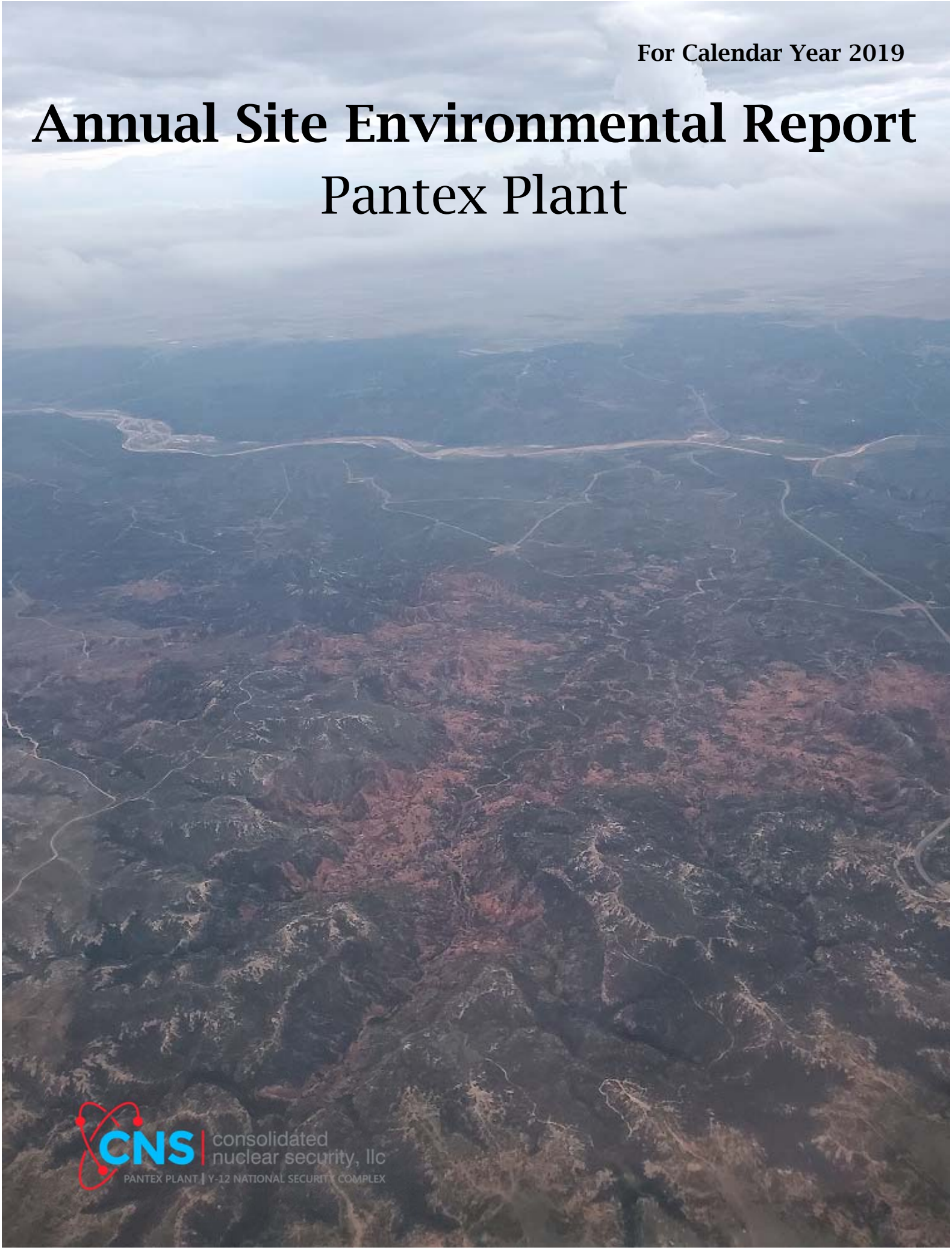
For Calendar Year 2019

Annual Site Environmental Report

Pantex Plant



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PANTEX PLANT | Y-12 NATIONAL SECURITY COMPLEX

CNS | consolidated nuclear security, llc
PANTEX PLANT | Y-12 NATIONAL SECURITY COMPLEX

It is the CNS environmental policy to protect the environment, prevent pollution, comply with applicable requirements, and continually take actions to conserve and improve our natural environment within which we perform our missions. The CNS Environmental Management System:

- Implements appropriate controls and actions to minimize environmental impacts caused by our activities, products, and services;
- Seeks continual improvement in protection of the environment through sustainability, pollution prevention/source reduction, recycling/reuse, and housekeeping excellence;
- Advances strict compliance with relevant environmental laws, regulations and other requirements;
- Provides the framework for setting and reviewing environmental objectives and targets; and
- Documents conformance to each element of the International Organization for Standardization (ISO), *Environmental Management Systems – Requirements with Guidance for Use (ISO 14001).*

Michelle Reichert
Chief Executive Officer

On the cover: The Palo Duro Canyon begins approximately 25 miles south of the Pantex Plant. It is the second largest canyon in the United States with a very rich cultural and geological history. The canyon is the result of the erosion from the Prairie Dog Town Fork Red River that cut deep into the Earth during and after the geologic uplifting of the area. The canyon exemplifies the significance of diligence where, much like the Pantex Plant, the cumulative effect of everyday actions can lead to extraordinary things.

Site Environmental Report
Pantex Plant 2019

Prepared for

U.S. Department of Energy/National Nuclear Security Administration Production Office

Prepared by

Environmental Compliance Department

Waste Operations Department

and the Environmental Projects Department

Consolidated Nuclear Security, LLC (CNS Pantex)

Amarillo, Texas 79120-0020

https://pantex.energy.gov

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Acknowledgments

This report was prepared primarily by the staff of the Environmental Programs of Consolidated Nuclear Security, LLC Pantex Plant. The Environmental Compliance Department is managed by J. R. Flowers, the Environmental Projects Department is managed by A. T. Biggs, and the Waste Operations Department is managed by P. B. Moon.

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The results presented in this report are from samples collected by the Environment, Safety & 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 2019 Annual Site Environmental Report for Pantex Plant was reviewed for classification issues and it was determined to be unclassified.

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Help Us Make This Site Environmental Report More Useful For You!

We want this summary to be easy to read and useful. To help continue this effort, please take a few minutes to let us know if this annual report meets your needs. Please tear out this page and mail or fax it to:

CNS Pantex Plant
J. W. Dupre
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1. How do you use the information in this summary? Please circle.

To become more familiar with Pantex Plant monitoring
To help me make a decision about moving to the Texas Panhandle
To send to others outside the Texas Panhandle
To prepare for public meetings
Other (please explain)

2. What parts of the summary do you use? Please circle.

Pantex Plant overview/mission
Site management
Environmental compliance
Environmental monitoring
Quality assurance
Regulatory oversight
Current issues and actions

3. Does this guide contain?

Enough detail Too much detail Too little detail

Comments:

4. If you could change this report to make it more readable and useful to you, what would you change?

What is your affiliation? Please circle.

Pantex contractor	DOE
State agency	Federal agency
Public interest group	Member of the public
Member of Native American Nation	Local government
University	Industry

Other Comments:

Thank you!

Annual Site Environmental Report for Pantex Plant

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List of Acronyms

AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
AQMR	Air Quality Management Requirement
ARPA	Archaeological Resource Protection Act
BCG	Biota Concentration Guide
B&W	Babcock & Wilcox
BOD	Biochemical Oxygen Demand
CAA	Clean Air Act
CAP	Corrective Action Plan
CAR	Corrective Action Report
CCL	Contaminant Candidate List
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNS	Consolidated Nuclear Security
COC	Chain of Custody
COC	Contaminants of Concern
COD	Chemical Oxygen Demand
CRM	Cultural Resource Management
CWA	Clean Water Act
CY	Calendar Year
D&Z	Day & Zimmerman
DBP	Disinfectant By-Product
DCS	Derived Concentration Standard
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DOT	Department of Transportation
DPS	Department of Public Safety
DQO	Data Quality Objective
EA	Environmental Assessment
ECD	Environmental Compliance Department
EIS	Environmental Impact Statement
EMCS	Energy Management Control System
EMS	Environmental Management System
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
ESA	Endangered Species Act
FGZ	Fine Grained Zone
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FM	Farm-to-Market Road
GHG	Greenhouse Gas
GPS	Global Positioning Satellite
GWPS	Groundwater Protection Standard
HAP	Hazardous Air Pollutant
HE	High explosive
HEPA	High-Efficiency Particulate Air
HRO	High Reliability Organization

HWTPF	Hazardous Waste Treatment & Processing Facility
IAG	Interagency Agreement
ICRP	International Commission on Radiological Protection
ISB	In-Situ Bioremediation
ISM	Integrated Safety Management
ISO	International Organization for Standardization
IWQP	Inland Water Quality Parameter
LQAP	Laboratory Quality Assurance Program
LTM	Long-Term Monitoring
LTS	Long-Term Stewardship
M&E	Material and Equipment
MAPEP	Mixed Analyte Performance Evaluation Program
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MEI	Maximally Exposed Individual
MHC	Mason and Hanger Corporation
MSGP	Multi-Sector General Permit
NCR	Non-conformance Report
NELAC	National Environmental Laboratory Accreditation Conference
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NNSA	National Nuclear Security Administration
NPO	National Nuclear Security Administration Production Office
NPS	National Park Service
NRF	NEPA Review Form
NWS	National Weather Service
O&M	Operation and Maintenance
OSSF	On-Site Sewage Facility
P1PTS	Playa 1 Pump & Treat System
P2	Pollution Prevention
PA/CRMP	Programmatic Agreement/Cultural Resources Management Plan
PBR	Permits-By-Rule
PCB	Polychlorinated Biphenols
PE	Performance Evaluation
PFAS	Per- and polyfluoroalkyl substances
PQL	Practical Quantitation Limit
PREP	Pantex Renewable Energy Project
PST	Petroleum Storage Tank
PTE	Potential to Emit
PWS	Public Water System
QA	Quality Assurance
QC	Quality Control
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RER	Replicate Error Ratio
RSD	Radiation Safety Department
SAP	Sampling & Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SEPTS	Southeast Pump and Treat System

SHPO	State Historic Preservation Office
SMP	Site Management Plan
SOC	Synthetic Organic Chemicals
SOW	Statement of Work
SPD	Sustainability Performance Division
SSP	Site Sustainability Plan
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
SWEIS	Site-wide Environmental Impact Statement
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TCAA	Texas Clean Air Act
TCEQ	Texas Commission on Environmental Quality
TDSHS	Texas Department of State Health Services
TTHM	Total Trihalomethanes
TLAP	Texas Land Application Permit
TLD	Thermoluminescent Dosimeter
TNI	The NELAC Institute
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TPY	Tons per Year
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
TTRF	Texas Tech Research Farm
TTU	Texas Tech University
TWQP	Texas Water Quality Permit
UIC	Underground Injection Control
USACE	U.S. Army Corps of Engineers
VOC	Volatile Organic Compound
VMF	Vehicle Maintenance Facility
WWTF	Wastewater Treatment Facility

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Executive Summary

The Pantex Plant is the nation's primary nuclear weapons manufacturing facility. The U.S. Department of Energy (DOE) through the National Nuclear Security Administration (NNSA) Production Office (NPO) oversees Pantex Plant operations. Consolidated Nuclear Security, LLC is the managing and operating contractor of the Pantex Plant under Contract No. DE-NA0001942. Like all manufacturing facilities, the Pantex Plant has the potential to release a variety of contaminants through its primary and supporting operations. Consolidated Nuclear Security, LLC – Pantex manages the environmental aspects of these operations in a manner consistent with Integrated Safety Management (ISM), applicable environmental regulations, and best management practices.

PURPOSE

The 2019 Annual Site Environmental Report (ASER) summarizes the Pantex Plant's status, data, and efforts for the environmental compliance, protection, and restoration programs. It has been prepared in accordance with DOE Order 231.1B, Environment, Safety and Health Reporting (DOEa), and DOE Order 458.1, Radiation Protection of the Public and the Environment (DOEb). 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 18,000 acres (ac), with most operations conducted on approximately 2,000 ac of land. As the nation's primary nuclear weapons manufacturing facility, it assembles, dismantles, modifies and maintains the nation's stockpile of nuclear weapons. The Pantex Plant also supports the weapons stockpile through the development, testing and fabrication of high explosives components. In addition, the Pantex Plant maintains its own steam-generating plant, water treatment plant, and sewage treatment plant. All work at the Pantex Plant 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 Consolidated Nuclear Security, LLC (CNS) environmental policy defines a comprehensive environmental program that contains components of environmental management including, but not limited to, regulatory compliance, pollution prevention (P2), and environmental monitoring.

Data obtained from the monitoring program 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 Plant website at http://pantex.energy.gov. Copies of previous years of the Pantex Plant ASER can be acquired by contacting Pantex Communications at public_communications@cns.doe.gov.

The purpose of the environmental monitoring component of Pantex Plant's Environmental Management System (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 Plant also operates a meteorological monitoring program that supports several of the requirements. Samples

for 2019 were routinely collected at diverse locations, and 26,226 analyses were performed for substances including explosives, metals, organic chemicals, inorganic chemicals, radionuclides, and water quality indicators.

The Pantex Plant 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 2019 relating to the Pantex EMS are listed below.

- Pantex Plant was active in conducting environmental outreach initiatives. The initiatives included sponsoring public meetings to share status of environmental management activities including groundwater status meetings, Natural and Cultural Resource Program accomplishments, providing information for Earth Day activities at DOE Headquarters, and participating in a Science Bowl Competition for area Middle Schools and High Schools.
- The 2019 Presidential Migratory Bird Federal Stewardship Award was to be named from among three finalists: DOE/NNSA/Pantex Plant, the National Park Service (NPS), and the Bureau of Ocean Energy Management in Coordination with the United States Geological Survey. DOE/NNSA/Pantex Plant was named the recipient of the award.
- Pantex Plant diverted approximately 40 percent of Municipal Solid Waste, and approximately 58 percent of construction & demolition material/debris originally earmarked for landfills and identified alternate pathways for beneficial reuse.
- Approximately 95 percent of all electronics procured have met criteria for being environmentally sustainable.
- Due to the Pantex Renewable Energy Project (PREP), CNS has reduced the purchase of energy from nonrenewable sources.

As required by DOE Order 436.1, Departmental Sustainability (DOEc), the Pantex Plant 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* (ISO). The last audit conducted at the Pantex Plant was during 2018, and was performed by a qualified party outside the control or scope of the Pantex Plant EMS Program. The outcome of the audit indicated that Pantex Plant continues to implement an EMS program that conforms to ISO 14001 standards. The next validation audit is scheduled to be performed in FY 2021.

Radiation Dose

In 2019, the calculated annual radiation dose from releases to the atmosphere generated by Plant operations was 7.24 x 10^{-8} 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) 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 the Pantex Plant in 2019. The ambient air monitoring results for 2019 were generally similar to those from previous years. All results were below the applicable DOE Derived Concentration Standard (DCS). Figure ES.1 provides a comparison of radiation doses from multiple sources.

Table ES.1 – Pantex Plant Radiation Dose for 2019 Compared to Regulatory Dosage Allowances

Pantex Plant Radiation Dose (mrem)	EPA Standard Air Pathway (mrem)	DOE Standard All Pathways (mrem)
0.0000000724 (7.24E-8)	10	100

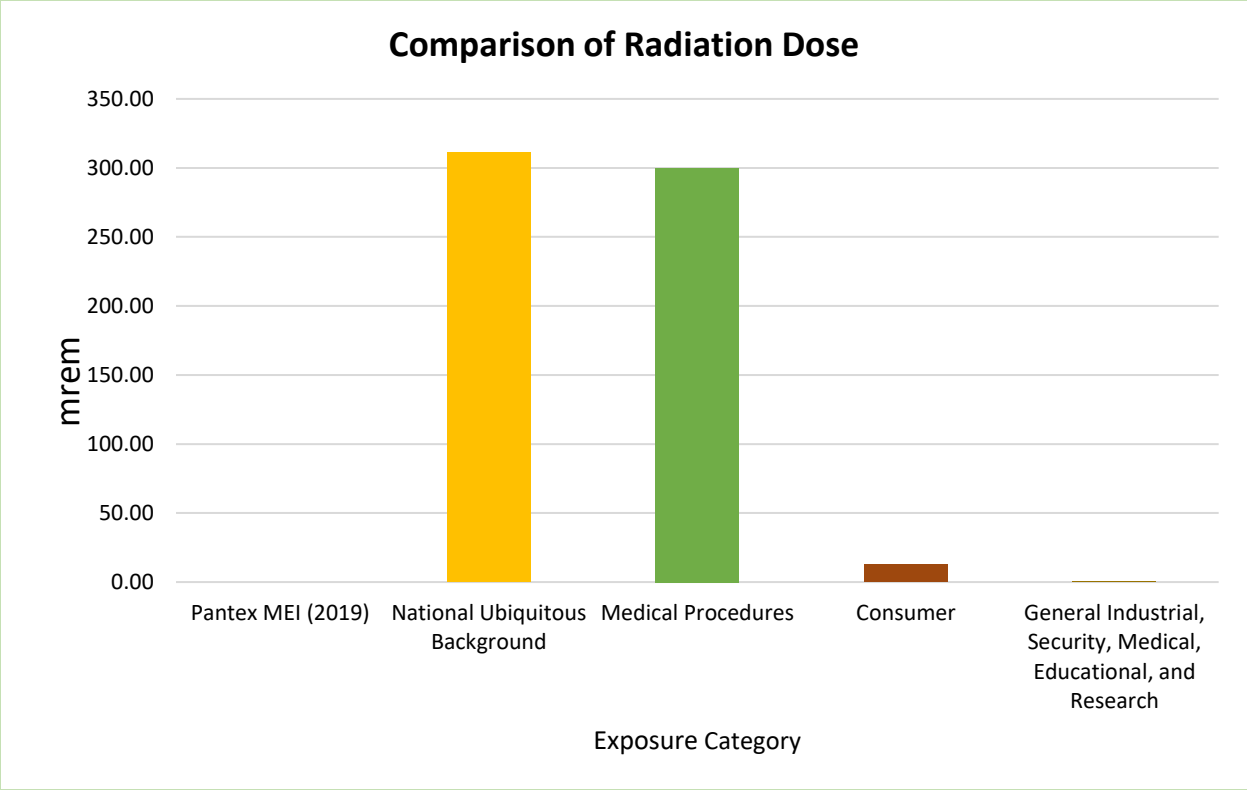

Figure ES.1 – Comparison of Radiation Dose

Drinking Water Monitoring

Results from routine drinking water compliance monitoring in 2019 confirmed that the drinking water system at the Pantex Plant met water quality regulatory requirements. All analytical results for bacteria, chemical compounds, and disinfection by-products were below regulatory limits, and adequate levels of disinfectant were maintained in the distribution system. Lead and copper sampling was conducted in 2018 and is not scheduled for sampling until 2021. The Pantex Plant Public Water System continues to be recognized by the Texas Commission on Environmental Quality (TCEQ) as a "Superior" supply system, the highest rating assigned by the state.

Wastewater Monitoring

During 2019, the Pantex Plant discharged approximately 145 million gallons of treated wastewater to the on-site playa lake. Pantex Plant plans to reinitiate the beneficial reuse of its wastewater for agricultural purposes once repairs to the on-site subsurface irrigation system have been completed.

Pantex Plant had two unauthorized discharges of untreated wastewater from the sanitary sewer system. TCEQ was notified and both instances were remediated as required.

Storm Water Monitoring

Storm water sampling of run-off from industrial activities at the Pantex Plant was conducted in accordance with Texas Pollutant Discharge Elimination System (TPDES) Multi-sector General Permit No. TXR050000. Monitoring conducted during 2019 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 2019 were similar with past monitoring results. The playa data continues to support the position that operations at the Pantex Plant are not negatively affecting the water quality of the playas.

Soil Monitoring

Results of soil monitoring conducted at the Pantex Plant Burning Ground in 2019 were within established background comparison values. Results of soil monitoring conducted at the subsurface irrigation sites were consistent with previous year's results.

Flora and Fauna Monitoring

Flora and Faunal surveillance is complementary to air, soil, and water monitoring in assessing potential short- and long-term effects of operations at the Pantex Plant on the environment. Animals at the Pantex Plant were sampled to determine whether Plant 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. Native vegetation and crops were sampled and compared to historical and control values.

Quality Assurance

Due to its unique mission and service to the country, the Pantex Plant must strive to become a High Reliability Organization (HRO). 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 Plant maintain an unparalleled QA and quality control (QC) program that meets our need for high reliability.

Environmental Remediation

Historical waste management practices at Pantex Plant resulted in impacts to on-site soil and perched groundwater. HE, solvents, and metals were found in the soil in the main operational areas, the Burning Ground, and in the perched groundwater beneath Pantex Plant. Data collected in 2019 indicate that the groundwater remedies are protective of groundwater resources and all detections in the main drinking water aquifer (Ogallala Aquifer) remain below background or the groundwater protections standards.

Pantex Plant 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 Plant to transition to Long-Term Stewardship (LTS) in 2009. A Record of Decision was issued by the EPA in September 2008 that described the final remedial actions for all investigated units.

As part of the transition to LTS, Pantex Plant operated and maintained the groundwater remediation systems, monitored the systems to determine effectiveness of the remedy, and maintained the soil remedies. Pantex Plant installed two types of groundwater remediation systems: two in-situ bioremediation (ISB) 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.

Soil remedies were also inspected, maintained, or scheduled for maintenance during 2019. The soil vapor extraction (SVE) system located at the Burning Ground continued to operate during 2019 and extracted over 508 pounds (lb.) of volatile organics.

Pollution Prevention

Efforts to reduce and eliminate waste from routine operations at the Pantex Plant have resulted in significant waste reductions over the past 30 years. The reduction of waste is even more important considering the Pantex Plant population and workload has increased as waste amounts have decreased. During 2019, Pantex Plant successfully recycled over 4.9 million lb. of materials including over 39,000 lb. of electronics.

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Chapter 1 - Introduction

Pantex Plant site, consisting of 17,503 acres (ac), is located 17 miles (mi) northeast of Amarillo, Texas, in Carson County. Pantex Plant was a World War II (WWII) munitions factory 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 Plant location, history and mission, and facility description, followed by the climate, geology, hydrology, seismology, land use, and population of the area around Pantex Plant.

1.1 SITE LOCATION AND ENVIRONMENTAL SETTING

Pantex Plant 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 1.1). 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 feet (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 Plant.

Pantex Plant is centered on a site that is approximately 17,503 acres (ac). The site consists of land owned and leased by the Department of Energy (DOE). The DOE owns 11,703 ac of the site, including:

- 9,100 ac - Pantex Plant area,
- 1,526 ac - Four tracts east of Farm-to-Market [FM] 2373 near Pantex Plant area, and
- 1,077 ac - Pantex Lake, located approximately 2.5 mi northeast of Pantex Plant 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 Plant area, and are leased from Texas Tech University (TTU) for a safety and security buffer zone.

1.2 FACILITY HISTORY AND MISSION

Pantex Plant is a government-owned, contractor-operated facility. DOE oversees the operation of Pantex Plant through the National Nuclear Security Agency/Production Office (NNSA/PO or NPO). At the end of 2019, approximately 4,600 persons (including Pantex Plant contracted employees, federal employees, and subcontracted employees) were employed at Pantex Plant. Mason & Hanger Corporation (MHC) was the Operation & Maintenance (O&M) contractor of Pantex Plant from 1956 through May 1999 when it became a subsidiary of Day & Zimmermann, Inc. (D&Z). MHC (D&Z) was replaced as contractor by BWXT Pantex, LLC on February 1, 2001. BWXT Pantex combined elements of BWXT Technologies, Honeywell, and Bechtel. Effective in January 2008, the name of the company was officially changed to Babcock & Wilcox Technical Services Pantex, LLC (B&W Pantex). On July 1, 2014, Consolidated Nuclear Security, LLC (CNS) became the O&M contractor of Pantex Plant.

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 Plant and constructing new facilities for nuclear weapons operations. In 1974, the Energy Research and Development Administration (ERDA) replaced the AEC and took responsibility for the operation of Pantex Plant, and in 1977, the ERDA was replaced by the DOE. In 2000, the DOE created and designated the NNSA to manage the nuclear weapons facilities and laboratories.

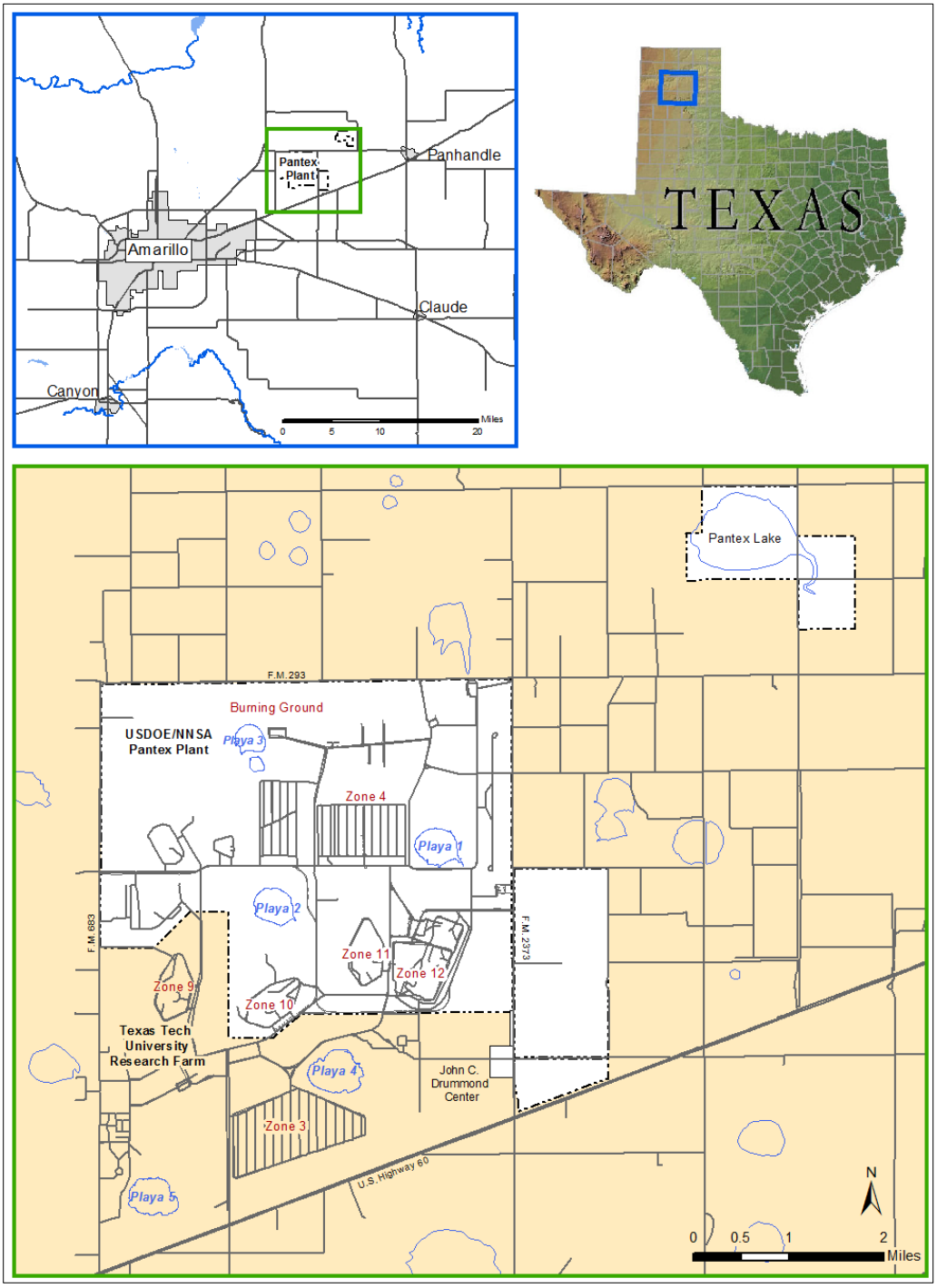


Figure 1.1 – Pantex Plant Site Location and Zones

The primary mission of Pantex Plant is to:

- **Assemble** nuclear weapons for the nation's stockpile,
- **Disassemble** nuclear weapons being retired from the stockpile,
- **Evaluate, repair, and retrofit** nuclear weapons in the stockpile,
- **Provide** interim storage for plutonium pits, and
- **Develop, fabricate, and test** chemical explosives and 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 Plant is composed of several functional areas, commonly referred to as numbered zones (refer to the lower portion of Figure 1.1). Included within the zones are a weapons assembly/disassembly area, a weapons staging area, an area for experimental explosives development, a drinking water treatment plant, a sanitary wastewater treatment facility (WWTF), a vehicle maintenance facility 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 fluid distribution system, and landfills. Overall, there are more than 600 buildings at Pantex Plant.

