche layers. The Blackwater Draw Formation overlies the Tertiary Ogallala Formation at Pantex.
Burning Ground – Pantex location where thermal processing (burning) of HE is conducted
Calibration – The adjustment of a measurement system and the determination of its accuracy using known sources and instrument measurements. Adjustment of flow, temperature, humidity, or pressure gauges and the determination of system accuracy should be conducted using standard operating procedures and sources that are traceable to the National Institute of Standards and Technology.
Categorical Exclusion – Categorical exclusions are categories of actions under the National Environmental Policy Act (NEPA) that DOE has determined, by regulation, do not individually or cumulatively have a significant effect on the human environment and for which; therefore, neither an environmental assessment nor an environmental impact statement normally is required.

Cation – A positively charged ion that in an electrolyte moves toward a negative electrode.
Cell – (1) This is the smallest unit capable of independent functioning. (2) A structure at Pantex in which certain nuclear explosive assembly or disassembly operations are conducted.
Code of Federal Regulations (CFR) – Final federal regulations in force: published in codified form.
Composite samples – Samples that contain a certain number of subsamples.
Cultural Resources – Districts, sites, structures, and objects and evidence of some importance to a culture, a subculture, or a community for scientific, traditional, religious, and other reasons. These resources and relevant environmental data are important for describing and reconstructing past lifeways, for interpreting human behavior, and for predicting future courses of cultural development.
Derived Concentration Standard – Concentration of the radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (for example, ingestion of water or breathing the air) would result in an effective dose equivalent of 100 mrem (0.1 rem or 1 mSv). Values for these concentrations are tabulated in DOE-STD-1196-2022, *Derived Concentration Technical Standard*.
Dismantlement – The disassembly of a nuclear weapon no longer required by the Department of Defense. This process takes place at Pantex.
Dockum Group – Triassic sedimentary rocks that underlie the Ogallala Formation at Pantex. The Dockum Group rocks consist of shale, clayey siltstone, and sandstone.
Dose – The quantity of ionizing radiation received. Often used in the sense of exposure dose (a measure of the total amount of ionization that the radiation could produce in air, measured in roentgens [R]). This should be distinguished from the absorbed dose (measured in rads) that represents the energy absorbed from the radiation per gram of any material. Furthermore, dose equivalent (or biological dose); given in rem, is a term used to express the amount of effective radiation when modifying factors such as quality factors have been considered. It is therefore a measure of the biological damage to living tissue from the radiation exposure.
Duplicate sample – A sample that is taken at the same location and the same site; it may be taken simultaneously or consecutively. This sample may be collected for the purpose of evaluating the performance of a measurement system or of the homogeneity of a sample population; i.e., to determine whether the sample results are representative or an anomaly. The duplicates are supposed to be similar in terms of the population sampled.
Ecosystem – Living organisms and their nonliving (abiotic) environment functioning together as a community.
Effective Dose Equivalent (EDE) – The sum of the products of the exposures to individual organs and tissues and appropriate weighting factors representing the risk relative to that for an equal dose to the whole body.
Effluent – A fluid discharged into the environment; an outflow of waste. Its monitoring is conducted at the point of release.
Emission – A substance discharged to the air.
Encephalitis – Inflammation of the brain. In the U.S., this is an acute, often fatal, viral disease of the central nervous system that is transmitted to humans by mosquitoes (arthropods) after a blood meal from infected horses or mules.
Environmental Assessment – A concise public document that a federal agency prepares under NEPA to provide sufficient evidence and analysis to determine whether a proposed agency action would require preparation of an environmental impact statement or a finding of no significant impact.
Environmental Impact Statement – The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to development, implementation, and enforcement of environmental laws, regulations, and policies.
Environmental Monitoring – Sample collection and analysis of environmental media, i.e., air, water, soil, foodstuff, and biota for the purpose of assessing effects of operations at that site on the local environment. It consists of effluent monitoring and environmental surveillance.
Environmental Projects – Program at Pantex responsible for investigation and remediation of Solid Waste Management Units.
Environmental Protection Agency – Federal agency created to protect the nation's water, land,

and air from pollution or environmental damage.