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, parts received from other DOE plants, chemical explosive components, and metal parts fabricated at Pantex Plant. The weapons can also be disassembled in this area.

One zone 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 Pantex Plant Center of Excellence for high explosives.

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 nonhazardous solid wastes, primarily construction debris. The other receives nonhazardous Solid Waste Management Unit debris. Before 1989, Pantex Plant'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 Plant is routed through a wastewater collection system to a WWTF. On October 6, 2003, the Texas Commission on Environmental Quality (TCEQ) issued Pantex Plant a Texas Land Application Permit (TLAP) that authorizes beneficial reuse of the wastewater for the purpose of agricultural irrigation via a subsurface fluid distribution system. Construction of the subsurface distribution system was completed prior to the end of 2004. During 2017, major filter leaks developed and use of the system was temporarily discontinued. Repairs are being made so that the treated effluent from the WWTF and from the perched aquifer pump and treat systems will once again be discharged to this subsurface irrigation system. Pantex Plant is also authorized to discharge wastewater to an on-site playa lake pursuant to a Texas Water Quality Permit (TWQP) issued by the TCEQ.

The drinking water system, common to many 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 beneficial purposes.

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. The average annual liquid rainfall is 20.36 inches (in) (DOCa). Approximately 70 percent 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 17.8 in (DOCa). Snow usually 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 last two to three days. The estimated potential gross lake surface evaporation in the area is about 55 in (Bomar, 1995) or 270 percent 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 not uncommon (DOCa).

Humidity averages are low, occasionally dropping below 20 percent 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 Plant is located in an area with a relatively high frequency of tornadoes, convective wind events[1] 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 2019 (DOCb). While the threat of tornadoes is real, tornado occurrences in Amarillo are generally rare. Tornadoes are most common from April to June. There were a total of 37 tornadoes reported in the Texas and Oklahoma

[1] High-speed, straight-line winds produced in the downdraft region of a thunderstorm.

Panhandles during 2019 (DOCb), approximately 64 percent of the number observed (58) during the very active year of 2007.

Based upon a review of the several monthly preliminary climatological data forms prepared by the National Weather Service (NWS) Forecast Office for Amarillo (located at Rick Husband International Airport), the mean temperature at the official NWS location during 2019 was 58.4 degrees Fahrenheit (°F), slightly above the normal annual mean temperature in Amarillo of 58.1°F. During 2019, the official NWS rain gauge recorded 25.8 in of precipitation, approximately 127 percent of the normal amount. (DOCa)

Pantex Plant maintains a meteorological monitoring station on the northeast corner of the Plant. The monitoring station is an instrumented 197 ft. tower located approximately 2.3 mi north of the Zone 12 production area. The tower is equipped with two sets of sensors, located at the 33 ft. and 197 ft. levels. Wind speed, wind direction, and temperature sensors are located at both levels and a relative humidity sensor is located at the 33 ft. level. A barometer measures the atmospheric pressure on the tower approximately 6 ft. above the tower base. A pyranometer (instrument that measures insolation or incoming solar radiation) and a tipping bucket rain gauge are located adjacent to the tower at approximately 3.3 ft. above ground level. Sensor measurements are generally taken every five seconds and stored in a "data logger" (mini-computer) located at the tower. Every 15 minutes, the system calculates statistical parameters (e.g., the average, maximum and standard deviation of the measurements from the previous 15-minute interval) for most sensors[2] and transfers the meteorological data for the latest 15-minute interval to a remote server. The data from Pantex Plant's meteorological tower are compared with those obtained from the Amarillo Airport NWS site located approximately 10 mi to the west-southwest of Pantex Plant's meteorological tower 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 frequencies of wind direction and wind speed during 2019 near Pantex Plant, at the NWS Amarillo located approximately 10 mi SW of the Pantex Plant, are illustrated by the wind rose in Figure 1.2. The figure indicates that, as in most previous years, a large percentage (approximately 55 percent) of the winds blew from southerly directions during the year.

Table 1.1 is a compilation of climatological data (temperature, relative humidity, precipitation; including the water equivalent of any snowfall and wind speed) for 2019 from Pantex Plant or Amarillo Airport NWS meteorological instrumentation. The range of mean monthly temperatures during the year measured at Pantex Plant's meteorological tower and the monthly precipitation totals as measured at the Amarillo Airport NWS site are shown in Figures 1.3 and 1.4.

[2] The number of one-hundredths of an inch of rain received, corresponding to the number of times the tipping cup has tipped over during the 15-minute interval, is the only parameter transferred for precipitation.

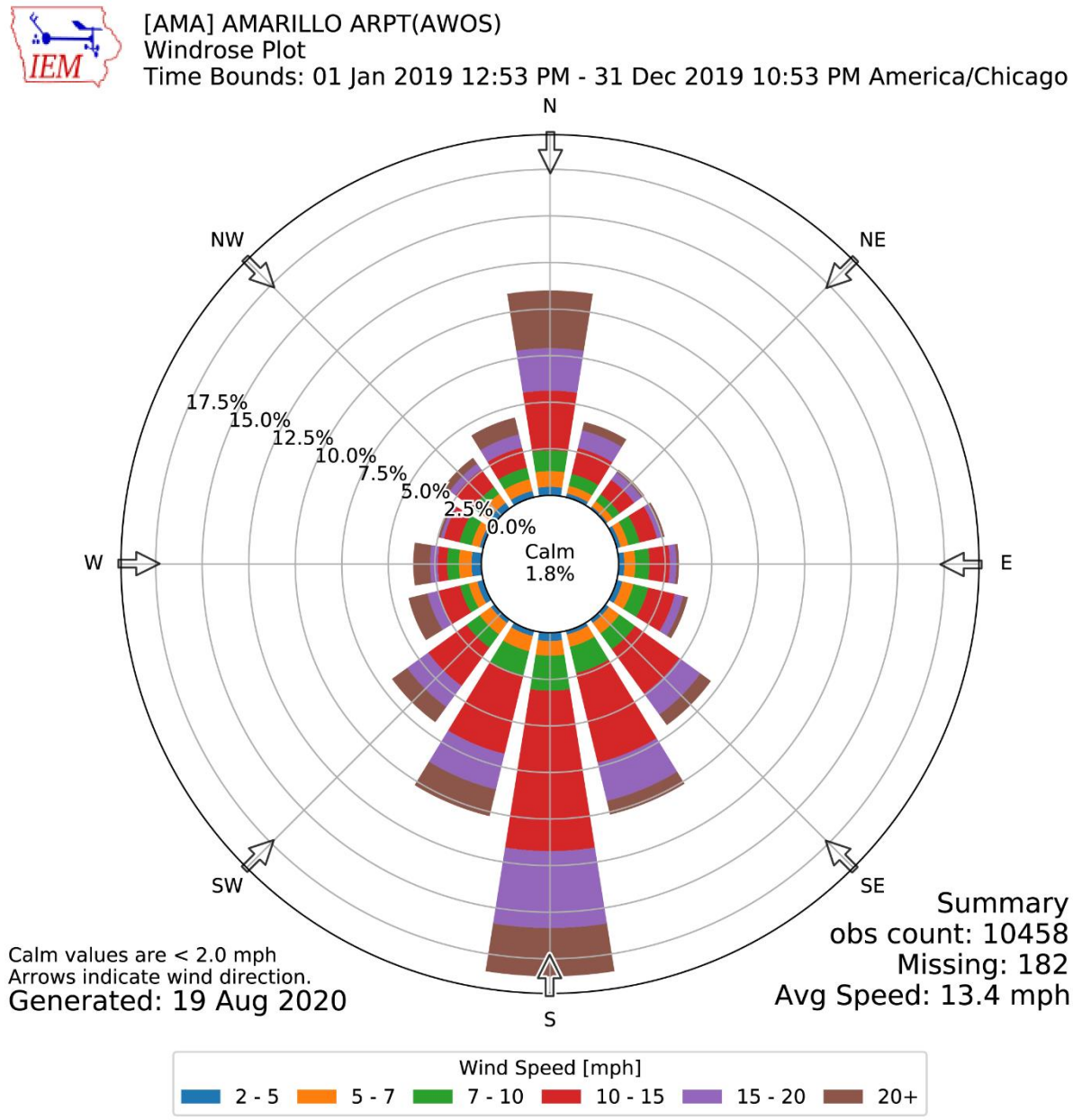


Figure 1.2 – Pantex Plant Annual Wind Rose for 2019

Table 1.1 – Pantex Plant 2019 Climatological Data by Month

Month	Temperature ^{0}F			Mean Relative Humidity (percent)	Precipitation[a] inches	Wind Speed mph	
	Maximum	Minimum	Mean Monthly			Mean	Maximum
January	74	11	39.6	56	0.06	12.8	49.0
February	75	7	40.8	56	0.28	15.2	53.0
March	84	3	45.9	55	2.11	13.2	80.0
April	88	28	58.1	59	1.64	14.1	63.0
May	88	38	62.4	52	3.69	13.0	62.0
June	100	53	72.8	67	2.79	12.5	52.0
July	102	60	80.4	56	2.89	12.1	43.0
August	104	62	81.8	49	3.53	11.9	47.0
September	96	58	76.5	54	1.10	13.4	42.0
October	87	14	52.9	57	5.92	13.0	48.0
November	78	7	44.5	58	0.87	12.8	64.0
December	73	13	41.9	59	1.00	12.5	48.0
Annual			**58.1**	**56**	**25.88**	**13.04**	

[a] Includes water equivalent of snowfall. (Precipitation data from Amarillo Airport NWS site.)

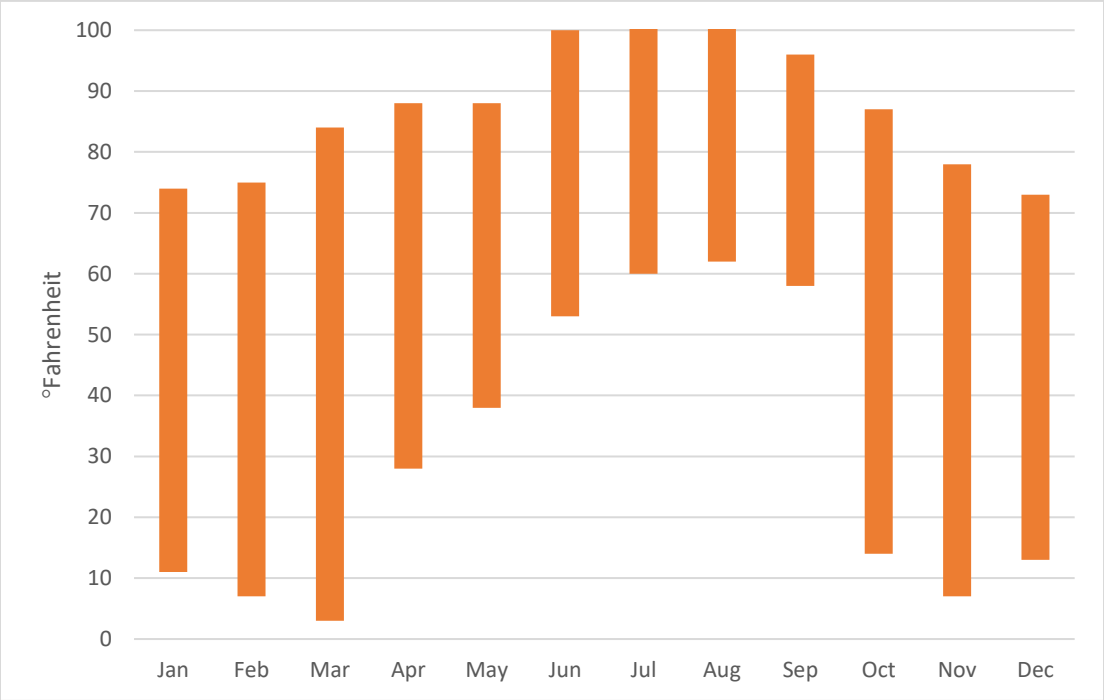


Figure 1.3 – Pantex Plant Monthly Temperature Range During 2019

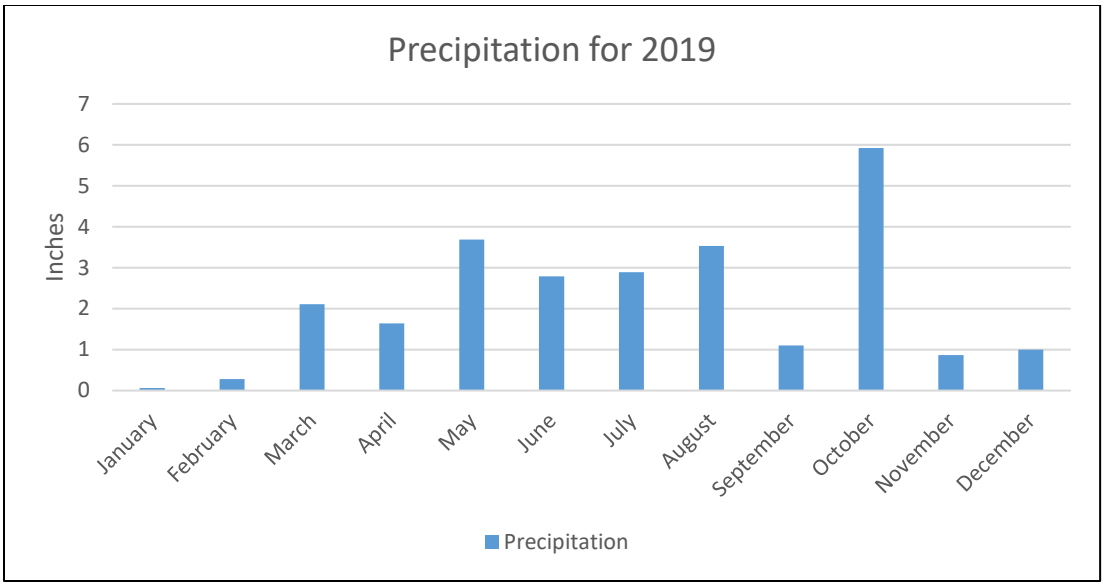


Figure 1.4 – Amarillo National Weather Service (NWS) Precipitation During 2019

1.5 GEOLOGY

The primary surface deposits at Pantex Plant are the Pullman and Randall soil series, which grade downward to the Blackwater Draw Formation. This formation consists of 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 Plant, 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 sedimentary rock of the Dockum Group, consisting of shale, clayey siltstone, and sandstone. The deep geology (4,000 ft.) below the Pantex Plant has a major influence on the natural radiation environment as a result of radon released from the underlying granitic rocks.

1.6 HYDROLOGY

The closest riverine water feature on the Southern High Plains is the Canadian River, which flows southwest to northeast approximately 17 miles north of Pantex Plant. Surface waters at Pantex Plant do not drain into this system, but for the most part discharge into on-site playas. Storm water from agricultural areas at the periphery of Pantex Plant 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 Plant 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 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 Plant 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. (PGCD, 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 Plant trends from the southwest to the northeast, where the zone of saturation is thickest. Pantex Plant'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 Plant's well field.

1.6.3 Dockum Group Aquifer

The Dockum Group Aquifer lies under the Ogallala Formation at Pantex Plant. Water contained in sandstone layers within the Dockum Group supplies domestic and livestock wells south and southeast of Pantex Plant. Other wells reaching the Dockum Group Aquifer are located 10 mi south and west of Pantex Plant. 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 closest riverine water feature near Pantex Plant, the Canadian River, flows into the man-made Lake Meredith approximately 25 mi north of Pantex Plant. Many local communities use water from Lake Meredith for domestic purposes, when the water depth is sufficient. The major groundwater source near Pantex Plant is the Ogallala Aquifer. It is used as a domestic 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 gallons (gals) 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 Ogallala water user in the area. It pumps water for public use from the Carson County Well Field, located north and northeast of Pantex Plant. Pantex Plant obtains water from five wells in the northeast corner of the site. In 2019, Pantex Plant pumped approximately 115 million gal of water from the Ogallala Aquifer. Most of the water used at Pantex Plant is for domestic purposes. Through an agreement with TTU, Pantex Plant provides water to the TTU research farm properties for domestic and livestock uses.

Pantex Plant reviews emerging contaminants to potentially add to sampling lists when a contaminant could be of concern. 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 (EPAa). Pantex Plant is anticipated to have lab contracts with PFAS sampling capabilities in FY 2021.

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 Plant indicates that anticipated seismic activity is well below the level that is necessary to cause significant damage to structures at the Plant. 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 Plant is used mainly for winter wheat and grain sorghum farming, for ranching, and for drilling for oil and gas. 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 and includes 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 Plant; Owens-Corning Fiberglass (a fiberglass reinforcement Plant); ASARCO (a large silver and copper refiner); 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 Plant showed that most of the population is located west-southwest of Pantex Plant in the Amarillo metropolitan area. Population data from the 2010 Census were used to generate Figure 1.5 (DOCc), showing the population distribution at 5-mi intervals within 50 mi of Pantex Plant. According to the 2010 Census, the total population within 50 miles of Pantex Plant is 316,132 people.

The total population of the 20 county area (defined as the Texas Panhandle) surrounding Pantex Plant is 389,721. The population of the City of Amarillo (190,695 in 2010) represents approximately 49 percent of the counties' population. Approximately 32 percent of the population lives in other incorporated cities, and approximately 19 percent reside in unincorporated areas. 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 132 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 (DOCc). 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.

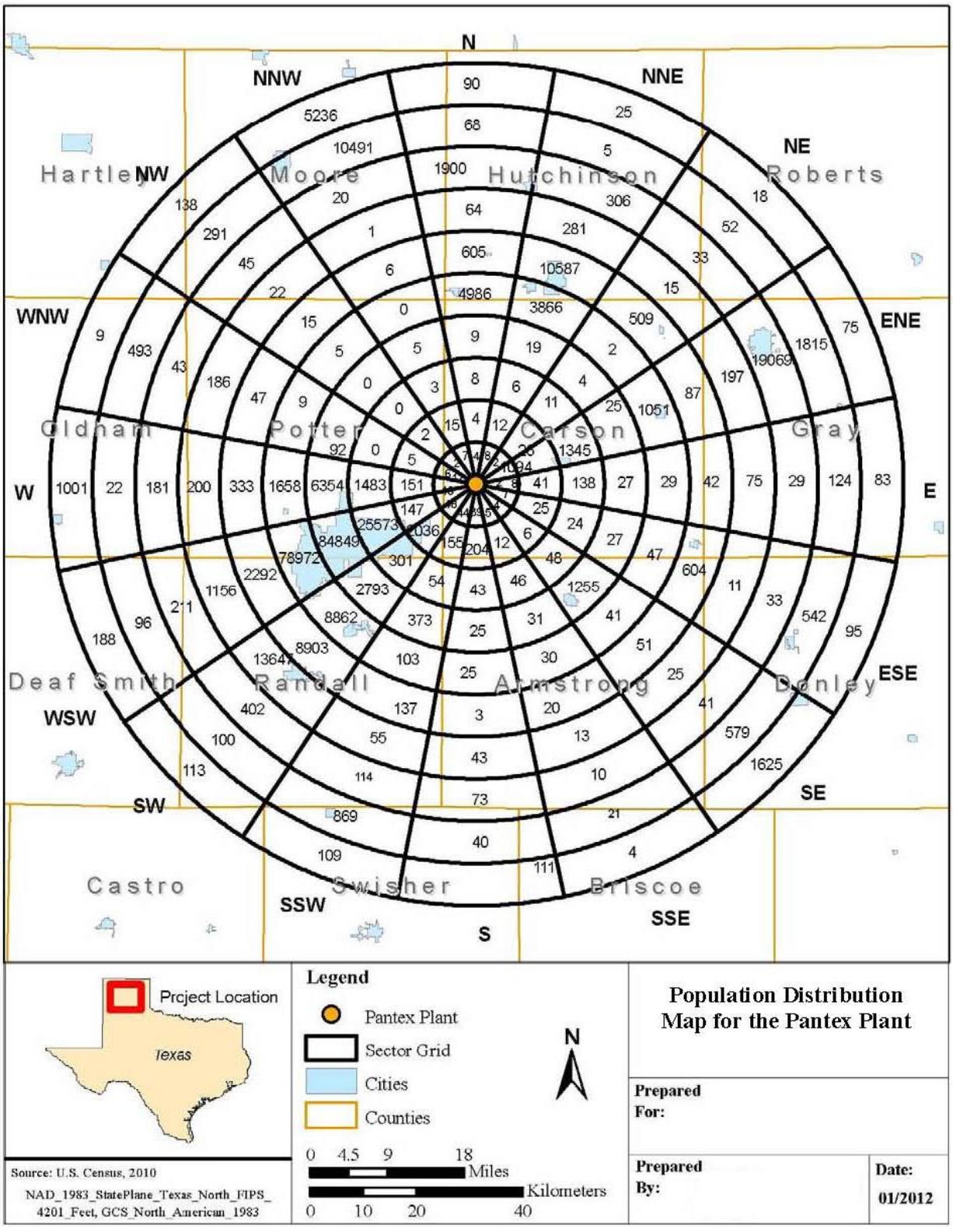


Figure 1.5 – Population Distribution within 50 Miles of Pantex Plant (2010)

1.9 ORGANIZATION OF THE REPORT

The remainder of this report is organized into twelve chapters and nine appendices:

Chapter 2 discusses regulatory requirements for environmental compliance during 2019 and describes the Pantex Plant's compliance-related issues and activities. It presents results of various regulatory inspections and environmental activities and lists the environmental permits issued to Pantex Plant.

Chapter 3 provides a brief summary of the environmental programs that are conducted at Pantex Plant. Overviews are provided for environmental management, 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 Plant operations. Also discussed are results of the environmental Thermoluminescent Dosimetry (TLD) program and other radiological monitoring programs for various environmental media (i.e., air, groundwater, surface water, plants, and animals).

Chapters 5 through 12 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. Faunal and floral monitoring are discussed in Chapters 11 and 12, respectively. Each of these chapters includes a description of the monitoring program for the specific medium and an analysis of radiological (if available) and non-radiological data for the 2019 samples.

Chapter 13 reviews Pantex Plant's quality assurance program for environmental monitoring efforts, as initiated in response to Title 10 of the Code of Federal Regulations (CFR), Chapter 830.120 and DOE Order 414.1D (DOEd). The chapter also includes an analysis of quality control (QC) samples collected during 2019 and a data validation summary.

Appendix A lists all of the birds sighted at Pantex Plant.

Appendix B provides the 2019 drinking water sampling analytical results.

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

Appendix D provides the 2019 soil sampling analytical results.

Appendix E is a glossary that lists and defines key terms utilized 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.

Chapter 2 - Compliance Summary

The Pantex Plant policy is to conduct all operations in compliance with applicable environmental statutes, regulations, and the requirements of the various authorizations issued to the Plant. This chapter describes and reviews current issues, initiatives and clean-up agreements in place, regulatory authorizations issued to Pantex Plant, and measures to support the Department of Energy (DOE) environmental performance indicators. It also summarizes the compliance status of Pantex Plant for 2019.

Chapter Highlights

- The Texas Commission of Environmental Quality (TCEQ) did not perform an air quality compliance inspection of Pantex Plant during 2019.
- Pantex Plant tracked emissions from 30 different processes at specific locations and grouped sources across the site. Emissions remained well below the certified and authorized Potential-to-Emit (PTE) levels for each of the pollutants tracked.
- Pantex Plant is in compliance with the applicable provisions of the Endangered Species Act.
- The TCEQ did not conduct a Comprehensive Compliance Investigation of Permit WQ0004397000 during calendar year (CY) 2019. Two separate sanitary sewer over-flow events occurred in 2019. Both were resolved and no further actions were required.
- The annual Resource Conservation and Recovery Act (RCRA) waste site inspection was conducted by the TCEQ on May 13 – May 15, 2019. It concluded with no findings or issues identified.
- The TCEQ conducted an investigation of the petroleum storage tank program on May 13, 2019. The investigation 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 Plant. Table 2.1 presents environmental regulations applicable to operations at Pantex Plant.

Table 2.1 – Major Environmental Regulations Applicable to Pantex Plant

Regulatory Description	Authority	Codification	Status
CLEAN AIR ACT (CAA)	Federal: Environmental Protection Agency (EPA)	Federal: 40 CFR 50-82	Pantex Plant complies with permits and Permits-by-Rule issued or promulgated by the TCEQ to authorize releases of pollutants to the atmosphere.
CAA and the Texas Clean Air Act (TCAA), through their implementing regulations, control the release of regulated emissions to the atmosphere and provide for the maintenance of ambient air quality.	State: Texas Commission on Environmental Quality (TCEQ) Texas Department of State Health Services (TDSHS)	State: Title 30 of the Texas Administrative Code (TAC), Chapter 101 through Chapter 122 (30 TAC 101-122) & 305 25 TAC 295 (Asbestos only)	Pantex Plant complies with the applicable requirements codified in the CFR and TAC (including those dealing with emissions of radionuclides at DOE facilities (40 CFR 61, Subpart H).

Regulatory Description	Authority	Codification	Status
CLEAN AIR ACT (CAA) (continued)			Pantex Plant is a self-certified "Minor" emission source under the Federal Operating Permit program.
ARCHAEOLOGICAL RESOURCE PROTECTION ACT (ARPA) ARPA provides for the protection of archeological resources and sites located on public and Native American lands.	Federal: Advisory Council on Historic Preservation State: State Historic Preservation Office (SHPO)	Federal: Title 36 of the Code of Federal Regulations (CFR), Chapter 79 (39 CFR 79), 43 CFR 7	All archeological surveys and testing at Pantex Plant conformed to ARPA standards.
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, & 370	Pantex Plant has been on the National Priorities List (NPL) since 1994. The EPA, TCEQ, and National Nuclear Security Administration Production Office (NPO) have signed an Interagency Agreement (IAG) concerning the conduct of the remediation at Pantex Plant. A Record of Decision was issued and approved in 2008 and Pantex Plant was added 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 Plant, and selection of the final remedy. The Agency for Toxic Substances and Disease Registry published its final report *Public Health Assessment-Pantex Plant* in September 1998.
ENDANGERED SPECIES ACT (ESA) 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)	Federal: 50 CFR 10; 50 CFR 17; Title 16 of the United States Code, Chapter 153 (16 USC 153), et seq.	Ongoing and proposed actions are assessed as to their potential adverse effects on threatened and endangered species.

Regulatory Description	Authority	Codification	Status
PROTECTION of ENDANGERED SPECIES (STATE)	State: Texas Parks and Wildlife Department (TPWD)	State: TPW Code, 68	Ongoing and proposed actions are assessed as to their potential adverse effects on threatened and endangered species.
FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA) FIFRA governs the manufacture and use of biocides, specifically the use, storage, and disposal of all pesticides and pesticide containers and residues.	Federal: EPA State: Texas Department of Agriculture; Structural Pest Control Board	Federal: 40 CFR 170-171 State: 4 TAC 7.1-7.40; Structural Pest Control Act (Art. 135b-5)	State-licensed personnel apply pesticides in accordance with applicable regulations. Pantex Plant implemented a land-applied chemical use plan in 1996. The plan was updated in 2016.
FEDERAL WATER POLLUTION CONTROL ACT / CLEAN WATER ACT (CWA) The Texas Water Code, through its implementing regulations, regulates the quality of water discharged to waters of the State of Texas.	Federal: EPA State: TCEQ	Federal: 40 CFR 120-136 & 40 CFR 300 - 583 State: 30 TAC 205-299, 305, 309, 317 & 319	As currently defined, Pantex Plant does not discharge its wastewaters to 'Waters of the United States'. Pantex Plant discharges its industrial wastewaters pursuant to Permits WQ0002296000, WQ0004397000, and Underground Injection control (UIC) 5W2000017. Pantex Plant has coverage under the Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit, for storm water via Permit No. TXR150000. It complies with requirements of the permit whenever applicable to a project. At of the end of 2019, four active projects had been filed under the General Permit. Pantex Plant operates under the TPDES Multi-Sector General Permit for Discharges of Storm Water from Industrial Sources via Permit No. TXR05CD31.
MEDICAL WASTE	Federal: U.S. Department of Transportation (DOT) State: TDSHS	Federal: 49 CFR 173 State: 30 TAC 330.1201-1221	Pantex Plant manages medical waste in accordance with applicable regulations.

Regulatory Description	Authority	Codification	Status
MIGRATORY BIRD TREATY ACT Establishes criteria for the protection of migratory birds. Pantex provides habitat for many migratory bird species protected by federal law. All migratory birds, their parts, and their nests were fully protected as required by statute.	Federal: USFWS	Federal: 50 CFR 10 pursuant to 16 USC 704-707and 712	Actions being considered at Pantex Plant are reviewed through the National Environmental Policy Act (NEPA) process, which considers impacts to migratory species. Nuisance and other bird situations are handled within compliance of the Migratory Bird Treaty Act.
PROTECTION OF MIGRATORY BIRDS (STATE)	State: TPWD	State: TPW Code 64 (2-5, 7, & 26-27)	Actions being considered at Pantex Plant are reviewed through the NEPA process, which considers impacts to migratory species. Nuisance and other bird situations are handled within compliance of state regulations.
Executive Order 13186: Responsibilities for Federal Agencies to Protect Migratory Birds (2001) Establishes commitment to migratory bird protection, management, research, and outreach on federal properties. Reaffirms relationship between the USFWS and other federal agencies.	Federal: DOE	Volume 66 Federal Register, page 3853 (66 FR 3853), 2001	Actions being considered at Pantex Plant are reviewed through the NEPA process, which considers impacts to migratory species. This Executive Order (EO) adds additional language beyond the Migratory Bird Treaty Act to consider impacts to habitat.
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 (CEQ)	Federal: 10 CFR 1021, 40 CFR 1500-1508	In 2019, nine Standard NEPA Review Forms, 32 Internal NEPA Review Forms, and three amendments were prepared. In 2019, one Environmental Assessment (EAs) was prepared and forecasted to be approved by 2020.

Regulatory Description	Authority	Codification	Status
PROTECTION OF BIRDS, NONGAME SPECIES, AND FUR-BEARING ANIMALS Requires the protection of all indigenous birds and ring-necked pheasants, non-game species, and fur-bearing animals except where exceptions are stated in the TPWD Code.	Federal: USFWS State: TPWD	Federal: 50 CFR 10 State: TPWD Code 67 and 71	Actions being considered at Pantex Plant are reviewed through the NEPA process, which considers impacts to all protected species.
SAFE DRINKING WATER ACT (SDWA) SDWA and the Texas Water Code govern public water supplies.	Federal: EPA State: TCEQ	Federal: 40 CFR 141-143 State: 30 TAC 290	Pantex Plant operates a Non-Transient, Non-Community Public Water Supply System (No. 0330007). The system is recognized as a Superior Public Water System (PWS) by the TCEQ.
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 Plant is defined as a large-quantity generator. Permit HW-50284 authorizes the management of hazardous wastes in various storage and processing units at Pantex Plant. Compliance Plan CP-50284 (now HW-50284) addresses corrective action requirements at Pantex Plant. Pantex Plant operates five regulated underground storage tanks.
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 & 10 CFR 850	Pantex Plant manages polychlorinated biphenyl (PCBs), asbestos, beryllium, and chemicals in compliance with applicable regulations.

2.2 CLEAN AIR ACT

Most requirements of the Federal CAA in Texas are implemented under the TCAA, 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, Subpart H (Emissions of Radionuclides Other Than Radon from DOE Facilities); 40 CFR 61, Subpart M (National Emissions Standard for Asbestos); and regulations dealing with stratospheric ozone protection and greenhouse gasses. The primary regulatory authority for 40 CFR 61, Subpart M, is delegated to the TDSHS.

2.2.1 40 CFR 61 Subpart H (Emissions of Radionuclides Other Than Radon from DOE Facilities)

According to the standard established in 40 CFR 61.92, 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 millirem per year (mrem/yr.) or 0.10 milliSievert per year (mSv/yr.). Based upon evaluations using the most conservative assumptions about the emissions of radionuclides from several Pantex Plant locations that have the potential to emit radioactive materials, Pantex has determined that the maximum effective dose equivalent that any member of the public received in 2019 was 7.24×10^{-8} mrem/yr. (7.24×10^{-10} mSv/yr.). Accordingly, Pantex Plant is in compliance with the EPA standard. Continuous emission monitoring, as described in 40 CFR 61.93, is not required of any source at Pantex Plant, based on each source's emission potential. Pantex Plant performs periodic confirmatory measurements and modeling to assure compliance with 40 CFR 61 Subpart H regulations.

In accordance with 40 CFR 61.96, all new construction projects and activities (or modifications to existing structures or activities) that have the potential to emit radioactive materials are evaluated to determine if the effective dose equivalent, caused by all emissions, is less than one percent of the 40 CFR 61.92 standard (i.e., is less than 0.1 mrem/yr. [0.001 mSv/yr.]). During 2019, 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 40 CFR 61 Subpart M (National Emissions Standard for Asbestos)

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

Subcontractors at Pantex Plant are required to prepare separate notifications for work that qualifies as "demolition" or "renovation" as defined in 40 CFR 61, Subpart M, and 25 TAC 295.61, which implements the Texas Asbestos Health Protection Act. Separate notifications are also required for jobs conducted by Pantex Plant personnel that involve amounts that would require job-specific notifications. Pantex Plant maintains the required certifications for the personnel who plan, oversee, and conduct these efforts. By filing the required forms and maintaining the described records, Pantex Plant demonstrates that it is in compliance with 40 CFR 61, Subpart M.

2.2.3 40 CFR 68 (Chemical Accident Prevention)

Pantex Plant has established and maintains controls on the introduction of new chemicals to any area of the Plant. Through this process, Pantex Plant continues to demonstrate that it has control of the chemicals in use. It continues to ensure that the quantities of chemicals at any location are below the threshold quantities stated in 40 CFR 68, thus, exempting Pantex Plant from having to perform risk management planning.

2.2.4 40 CFR 82 (Ozone Depleting Substances)

At Pantex Plant, licensed technicians install and maintain stationary and motor vehicle air conditioning systems. Technicians use approved recycling devices as needed when conducting these efforts. Pantex Plant maintains records of training and maintenance activities to demonstrate compliance with these regulations.

2.2.5 Air Quality Permits and Authorizations

Pantex Plant continues to use a combination of an air quality permit issued under 30 TAC 116 (Permit No. 84802), de minimis activities as authorized by 30 TAC 116.119, and authorizations issued under 30 TAC 106 (Permits by Rule [PBR]) to authorize operations conducted at the Plant. During 2019, Pantex Plant completed the process of renewing Permit No. 84802, in accordance with state requirements.

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 2019, Pantex Plant maintained documentation demonstrating that it was not a major 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 Plant during 2019.

2.2.8 Emission Tracking and Calculation

Pantex Plant is subject to the Federal CAA and the state of Texas regulations under 30 TAC 101, 106, 111, 112, 113, 116, 117, 118, and 122. The main scope or function of Pantex Plant's air emission tracking system is to monitor process emissions to (a) maintain the facility designation of "Synthetic Minor" under the federal Title V program, and (b) demonstrate compliance with authorizations issued to Pantex Plant. Pantex Plant 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 Plant processes that have emissions are conducted under the authority of various regulations and authorizations [Permits, Standard Exemptions (SE), and PBR]. Table 2.2, below, identifies the tracked emission sources at Pantex Plant and their authorizations.

Table 2.2 – Tracked Emission Sources at Pantex Plant

Process:[a]	Authorization Permit #	Standard Exemption [b]	Permit By Rule
HE Synthesis Facility	Permit 84802		
HE Fabrication	Permit 84802		
Firing Site Activities	Permit 84802		
Boiler House	Permit 84802		
Stationary Standby Emergency Engines	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		
Epoxy Foam Production	Registration 43702		PBR 262
Component Sanitization	Registration 41577		PBR 261 & 262
Machining		SE 41	PBR 432 & 452
Vehicle Maintenance Facility (VMF) Fueling Operations	Permit 84802		
Pantex Plant Site-wide Cooling Towers	Permit 84802		

Process:[a]	Authorization Permit #	Standard Exemption [b]	Permit By Rule
Hazardous Waste Treatment & Processing Facility (HWTPF) Liquid Processing Facility	Permit 84802		
Stationary Standby Emergency Engines	Permit 84802		
Painting Facilities	Registration 32674, 52638, 52639	SE 75	
Pressing & Transferring HE & Mock		SE 106 & 118	
Burning Ground-Soil Vapor Extraction	Registration 70894		PBR 533
Miscellaneous Chemical Operations: e.g., Emissions of HAP from laboratories, small coating operations and fugitive sources.		SE 34	PBR 106.122, PBR 106.433, de minimis
Chemical Transfer Operations	Registration 72373		PBR 262, 472, and 473
Drum Management Operations	Registration 92876		PBR 261, 262, and 512
High Explosive Pressing Facility	Registration 145558		PBR 261, 262
Emergency Water Pump	Registration 87270		PBR 512

[a] Authorization dates (the effective dates) can be found in Table 2.5.
[b] Standard Exemptions pre-date and were replaced by PBR.

2.2.8.1 Program Structure and Requirements

Pantex Plant 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 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 Plant and authorized/enforceable by the TCEQ and the EPA.

Pantex Plant maintains a tracking process to verify compliance with certified emissions limits. This tracking process is implemented through Air Quality Management Requirement (AQMR) documents, which are placed into the every-day operational procedures/activities that have either point source or fugitive emissions. AQMRs 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 AQMRs 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 enhanced commercial off-the-shelf computer software. The software uses emission factors from source tests, manufacturer's data, and EPA documentation to calculate hourly, calendar year and rolling 12-month emissions.

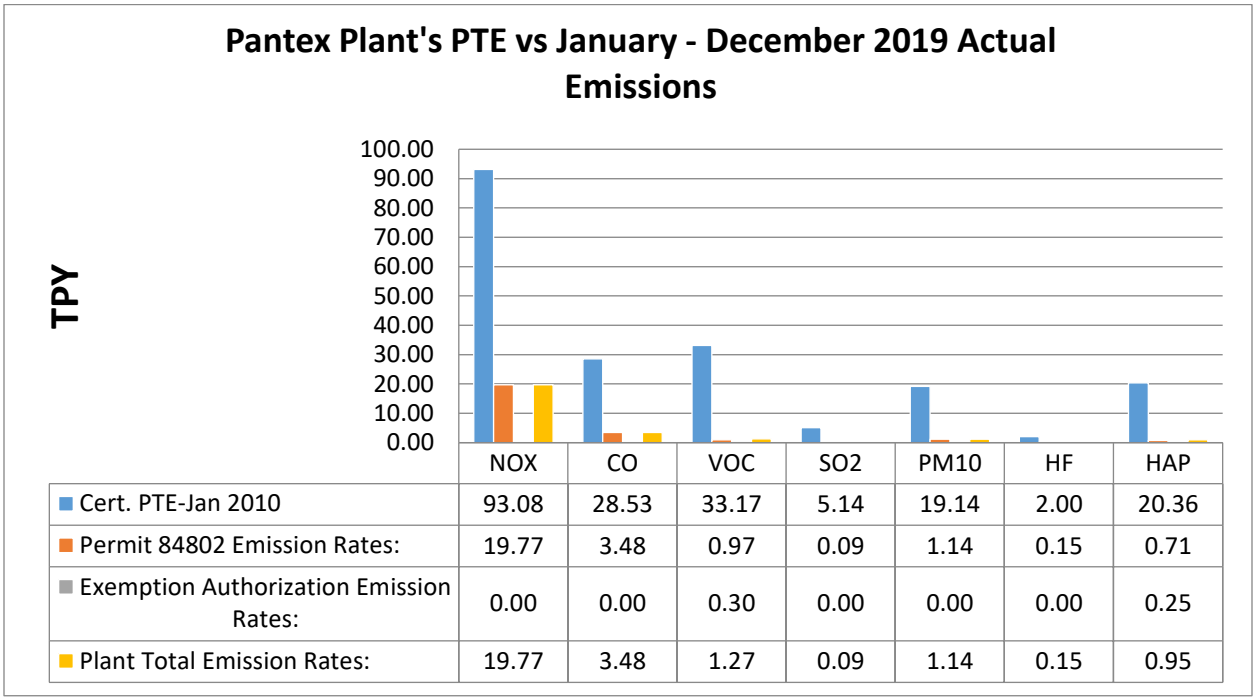
2.2.8.2 Types and Tracking of Emissions

During 2019, Pantex Plant tracked the emissions from 30 different processes both at specific locations and grouped sources across the Plant. Pantex Plant personnel responsible for air program compliance gathered facility data on emissions of common air pollutants including nitrogen oxides (NOx), carbon dioxide (CO), 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 Plant, to the annual limits set in the authorized PTE.

2.2.8.3 Conclusions of Air Emission Tracking for 2019

Over the 12 months of air emission tracking for 2019, operations at Pantex Plant 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 2019, expressed in relation to the PTE certification in Tons per Year (TPY). It provides a demonstration that Pantex Plant 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
Cert. PTE-Jan 2010	93.08	28.53	33.17	5.14	19.14	2.00	20.36
Permit 84802 Emission Rates:	19.77	3.48	0.97	0.09	1.14	0.15	0.71
Exemption Authorization Emission Rates:	0.00	0.00	0.30	0.00	0.00	0.00	0.25
Plant Total Emission Rates:	19.77	3.48	1.27	0.09	1.14	0.15	0.95

Figure 2.1 – Pantex Plant's PTE vs January – December 2019 Actual Emissions

2.3 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA OR SUPERFUND)

Because Pantex Plant is listed on the NPL, CERCLA Section 107 (Title 42 of the United States Code, Chapter 9607) is applicable. Section 107 provides for the designation of federal and state trustees who are responsible for assessing damages, for injury to, destruction of, and loss of natural resources. As Pantex Plant'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 Plant, EPA, and TCEQ. This agreement became effective in February 2008.

Pantex Plant 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 Five-Year Review and the Final Remedial Action Completion Report. No additional work has been identified for inclusion in the SMP.

Accordingly, Pantex Plant was added to the Construction Completion List, signifying the start of the Operation & 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 five-year reviews are conducted to ensure periodic comprehensive analyses of the protectiveness of the selected remedy. The first five-year review was completed in 2013, with the second five-year review started in 2018.

2.4 ENDANGERED SPECIES ACT

Pantex Plant provides habitat for several species protected by federal and state endangered species laws. In 1992, Pantex Plant 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 Plant. The current status of endangered or threatened species, as well as species of concern, known to appear on or near Pantex Plant (Carson and Potter counties) is summarized in Table 2.3. Pantex Plant is in compliance with the applicable provisions of the Endangered Species Act.

Table 2.3 – Endangered, Threatened, and Candidate Species and Species of Concern known to appear on or near Pantex Plant

Common Name		Scientific Name	Present in 2019	Federal Status	State Status
Birds	Peregrine falcon[a]	*Falco peregrinus anatum/tundrius*	-	Delisted	Threatened
	Bald eagle	*Haliaeetus leucocephalus*	Yes	Delisted	Threatened
	Ferruginous hawk	*Buteo regalis*	Yes	-	Concern
	Interior least tern	*Sterna antillarum athalassos*	-	Endangered	Endangered
	Mountain plover	*Charadrius montanus*	-	-	Concern
	Western burrowing owl	*Athene cunicularia hypugea*	Yes	-	Concern
	White-faced ibis	*Plegadis chihi*	-	-	Threatened
	Whooping crane	*Grus americana*	-	Endangered	Endangered
Mammals	Big free-tailed bat	*Nyctinomops macrotis*	-	-	Concern
	Black-tailed prairie dog	*Cynomys ludovicianus*	Yes	-	Concern
	Cave myotis bat	*Myotis velifer*	-	-	Concern
	Pale Townsend's big-eared bat	*Corynorhinus townsendii pallescens*	-	-	Concern
	Plains spotted skunk	*Spilogale putorius interrupta*	-	-	Concern
	Swift fox	*Vulpes velox*	-	-	Concern
	Western small-footed bat	*Myotis ciliolabrum*	-	-	Concern
Reptiles	Texas horned lizard	*Phrynosoma cornutum*	-	-	Threatened

[a] *Falco peregrinus tundrius* is classified as threatened based only on similarity

Several species listed as Threatened or Endangered for Carson County or surrounding counties, but not included in Table 2.3 because of their dependence on habitat not found on Southern High Plains soils, include the following:

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 Plant
- 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

2.5 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) 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 4 TAC 7. Regulations promulgated under FIFRA 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 Plant.

2.5.1 Pesticide Use in 2019

Texas Tech Research Farm (TTRF) submitted 25 agricultural spray requests during the 2019 growing season, however only 17 applications were made. All 25 agricultural spray requests were reviewed and approved by the Environmental Compliance Department, Safety & Industrial Hygiene, and the National Nuclear Security Administration Production Office. Pantex Plant's Maintenance Department made 27 applications during 2019. The majority of these applications were for weed control in Zone 4, Zone 11, Zone 12, and the associated Perimeter Intrusion Detection and Surveillance beds. The second most frequent pesticides used were insecticides for spiders and mosquitos. Contractors submitted nine applications to control or suppress weeds and prairie dogs, as specified in the contract work completed at Pantex Plant in 2019. Table 2.4 shows the number of pesticide applications conducted at Pantex Plant since 2009.

Table 2.4 – Number of Pesticide Applications Conducted at Pantex Plant

Year of Pesticide Applications	Texas Tech Research Farm	Maintenance Department	Contractors	Total
2009	32	81	23	136
2010	44	55	36	135
2011	21	150	4	175
2012	33	121	7	161
2013	36	113	13	162
2014	23	122	15	160
2015	25	81	4	110
2016	18	57	12	87
2017	18	59	0	77
2018	10	35	4	49
2019	17	27	9	53

2.6 FEDERAL WATER POLLUTION CONTROL ACT (OR CLEAN WATER ACT) AND TEXAS WATER CODE

Pantex Plant does not discharge wastewaters into or adjacent to waters of the United States; thus, Pantex Plant is not subject to the Federal Water Pollution Control Act. Pantex Plant 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 2019, Pantex Plant maintained two permits and one authorization issued by the TCEQ authorizing the disposal of treated industrial and domestic wastewaters. Pantex Plant disposed all of its treated industrial and domestic wastewaters via discharge to an on-site playa lake. Pantex Plant is authorized by Permit WQ0004397000 (Texas Land Application Permit [TLAP]) and Underground Injection Control (UIC) Authorization 5W2000017 to discharge treated wastewater through a subsurface fluid distribution system. Combined, these authorizations support the production of approximately 400 ac of crops. The TLAP authorizes the disposal of treated wastewaters when the subsurface irrigation area is covered by vegetation. The UIC authorization allows the application of limited quantities of treated wastewater to the irrigation area during periods when the agricultural fields are fallow.

During 2017, major filter leaks developed in the system, and use of the system was temporarily discontinued. After June 2017, all treated industrial and domestic wastewaters were discharged via a surface water outfall into Playa Lake 1, per Texas Water Quality Permit WQ0002296000. Repairs are ongoing so that treated effluent from the wastewater treatment facility and from the perched aquifer pump-and-treat systems can once again be discharged to the subsurface fluid distribution system.

Pantex Plant operates under the TPDES Multi-Sector General Permit (TXR05CD31) for the discharge of storm water related to industrial activities.

Pantex Plant also obtains coverage as needed under the TPDES Storm Water General Permit for Construction Activities (Permit TXR150000). The Notices of Intent filed for large construction projects during 2019 are listed with other Pantex Plant environmental authorizations and permits in Table 2.5.

Table 2.5 – Permits Issued to Pantex Plant

Building or Activity	Permit Number	Issuing Agency	Effective Date	Expiration Date
Air				
Air Quality Permit	84802	TCEQ	03/29/2019	03/29/2029
All other small sources	Standard Exemptions, De Minimis authorization, and Permit by Rule	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	EPA TCEQ	10/30/1980 10/30/1980	None None
Industrial and Solid Waste Management Site Permit; RCRA Compliance Plan	HW-50284	TCEQ	05/30/2014	05/30/2024

Building or Activity	Permit Number	Issuing Agency	Effective Date	Expiration Date
UIC TLAP associated	5W2000017	TCEQ	11/29/2004	When cancelled.
UIC- Environmental Restoration Program	5X2600215	TCEQ	10/23/2001	When cancelled.
UIC - Environmental Restoration Program	5X2500106	TCEQ	11/28/2005	When cancelled.
Water				
Texas Water Quality Permit	WQ0002296000	TCEQ	08/24/2016	12/01/2020
TLAP	WQ0004397000	TCEQ	04/12/2013	01/01/2020
TPDES Multi-Sector (Industrial) Storm Water Permit	TXR05CD31	TCEQ	06/19/2018	08/14/2021
TPDES Storm Water General Permit for Construction Activities	TXR150000	TCEQ	03/05/2018	03/05/2023
Southeast Well Extension Project	TXR15491V	TCEQ	02/20/2019	05/14/2019
Building Removal Project	TXR15884X	TCEQ	06/04/2019	Upon completion
Natural Resources				
Scientific Permit	SPR-1296-844	TXPWD	12/05/2011	12/05/2020
Letter of Authorization: Trap and Release Fur-bearing Animals	None	TXPWD	07/28/2000 (Initial)	Renewed annually.
Bee Removal Permit	TX-6-18-07	Texas Apiary Inspection Service	08/10/2010 (Initial)	Renewed annually.
Intrastate Bee and Equipment Permit	01/12/2003	Texas Apiary Inspection Service	08/10/2010 (Initial)	Renewed annually.

At seven of its more remote buildings, Pantex Plant 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.

2.6.1 Wastewater Discharge Permit Inspections

The TCEQ did not conduct a Comprehensive Compliance Investigation of Permit WQ0004397000 or WQ0002296000 during CY 2019. In January and March, Pantex Plant had two separate sanitary sewer over-flow events (unauthorized discharge) which were reported to the TCEQ and mitigated.

2.7 MEDICAL WASTE

Medical waste at Pantex Plant is regulated by the DOT, the State of Texas, and associated Plant requirements. Pantex Plant 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 Plant, proposed activities are reviewed for NEPA requirements.

At Pantex Plant, the NEPA process is initiated by completing a NEPA Review Form (NRF). The NRF includes a description of the proposed action. Subject matter experts review for the actions for potential environmental concerns. NEPA documentation ranges from internal reviews that tier off previously approved NEPA documents, categorical exclusions, Environmental Assessments (EAs), and Environmental Impact Statements (EIS). *Implementation Guidance for DOE Policy on Documentation and Online Posting of Categorical Exclusion Determinations: NEPA Process Transparency and Openness*, October 16, 2009, mandates that all determinations for categorical exclusions involving classes of actions listed in Appendix B to Subpart D of the DOE's NEPA regulations, 10 CFR 1021, be published online.

Every five years, the DOE is required to evaluate Site-wide EISs (SWEIS) by means of a Supplement Analysis. Based on the SA, DOE determines whether the existing SWEIS remains adequate, or whether to prepare a new SWEIS or supplement the existing SWEIS. The determination and supporting analysis are made available in the appropriate DOE Information Repositories, Pantex Plant website, and the DOE Office of NEPA Policy and Compliance website for a reasonable time. The most current Supplement Analysis for Pantex Plant was approved by NPO in June 2018.

In 2019, nine Standard NRFs (Categorical Exclusion determinations), 32 Internal NRFs, and three amendments were prepared and approved. Categorical Exclusion determinations for nine Standard NRFs and three amendments were posted on the Pantex Plant website. In 2019, one EA was prepared and forecasted to be approved in 2020.

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

In October 2004, NPO, Pantex Plant, SHPO, and the President's Advisory Council on Historic Preservation (Advisory Council) completed execution of a Programmatic Agreement and Cultural Resource Management Plan (PA/CRMP) (PANTEXa). 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 Plant projects having the potential to impact prehistoric, WWII era, or Cold War era properties. In addition, the PA/CRMP outlines a range of preservation activities planned for Pantex Plant's compliance program. The PA/CRMP provides for the systematic management of all archeological and historic resources at Pantex Plant under a single document.

Compliance with the Archaeological Resource Protection Act (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 Plant, compliance with the Native American Graves Protection and Repatriation Act is also addressed in the plan. Both archeological and natural resources at Pantex Plant are closely concentrated around four playa lakes. These playa and floodplain areas have been reserved for comprehensive ecosystem management, resulting in preservation of many of Pantex Plant's archeological sites.