Environmental Surveillance – The collection and analysis of samples, or direct measurements of air, water, soil, foodstuff, and other media for the purpose of determining compliance with applicable standards and permit requirements, assessing radiation exposures of members of the public, and assessing the effects, if any, on the local environment.

Ephemeral – Lasting only a short period of time. Used in this document to describe water bodies that often does not have water year-round. Typically, these water bodies have water following the wet seasons and then are dry during the dry seasons.

Fauna – Animal life, or animals as a whole, especially those that are characteristic of a region.

Flora – Plant life or plants as a whole, especially those that are characteristic of a region.

Gamma ray (gamma radiation) – High-energy, short wavelength electromagnetic radiation (a packet of energy) emitted from the nucleus. (Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission.) Gamma rays are very penetrating and can be stopped or shielded against by dense materials such as lead or uranium. Gamma rays are similar to X-rays, but are usually more energetic.

Greenhouse Gases (GHGs) – Chemical compounds found in the earth's atmosphere which absorb infrared radiation (heat) from the reflection of sunlight striking the earth's surface and cause rising temperatures. Some occur in nature (e.g., carbon dioxide, methane, and nitrous oxide), and others such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are anthropogenic (man-made). For Federal agencies emissions of greenhouse gases are further classified as:

Scope 1: direct GHG emissions from sources that are owned or controlled by the Federal agency;

Scope 2: direct GHG emissions resulting from the consumption of purchased or acquired electricity, heat, or steam purchased by a federal agency; and

Scope 3: GHG emissions from sources not owned or directly controlled by a federal agency but related to agency activities such as vendor supply chains, delivery services, and employee travel and commuting.

Hazardous material – A material, including a hazardous substance, as defined by 49 CFR 171.8, *Transportation*, "Definitions and Abbreviations," that poses a risk to health, safety, and property when handled or transported.

Hazardous waste – Defined by 40 CFR Part 261, as any material that a) is a solid waste, and b) is a listed hazardous waste (Subpart D), or c) exhibits any of the characteristics of ignitibility, corrosivity, reactivity or toxicity (Subpart C).

Herbicide – A substance (usually chemical) used to destroy undesirable plants.

High explosives – Any chemical compound or mechanical mixture which, when subjected to heat, impact, friction, shock, or other suitable initiation stimulus undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressure in the surrounding medium.

Histopathology – The science or study of dealing with the structure of abnormal or diseased tissue; examination of the tissue changes that accompany a disease.

Historic – Of, relating to, or existing in times postdating the development of written records. Historic cultural resources are all evidences of human occupations that date to recorded periods in history. Historic resources may be considered archaeological resources when archaeological work is involved for identification and interpretation.

Industrial solid waste – Solid waste resulting from or incidental to any process of industry or manufacturing, or mining or agricultural operations.

Infrastructure – The basic services, facilities and equipment needed for the functioning and growth of an area.

Insecticide – A substance used to destroy undesirable insects.

Isotope – Any of two or more species of atoms of a chemical element with the same atomic number and position in the periodic table and nearly identical chemical behavior but with different numbers of neutrons in their nuclei, and thus differing atomic mass number and different physical properties.

Less than 55-gallon Hazardous Waste Accumulation Sites – Temporary hazardous or mixed waste accumulation points located at or near the point of generation to collect no more than a total of 55 gallons of hazardous waste or no more than 1 quart of acutely hazardous waste. This area must be under the control of the operator of the process generating the waste.

Less than 90-Day Hazardous Waste Accumulation Sites – These are temporary accumulation areas used to collect hazardous wastes for 90 days or less before transfer to an interim status or permitted hazardous waste processing or storage facility.

Llano Estacado – Spanish for "staked plains", used to refer to the Southern High Plains.