Fulfilling Pantex Plant's cultural resource management obligations under Section 106 of the NHPA, 45 projects were evaluated in 2019 under the PA/CRMP. Of these projects, 37 did not involve either National

Register-eligible properties or possible adverse effects. For the remaining eight projects, a prior notification and a walk-down prior to start-up was 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 Plant include:

- Hazardous waste,
- Universal waste,
- Non-hazardous industrial solid waste,
- Waste regulated by the TSCA,
- Low-level radioactive waste,
- Mixed low-level radioactive waste, and
- Sanitary waste.

Table 2.6 summarizes wastes generated from the operation, maintenance, and environmental cleanup at Pantex Plant in CY 2019. Overall, the amount of waste generated in 2019 increased 70.0 percent from 2018. This is due primarily to increased activity in the environmental restoration projects and the deactivation and decommissioning of excess facilities and construction projects.

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

Waste Type	1993	2016	2017	2018	2019	Percent Increase or (Decrease) from 1993	Percent Increase or (Decrease) from 2018
Non-hazardous Industrial Solid Waste	10,885	3,641	2,693	3,420	6,621.9	(39.2)	93.6
Sanitary Waste	612	965.2	927.3	927.3	794.9	29.9	(14.3)
Hazardous Waste	369.6	460.2	398.9	387.3	935.1	153	141
Low-Level Waste	287	36.2	47.6	16.1	17.8	(93.8)	10.6
Mixed Waste	37.5	0.12	0.45	0.0	1.1	(97.1)	100
TSCA Waste	112.9	3.3	430.9	245.8	138.6	22.8	(43.6)
Universal Waste[a]	-	13.8	13.2	16.7	15.1	-	(9.6)
Total	12,304	5,119.8	4,511.3	5,013.2	8,524.5	(30.7)	70.0

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

During 2019, 935.1 cubic meters (m^3) of hazardous waste was generated at Pantex Plant. Typical hazardous wastes generated included:

- 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 (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 54.3 percent of the total hazardous waste generated. For 2019, 507.7 m^3 of the hazardous wastes from environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities were RCRA exempt hazardous scrap metal. Hazardous wastes and residues from hazardous waste processing are shipped to commercial facilities authorized for final treatment and disposal or, as applicable, recycling.

Pantex Plant generated 6,621.9 m^3 of non-hazardous industrial solid waste in 2019. 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. Class 1 non-hazardous industrial solid wastes generated at Pantex Plant 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 Plant's environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities contributed 64.9 percent of the total non-hazardous industrial solid waste generated during 2019. In addition, 794.9 m^3 of sanitary waste (cafeteria waste and general office trash) was generated at Pantex Plant. Sanitary wastes were also characterized as Class 2 non-hazardous industrial solid wastes and disposed of at authorized off-site landfills.

Pantex Plant generated 138.6 m^3 of waste regulated by TSCA during 2019. These wastes include asbestos, asbestos-containing material, and materials containing or contaminated by PCBs. During the year, environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities contributed to 99.3 percent of the total TSCA waste generated. All TSCA wastes were shipped off-site for final treatment and disposal.

During 2019, 15.1 m^3 of waste that were managed as universal wastes was generated at Pantex Plant. 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, environmental restoration projects contributed to 5.1 percent of the total universal waste generated. These wastes are shipped off-site for final treatment, disposal, or, as applicable, recycling.

Pantex Plant generated 17.8 m^3 of low-level radioactive waste during 2019. The low-level radioactive wastes were generated by weapons-related activities.

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 2019, 1.1 m^3 of mixed waste was generated at Pantex Plant.

2.10.2 Hazardous Waste Permit Modifications

There were no permit modifications or applications for modification for Permit HW-50284 during 2019.

2.10.3 Annual Resource Conservation and Recovery Act Inspection

The annual RCRA waste site inspection was conducted by the TCEQ on May 13 – May 15, 2019. The inspection included facility walk-downs of all hazardous waste permitted locations, all less-than-90-day

waste accumulation sites, and most waste accumulation areas located in Zone 12 North. The inspection also included a records review to ensure compliance with Pantex Plant hazardous waste permit and the applicable requirements from the CFR and the TAC. This year's inspection concluded with no findings or issues identified.

Additionally, during the RCRA inspection, the TCEQ inspector completed a Texas Tier II Right-To-Know investigation. The inspection reviews all reporting and planning requirements of Section 302-303 of the Emergency Planning and Community Right-To-Know Act (see also section 2.13 below), also known as the Superfund Amendments and Reauthorization Act Title III. The inspection was also completed with no findings or issues identified.

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

Progress reports, required by Table VII of HW-50284 (TCEQa) and Article 16.4 of the Pantex Plant IAG, were submitted to both the TCEQ and EPA in 2019. The annual report contained a full reporting of all monitoring information for 2019. Quarterly progress reports were also submitted in 2019 in accordance with the schedule in the approved Sampling and Analysis Plan (SAP) and Table VII of Permit HW-50284. These reports focused on continued operation of remedies and on monitoring results from key groundwater wells.

2.10.5 Underground Storage Tanks

Pantex Plant operated five regulated underground Petroleum Storage Tanks (PSTs) during 2019. Of the five regulated underground storage tanks at Pantex Plant, two are used for emergency generator fuel storage. Three other PSTs at Pantex Plant are used for vehicle fueling. These tanks store unleaded gasoline, diesel, and a gasoline–ethanol mix (E-85). An inspection of all five underground PSTs was performed by the TCEQ during May 2019. This inspection was completed with no findings or issues identified.

2.11 SAFE DRINKING WATER ACT

Pantex Plant operates a Non-community, Non-transient Public Drinking Water System, which is registered with the TCEQ. This category of systems identifies private systems that continuously supply water to a small group of people; i.e., schools and factories. Pantex Plant obtains its drinking water from the Ogallala Aquifer through five wells located at the northeast corner of the Plant.

2.11.1 Drinking Water Inspection

On August 27, 2019, a TCEQ subcontractor collected samples from the water system. All sample results were below any regulatory limits and action levels. The TCEQ did not perform a comprehensive Compliance Inspection of the PWS during CY 2019.

2.11.2 Drinking Water System Achievements

On December 17, 2009, the TCEQ notified Pantex Plant 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 Plant maintained its Superior Public Drinking Water System Rating during 2019.

2.12 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 they 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 Plant.

As a user of chemical substances, Pantex Plant complies with applicable regulations issued under the Act, refrains from using PCBs, except as allowed by EPA regulations, and refrains from using any chemical substance that Pantex Plant 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 that contain PCBs, used at Pantex Plant, have PCBs that are in concentrations of less than 50 parts per million.

2.13 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 Executive Order 12856 require that Pantex Plant file several annual reports with the EPA (Table 2.7) and participate in Local Emergency Planning Committee activities. Pantex Plant remains in compliance with provisions of this statute.

Table 2.7 – 2019 Activities for Compliance with the Emergency Planning and Community Right-to-Know Act

Requirement	Applicable	Comment
Planning Notification (SARA 302-303)	Yes	Three chemicals defined as "Extremely Hazardous Substance" by SARA 302-303 were stored at Pantex Plant in quantities above the threshold planning quantities in 2019.
Extremely Hazardous Substance Notification (SARA 304)	Yes	There were no accidental releases of "Extremely Hazardous Substance" as defined by SARA 304 that exceeded quantities in 2019.
Material Safety Data Sheet/Chemical Inventory (SARA 311-312)	Yes	This requirement was satisfied by the Texas Tier Two Report[a]. Twenty-six chemicals were listed in the report for 2019.
Toxic Chemical Release Inventory Reporting (SARA 313)	Yes	A Toxic Chemical Release Inventory Report was required for CY 2019.

[a] Report submitted annually to the Chief, Hazard Communication Branch, Occupational Safety and Health Division, Texas Department of Health, the Local Emergency Planning Committee, and the local Fire Department.

2.14 FLOODPLAINS/WETLANDS ENVIRONMENTAL REVIEW REQUIREMENTS (10 CFR 1022)

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 (USACE, 1995), revising an earlier delineation. In CY 2019, all proposed activities at Pantex Plant were evaluated during the NEPA process for potential impacts on floodplains and wetlands and other criteria required by 10 CFR 1022.

Chapter 3 - Environmental Management Information

To implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by Pantex Plant operations, a comprehensive Environmental Management System (EMS) has been developed. The Pantex Plant EMS is a major component of the Integrated Safety Management System (ISM) and contributes to sustaining Pantex Plant imperatives of Safe, Secure, Zero Defects, and Deliver as Promised. The ISM/EMS applies to all personnel whether permanent or temporary, and to subcontractors working within the boundaries of Pantex Plant.

Chapter Highlights

- Pantex Plant exceeded clean energy targets set forth by the Sustainability Performance Office (SPO) of the Department of Energy (DOE).
- Water intensity at the Pantex Plant has decreased about 18.7 percent from the 2008 baseline year.
- The Pantex Plant was awarded the 2019 Presidential Migratory Bird Federal Stewardship Award.
- In 2019, the Pantex Plant pump-and-treat systems and the soil vapor extraction system combined removed greater than 1,000 lbs. of contaminants.

3.1 ENVIRONMENTAL MANAGEMENT SYSTEM

The Pantex Plant EMS meets the requirements of DOE Order 436.1 *Departmental Sustainability* (DOEc) and provides for systematic planning, integrated execution, and evaluation of programs for:

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

It includes policies, procedures, and 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 measureable environmental objectives and specific targets are developed for implementation. In accordance with DOE 436.1, Pantex Plant's EMS is modeled on the International Organization for Standardization (ISO) 14001, *Environmental Management Systems – Requirements with Guidance for Use*, 2004.

DOE defines its key clean energy and sustainability strategies and goals in its Site Sustainability Plan (SSP). Each DOE site is required to prepare an annual SSP that expresses the site's performance status and planned actions for meeting DOE's SSP goals and broader sustainability program. Pantex Plant uses its EMS as a platform for SSP implementation, as well as for other programs with objectives and measurable targets that contribute to meeting sustainability goals.

Each year, significant environmental impacts associated with Pantex Plant operations are evaluated to determine potential goals for the following year. Objectives and associated specific targets are set to improve the management of identified environmentally significant aspects related to Pantex Plant activities, products, and services. By adopting objectives, Pantex Plant commits to achieving the management goals

and ensures that appropriate resources (technical, organizational, infrastructure, financial, human, and special skills) will be considered to accomplish the environmental targets. Appropriate authority and responsibility are assigned to each relevant function and level within the organization to meet the objectives. Table 3.1 represents the status of Objectives and Targets for FY 2019.

Table 3.1 –Pantex Plant Objectives and Targets for 2019

Objective	Target(s)	Status/Comments
Maximize use of Ogallala Aquifer	Maximize use of Primary & Secondary Ogallala Aquifer using recommendations from Asset Management Plan (AMP) study performed by PNNL in FY16.	On-going
Depletion of Natural Resources	Upon footprint reduction assure utilities are discontinued from buildings as close to the source as practicable.	On-going

3.1.1 EMS Accomplishments for 2019

In accordance with the current DOE Order 436.1 *Departmental Sustainability*, Pantex Plant continues to implement and maintain a formal EMS using the ISO 14001 Standard as the platform for site implementation. To meet the intent of this DOE Order, on four occasions the Pantex Plant EMS has been the subject of required formal triennial audits by qualified auditors, outside the control or scope of the EMS, and was successfully identified as conforming to ISO 14001 at each audit.

Opportunities for continuous improvement are the emphasis of regularly scheduled building environmental walk down surveillances. These surveillances focus on EMS principles, energy and water conservation, environmental sustainability, recycling, safety, and P2.

Select accomplishments of the environmental programs at Pantex Plant include, but are not limited to:

- 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 percent of applicable contracts,
- Diversion of approximately 40 percent of Municipal Solid Waste, and approximately 58 percent construction & demolition material/debris originally earmarked for landfills and identified alternate pathways for beneficial reuse,
- In 2019, Pantex Plant underwent a very aggressive project to repave and resurface a majority of the site roadways. During this project approximately 3,931,576 pounds of asphalt was reused,
- Achievement of sufficient energy savings that enable meeting clean and renewable electric energy targets, and
- Awarded the Presidential Migratory Bird Federal Stewardship Award for contributions to research on migratory birds.

3.1.2 Energy

In the remainder of this Section, the goals established by the DOE Sustainability Performance Division (SPD) are expressed in fiscal years from DOE determined baselines. Pantex Plant reported progress towards meeting these goals in a SSP produced after the completion of FY 2019. For the purpose of this document, the progress during CY 2019 is also reported as applicable. Success in reducing energy use at Pantex Plant has historically been realized from energy savings activities such as:

- Utilization of the Energy Management Control System (EMCS) 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 Environmental Protection Agency's (EPA's) 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 2019, Pantex Plant continued to use an alternate work schedule, which has helped reduce energy consumption for a large number of administrative personnel. In addition, a major source of reductions in energy intensity has been the installation of the Pantex Renewable Energy Project (PREP) (see Figure 3.1) in the summer of 2014.

Figure 3.1 – Pantex Renewable Energy Project[3]

A new goal established in 2016, included in guidance from the U.S. DOE SPD[4], requires a 25 percent reduction in energy intensity by FY 2025 from a FY 2015 baseline. Pantex had a 0.1 percent increase in energy intensity from the 2015 baseline as the energy intensity increased from 164.9 kBtu/ft^2/year for FY 2015 to 165.0 kBtu/ft^2/year for FY 2019. The slight increase in energy intensity is primarily attributable to the continued work of reducing the number of buildings vacated to occupy the John C. Drummond Center (JCDC), causing a temporary increase in total site square footage. As demolition of these vacated buildings continues, and with the renewable energy production from PREP, Pantex Plant expects to see the beginning of a decrease in energy intensity.

During CY 2019, the PREP supplied 47,515 MWh (equivalent to 162,126 MMBtu) of electricity to

Pantex Plant and the local electrical grid. Pantex Plant exceeded clean energy targets set forth by the SPD of the Department of Energy.

[3] Pantex Renewable Energy Project (PREP) consists of five 2.3-MW-Siemens wind turbines
[4] Scheduled to be incorporated in a future revision to DOE O 436.1

3.1.3 Greenhouse Gases

Guidance from the SPD has expanded upon the energy reduction and environmental performance requirements indicated in DOE Order 436.1 by setting requirements in several areas, including the management of Greenhouse Gases[5] (GHGs). The guidance requires a 50 percent reduction of electricity-related and natural gas GHG emissions and 25 percent reduction of other indirect GHG emissions by FY 2025 from their respective FY2008 baselines.

The largest component of the GHG emissions accredited to Pantex Plant 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 74,747[6] metric tons CO_2 equivalent ($MtCO_2e$) of GHGs in 2008.

During CY2019, the operation of Pantex Plant yielded a total of 72,983 $MtCO_2e$. Of this total, 20,270 MtCO2e was due to the combustion of natural gas, 34,160 MtCO2e due to the purchase and use of electricity generated off-site and 18,760 $MtCO_2e$ was due to other indirect GHG emissions. These emissions are illustrated in Figure 3.2.

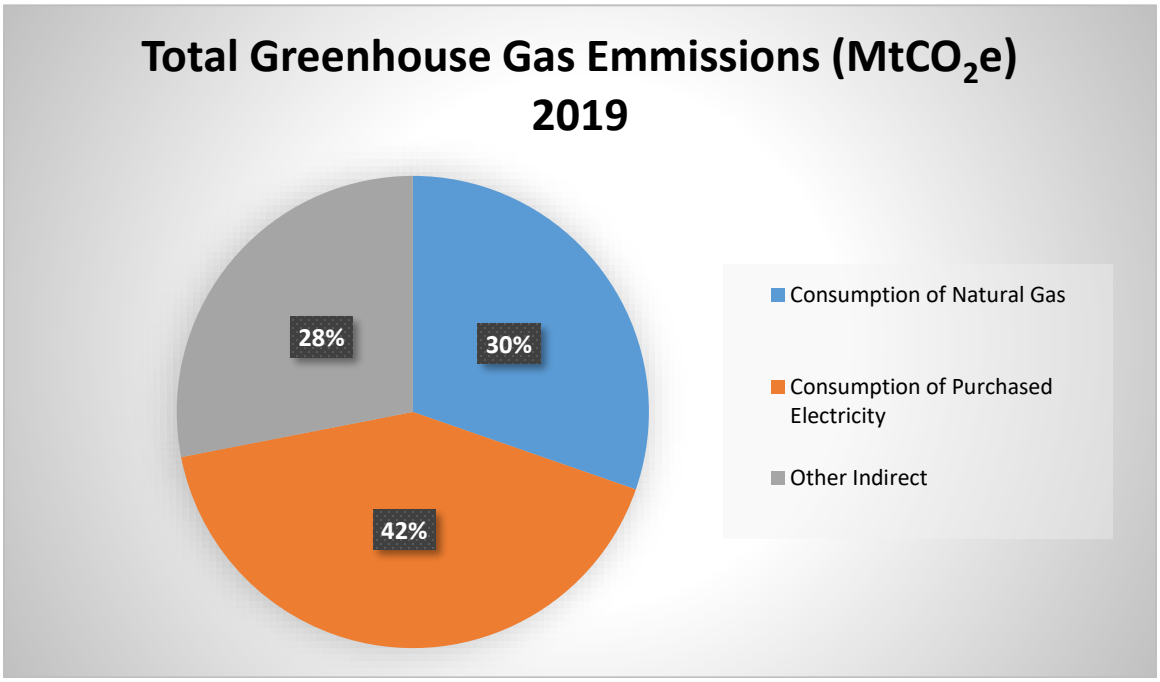


Figure 3.2 – Total 2019 GHG Emissions

By the operation of the PREP during CY2019, Pantex Plant did not need to purchase as much electricity, and the quantity of electricity-related GHG emissions continued to be reduced from the baseline year (FY 2008) levels. In addition, reducing energy consumption by the means discussed in Section 3.1.2, Pantex Plant has concurrently reduced the generation of electricity-related GHGs. Pantex Plant also continued efforts to reduce natural gas emissions by improving operations of its fleet, reducing petroleum fuel use,

[5] See the definition of this term and those for Scopes 1, 2, & 3 GHGs in the Glossary.

[6] An additional 23,412 $MtCO_2e$ was generated from emissions associated with air and ground travel, employee commuting, transmission and distribution losses and other Scope 3 (Other Indirect) GHGs. Thus, 99,802 $MtCO_2e$ GHGs was associated with Pantex Plant operations during FY2008, the baseline year for goals relating to GHGs.

using more hybrid vehicles for better gas mileage, 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 PREP continues.

Pantex Plant also continued to reduce other indirect GHG emissions compared to the FY2008 baseline. The decrease in other indirect GHG emissions for CY 2019 are primarily due to reductions in travel. The conversion of all Pantex Plant personnel to an alternative shift working every other Friday, and the encouragement of telecommuting programs in select organizations reduced the quantity of emissions associated with employee commutes. In addition, with less energy being directly purchased from the regional vendor, transmission and distribution losses as well as the associated other indirect GHG emissions have been reduced.

3.1.4 Water

Pantex Plant has been required, beginning in 2008, to reduce water intensity[7] relative to the baseline of the Plant's water consumption in 2007 of approximately 129 million gal. Pantex Plant has continued to develop and implement initiatives based upon requirements in DOE O 436.1 to reduce annual use and meet sustainability goals integrated into our SSP.

During 2019, water consumption was approximately 117.4 million gal. Despite a 12.2 percent increase in square footage since the baseline year, water intensity has decreased about 18.7 percent from the baseline year.

During 2015 thru 2017, a noticeable increase in water intensity occurred. Despite repair and replacement that occurred during the last several years, the increase was attributed to leaking WWII era water lines, inefficient water-cooled equipment, and other factors. Focused repairs during CY2019, the relocation of approximately one-third of the Pantex Plant population to the new JCDC in April 2018, and planned demolition and decommissioning of approximately 50 legacy facilities that require costly maintenance are anticipated to continue the water intensity reduction trend.

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 2019.

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 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, and 2015. The current agreement is in effect through September 30, 2020. It focuses on general cooperation with all state agencies, including emergency management. Six state agencies are involved: the Governor's Office (acting through the State Energy Conservation Office), the Texas Attorney General's Office, the Texas Commission on Environmental Quality (TCEQ), the Texas Department of Public Safety (DPS)-Division of Emergency

[7] The ratio of the number of gallons of water used divided by the square footage of the site.

Management, the Texas Department of State Health Services (TDSHS)-Radiation Control, and the Texas Bureau of Economic Geology.

The agreement also provides for joint emergency planning with Carson, Armstrong, and Potter counties, and the City of Amarillo. A number of meetings between DOE and these agencies were held in 2019. In addition, DOE provided information to the State of Texas, as required, and the State conducted its own environmental sampling and research, and participated in joint emergency exercises and drills with Pantex Plant and local jurisdictions.

3.3 POLLUTION PREVENTION

Activities in support of the P2 Program are waste elimination, material substitution, waste minimization, recycling, and energy & water conservation. Team members are continually searching and seeking new and innovative initiatives to further the advancement of P2 principles, the philosophy of sustainable acquisition, and the proper management & disposition in the life cycle of all materials and items acquired by Pantex Plant.

In accordance with DOE O 436.1, Pantex Plant has continued an active recycling program, reducing the waste disposal volumes, and saving the taxpayers' money. Table 3.2 lists the results of ongoing recycling initiatives.

Table 3.2 – Pantex Plant Site-wide Recycling for 2019

Recycled Material	Pounds	Kilograms
Aluminum (Scrap Metal)	1160	526
Batteries	100,030	45,373
Computers & Other Electronics	39,541	17,935
Concrete & Asphalt	3,931,576	1,783,333
Corrugated Cardboard	109,190	49,528
Engine Oils	31,460	14,270
Fluorescent Bulbs	4,058	1,841
Newspapers/Magazines/Phonebooks	9,975	4,525
Non-Suspension Scrap Metals	587,147	266,325
Office and Mixed Paper	127,220	57,706
Oil Filters	1,750	794
Plastic	5,980	2,712
Tires/Scrap Rubber	36,720	16,656
Total	4,985,807	2,261,524

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. These types of reductions have occurred at Pantex Plant. The remaining areas of near-native habitat at Pantex Plant are small and include wetlands and shortgrass prairie uplands located near the playas.

A biological assessment at Pantex Plant, completed in 1996, addressed the impacts from continuing Plant operations to endangered or threatened species and species of concern that may occur in or migrate through the area. The U.S. Fish & Wildlife Service (USFWS) approved the assessment, and concurred with the conclusion that continued Pantex Plant operations would not be likely to adversely affect any federally listed threatened or endangered species (PANTEXb). This was reaffirmed in subsequent Supplement

Analyses (2003, 2009, 2013, and 2018) for the Sitewide Environmental Impact Statement (SWEIS). 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 Chapters 11 and 12.

3.4.1.1 Mammals

When including domestic dogs (*Canis familiaris*), at least 12 species of mammals were recorded at Pantex Plant in 2019 during field activities and nuisance animal responses (Table 3.3). The all-time mammal list for Pantex Plant includes 46 species. Spotlight surveys in 2019 revealed badgers (*Taxidea taxus*), black-tailed jackrabbits (*Lepus californicus*), cottontails (*Sylvilagus spp*.), coyotes (*Canis latrans*), mule deer (*Odocoileus hemionus*), red fox (*Vulpes vulpes*), and white-tailed deer (*Odocoileus virginianus*). Black-tailed prairie dogs (*Cynomys ludovicianus*) are managed under the *Management Plan for Black-Tailed Prairie Dogs and Western Burrowing Owls at Pantex Plant.*

Table 3.3 – Mammals Identified at Pantex Plant During 2019

Common Name	Scientific Name	Playa 1	Playa 2	Playa 3	Pantex Lake	East Property	Other Area
Badger	*Taxidea taxus*				X		
Black-tailed jackrabbit	*Lepus californicus*	X	X		X		X
Black-tailed prairie dog	*Cynomys ludovicianus*		X		X		X
Cottontail	*Sylvilagus spp.*[a]	X	X		X		X
Coyote	*Canis latrans*	X	X		X		X
Domestic dog	*Canis familiaris*						X
Mule deer	*Odocoileus hemionus*	X	X		X		X
Pronghorn	*Antilocapra americana*		X			X	X
Red fox	*Vulpes vulpes*						X
Striped skunk	*Mephitis mephitis*						X
Virginia opossum	*Didelphis virginiana*						X
White-tailed deer	*Odocoileus virginianus*	X			X		

[a] Desert (*S. audubonii*) and eastern (*S. floridanus*) cottontails could occur on Pantex Plant and, thus, the "at least 12 species".

In 2019, a survey of black-tailed prairie dog colonies conducted with the assistance of Global Positioning System (GPS) equipment revealed that the colonies occupied about 425 acres (ac) at Pantex Plant (including Pantex Lake; Figures 3.3 and 3.4). Prairie dogs are occasionally controlled where they have spread into operational areas of concern. Environmental Projects and Security provided funding in 2019. Prairie dog control was conducted in landfill and Security training areas west of Zone 4 to the northwest of Range 1.

3.4.1.2 Birds

Migratory birds are an important part of Pantex Plant's natural resources. K. D. Seyffert compiled a bird checklist for Pantex Plant. It indicates the species and their abundances expected in Pantex Plant 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 (PANTEXc) provides for monitoring of birds across Pantex Plant. The all-time bird list for Pantex

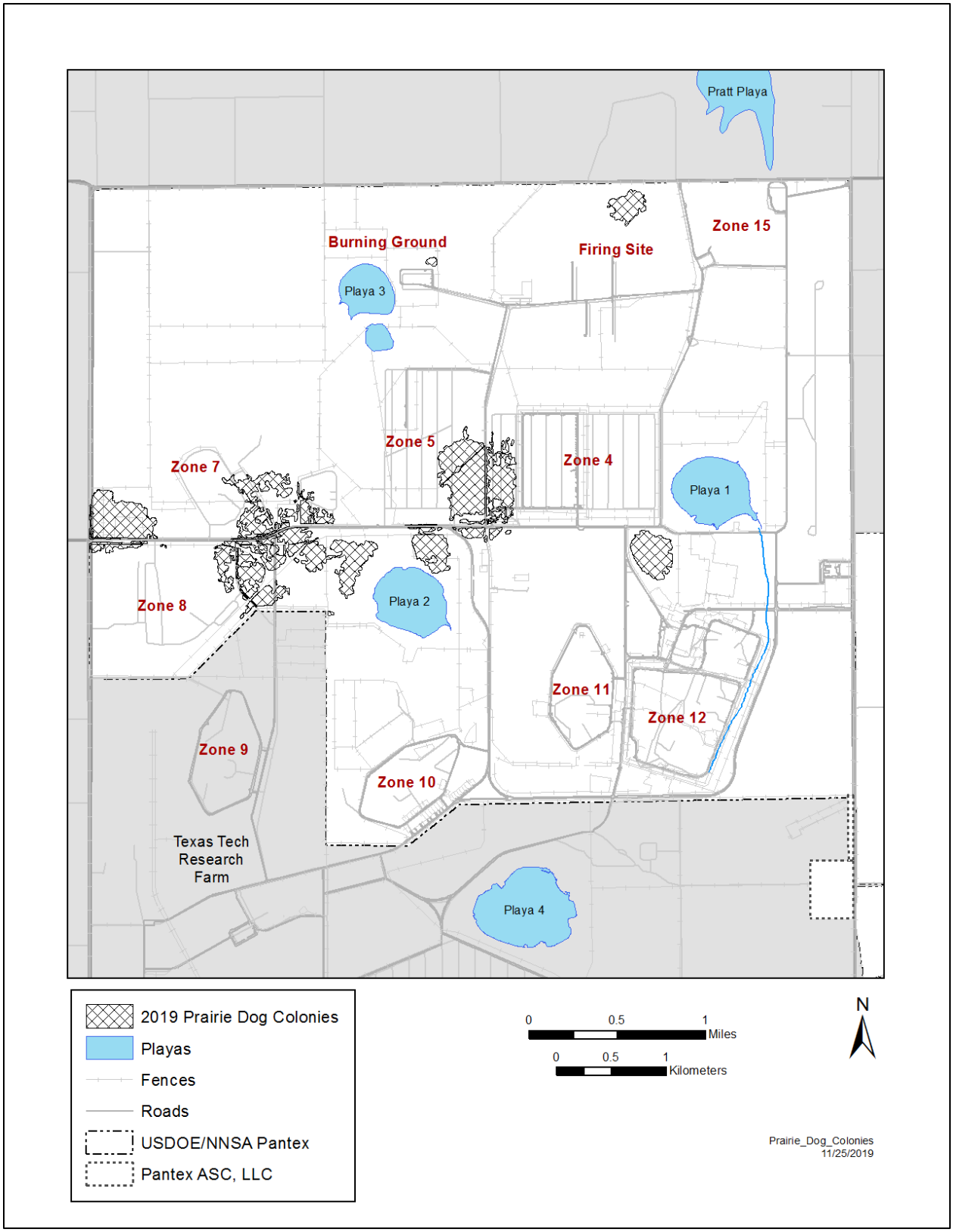


Figure 3.3 – Locations of Prairie Dog Colonies at Pantex Plant, 2019

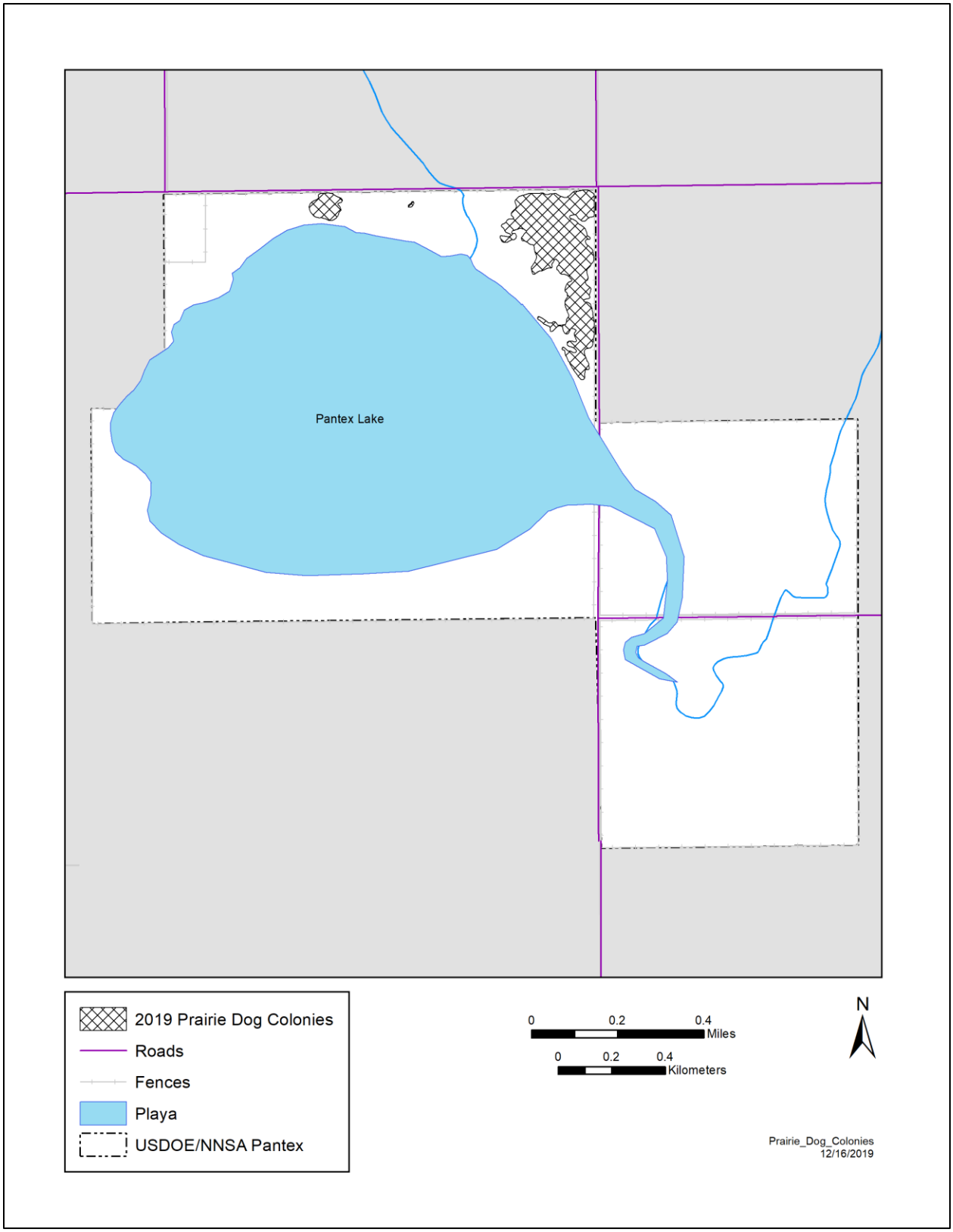


Figure 3.4 – Location of Prairie Dog Colonies at Pantex Lake, 2019

Plant includes 202 species, a result of systematic transect and plot surveys, intensive research projects, trailcam photos, and casual observations. Currently, birds are recorded during work activities thus the distribution of sightings across Pantex Plant is determined by staff field activity and work locations. Sixty species of birds were recorded at Pantex Plant during 2019 (Appendix A).

Figure 3.5 – 2019 Presidential Migratory Bird Federal Stewardship Award

Migratory bird-related research, collaborations, and outreach conducted and sponsored by Pantex Plant since 2002 earned the USDOE/NNSA the *2019 Presidential Migratory Bird Federal Stewardship Award* (see Figure 3.5). The Council for the Conservation of Migratory Birds presents the award annually. The nomination was titled, *Pantex - A Multi-Dimensional Approach to Contributing to Migratory Bird Conservation Across Hemispheres*.

Pantex Plant collaborates with York University, University of Manitoba, and the Purple Martin Conservation Association and 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. Pantex Plant is also collaborating in opportunistic collaborations on research projects dealing with microclimate of nesting cavities in artificial housing used by purple martins and whether the species can be lured back into nesting in forest ecosystems. Weyerhaeuser Corporation, Mississippi State University, and Texas Tech University are involved with these projects.

During CY 2019, Pantex Plant and collaborators shared research results from studies on purple martins, Swainson's hawks, and its migratory bird program. The results were presented at meetings of the Council for the Conservation of Migratory Birds (Washington, DC), the Federal Environmental Symposium (Bethesda, MA), the Raptor Research Foundation Conference (Fort Collins, CO), The Wildlife Society Annual Conference (Reno, NV), and the Annual Meeting of the Texas Chapter of The Wildlife Society (Dallas, TX). Articles on purple martins were published in the Journal of Field Ornithology, The Wildlife Society Bulletin, and The Bulletin of the Texas Ornithological Society.

3.4.1.3 Amphibians and Reptiles

Eight species of reptiles were recorded at Pantex Plant in 2019 during field activities and nuisance animal responses (Table 3.4). One western diamondback rattlesnake (*Crotalus atrox*) was recorded and was a Pantex Plant and county record for occurrence. No amphibians were observed during 2019. The all-time amphibian and reptile list for Pantex Plant includes 28 species. Documentation of three county occurrence records are in-press at Herpetological Review.

Table 3.4 – Reptiles Identified at Pantex Plant During 2019

Common Name	Scientific Name
Bullsnake	*Pituophis melanoleucus sayi*
Central plains milksnake	*Lampropeltis Triangulum gentilis*
Checkered garter snake	*Thamnophis marcianus marcianus*

Common Name	Scientific Name
Common kingsnake	*Lampropeltis getula splendida*
Diamondback rattlesnake	*Crotalus atrox*
Plains black-headed snake	*Tantilla nigriceps*
Prairie rattlesnake	*Crotalus viridis viridis*
Western coachwhip	*Masticophis flagellum testaceus*

3.4.1.4 Pollinators

In support of the Presidential Memorandum, *Sustainable Practices for Designed Landscaping and Supporting Pollinators on Federal Landscapes*, and the DOE's *Pollinator Protection Plan*, Pantex Plant continued a contract with the University of Oklahoma's Plains Institute for research exploring the potential of weather radar for monitoring migrations of insect pollinators. In particular, it is hoped that the study could prove valuable in developing a monitoring tool for the monarch butterfly (*Danaus plexippus*), a species that has been proposed for listing as "threatened" under the Endangered Species Act.

Results from this study are showing great promise for studying monarch migration behavior and NEXRAD as a tool for monitoring migrations and population. During 2019, Pantex Plant and collaborators presented shared research results from these studies at The Wildlife Society Annual Conference (Reno, NV), and the Annual Meeting of the Texas Chapter of The Wildlife Society (Dallas, TX). The first manuscript resulting from the study is currently in preparation.

Plants of the milkweed family (primarily the genus *Asclepias*) serve as the exclusive food source for larvae of the monarch butterfly. Pantex Plant conducts surveillance for milkweed species and monarch butterfly caterpillar use of that family of plants (Table 2). Established, randomly selected and known plots were monitored again in 2019 and milkweed was observed in only 12.5 percent (n=19) of randomly selected plots compared to 25.8 percent (n=47) in 2017. However, 21 less plots were monitored in 2019. Of plots containing milkweed in 2017 and 2019, 48.1 percent of plots did not contain milkweed in 2019. However, milkweed appeared in four plots in 2019 that did not contain any in 2017.

Monarch caterpillars were again sparse and later than expected based on incidental observations leading up to the study. Only one plot, a known plot containing approximately 200 horsetail/western whorled milkweed (*A. subverticillata*) plants hosted monarch caterpillars in 2019.

3.4.2 Nuisance Animal Management

In 2019, Environmental Compliance Department (ECD) staff addressed 157 nuisance animal situations. These involved domestic dogs (*Canis familiaris*), rock pigeons (*Columba livia*), and fifteen wildlife species. Nine striped skunks were trapped and delivered to the Amarillo Animal Control Facility by ECD. No cottontails, black-tailed jackrabbits, or rock pigeons were harvested by Security in 2019.

3.5 CULTURAL RESOURCES

Cultural resources identified at Pantex Plant include archeological sites from prehistoric Native Americans; standing structures that were once part of the WWII-era Pantex Ordnance Plant (1942-1945); and buildings, structures, and equipment associated with Pantex Plant'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 Plant. 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 National Historic Preservation Act (NHPA) and related Cultural Resource Management (CRM) requirements. Pantex Plant's CRM program ensures compliance with all applicable state and federal requirements.

The goal of the CRM program is to manage Pantex Plant's cultural resources efficiently and systematically, taking into account both Pantex Plant's continuing mission and historic preservation concerns. This goal is achieved through coordination with Pantex Plant's project review process for compliance with the National Environmental Policy Act (NEPA), and through consultation with the State Historic Preservation Office (SHPO) and the President's Advisory Council on Historic Preservation (Advisory Council). In October 2004, DOE, Pantex Plant, the Texas SHPO, and the Advisory Council completed execution of a Programmatic Agreement/Cultural Resource Management Plan (PA/CRMP) (PANTEXa). The PA/CRMP provides for the systematic management of all archeological and historic resources at Pantex Plant under a single document. It ensures compliance with Section 106 of the NHPA, providing for more efficient and effective review of Pantex Plant 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 Plant's compliance program. No changes were made to the program in 2019.

3.5.1 Archeology

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

Sixty-nine archeological sites have been identified at Pantex Plant 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 Plant determined that the 12 historic sites are not eligible for inclusion in the *National Register*. Pantex Plant 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 Plant will continue to protect these two sites and monitor them on a regular basis, as though they are eligible. 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 archeological methods. All archeological reports, records, photographs, maps and artifacts will be archived at Pantex Plant 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 Plant 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 archeologist. The bones were identified, preserved, and placed in a permanent exhibit within the Pantex Visitor Center.

In 2019, staff members monitored archeological sites on four separate occasions. Staff members found zero artifacts during the year.

3.5.2 World War II (WWII)

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 United States Army Corps of Engineers (USACE) and operated by the Certain-teed Products Corporation to produce bombs and artillery shells.

The WWII-era historical resources of Pantex Plant consist of 118 standing buildings and structures, all of which have been surveyed and recorded. In consultation with the SHPO, Pantex Plant 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 Visitor Center includes a WWII exhibit, which includes world events from the beginning of the fundamental activities for tactical and thermonuclear weapons that were developed and proved, to the creation of physical infrastructure of the nuclear weapon complex that lead to the growth of the stockpile and its effect on Pantex Plant.

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 Plant 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). Sixty-nine buildings constructed during WWII and used during the Cold War are eligible for inclusion in the *National Register* under the Cold War context. Many properties at Pantex Plant 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 Plant lies at the very heart of Cold War history.

The period of Cold War operations at Pantex Plant date from 1951 to September 1991. In 1951, the Atomic Energy Commission (AEC) reclaimed Pantex Plant as part of the expansion of the nuclear weapons complex. In September 1991, the Pantex Plant mission changed from one of nuclear weapon assembly to one of disassembly when President, George H.W. Bush addressed the nation, directing the dismantlement of a portion of the nation's nuclear weapon stockpile. The Cold War-era historical resources of Pantex Plant consist of approximately 600 buildings and structures and a large inventory of process-related equipment and documents. The historical resources of this period are among Pantex Plant's most significant, and offer a valuable contribution to the nation's cultural heritage.

Pantex Plant Master Site Plan, 2017-2040, specifically lists improvements and preservation of buildings listed in the PA/CRMP for in-situ preservation (PANTEXd). The ten facilities designated for in-situ preservation are additionally included in all NEPA reviews. Cultural resources management personnel review NEPA documentation to identify adverse effects on historical structures, objects, and archeological 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, maintaining the Pantex Visitor Center and railcar displays, collection of artifacts and records, monitoring archeological sites, educational outreach, and other preservation activities. Sixty-nine outreach activities for Pantex Plant history occurred in calendar year 2019, including history

presentations to newly hired staff members, students, and community leaders. These projects strengthen continued use of the historical facilities, and confirm the Pantex Plant pledge for implementing preservation activities.

3.6 EDUCATIONAL RESOURCES AND OUTREACH OPPORTUNITIES AT PANTEX PLANT

Pantexans donated their time and talent to area schools by speaking to students about the various careers that are available at Pantex Plant. Engineer Week, in February, helps stimulate students' interest in science, technology, engineering, and math. For 27 years, the Pantex 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 in Washington, D.C. In addition, Pantex Plant supported area schools with their robotics programs.

Pantexans showed their commitment to their community by volunteering their time during various events, such as the United Way Day of Caring where Pantexans built ramps for individuals that require accessibility to their homes. Pantex Plant also participated in the CNS Day of Volunteering. During the CNS Day of Volunteering, Pantexans helped local agencies such as the American Red Cross, where they installed smoke detectors in homes, and Snack Pak for Kids, where they packed bags to help end child weekend hunger.

3.7 ENVIRONMENTAL RESTORATION

Historical waste management practices at Pantex Plant resulted in impacts to on-site soil and perched groundwater. These historical practices included disposal of spent solvents in unlined pits and sumps, and disposal of high explosive (HE) wastewater and industrial wastes 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 Plant and in the uppermost (perched) groundwater beneath Pantex Plant. Pantex Plant and regulatory agencies identified 254 units for further investigation and cleanup. Investigations that identified the nature and extent of contamination at SWMUs and associated groundwater were submitted to the TCEQ and EPA in the form of Resource Conservation and Recovery Act (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 3.6 depicts the location and status of the units. The 15 units still in active use will be closed in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 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.

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 *Pantex Site-Wide Record of Decision*, (Pantex Plant and Sapere, 2008). The final approved remedial actions are detailed in the ROD. On-going remedial actions focus on:

- 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.

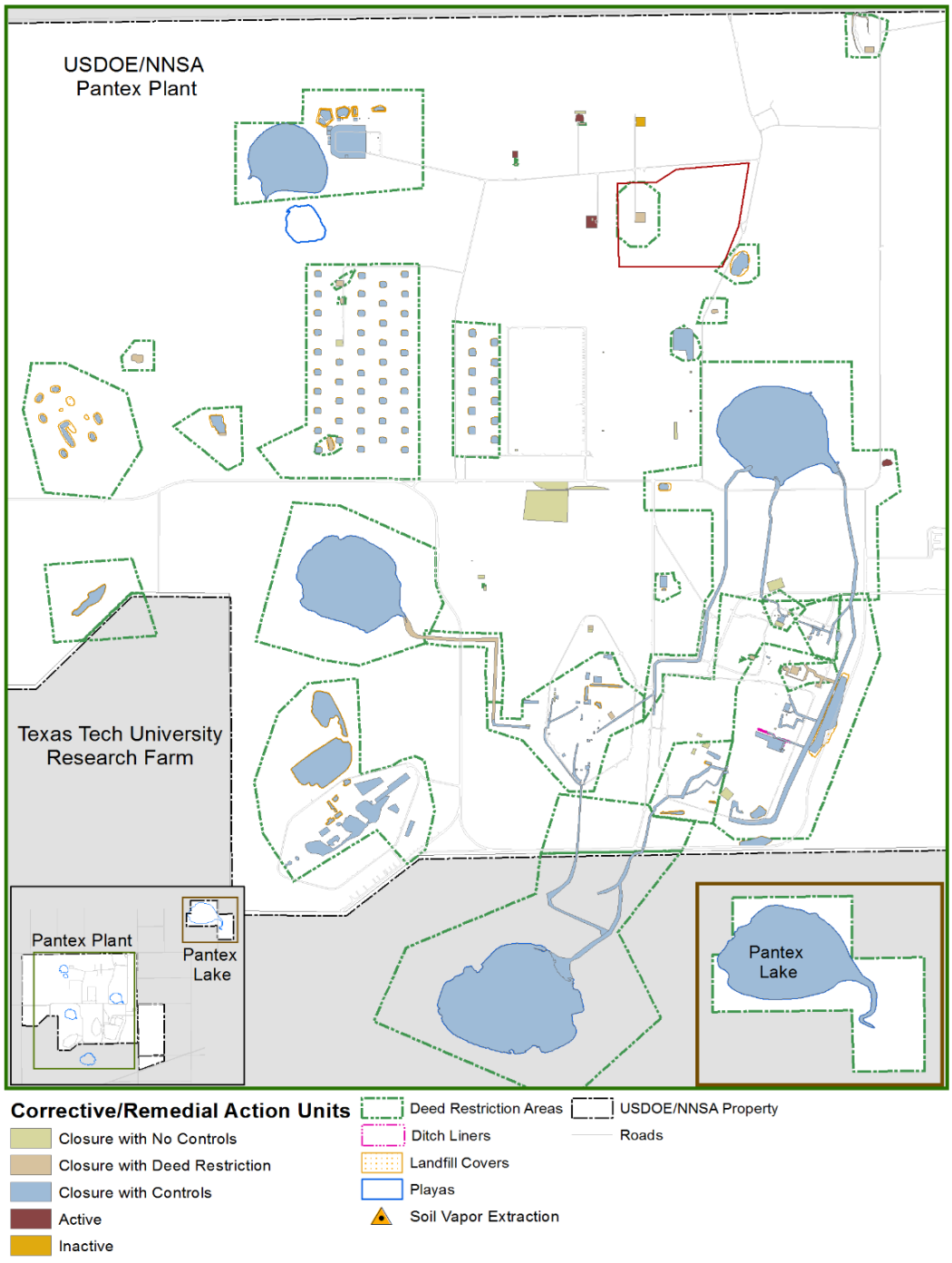


Figure 3.6 – Location and Status of Solid Waste Management Units

3.7.1 Environmental Restoration Milestones

During 2019, Pantex Plant completed several milestones under the continued Long-Term Stewardship (LTS) of environmental units. LTS includes the long-term Operation and Maintenance (O&M) of the remediation systems, monitoring of the systems to ensure that cleanup goals established in the ROD and Compliance Plan will be met, maintenance of soil remedies and institutional controls, and reporting of that information to regulatory agencies and the public. Major Milestones for the 2019 Remedial Actions are shown in Figure 3.7 and Remedial Action Systems at Pantex Plant are depicted in Figure 3.8.

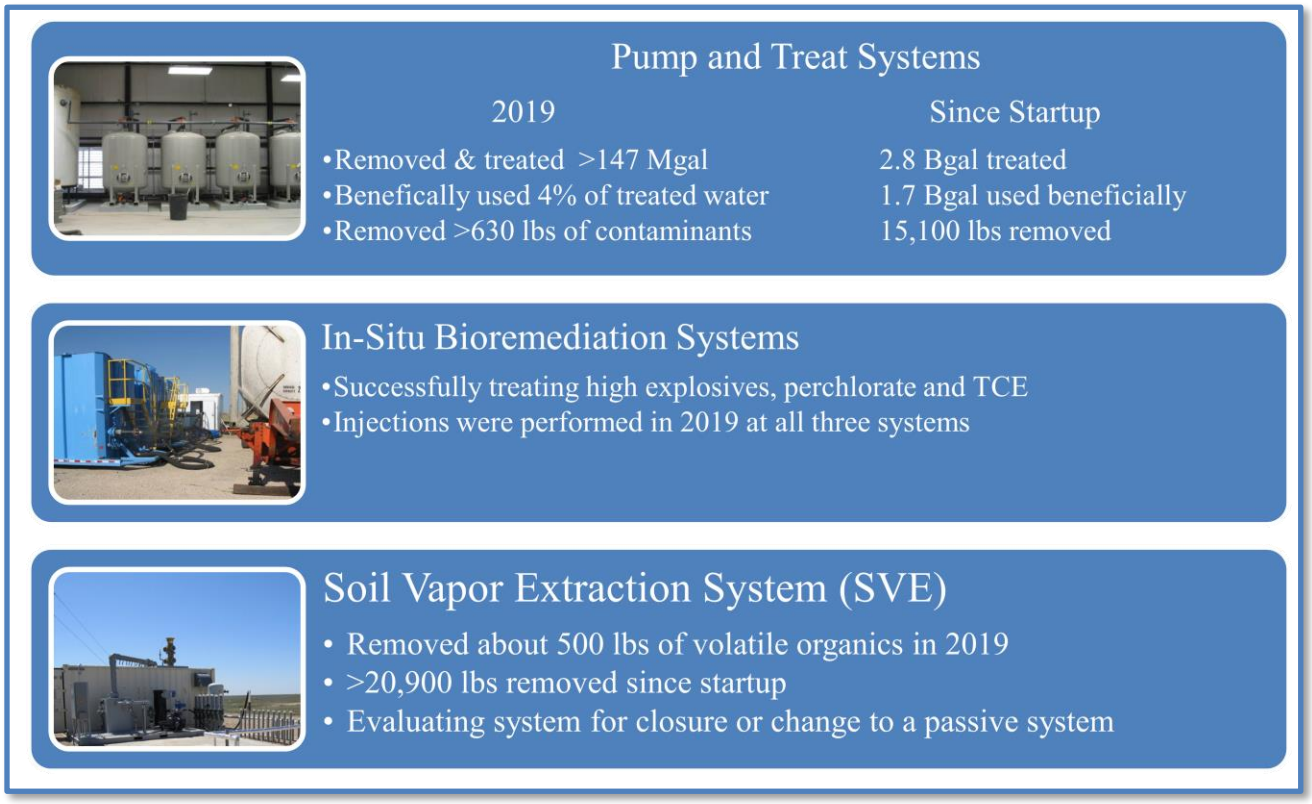
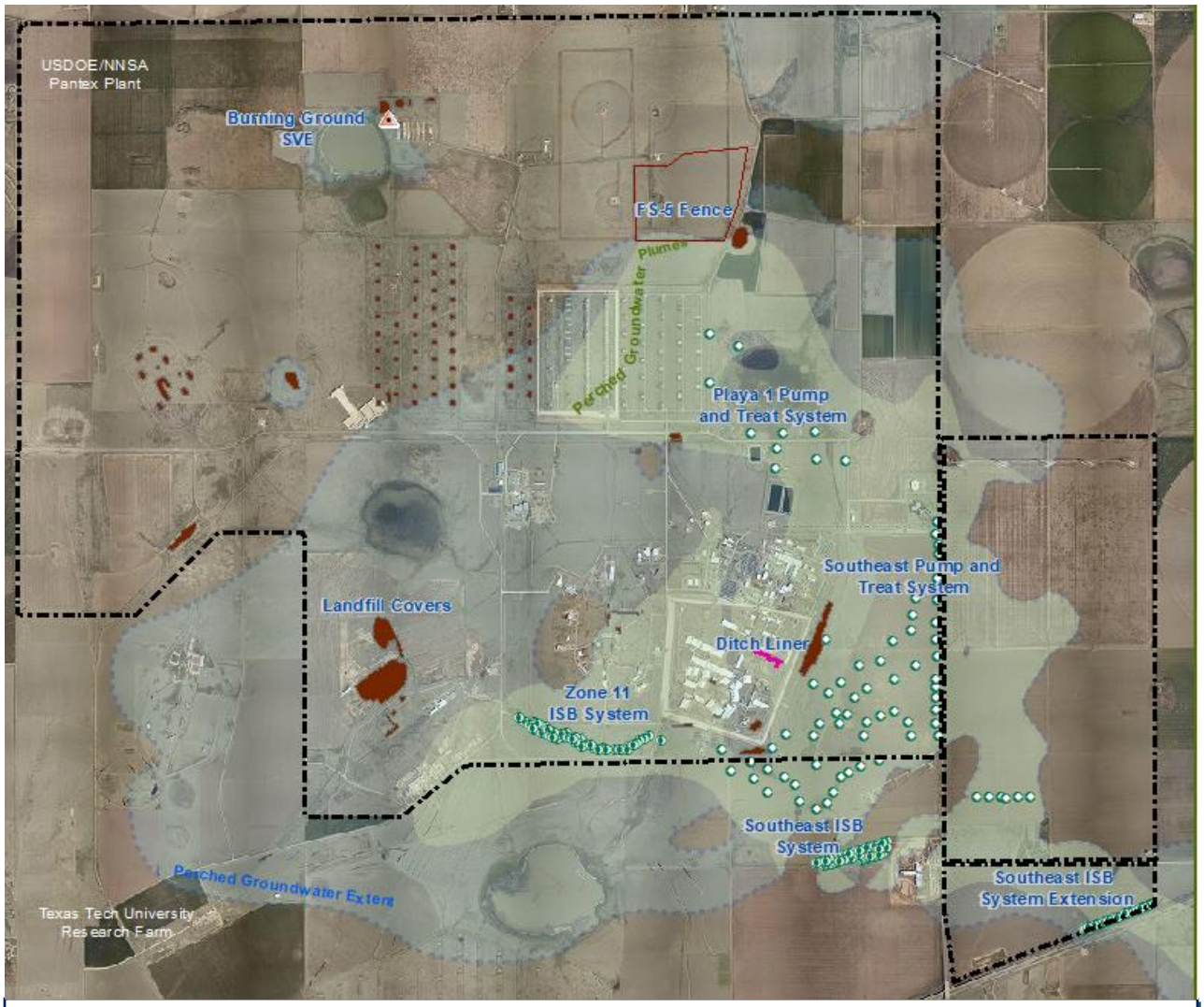


Figure 3.7 – Major Milestones for 2019 Remedial Actions

To reach the goal of reducing saturated thickness, the Pump and Treat Systems have a goal of operating 90 percent of the time and at 90 percent of treatment capacity if the wastewater treatment facility and irrigation system can receive all of the treated water. Pantex Plant revised the goals during 2014 to prioritize treatment and use of the water to align operation with the goal of reducing saturated thickness. During 2019, only four percent of the treated water was beneficially used due to the shutdown of the subsurface irrigation system resulting from the filter bank break that occurred in 2017. Performance of the Pump and Treat Systems for 2019 is depicted in Figure 3.9.