Low-level radioactive waste – Waste containing radioactivity not classified as high-level, transuranic waste, spent nuclear fuel, or special by-product material.

Mammal – Animals in the class Mammalia that are distinguished by having self-regulating body temperature, hair, and in females, milk-producing mammary glands to feed their young.

Maximum Contaminant Levels – The maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.

Method Detection Limit – A measure of instrument sensitivity using solutions that have been subjected to all sample preparation steps for the method.

Metric System – See International System of Units.

Mixed waste – Waste containing both radionuclides as defined by the Atomic Energy Act, and hazardous constituents as defined by 42 USC 6901 et seq. and 40 CFR 261.

Mortuary remains – Human physical remains and associated artifacts that exist in prehistoric and historic temporal contexts.

National Ambient Air Quality Standards NAAQS) – Standards developed, under the authority of the CAA by the Environmental Protection Agency, to protect the quality of the air we breathe. Standards are set for six pollutants: sulfur dioxide, particulate matter with a mean aerodynamic diameter of 10 microns or less, carbon monoxide, ozone, nitrogen dioxide, and lead.

National Environmental Policy Act (NEPA) – Federal statute promulgated under 40 CFR part 1500 through 1508; requires Federal facility actions be evaluated for environmental impacts, usually in the form of environmental Impact Statements or Environmental Assessments. 10 CFR 1021 is DOE's Implementing Procedures for NEPA.

National Pollutant Discharge Elimination System (NPDES) – U.S. Federal Regulation (40 CFR, Parts 122 and 125) that requires permits for the discharge of pollutants from any point source into the waters of the United States.

National Register of Historic Places (NRHP) – A national list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture.

Native American – A tribe, people, or culture that is indigenous to the United States.

Necropsy – Autopsy, postmortem examination.

Nuclear weapon – Any weapon with a nuclear device designed specifically to produce a large release of energy (nuclear explosion) from the fission and/or fusion of atomic nuclei.

Off-site – Outside Pantex site boundary.

On-site – Within Pantex site boundary.

Ogallala Formation – Tertiary formation consisting of gravel, sand, silt, and clay. This is the principal geologic unit in the High Plains Aquifer. Comprises the Ogallala Aquifer in the Panhandle of Texas, the primary source of groundwater in the region. The top of the Ogallala Formation in large areas of Texas and New Mexico consists of a resistant caliche layer. The Ogallala Formation at Pantex overlies the Triassic Dockum Group strata and underlies the Quaternary Blackwater Draw Formation.

Outfall – The outlet of a body of water. In the surface water permitting program, the term outfall refers to the effluent monitoring location identified by the permit. An outfall may be "internal" (associated with a building) or "final" (the last monitoring point at Pantex.)

Perched aquifer – Groundwater separated from the underlying main body of groundwater, or aquifer, by unsaturated rock.

Permian – The last period of the Paleozoic era (after the Pennsylvanian) thought to have covered the span of time between 280 and 225 million years ago (Ma); also, the corresponding system of rocks. It is named after the province of Perm, Russia, where rocks of this age were first studied.

Per- and Polyfluoroalkyl Substances (PFAS) – PFAS are a group of manufactured chemicals that have been used in industry and consumer products since the 1940s because of their useful properties. There are thousands of different PFAS, some of which have been more widely used and studied than others.

Plague – An acute infection caused by the bacterium *Yersinia pestis*. It is transmitted from rodent to humans by the bite of an infected flea. It is less commonly transmitted by direct contact with infected animals or airborne droplets. This disease is also manifested by an acute onset of fever followed by shock, multiple organ failure, and death; caught early, it is treatable with antibiotics.

Playa Lake – A natural depression acting as a detention basin receiving surface runoff within a watershed area; an ephemeral lake.

Plume – An elongated pattern of contaminated air or water originating at a point source, such as a smoke stack or a hazardous waste disposal site.