Engineering evaluations of the irrigation filter bank break indicated that repairs are complex and will take an extended period of time. For this reason, treated water has been discharged to Playa 1 or injected into the perched groundwater since the shutdown of the system. Since the discharge to Playa 1 and injection near the Southeast Pump and Treat System (SEPTS) do not align with goals to reduce water infiltration to the perched aquifer, Pantex Plant has reduced throughput from the systems. A combination of the injection and the discharge of treated water to Playa 1 is currently used to manage the treated water from the systems.



Groundwater Remedies:

- 2 Pump & Treat Systems
  - Playa 1 Pump and Treat
  - Southeast Pump and Treat
- 3 In-Situ Bioremediation (ISB) Systems
  - Zone 11 ISB
  - Southeast ISB
  - Southeast ISB Extension
- Institutional Controls

Soil Remedies:

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

Figure 3.8 – Remedial Action Systems at Pantex Plant

Pantex Plant is planning for the construction of surface irrigation components at Plant property east of FM 2373, pending approval of funding.

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 Playa 1 Pump & Treat System (P1PTS) primarily removes the HE RDX and the SEPTS primarily removes RDX and hexavalent chromium. Figure 3.10 provides the mass removal for HEs and chromium for 2019, 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.

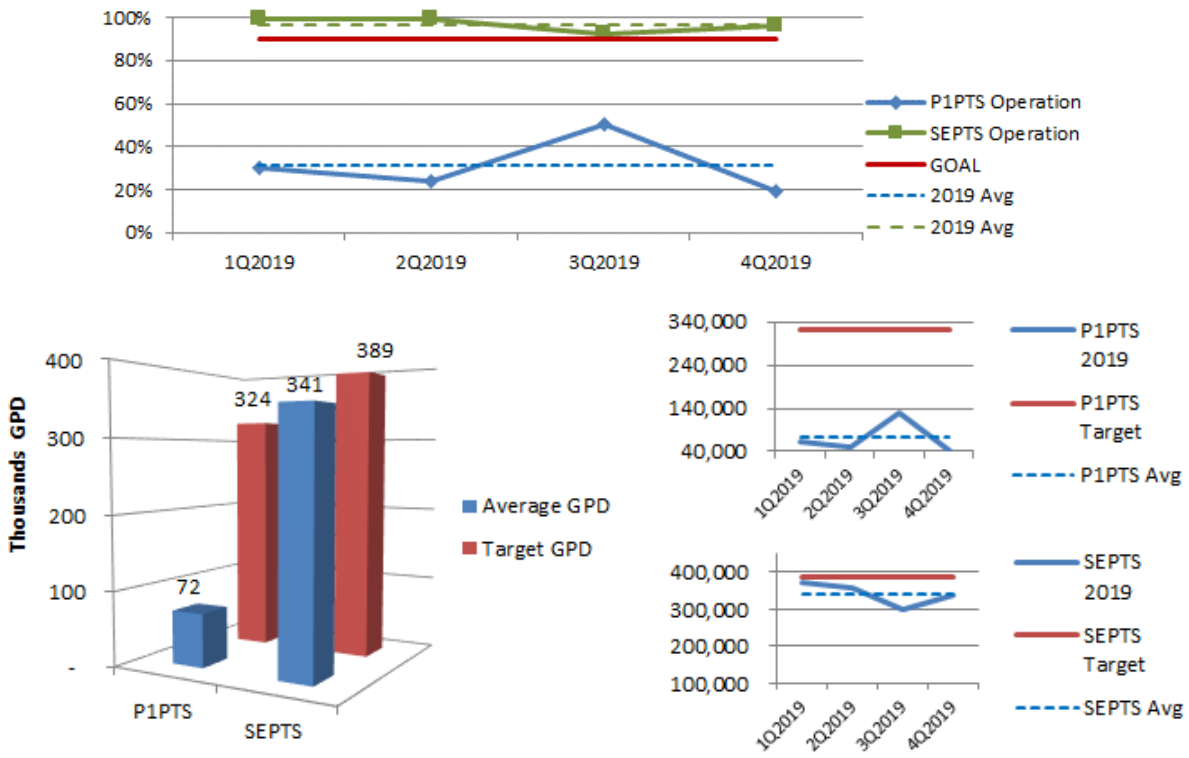
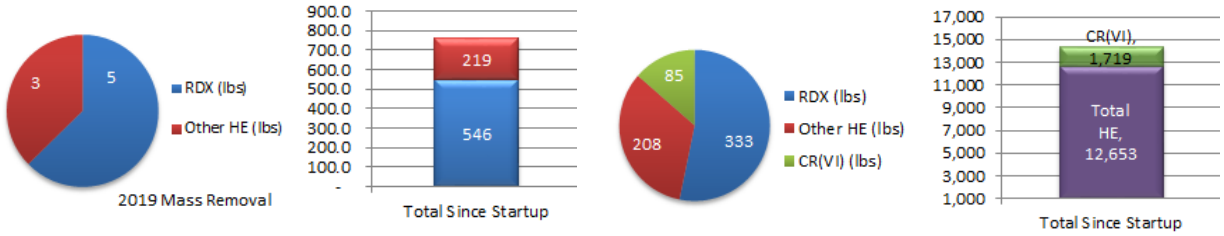


Figure 3.9 – Pump and Treat Systems Performance



P1PTS Mass Removal **SEPTS Mass Removal**

Figure 3.10 – Pump and Treat Systems Operation and Mass Removal

3.7.1.1 In-Situ Bioremediation (ISB) Systems

Three ISB systems (Zone 11 ISB, Southeast ISB, and Southeast ISB Extension) are in operation at Pantex Plant where pump and treat technology is not effective. 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 Texas Tech University (TTU) property south of Zone 11, or where the area is sensitive to vertical migration of contaminants of concern (COCs) to the underlying aquifer. 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. During 2019, Pantex Plant began using a different amendment, molasses, for use in the ISBs. This more soluble carbon amendment provides better distribution of amendment away from the injection wells. A discussion of treatment zone effectiveness and downgradient performance monitoring well information is included in Chapter 6. Pantex Plant injected the new Southeast ISB Extension in 2019. The new system was designed to arrest further movement of COCs to off-site areas. A new off-site treatment system has been designed to treat COCs that have already moved off-site. Pantex Plant will install the new off-site system in phases, beginning in 2020, based on availability of funds.

3.7.1.2 Burning Ground Soil Vapor Extraction (SVE)

A SVE system was installed and has been operating at the Burning Ground since 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 after the large-scale system became inefficient at continued removal of remaining soil gas and residual non-aqeous phase liquids (NAPL). The current 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 air flow through the soils to increase remediation and evaluate the system for closure. The current system continues to focus on treating residual soil gas and NAPL at a single well (SVE-S-20) where soil gas concentrations continue to remain high. As depicted in Figure 3.11, the SVE system removed about 508 lbs. of volatile organic compounds (VOCs) during 2019. As expected, concentrations and mass removal of VOCs continues to decrease at the system.

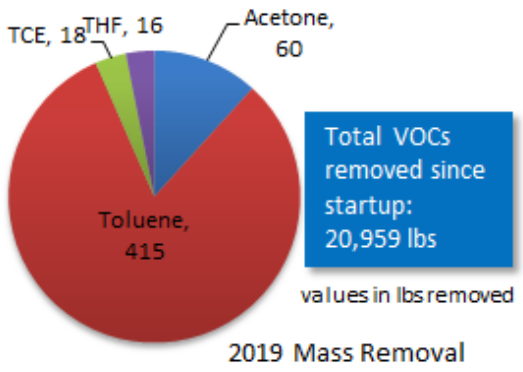


Figure 3.11 – 2019 SVE Mass Removal

3.7.1.3 Soil Remedies and Institutional Controls

Institutional controls are required as part of the LTS of soil remedial action units at Pantex Plant. Deed restrictions have been placed on all soil units with the exception of the active units. All SWMUs at Pantex Plant are restricted to industrial use. To support the deed restrictions, Pantex Plant maintains long-term control of any type of soil disturbance in SWMUs to protect human health and to prevent spread of contaminated soils. Pantex Plant 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. The ditch liner is also regularly inspected and maintained to prevent infiltration of water through soils that have been impacted by past releases.

3.7.1.4 Second Five-Year Review

The five-year review is conducted to ensure that Remedial Actions for soils and groundwater at Pantex Plant remain protective of human health and the environment. Pantex Plant started the second five-year review in May 2017 and regulatory approval for the final report was received in September 2018. 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, O&M of the remedial action systems must continue and enhancements to existing systems and institutional controls need to be evaluated, planned, and implemented. Pantex Plant is currently working towards completing the action items included in the approved five-year review. The action items are scheduled for completion before the next five-year-review.

3.7.2 Long-Term Groundwater Monitoring

Pantex Plant transitioned to the Long-Term Monitoring (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 remedial system is effective in stabilizing plumes and meeting cleanup goals, detecting 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 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 Order 458.1 *Radiation Protection of the Public and Environment*, requires the performance of monitoring that is integrated with the general environmental surveillance[8] and effluent monitoring[9] program in order to:

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

The monitoring program with its constituent planning, implementation, and assessment phases was designed based upon the system described in the EPA's *EPA QA/G-1, Guidance for Developing Quality Systems for Environmental Programs (*EPAb*)*. Another document useful in the continuous improvement of the design of the Pantex Plant monitoring program was National Council on Radiation Protection (NCRP) Report No. 169 (NCRPa) published by the National Council on Radiation Protection and Measurements. 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 subject matter experts (for

[8] Environmental surveillance refers to measurements performed throughout the environment where it is assumed that a particular substance, sometimes referred to as a contaminant, is well-mixed in the environment and the concentration of the substance in a collected sample is representative of its actual concentration in the environment.

[9] Effluent monitoring refers to the collection and analysis of samples at or before their entry into the environment.

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* (EPAc). When planning sample collection locations and frequencies for various environmental media, subject matter experts must consider several factors including:

- 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 Plant, 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 included 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. Due to the minimal number of points where measurable quantities of radiological and non-radiological contaminants can be directly measured and compared to some risk-based standard, the majority of planned sampling locations are best characterized as surveillance locations.

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 aforementioned manual contains procedures specific to each different environmental media. These specific procedures are based upon the collection protocols included in different national consensus standards.[10] The majority of the analyses of Pantex Plant environmental samples are completed by independent laboratories under a scope of work that requires the analysis of Pantex Plant samples be conducted by protocols that are equivalent to those in consensus standards.[11] In some instances, analysis results were not available due to drought conditions, electrical power failures during sample collection, or laboratory errors during analysis.

Data assessment processes were employed by Pantex Plant to verify that the data collected for the monitoring programs met the specified data acceptance criteria. These processes included evaluation of sampling quality assurance (QA), laboratory technical performance and QA, and data verification and validation. Chapter 13 in this document contains a discussion of the program used to ensure that the environmental monitoring data meet the appropriate data quality requirements.

The results of the data assessment processes described above and management reviews performed for the monitoring programs were then used as feedback for periodic revisions of the monitoring requirements. The revisions may include changes to the analytes being monitored, as wells as locations and frequencies of sample collection.

Media-specific descriptions of the sampling locations and the results of the monitoring program for samples collected during 2019 are contained in Chapters 4-12 of this report.

[10] Examples of consensus standards include "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association with the assistance of other similar organizations and "Methods of Air Sampling and Analysis" compiled by an intersociety committee including the Air and Waste Management Association, the American Chemical Society, the Health Physics Society and other similar organizations.

[11] 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 TLDs discussed in Chapter 4.

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Chapter 4 - Environmental Radiological Program

Pantex Plant's environmental radiological monitoring program is conducted according to the Department of Energy (DOE) Order 458.1, Radiation Protection of the Public and the Environment (DOEb). 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 Plant 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[12] although gamma radiation emissions from these radionuclides were also monitored and evaluated. Tritium emits beta particles. Monitoring results for the air pathway are discussed in detail in Chapter 5.

Chapter Highlights

- Monitoring results for the environmental radiological pathways in 2019 indicated levels below relevant standards, similar to results from previous years, and consistent with background conditions.
- There were no emissions due to unplanned releases during the reporting period.

4.1 RADIOLOGICAL DISCHARGES AND DOSES[13]

DOE Order 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 Plant, 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 (DCS) listed in DOE-STD-1196-2011, *DOE Derived Concentration Technical Standard* (DOEe).[14] The DCS values were derived in accordance with dose limitation systems recommended by the International Commission on Radiological Protection (ICRP) in its several publications (ICRPa) and used by the Environmental Protection Agency (EPA), the Nuclear Regulatory Commission, and other regulatory bodies including DOE in establishing standards for radiological protection. The 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 Order 458.1 requires evaluations to demonstrate compliance with the aforementioned dose limit. The 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 Plant, external gamma radiation is measured at several

[12] The alpha energies of U-233 and U-234 are very similar, as are the alpha energies for Pu-239 and Pu-240. Alpha-spectroscopy techniques used to perform analyses cannot distinguish between the two isotopes in either case. Accordingly, a single analysis result will indicate both isotopes in the respective pairs as U-233/234 and Pu-239/240.

[13] Radiological results are reported in units that are specific to different types of exposure and environmental media (i.e., air, water, etc.). See Appendix H.

[14] The DCS values listed in the technical standard represent the concentration of a given radionuclide in either air or water that would result in a member of the public receiving an effective dose of 100 mrem following continuous exposure for one year for each of the following pathways: ingestion of water, air contact, and inhalation.

locations at or near the site to determine the magnitude of doses from these pathways. Accordingly, DOE radiological activities at Pantex Plant do not cause any dose above that due to background radiation and thus do not contribute significantly to the exposure of members of the public to ionizing radiation.

4.1.2 Air Pathway

DOE Order 458.1 further requires that internal doses[15] to members of the public from inhalation of airborne effluents be evaluated using the EPA's CAP-88 model (or another EPA-approved model or method) to demonstrate compliance with applicable subparts of Title 40 of the Code of Federal Regulations (CFR), Chapter 61, *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 is demonstrated at Pantex Plant by calculating the effective dose equivalent received by the maximally exposed individual (MEI)[16] member of the general public by the use of the CAP-88-PC (EPAd) model.

Meteorological data used in this modeling effort was obtained from the meteorological tower from the Amarillo National Weather Service station at the Rick Husband International Airport. The source term for releases to air was calculated based on process knowledge of the releases of radionuclides from the routine operations at Pantex Plant (e.g., calibration of radiation detection instrumentation, sanitization of components at the Burning Ground and Firing Sites, etc.), 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 (HEPA) filters were made to maximize the potential emissions. A small percentage (0.0044 percent) of these calculated emissions is due to emissions of U-238 and other radionuclides from various routine Pantex Plant activities, while the balance is due to emissions of tritium.[17] These emissions are summarized in Table 4.1 below.

Table 4.1 – Pantex Plant Radiological Atmospheric Emissions in Curies (Bq)

Tritium	Total Uranium	Total Plutonium	Total Other Actinides	Other
6.67E-04 (2.47E+07)	2.93E-08 (1.08E+03)	None	None	2.3E-14 (8.65E-04)

Based on the 2019 operational data, the results of the CAP-88-PC modeling indicate that the maximally exposed individual (MEI) for 2019 located approximately 1.2 km northeast [NE] of the Burning Ground would have received a dose of 7.24 x10^{-8} mrem (7.24 x 10^{-10} mSv). 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. The indicated dose is also equivalent to 7.24 x 10^{-9} percent of the DOE Public Dose Limit for all pathways. Based upon the same CAP-88-PC modeling results, the collective population dose equivalent received by those living within 80 km (50 mi) of Pantex Plant would have been 1.50 x 10^{-7} person-rem/year

[15] Internal doses to organs or tissues of an organism which are due to the intake of radionuclides by ingestion, inhalation, or dermal absorption (NCRPc).

[16] The MEI is a person who resides near Pantex Plant, and who would receive, based on theoretical assumptions about lifestyle, the maximum exposure to radiological emissions and therefore, the highest effective dose equivalent from Plant operations.

[17] The overwhelming majority, approximately 99.9 percent, of these emissions arose from activities conducted within the southern portion of Zone 12. The balance of the emissions arose from sanitization activities conducted at the Burning Ground and Firing Sites.

(1.50 x 10^{-9} person-Sievert/year) in 2019. The majority of this collective population dose equivalent is contributed by tritium.

The effective dose equivalent for the MEI is less than that calculated for 2018, but is roughly equivalent to those over the last six years as illustrated in Table 4.2 below. Variation in the doses between years is due to changes in the emissions of tritium and isotopes of uranium as operations such as instrument calibration, sanitization of certain high explosive components and waste treatment operations may not necessarily have been conducted at the same rates during the period under consideration. The collective population dose equivalent for the same years displays the same general trend as that for the MEI dose.

Table 4.2 – Effective Dose Equivalent for Maximally Exposed Individual Member of General Public during CYs 2014-2019

Year	Maximally Exposed Individual Dose (mrem)	Population Dose (Person-rem/yr.)
2014	2.62E-07	3.40E-06
2015	1.35E-07	3.21E-06
2016	2.70E-05	9.94E-04
2017	7.60E-06	1.04E-05
2018	1.70E-06	2.41E-06
2019	7.24E-08	1.50E-07

4.1.3 Water Pathway

In addition to promulgating the dose limit mentioned above, DOE Order 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 Plant 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 level (MCL) limitations for individual radionuclides potentially released from Pantex Plant activities, with the exception of tritium, is demonstrated by comparing measured concentrations of radionuclides in drinking water to four percent of the DCS values for ingested water.[18] 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 Plant activities during 2019.

4.1.4 Other Pathways

Pantex Plant has considered doses, which might arise from radioactive materials ingested with food from terrestrial crops, animal products, and aquatic food products (including plant as well as animal species).

[18] 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, or 2.0 x 10^{-5} µCi/mL, equal to 1 percent of the ingested water DCS for tritiated water listed in DOE-STD-1196-2011(DOEe).

The results of the faunal monitoring measurements and monitoring of native vegetation and crops did not indicate releases to either pathway from Pantex Plant activities during 2019.

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 as low as reasonably achievable (ALARA). Public doses from this pathway are negligible.

4.1.5 Public Doses from All Pathways

The dose equivalent received by the MEI during 2019, the 2019 collective population dose, and the 2019 natural background population dose are presented in Table 4.3. Because there were no releases from Pantex Plant to the water or other pathways, the air pathway dose represents the public dose from all pathways.

Table 4.3 – Pantex Plant Radiological Doses in 2019

Dose to Maximally Exposed Individual from Pantex Plant Operations mrem (mSv)	Percent of DOE 100-mrem Limit	Estimated Population Dose from Pantex Plant Operations person-rem (person-Sv)	Population within 80 km (50 mi)	Estimated Background Radiation Population Dose at Pantex Plant (person-rem)
7.24E-08 (7.24E-10)	7.24E-08	1.50E-07 (1.50E-09)	296,000	29,600

4.2 RELEASE OF PROPERTY CONTAINING RESIDUAL RADIOACTIVE MATERIAL

DOE Order 458.1 provides requirements for the clearance of potentially contaminated material and equipment (M&E) from Pantex Plant 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 clearance to the public. DOE Order 458.1 specifically indicates that previously approved guidelines and limits (such as those developed for compliance with DOE Order 5400.5) 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 Order 5400.5. Table 4.4 presents the DOE Order 5400.5 pre-approved clearance limits.

Table 4.4 – Surface Activity Limits -Allowable Total Residual Surface Activity (dpm/100 cm^2)

Radionuclides	Average	Maximum	Removable
Group 1 – Transuranics, Iodine-125, Iodine-129, Actinium-277, Radium-226, Radium-228, Thorium-228, Thorium-230, Protactinium-231	100	300	20
Group 2 - Thorium-natural, Strontium-90, Iodine-126, Iodine-131, Iodine-133, Radium-223, Radium-224, Uranium-232, Thorium-232	1,000	3,000	200
Group 3 - Uranium-natural, Uranium-235, Uranium-238 and associated decay products, alpha emitters	5,000	15,000	1,000

Radionuclides	Average	Maximum	Removable
Group 4 - Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Strontium-90 and others noted above	5,000	15,000	1,000
Tritium (applicable to surface and subsurface)	NA	NA	10,000

Since 1993 Pantex Plant's clearance process, as stated in the *Pantex Radiological Control Manual* (PRCM) (PANTEXe), requires the Radiation Safety Department's (RSD's) evaluation of any potentially contaminated M&E using process and forms including:

- RSD 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 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 method, and/or
- PX-3134, *Process Knowledge*, for non-radioactive M&E having no potential for radioactive contaminated surfaces.

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

DOE Order 458.1 requires that personnel independent of contractor personnel conducting property clearance activities perform verification. At Pantex Plant, a Waste Characterization Official (WCO) 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 Plant during 2019 is discussed in Chapter 2. As there were no releases of real property containing residual radioactive material during 2019, those values represent the quantities of personal property released from Pantex Plant in 2019.

4.3 RADIATION PROTECTION OF BIOTA

DOE Order 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-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOEf) 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 as 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.[19]

During 2019, there was sufficient precipitation near Playa 1, in addition to discharge from the wastewater treatment facility, for the collection of surface water and/or sediment samples. These samples were

[19] These dose limits have been developed and/or discussed by the NCRP, in *Effects of Ionizing Radiation on Aquatic Organisms, Report No. 109* (NCRPb), and the International Atomic Energy Agency (IAEA), in *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standard, Technical Report Series No. 332* (IAEAa).

analyzed for tritium, U-234, U-235, U-238, and Pu-239/240. To implement the aforementioned standard, DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOEf), the radionuclide concentrations obtained were entered into the calculation tool (RAD-BCG) provided by the DOE 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 4.5a and 4.5b.

Table 4.5a – Evaluation of Dose to Aquatic Biota in 2019

Nuclide	Water Conc. (pCi/L)	BCG (Water) (pCi/L)	Partial Fraction (Water)	Sediment Concentration (pCi/g)	BCG (Sediment) (pCi/g)	Partial Fraction (Sediment)	Sum of Fractions (Water & Sediment)
Tritium	137	2.60E+08	5.27E-07	0.21	4.00E+05	5.25E-07	1.05E-06
U-234	1.74	2.00E+02	8.70E-03	0.434	5.00E+03	8.68E-05	8.79E-03
U-235	0.05	2.20E+02	2.27E-04	0.0344	4.00E+03	8.60E-06	2.36E-04
U-238	0.97	2.20E+02	4.41E-03	0.477	2.00E+03	2.39E-04	4.65E-03
Pu-239	0.0415	1.90E+02	2.18E-04	0.00625	6.00E+03	1.04E-06	2.19E-04
Sum of Fractions			1.36E-02			3.35E-04	1.39E-02

Table 4.5b – Evaluation of Dose to Terrestrial Biota in 2019

Nuclide	Water Conc. (pCi/L)	BCG (Water) (pCi/L)	Partial Fraction (Water)	Soil Concentration (pCi/g)	BCG (Soil) (pCi/g)	Partial Fraction (Soil)	Sum of Fractions (Water & Soil)
Tritium	137	2.31E+08	5.93E-07	0.21	1.71E+05	1.23E-06	1.82E-06
U-234	1.74	4.04E+05	4.31E-06	0.434	5.13E+03	8.46E-05	8.89E-05
U-235	0.05	4.19E+05	1.19E-07	0.0344	2.83E+03	1.22E-05	1.23E-05
U-238	0.97	4.06E+05	2.39E-06	0.477	1.58E+03	3.02E-04	3.04E-04
Pu-239	0.0415	2.00E+05	2.08E-07	0.00625	6.11E+03	1.02E-06	1.23E-06
Sum of Fractions			7.62E-06			4.01E-04	4.09E-04

As the sum of fractions for the aquatic system and the terrestrial system are 1.39×10^{-2} and 4.09×10^{-4} respectively, applicable BCGs were met for both evaluations. Therefore, it can be concluded that populations of aquatic and terrestrial biota on and near Pantex Plant 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 Plant during 2019.

4.5 ENVIRONMENTAL RADIOLOGICAL MONITORING

With the exception of the environmental dosimetry program discussed herein, media-specific descriptions, as well as the results of any radiological surveillance monitoring for samples collected during 2019, are contained in Chapters 5-12 of this report.

4.5.1 Environmental Dosimetry

The environmental dosimetry program uses thermoluminescent dosimeters (TLDs) to measure gamma radiation on and around Pantex Plant. This program has been conducted at several locations in parallel with monitoring conducted by the Texas Department of State Health Services (TDSHS)[20] since the early 1980s. Figure 4.1 on page 60 shows the locations of Pantex Plant's dosimeters during 2019.

Pantex Plant's TLDs are generally placed at the same locations where Pantex Plant operates air monitors, as discussed further in Chapter 5. Pantex Plant'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.[21]

Table 4.6 on page 61 lists results for 2019 and reflects the dose that an individual would have received at the TLD location if the person were present continuously for a full quarter. The average quarterly dose for all on-site locations during 2019 was approximately 23.0 mrem. The equivalent average annual dose is 92.0 mrem/year (0.92 mSv/year). The average quarterly dose at the TLD monitoring locations which are located in the direction of the predominant wind direction at Pantex Plant was 24.4 mrem (equivalent to 97.6 mrem/yr. or 0.98 mSv/yr.), while the quarterly dose at upwind locations averaged 23.1 mrem (equivalent to 92.4 mrem/yr. or 0.92 mSv/yr.). The quarterly measurements indicate evidence of seasonality as the measurements taken during the winter quarters (in the Northern Hemisphere) when the Earth is closest to the sun in its orbit and levels of cosmic radiation are highest) are generally higher than those taken during the summer quarters. However, all measured doses are similar to those obtained during previous years (see Figure 4.2 on page 61).