Plutonium – A heavy, radioactive, man-made metallic element with atomic number 94. Its most important isotope is fissile ^{239}plutonium, which is produced by neutron irradiation of ^{238}uranium. The nuclei of all atoms of this isotope contain 94 protons and 145 neutrons.

Pollution prevention – The process of reducing and/or eliminating the generation of waste materials through source reduction, process modification, and recycling/reuse to minimize environmental or health hazards associated with hazardous wastes, pollutants or contaminants.

Potable – Suitable for drinking.

Practical Quantitation Limit (PQL) – The Final Risk Reduction Rule Guidance is used to identify the quantifiable limit of detection for sampled constituents at Pantex. This limit is defined as practical quantitation limit. A PQL is the lowest level that can be accurately and reproducibly quantified.

Prehistoric – Of, relating to, or existing in times antedating written history. Prehistoric cultural resources are those that pre-date written records of the human cultures that produced them.

Process knowledge – Used to characterize a waste stream when it is difficult to sample because of physical form, the waste is too heterogeneous to be characterized by one set of samples, or the sampling and analysis of the waste stream results in unacceptable risks of radiation exposure.

Programmatic Agreement – The document outlining specific plans for the management of cultural resources at Pantex before the long-term Cultural Resource Management Plan was implemented. The parties to the agreement were the U.S. DOE, the President's Advisory Council on Historic Preservation, and the Texas State Historic Preservation Office.

Pseudorabies – A highly contagious disease affecting cattle, horses, dogs, swine, and other mammalian species, caused by porcupine herpes virus 1, which has its reservoir in swine. In species other than swine, pseudorabies is highly fatal.

Pullman soil series – Silty clay loams; soils found in the inter-playa areas at Pantex.

Quaternary – The most recent of the three periods of the Cenozoic Era in the geologic time scale. It follows the Neogene Period and spans from 2.588 ± 0.005 million years ago to the present. It is divided into two epochs: the Pleistocene and the Holocene.

Rabies – A rapidly fatal disease of the central nervous system that may be transmitted to any warm-blooded animal. The disease starts with a fever, headache, muscle aches, nausea, and vomiting, and eventually progresses to agitation, confusion, combativeness, increased salivation and decreased swallowing, followed by coma and death. It can be transmitted to humans through the bite of infected animals such as dogs, cats, skunks, wolfs, foxes, raccoons, and bats.

Radiation (nuclear) – Particles (alpha, beta, neutrons) or photons (gamma) emitted from the nucleus of an unstable (radioactive) atom as a result of radioactive decay. It does not include non-ionizing radiation, such as microwaves or visible, infrared, or ultraviolet light.

Radioactive – The state of emitting radiation in the form of waves (rays) or particles.

Radioactivity – The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the nucleus of an unstable isotope.

Randall soil series – Clay soils present in the playa lake bottoms at Pantex.

Replicate analysis – A repeated operation occurring within an analytical procedure, e.g., two or more analyses for the same constituent in an extract of a single sample. Replicate environmental samples measure the overall precision of the sampling or analytical methods, while replicate analyses are identical analyses carried out on the same sample multiple times. They measure analytical laboratory precision only.

Resource Conservation and Recovery Act (RCRA) – Federal statute which governs current and planned hazardous waste management activities.

Risk Reduction Rules – 30 TAC 335 Subchapter S, outline three risk reduction levels to be considered relative to the corrective measures.

Risk Reduction Standard 1 – Closure and/or remediation to background levels by removing or decontaminating all waste, waste residues, leachate, and contaminated media to levels unaffected by waste management activities.

Risk Reduction Standard 2 – Closure and/or remediation to health-based standards and criteria by removing, containing, or decontaminating all waste, waste residues, leachate, and contaminated media to meet standards and criteria such that any substantial present and future threats to human health and the environment are very low.

Risk Reduction Standard 3 – Closure and/or remediation with controls, which entails removal, containment, or decontamination of 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 reduced to an acceptable level, based on use.

Sanitization – The irreversible modification or destruction of a component or part of a component of a nuclear weapon, device, trainer or test assembly, as necessary, to prevent revealing classified or otherwise controlled information, as required by the Atomic Energy Act of 1954, as amended.

Saturated zone – The zone in which the voids in the rock or soil are filled with water at a pressure greater than atmospheric. The water table is the top of the saturated zone in an unconfined aquifer.

Seismic – Pertaining to any earth vibration, especially an earthquake.

Sievert (Sv) – The Système International d'Unités (SI units) unit of equivalent dose. One sievert is equivalent to 100 rem.

Site – A geographic entity comprising leased or owned land, buildings, and other structures required to perform program activities.

Site (archaeological) – Any area or location occupied as a residence or used by humans for a sufficient length of time to leave physical remains or traces of occupancy. The sites are extremely variable in size and may range from a single hunting camp to an extensive land surface with evidence of numerous settlements and activities. The site(s) may consist of secondarily deposited archaeological remains.

Solid Waste Management Unit (SWMU) – Any unit from which hazardous constituents may migrate, as defined by RCRA. A designated area that is, or is suspected to be, the source of a release of hazardous material into the environment that will require investigation and/or corrective action.

Split – One larger sample is split into “equal” parts. The goal of a split sample is to evaluate analytical accuracy. If a sample is split into two parts: one may go to the contractor, one to the regulator; or the two parts may go to two different labs for comparison purposes, or one may be sent to a laboratory for analysis; the second one held for later confirmatory analysis, or in case the first one is lost/broken.

Standard deviation – The absolute difference between one of a set of numbers and their means. It is a statistic used as a measure of dispersion in a distribution, the square root of the arithmetic average of the squares of the deviations from the mean.

Stormwater – A precipitation event that leads to an accumulation of water; it includes stormwater runoff, snowmelt runoff, surface runoff, and drainage.

Supplemental Analysis – A document that DOE prepares in accordance with DOE NEPA regulations (10 CFR 1021.314(c)) to determine whether a supplemental or new EIS should be prepared pursuant to TCEQ NEPA regulations (40 CFR 1502.9(c)).

Surface water – Water that is open to the atmosphere and subject to surface runoff. Surface water includes stormwater.

Tertiary – The first period of the Cenozoic era (after the Cretaceous of the Mesozoic era and before the Quaternary) thought to have covered the span of time between 65 and 2 Ma; also, the corresponding system of rocks.

Texas Commission on Environmental Quality (TCEQ) –The state agency responsible for the environmental quality of Texas. TCEQ has the lead regulatory role for RCRA-regulated waste generated at Pantex.

Thermoluminescent Dosimeter (TLD) – A device containing crystalline materials that, when struck by radiation, contain more energy than in their normal state. At the end of the measurement period, heat is used to anneal the crystals and free the energy, which emerges as a light pulse. The pulse is then mathematically converted to the dose received by the TLD. Correction factors in the conversion equation are adjusted for various filters, TLD crystal elements and incident radiation. The device can either be carried by a radiation worker, or, as used in this document, placed at a specific location to measure the cumulative radiation dose.

Thorium – A radioactive metallic element that occurs combined in minerals and is usually associated with rare earth elements. Thorium's atomic number is 90.

Toxic Substances Control Act (TSCA) – Federal statute that establishes requirements for identifying and controlling toxic chemical hazards to human health and the environment.

Tracer – A labeled element used to trace the course of a chemical or biological process.

Triassic – The first period of the Mesozoic era (after the Permian of the Paleozoic era, and before the Jurassic) thought to have covered the span of time between 225 and 190 Ma; also, the corresponding system of rocks.

Trihalomethanes – One of the families of organic compounds (methane derivatives) in which three of the four hydrogen atoms in methane are substituted by a halogen atom in the molecular structure.