4.5.2 Future Radiological Monitoring

As discussed herein, media-specific subject matter experts periodically make revisions to the Pantex Environmental Monitoring Program based on process changes and potential impacts. The revisions are highly controlled via procedures that force evaluation of any new process thoroughly prior to construction of new facilities and again prior to operation using a very disciplined and tiered readiness review/assessment process to assess impacts and characterize exposures and doses to individual members of the general public, to the population, and to biota near Pantex Plant. The subject matter experts develop or revise monitoring requirements using a process based upon EPA guidance documents and consider potential releases from

[20] The TDSHS used optically stimulated luminescence devices similar in function to the TLDs used by Pantex Plant.
[21] This exposure includes ubiquitous background (i.e. cosmic radiation) as well as that from Pantex Plant Operations.

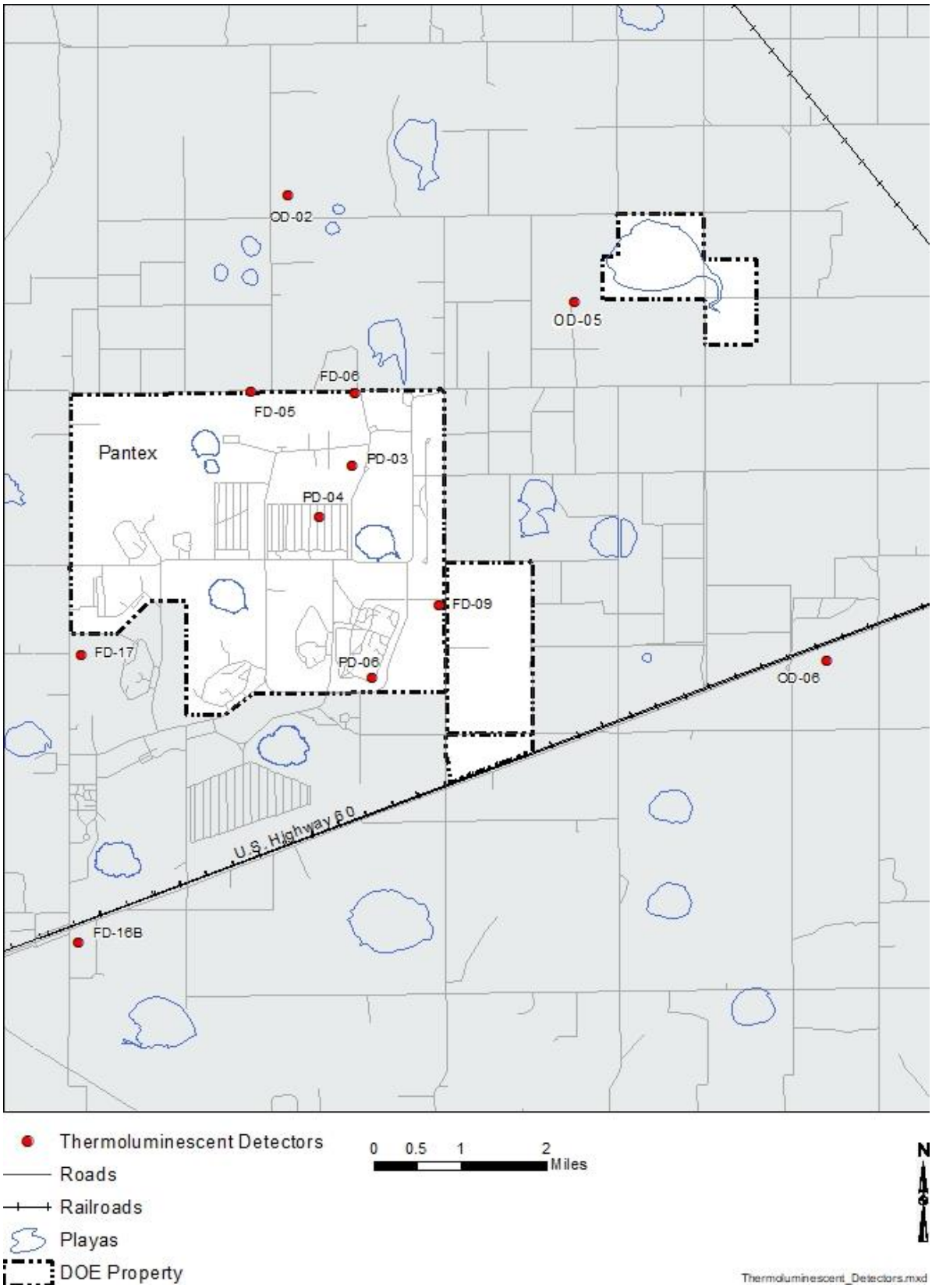

Figure 4.1 – Locations of Pantex Plant TLDs

Table 4.6 – Environmental Doses[a] Measured by TLDs in 2019 in Millirem[22]

Location	Q1	Q2	Q3	Q4	Total
On-site					
PD-03	27	22	18	14	81
PD-04	30	27	24	18	99
PD-06	30	26	22	18	96
Upwind					
FD-17	30	26	22	18	96
Downwind					
FD-05	33	27	23	20	103
FD-06	32	26	23	21	102
FD-09	30	25	24	20	99
OD-02	28	24	20	18	90
OD-05	30	25	23	20	98
OD-06	29	24	22	19	94
Control					
FD-16B	28	23	20	18	89
Blank Correction	1	2	2	15	20

[a] Includes ubiquitous background (i.e. cosmic radiation) and Pantex Plant operations

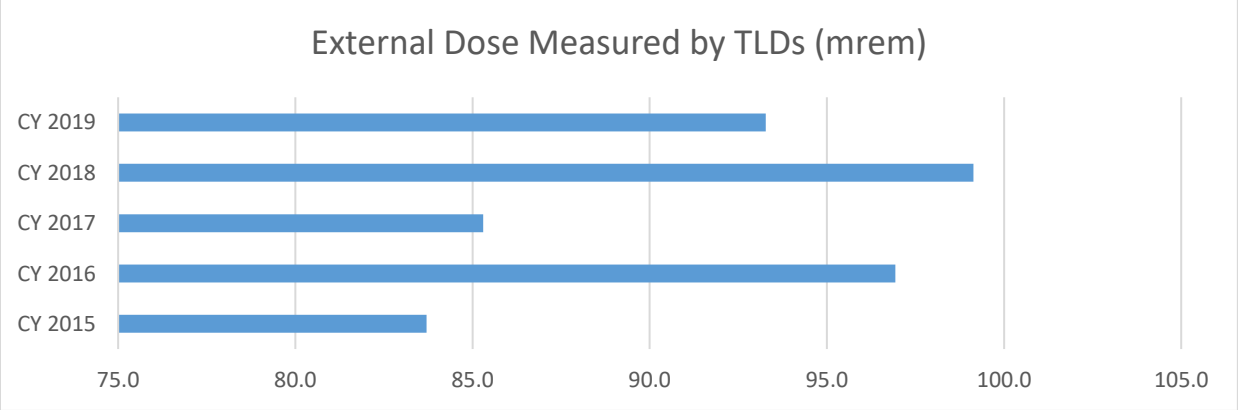

Figure 4.2 – Environmental Doses Measured by TLDs CY 2015-2019

[22] All measurements have been blank corrected. This is accomplished by measuring the residual doses on dosimeters which have been stored in a location where they receive no exposure during the same period as those dosimeters which have been deployed at the indicated locations. The residual dose that was subtracted from the raw data of the deployed dosimeters is indicated in the table.

current DOE activities at the site. However, the subject matter experts also consider planned new activities identified in the National Environmental Policy Act (NEPA) process discussed in Chapter 2. Based upon pathway analyses the subject matter experts make adjustments to the monitoring program for their individual environmental media.

4.6 CONCLUSIONS

The calculated doses to the public and to the environment from Pantex Plant operations discussed above are minute when compared to those from naturally occurring sources and those from other man-made sources. The estimated total average annual effective dose equivalent to any individual member of the U.S. population and the collective effective dose from these several sources are presented in Table 4.7. Pantex Plant measured and/or calculated effective doses are several orders of magnitude smaller than the smallest doses indicated. Additionally, the measured doses are of the same order of magnitude as the external components of national ubiquitous[23] background.

Table 4.7 – Effective Dose per Individual in the U.S. Population and Collective Effective Dose for Population Located within 50 Miles of Pantex Plant

Exposure Category	Effective Dose per Individual (mrem)	Collective effective dose (person-rem)
National ubiquitous background	311	9.33×10^4
Medical procedures	300	8.99×10^4
Consumer	13	3.99×10^3
General public exposure to industrial, security, medical, educational, and research	0.30	1.00×10^2

Modified from a table in NCRP Report No. 160 "Ionizing Radiation Exposure of the Population of the United States" (NCRPc).

The environmental radiological monitoring program at Pantex Plant continues to provide information that supports the hypothesis that current Plant operations do not have a detrimental effect on the quality of the environment at or near Pantex Plant. Pantex Plant's monitoring results for the environmental radiological pathways in 2019 indicated levels below relevant standards, similar to results from previous years, and consistent with background conditions.

[23] The external components of ubiquitous radiation include radiation from space incident on the earth's atmosphere and radiation from radionuclides in the environment.

Chapter 5 - Air Monitoring

Pantex Plant implements a radiological air monitoring program to ensure Plant operations are not having an impact on ambient air quality. Monitoring and sampling to detect possible airborne emissions of radiological material or hazardous pollutants at Pantex Plant is conducted at on-site and off-site locations as a part of an environmental surveillance program. Some operations at Pantex Plant are sources or potential sources of airborne emissions. Ambient air monitoring for releases of airborne emissions from Pantex Plant facilities has historically been done at fixed remote locations

Chapter Highlights

- Pantex Plant collected more than 85 percent of planned samples from all locations.
- High winds in the spring and summer of 2019 resulted in the re-suspension of dust in the atmosphere leading to increased quantities of naturally occurring radioactive material being collected by the upwind and downwind monitoring stations.
- All of the radiological air monitoring data for 2019 indicated that results were below detection limits.
- Data continues to support the hypothesis that operations at Pantex Plant are not having a detrimental effect on the environment.

5.1 NON-RADIOLOGICAL AIR MONITORING

As noted in previous annual reports, Pantex Plant has not routinely operated non-radiological monitors since 2003. However, a qualitative monitoring system has continued to operate at Pantex Plant. During 2019, one Visual Emission Evaluation (VEE) was conducted.

5.2 RADIOLOGICAL AIR MONITORING

During current operations at Pantex Plant, various radioactive materials including tritium, plutonium, uranium, and miscellaneous sources (e.g., thorium, cobalt, and cesium) may be present in the components of nuclear weapons being managed. However, in normal operating situations, the nature of the work at Pantex Plant and the physical form of the material are such that there is very little potential for the public, the environment, or Pantex Plant personnel to be affected by releases of radioactive materials as a result of Plant operations. As shown in Table 4.1, most of the small numbers of radionuclide releases during normal operations at Pantex Plant are tritium releases. Very small amounts of tritium escape as gas or vapor during normal operations, as well as from the area of the accidental release that occurred in 1989 (as described in the *Environmental Information Document* {PANTEXf}).

During 2019, a total of ten air monitoring stations were operated continuously. Monitoring stations were designated as PA-AR-XX for Pantex Plant air; FL-AR-XX for fence line air; and OA-AR-XX for off-site air.

Stations designated as PA-AR-XX are located near operating areas where radiological material is used and/or stored. Station PA-AR-04 is located near the firing sites and monitors the ambient air associated with activities in which testing and sanitization of tritium impacted components are conducted. Station PA-AR-04 is also adjacent to the north fence of Zone 4 East. Since the predominant wind direction at Pantex Plant is from the south-southwest, this station also monitors the ambient air associated with shipping and

receiving operations conducted in Zone 4. Station PA-AR-06 is located near an area where operations involving the disassembly of nuclear weapons, the calibration of portable radiation detection instruments, and the packaging of radiological waste occur.

Stations designated as FL-AR-XX are located along Pantex Plant perimeter. 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. Four fence line radiological monitoring stations are located along the perimeter. Stakeholders were considered in establishing the locations of the stations. Stations FL-AR-05, FL-AR-06, FL-AR-09, FL-AR-16 and FL-AR-17 are all located along the perimeter and are noted in Figure 5.1.

Stations designated OA-AR-XX are off-site air monitoring stations, located several miles from Pantex Plant. Stations OA-AR-02, OA-AR-05 and OA-AR-06 are approximately 5 miles from the center of Pantex Plant. The locations of these stations are noted in Figure 5.2.

The predominant wind direction at Pantex Plant is south-southwest. Stations FL-AR-05, FL-AR-06, FL-AR-09, OA-AR-02, OA-AR-05 and OA-AR-06 are all located in the predominant downwind direction from Pantex Plant. This would be the expected direction in which hypothetical releases of radiological material from Pantex Plant would be expected to travel. Monitoring stations FL-AR-16 and FL-AR-17 are located upwind of Pantex Plant, opposite the predominant wind direction, and were monitored less frequently the other stations as a result.

5.2.1 Collection of Samples

Each monitoring station was equipped with a high-volume air sampler and a low-volume air sampler (Figure 5.3). On the far-left of the figure is a container for the co-located thermoluminescent dosimeters (TLDs). The high-volume sampler is located on the left, and a "doghouse" containing the low-volume sampler is on the right. The samplers ran continuously, and filters or silica gel samples were collected from the samplers on a weekly basis. Sampler operational characteristics, such sample collection period length, beginning flow rates, ending flow rates, and other parameters were recorded by the sampling technicians at the initiation and/or at the completion of the sampling activity.

The high-volume samplers operated at a flow rate of approximately 40 cubic feet per minute (ft^3/min or more commonly cfm). During sampling, particles were collected on 8×10-inch filters. Each air filter sample included particulate matter from approximately 403,000 ft^3 of air. Weekly[24] samples for a given month[25] were combined as one sample for later analysis for uranium-234 (U-234), uranium-238 (U-238), and plutonium-239 (Pu-239) by a radiological analysis laboratory.

Nominal airflow through the low-volume air samplers was much lower than that for the high-volume samplers, being 1.5 ft^3/min. Each low-volume sampler contained silica gel within the "U-tube" (illustrated in Figure 5.4). The silica gel acted as a desiccant, removing water vapor from air as it flowed through the sampler. The silica gel samples were collected at the same time as the individual filters were collected from the high-volume samplers. Any tritiated water vapor present in the sampled air was recovered and quantified during analysis of the silica gel by a radiological analysis laboratory.

[24] The sample collection period is nominally one week. However, some samples were collected for longer periods in cases where the sampling technician could not access a monitoring location due to weather, or when there were modifications in the sampling schedule due to holidays or periods when radiological material releases to the atmosphere could not occur due to inactivity.

[25] A sample collection month might commence several days prior to the designated month or extend into the following month.

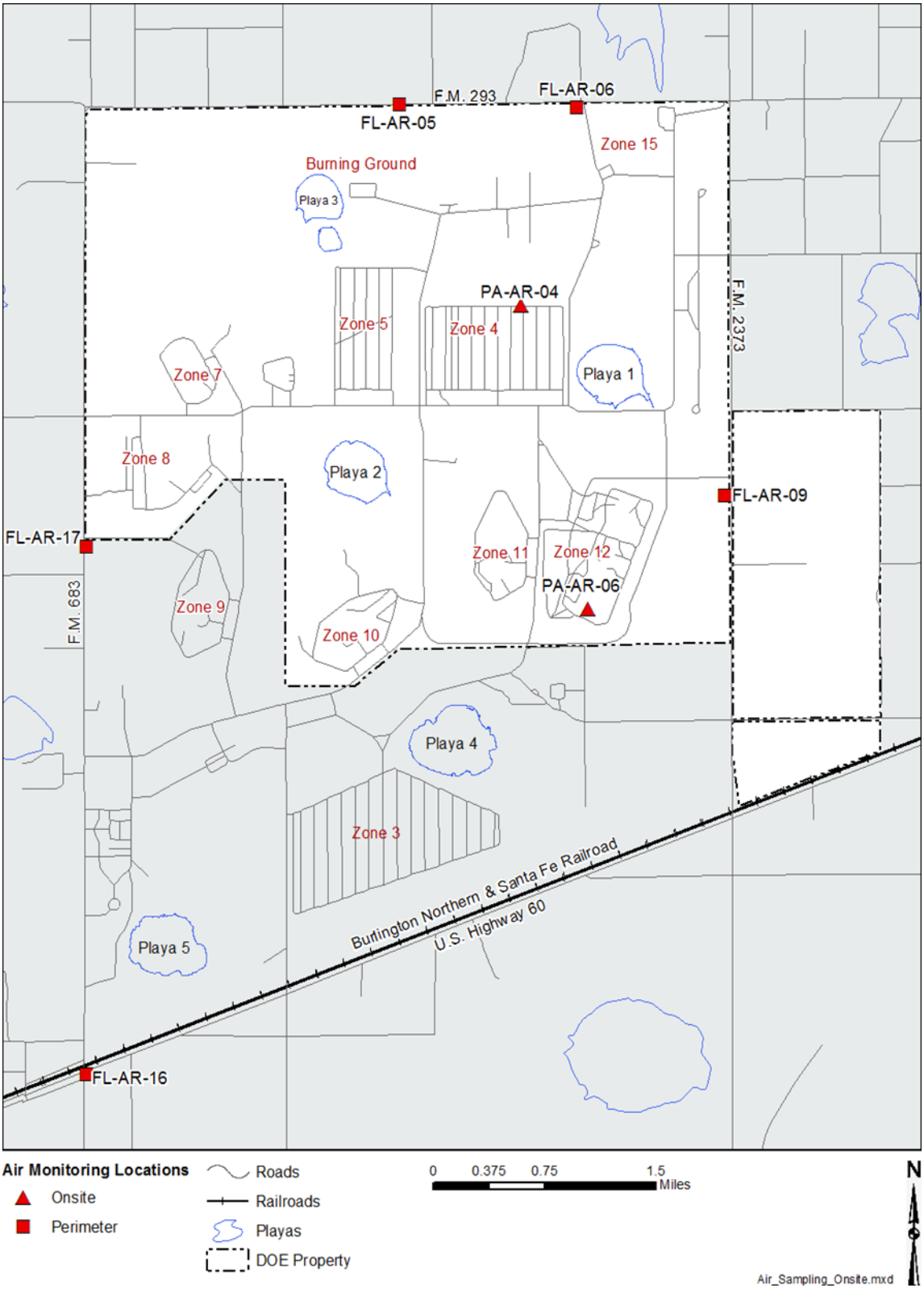

Figure 5.1 – Locations of On-site and Fence Line Air Monitoring Stations

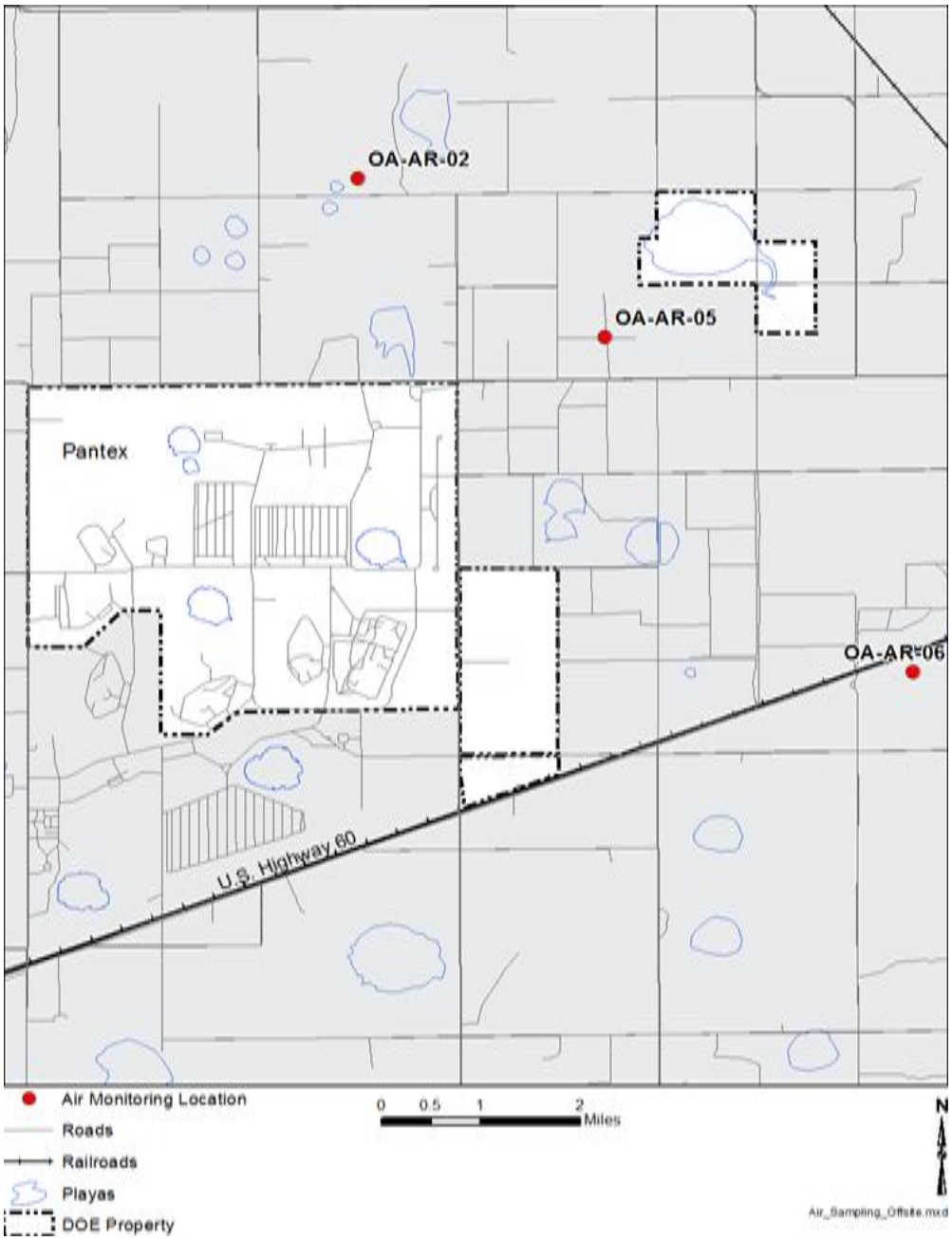

Figure 5.2 – Locations of Off-site Air Monitoring Stations

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Figure 5.3 – Typical Air Monitoring Site

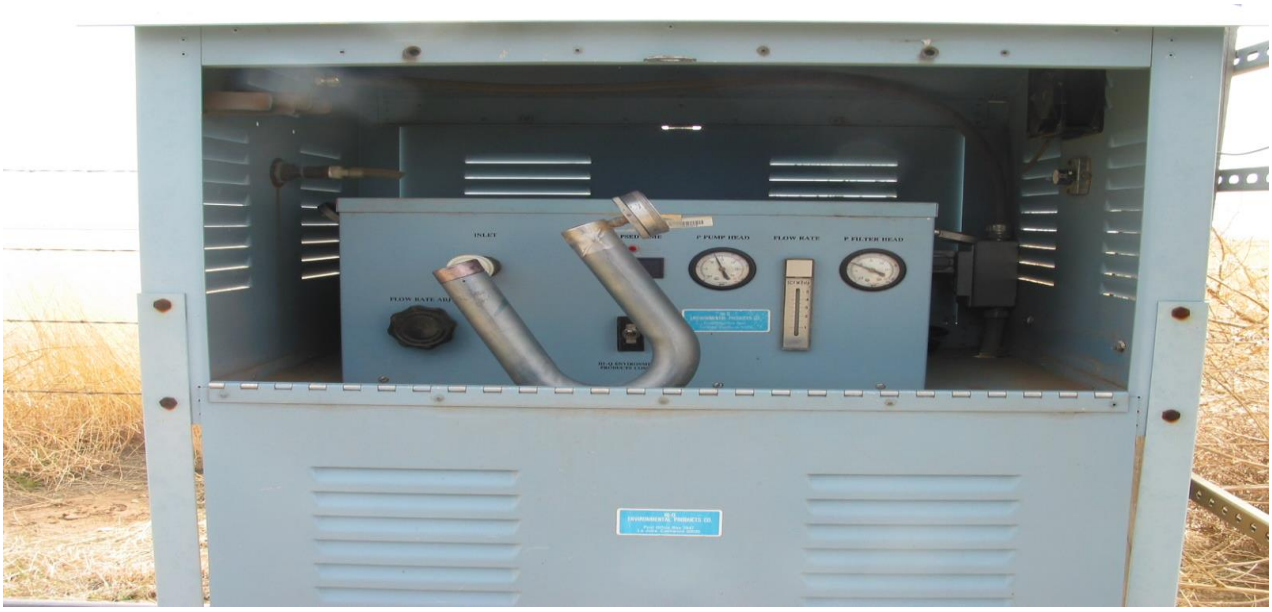

Figure 5.4 – Low-Volume Sampling Apparatus

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, and when necessary, temperature, pressure, and relative humidity data obtained from the meteorological tower described in Chapter 1. Table 5.1 summarizes the values for the several analytes in four categories of monitoring stations (on-site, upwind, downwind, and

control [or background]). The values indicated are the mean, the standard deviation, the maximum value and its associated counting error, the historical background,[26] and the Derived Concentration Standard (DCS)[27] for comparison.

Table 5.1 – Concentrations of Radionuclides in Air for 2019 at (a) On-site Locations; (b) Upwind Locations; and (c) Downwind Locations (µCi/mL)

a.

Radionuclide	Number of Samples Analyzed/Planned	Mean ±Std. Dev.	Max ± Counting Error	Historical Background	DCS
Tritium[a]	76/86	0.617±1.817	9.200±1.711	1.320	14000
U-234[b]	20/24	13.840±3.150	18.270±3.490	30.400	400,000
U-238[b]	20/24	11.970±2.946	16.420±3.133	28.960	470,000
Pu-239[b]	20/24	0.191±0.367	1.178±0.792	0.930	240,000

b.

Radionuclide	Number of Samples Analyzed/Planned	Mean ±Std. Dev.	Max ±Counting Error	Historical Background	DCS
Tritium[a]	82/82	-0.066±0.280	0.629±1.017	1.320	14000
U-234[b]	24/24	17.760±5.632	29.017±5.675	30.400	400,000
U-238[b]	24/24	16.590±4.517	26.900±4.233	28.960	470,000
Pu-239[b]	24/24	0.212±0.297	1.076±0.967	0.930	240,000

c.