2,4,6-trinitrotoluene (TNT) – A flammable toxic compound ($C_7H_5N_3O_6$) obtained by nitrating toluene and used as an high explosive and in chemical synthesis.

Trip blanks – Provided for each shipping container to be analyzed for VOCs. Analytical results from trip blanks are used to evaluate whether there was any contamination of the sample bottle during shipment from the manufacturer, storage of the bottles, during shipment to the laboratories, or during analysis at the laboratory.

Tritiated – Containing tritium.

Tritium – A radioactive isotope of hydrogen with one proton and two neutrons in its nucleus. It is chemically identical to natural hydrogen and reacts with other substances and is absorbed into the body in the same manner. Elemental tritium incorporates readily with water to form tritiated water (HTO) or oxidized tritium. When this tritiated water is present in the gaseous state in the atmosphere, it is referred to as tritiated water vapor. Tritium decays by beta emission with a radioactive half-life of about 12.5 years.

Uranium – A silvery, heavy, radioactive, polyvalent metallic element that is found especially in pitchblende and uraninite and exists naturally as a mixture of three isotopes of mass number 234, 235, and 238 in the proportions of 0.006%, 0.71%, and 99.28%, respectively. Uranium has an atomic number of 92.

Vadose zone – Also called the unsaturated zone, the zone between the land surface and the water table. The pore spaces in the vadose zone contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched aquifers, may exist in the vadose zone.

Volatile organic compounds (VOCs) – Organic compounds capable of being readily vaporized at normal temperatures and pressures. Examples are benzene, toluene, and carbon tetrachloride.

Waste generator – Any individual or group of individuals that generate radioactive, mixed, hazardous, or other types of wastes at Pantex.

Waste minimization – Refers to a practice that reduces the environmental or health hazards associated with hazardous wastes, pollutants, or contaminants after generation.

Waste Tracking System Database – The computerized log maintained by the Waste Operations Department.

Watershed – A ridge of high land dividing two areas that are drained by different river systems. It can also be the region draining into a river, river system, or body of water.

Weapon component – A part designed specifically for use in a weapon.

Weir – A fence or enclosure set in a waterway to raise the water level or to gauge or divert its flow.

Wetlands – Land or areas exhibiting hydric soil concentrations saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions.

Wind-rose – A graphical depiction of the annual frequency distribution of wind speed and the direction from which the wind has blown.

APPENDIX F - ELEMENTS AND CHEMICALS

Ag	silver
As	arsenic
Ba	barium
Be	beryllium
Ca	calcium
Cd	cadmium
CO	carbon monoxide
CO_2	carbon dioxide
Cr	chromium
Cu	copper
DNX	hexahydro-1,3-Dinitroso-5-Nitro 1,3,5-triazine
DNT	4-amino-2,6-dinitrotoluene
DNT4A	4-amino-2,6-DNT
Fe	iron
HAA5	haloacetic acids
Hg	mercury
HMX	octahydro-1,3,5,7-tetranitro 1,3,5,7-tetrazocine
MEK	methyl ethyl ketone
Mn	manganese
MNX	hexahydro-1-Nitroso-3,5-Dinitro-1,3,5-triazine
NO_x	nitrogen oxides
O_3	ozone
Pb	lead
PCBs	polychlorinated biphenyls
PCE	perchloroethylene
PETN	pentaerythritol tetranitrate
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
SO_x	sulfur oxides
SO_2	sulfur dioxide
TCE	trichloroethylene/ethene
THF	tetrahydrofuran
Ti	titanium
TNB	trinitrobenzene
TNT	trinitrotoluene
TNX	hexahydro-1,3,5-Trinitroso-1,3,5-triazine
VOC	volatile organic compound
Zn	zinc

APPENDIX G - UNITS OF MEASURE

ac	acres
Bq	becquerel
°C	degrees Celsius
ccm	cubic centimeters per minute
cfm	cubic feet per minute
Ci	curie
cm	centimeter
E ±n	exponential (E) is10± n where n is some number (see Appendix F: Conversion Information)
°F	degrees Fahrenheit
ft	foot/feet
ft/min	feet per minute
ft^2	square foot
ft^3	cubic foot
g or gm	gram
gal	gallon
gpm	gallons per minute
ha	hectare
hr	hour
in.	inch(es)
kg	kilogram
km	kilometer
$kBtu/ft^2/year$	energy per square foot per year
L	liter(s)
lb	pound
m	meter
m^3	cubic meter (approx. 1.308 cubic yards)
Ma	million years ago
mg/L	milligrams per liter
mGy	milligray
mi	mile
mi^2	square mile
min	minute
MMBtu	one million British thermal units
mps	meters per second
mrem/yr	millirem per year
mSv	millisievert
mSv/yr	millisievert per year
$MtCO_2e$	metric tons CO_2 equivalent
MWh	megawatt hour
pCi/g	picocuries per gram
ppb	parts per billion
ppm	parts per million
R	roentgen
rem	roentgen equivalent man

Sv	Sievert
TPY	tons per year
yr	year
µ	micro (1.0 x 10^{-6})
µg/L	micrograms per liter
µmho/cm	micromhos per centimeter

APPENDIX H ‑ CONVERSION FACTORS

Table H.1 Units of Radiation Measurement

Current System	*Systéme International*	Conversion
curie (Ci)	becquerel (Bq)	1 Ci = 3.7×10^{10} Bq
Rad	gray (Gy)	1 rad = 0.01 Gy
Rem	sievert (Sv)	1 rem = 0.01 Sv

Table H.2 Scientific Notation Used for Units

Multiple	Decimal Equivalent	Notation	Prefix	Symbol
1×10^{3}	1,000	E+03	kilo-	k
1×10^{-2}	0.01	E-02	centi-	c
1×10^{-3}	0.001	E-03	milli-	m
1×10^{-6}	0.000001	E-06	micro-	µ
1×10^{-9}	0.000000001	E-09	nano-	n
1×10^{-12}	0.000000000001	E-12	pico-	p
1×10^{-18}	0.000000000000000001	E-18	atto-	a

Table H.3 Metric Conversions

When you know	Multiply by	To Get	When you know	Multiply by	To Get
cm	0.39	in	in.	2.54	cm
m	3.28	ft	ft.	0.305	m
km	0.62	mi	mi	1.61	km
kg	2.21	lb	lb	0.45	kg
L	0.26	gal	gal	3.79	L
L	1.04	quart	quart	0.95	L
hectare	2.47	acre	acre	0.40	hectare
km^2	0.39	mi^2	mi^2	2.59	km^2
m^3	35.32	ft^3	ft^3	0.03	m^3
To convert the temperature in degrees Celsius (degrees C) to degrees Fahrenheit (degrees F), use degrees F = 1.8(degrees C) + 32 degrees.					

Table H.4 Prefixes Used in the Metric System

Prefix	Abbreviation	Meaning	Example
Giga	G	10^9	1 gigameter (Gm) = 1×10^9 m
Mega	M	10^6	1 megameter (Mm) = 1×10^6 m
Kilo	k	10^3	1 kilometer (km) = 1×10^3 m
Deci	d	10^{-1}	1 decimeter (dm) = 0.1 m
Centi	c	10^{-2}	1 centimeter (cm) = 0.01 m
Milli	m	10^{-3}	1 millimeter (mm) = 0.001 m
Micro	µ[a]	10^{-6}	1 micrometer (µm) = 1×10^{-6} m
Nano	n	10^{-9}	1 nanometer (nm) = 1×10^{-9} m
Pico	p	10^{-12}	1 picometer (pm) = 1×10^{-12} m
Femto	f	10^{-15}	1 femtometer (fm) = 1×10^{-15} m

[a] This is the Greek letter mu (pronounced “mew”).

APPENDIX I – REFERENCES

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