Radionuclide	Number of Samples Collected/Planned	Mean ±Std. Dev.	Max ±Counting Error	Historical Background	DCS
Tritium[a]	212/215	-0.074±0.281	0.646±0.570	1.320	14,000
U-234[b]	54/72	15.500±4.570	25.740±4.111	30.400	400,000
U-238[b]	54/72	15.040±4.296	26.490±4.173	28.960	470,000
Pu-239[b]	54/72	0.208±0.505	2.346±1.864	0.930	240,000

[a] Units in all tables are x 10^{-12} µCi/mL (or aCi/mL) for tritium.
[b] Units in all tables are x 10^{-18} µCi/mL (or yCi/mL) for α-emitting radionuclides (U-233/234, U-238, and Pu-239/240)

During 2019, as in most previous years, Pantex Plant collected and analyzed more than 85 percent of the planned samples at all locations. The monitor located at OA-AR-06 was not operational until October 2019 when electrical repairs were conducted. However, intermittent power losses or motor failures caused the non-collection of a large number of high-volume and low-volume samples and resulted in non-representative sampling volumes.

5.2.3 Data Interpretation

During 2019, the maximum measurements for the alpha-emitting radionuclides (U-234, U-238, and Pu-239) occurred during periods in the spring and summer when high wind speeds were observed in the Texas Panhandle, which caused an increase in the re-suspension of dust into the atmosphere. The relative maxima was observed to be occurring both upwind and downwind of Pantex Plant, indicating that many of the

[26] This parameter 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.
[27] DCSs 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, and air inhalation pathways. DOE-STD-1196-2011 (DOEe) lists several values of DCS for air inhalation for each radionuclide based upon the chemical form or the absorption class of the isotope.

maximum measurements represent the collection of increased quantities of naturally occurring radioactive material during these periods.

Statistical comparisons of the CY 2019 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 Plant operations are not distinguishable from background. The analysis laboratory indicated that more than 80 percent of the Pu-239 measurements were below detection, thus apparent statistical differences across the three location categories are likely the result of the use of this uncensored data set. Average concentrations for all three alpha-emitting radionuclides are a very small 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 Plant 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 negligible.

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 2015 through 2019. No tritium concentration in ambient air during 2019 (or any of the indicated years) exceeded the DCS. No radiological concentration in ambient air exceeded the applicable DCS for the radiological materials analyzed.

5.3 CONCLUSIONS

Results indicate that the air-monitoring program at Pantex Plant continues to provide information that supports the hypothesis that current operations do not have a detrimental effect on the quality of the environment at or near Pantex Plant.

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Chapter 6 - Groundwater Monitoring

Groundwater monitoring at Pantex Plant began in 1975 when the first investigative wells were installed. Pantex Plant completed its investigations in 2005 with the identification of contaminant plumes in the perched groundwater beneath Pantex Plant and Texas Tech University (TTU) property. Monitoring wells in the perched groundwater are being used to monitor two remedial actions: two pump and treat systems, with 75 operating extraction wells and two injection wells, and three In-Situ Bioremediation (ISB) systems consisting of a total of 115 active treatment zone wells. Pantex Plant also monitors 24 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 2019 demonstrated that current remedial actions continue to progress toward cleanup of perched groundwater contaminants and that constituent levels found in the deeper drinking water resource are below Environmental Protection Agency (EPA) drinking water standards or cleanup standards established for the Pantex Remedial Action.
- TCE and hexavalent chromium contamination have continued declining trends for 2019.
- Perchlorate and RDX both showed an increase in annual maximum concentrations in 2019, with both increases attributed to plume movement.

6.1 GROUNDWATER AT PANTEX PLANT

Groundwater beneath Pantex Plant and vicinity occurs in the Ogallala and Dockum Formations at two intervals (Figure 6.1). The first water-bearing unit below Pantex Plant in the Ogallala Formation is a discontinuous zone of perched groundwater located at approximately 200 to 300 feet (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 playas that initially migrates down to the fine-grained zone. It then flows outward in a radial manner away from the playa lakes and becomes influenced by the regional south to southeast gradient. The largest area of perched groundwater beneath Pantex Plant 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 storm water 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 Plant) and near the Old Sewage Treatment Plant in the northeast corner of Pantex Plant.

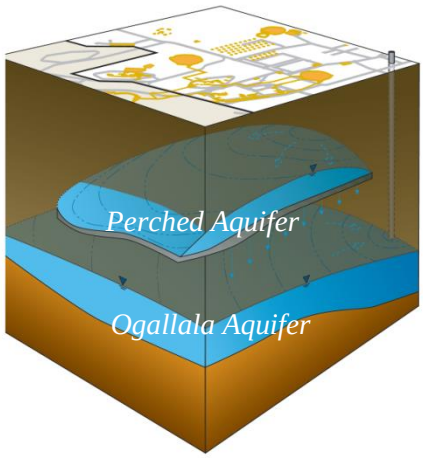


Figure 6.1 – Groundwater Beneath Pantex

The second water-bearing zone, the Ogallala Aquifer, is located below the fine-grained zone in the Ogallala and Dockum Formations. The Ogallala Aquifer is a primary drinking and irrigation water source for most of the High Plains. The groundwater surface of the Ogallala Aquifer beneath Pantex Plant 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 Plant and approximately 250 to 400 ft. in the northern regions. At Pantex Plant, 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 Plant.

Historical operations at Pantex Plant resulted in contamination of the larger perched groundwater area. The contaminant plume has migrated past Pantex Plant boundaries and beneath the adjacent property to the south and east. Most of the impacted property to the east was purchased in 2008 to allow better access for monitoring and control of perched groundwater. The primary contaminates of concern (COCs) in the perched aquifer are the explosives RDX and TNT and related breakdown products, perchlorate, hexavalent chromium, and trichloroethene (Figure 6.2). With the exception of one domestic well north of Pantex Plant, no public or private water supply wells are completed in the perched groundwater in the immediate vicinity of Pantex Plant. The domestic well north of Pantex Plant is in an area that has not been impacted by historic operations.

Perched groundwater is not used for industrial purposes at Pantex Plant; however, the treated perched groundwater is routed through the Wastewater Treatment Facility (WWTF) and is beneficially used for subsurface irrigation of crops. Because concentrations of contaminants in the perched groundwater beneath Pantex Plant'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 Plant restricts on-site use of perched groundwater. TTU and one off-site property owner to the east have placed a deed restriction on their property 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 Plant is currently working with off-site landowners to the southeast to gain agreements for cleanup and ensure water use is restricted.

6.2 LONG-TERM MONITORING (LTM) 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 the highlight box below.

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

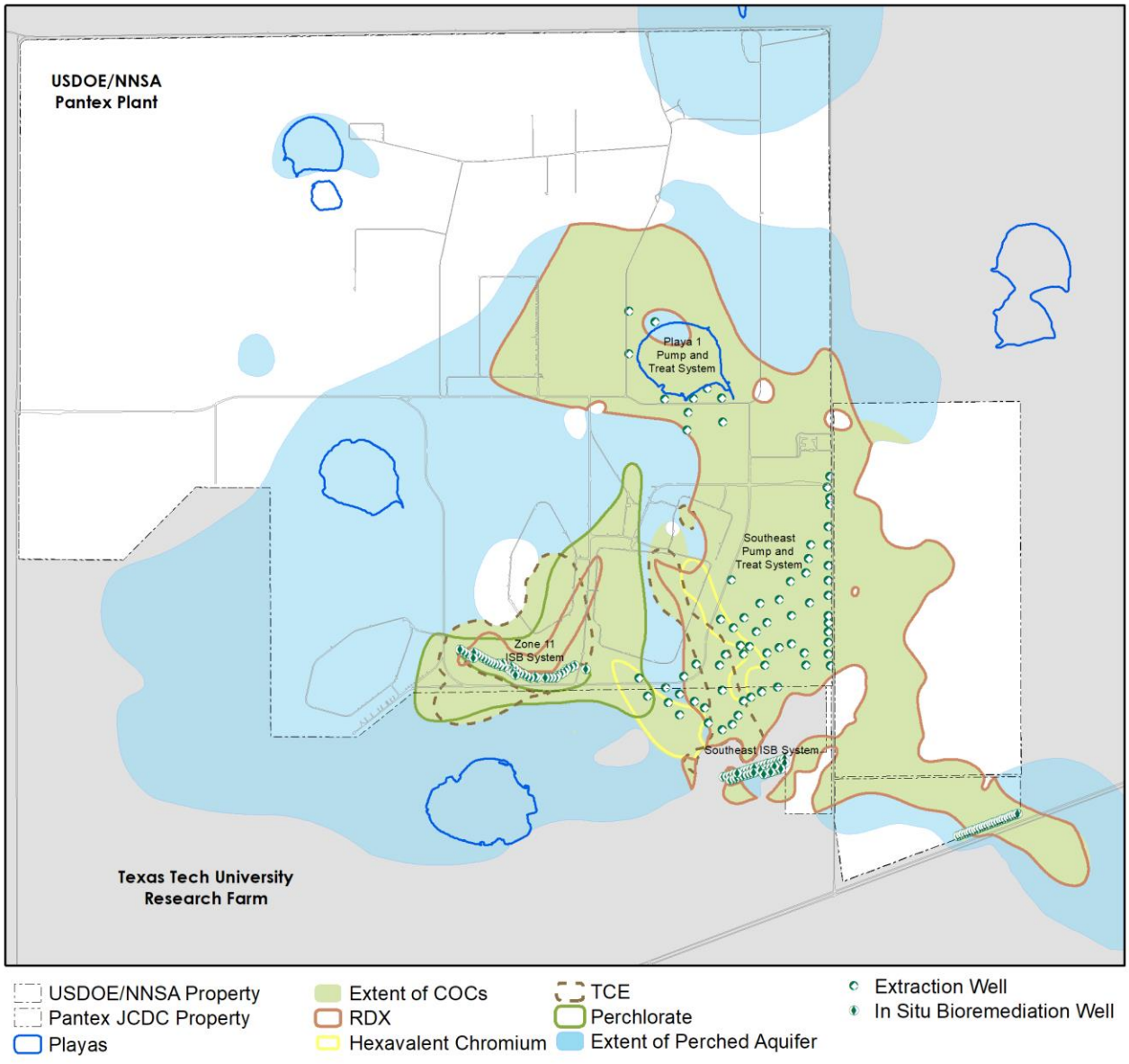


Figure 6.2 – Major Perched Groundwater Plumes and Remediation Systems

To ensure the achievement of the RAOs, wells and monitoring information were chosen with respect to specific objectives developed for the LTM network. The objectives are applied to perched and drinking water aquifer wells, as appropriate. Pantex Plant developed an *LTM System Design Report* (PANTEXg) and a *Sampling and Analysis Plan* (*SAP*) (PANTEXh) to detail the LTM network and monitoring. The network monitoring information is evaluated quarterly, annually, and on a five-year basis. Evaluations increase in detail and complexity for each type of report.

6.3 THE SCOPE OF THE GROUNDWATER MONITORING PROGRAM

Groundwater is monitored at Pantex Plant in accordance with requirements of the Texas Commission on Environmental Quality (TCEQ) HW-50284 (TCEQa). Pantex Plant is also subject to requirements in the Interagency Agreement (IAG), signed jointly by the EPA and TCEQ, and issued effective in 2008. The *LTM 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 *LTM System Design Report* and revised *SAP* were submitted to and approved by the TCEQ and EPA in 2014. Table 6.1 summarizes the number of wells sampled in 2019 that were used in the monitoring of the remedial actions and the total number of analytes assessed.

Table 6.1 – Summary of Well Monitoring in 2019

Well Type	Drinking Water Aquifer		Perched Groundwater	
	# Wells	# Analytes Assessed	# Wells	# Analytes Assessed
Long-Term Monitoring Well	24	1,341	100	6,861
Other Wells	4	113	1	44
Pump & Treat Extraction Well	--	--	61	1,090
ISB Treatment Zone Monitoring Wells	--	--	25	2,476
Total	28	1,454	187	10,436

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 remedial action objectives 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 over time indicators of the reduction in volume, toxicity, and mobility of constituents will be observed. 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 are designed to remove and treat perched groundwater, provide hydraulic control of plume movement away from Pantex, and reduce saturated thickness in the perched 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 reuse the treated water for beneficial use. The

Southeast Pump and Treat System (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 emphasizes beneficial use of water. Pantex Plant has focused on beneficial use of the treated water, to the extent possible, since the subsurface irrigation system operation began in May 2005.

The pump and treat systems' operation and throughput were variable in 2019. The Playa 1 Pump and Treat System (P1PTS) annual average operation was approximately 35 percent, which was heavily affected by the break at the irrigation filter bank that occurred in 2017. The SEPTS annual average operation in 2019 was 97 percent with system operation affected by shutdown to tie in new wells and various maintenance requirements. Partial repairs to the filter bank were completed in May 2019, with startup testing occurring afterward. A portion of the system is expected to be operational by the summer of 2020. Currently, Pantex Plant continues to release all WWTF wastewater to Playa 1. The flow to Playa 1 is restricted by permit, so flow from the systems must also be restricted until the irrigation system is operational.

The SEPTS system has operated at a higher capacity using injection, release to Playa 1, and intermittent shutdowns of the P1PTS to allow full treatment at the system. SEPTS operations focus on removing water in high priority locations that help control migration of the plume to the southeast. New extraction wells were drilled east of FM 2373 to provide additional control of plume movement. Pantex Plant has completed tie-in of the new extraction wells east of FM 2373 to SEPTS in April 2019, with full operation of the wells beginning in July 2019. 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.

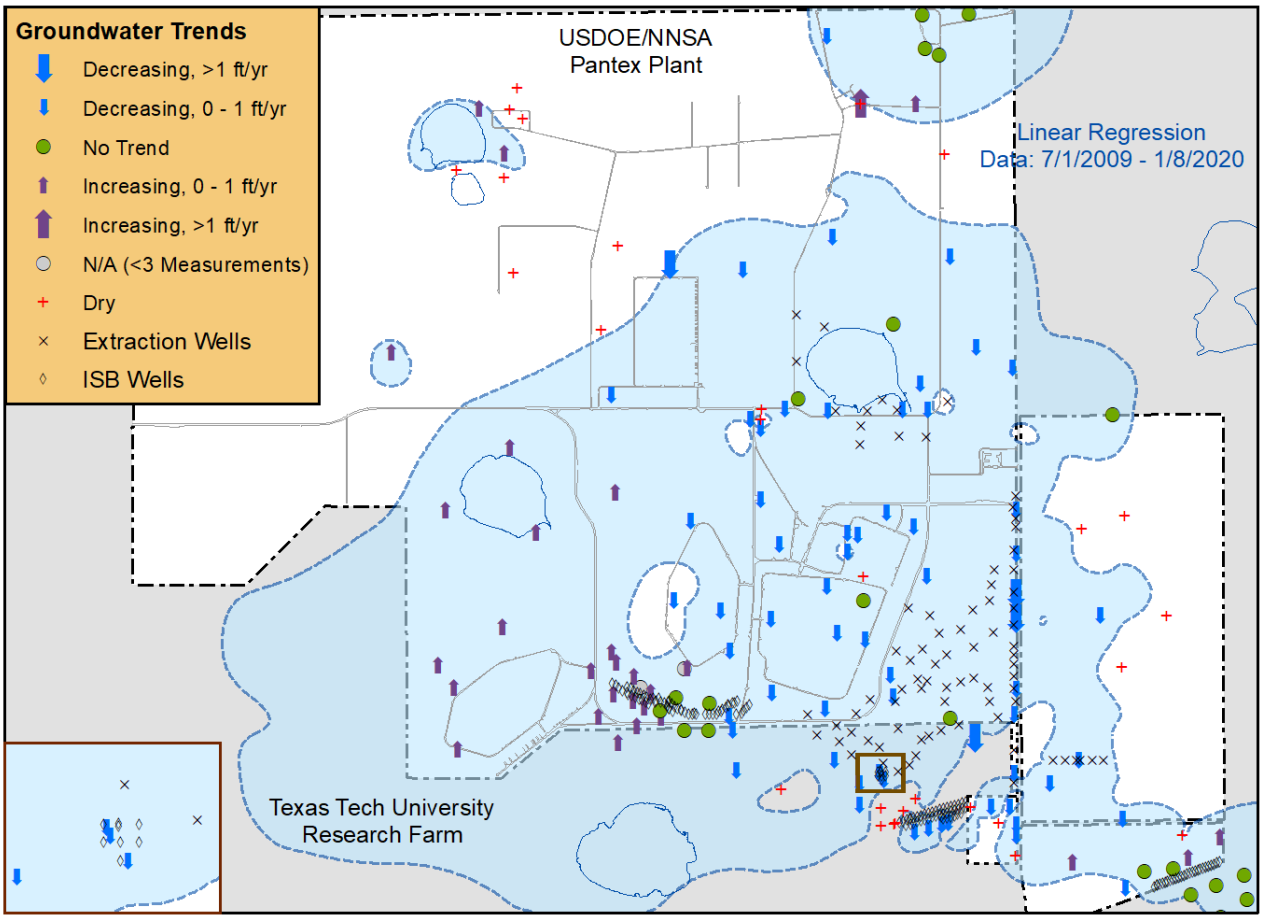


Figure 6.3 – Water Level Trends in the Perched Aquifer

RDX concentration trends since the start of remedial action in July 2009, depicted in Figure 6.4, generally indicate that RDX is decreasing or does not demonstrate a trend at the source areas (Playa 1 and the ditch along the eastern side of Zone 12). 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. To the southeast, only one (PTX06-1153) of the five wells indicating a long-term increasing trend currently exhibits an increasing trend based on recent data. PTX06-1153 is the only well downgradient of the Southeast ISB System that is not indicating effective treatment. Pantex Plant continues to evaluate conditions in the area of this well; further recommendations will be made based on evaluation of data over time.

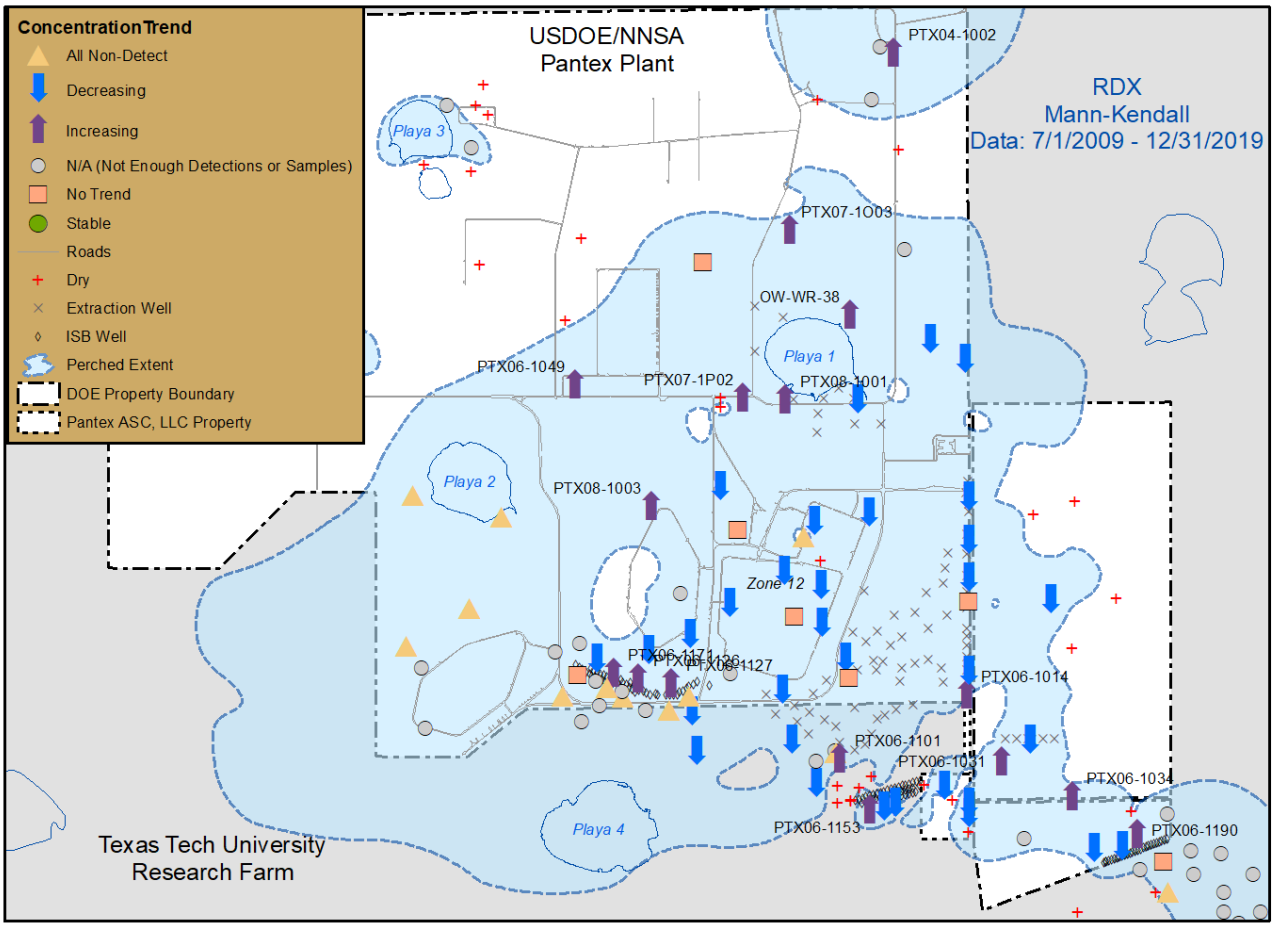
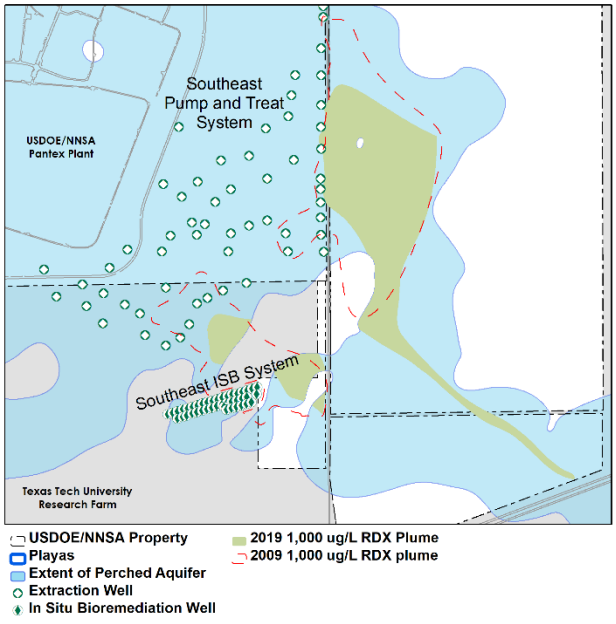
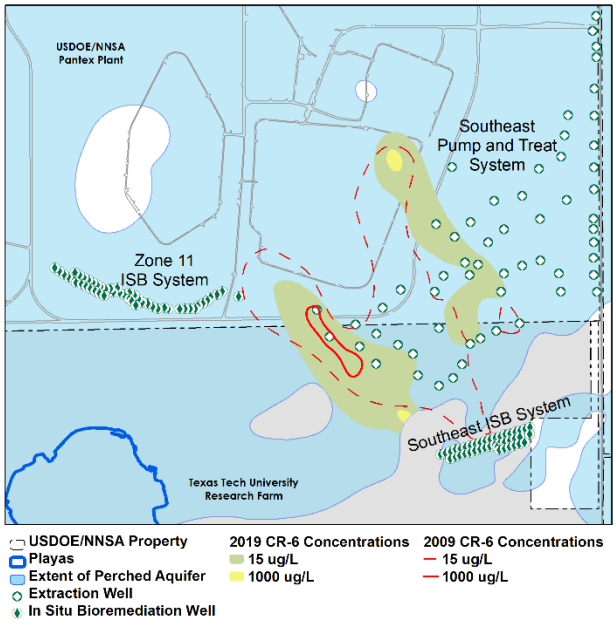


Figure 6.4 – RDX Concentration Trends in the Perched Aquifer

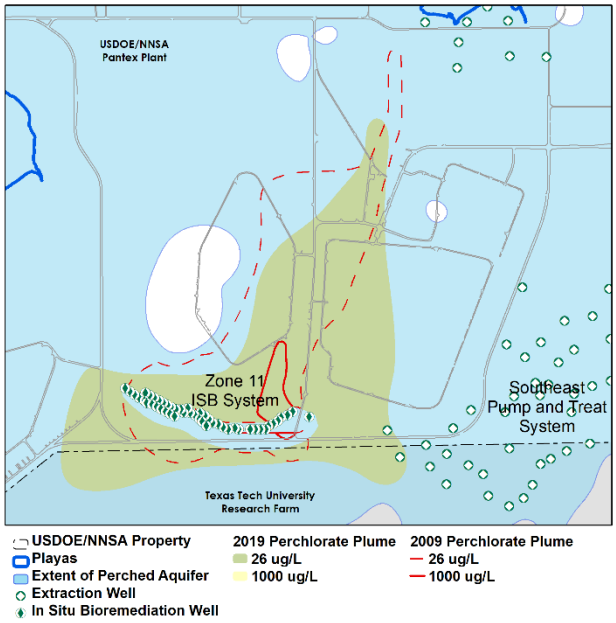
Concentration trends for the remaining major COCs (perchlorate, TCE, and hexavalent chromium) are discussed in the 2019 Annual Progress Report. Figure 6.5 shows plume movement in perched groundwater of major COCs for the time period of 2009 to 2019. Figure 6.6 shows the annual maximum concentrations of the major COCs observed in the perched aquifer since 2009. Continued declining trends are demonstrated for TCE and hexavalent chromium through 2019. However, perchlorate and RDX both showed an increase in annual maximum concentrations in 2019. The perchlorate increase is associated with plume movement in the area southwest of Zone 11, while increase in RDX is associated with plume movement towards the southeast. Areas outside the influence of the remedial action systems are also



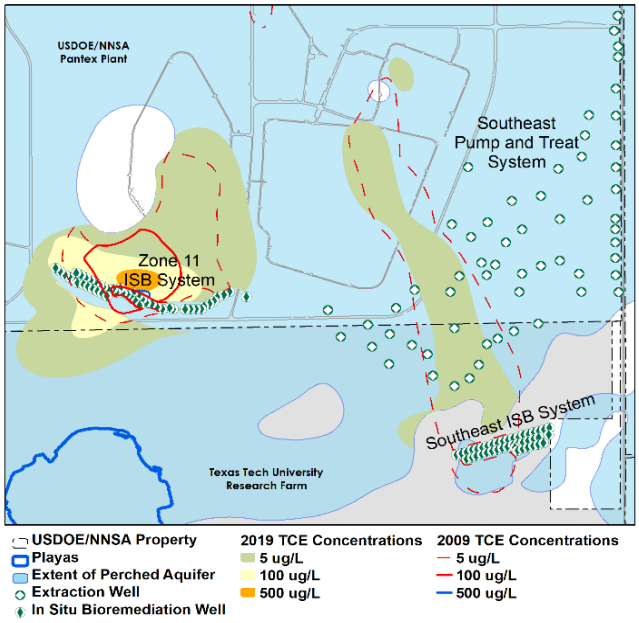
RDX Plumes



Hexavalent Chromium Plume



Perchlorate Plume



TCE Plume

Figure 6.5 – 2009 - 2019 Plume Movement – Perchlorate, Hexavalent Chromium, RDX, and TCE in the Perched Aquifer

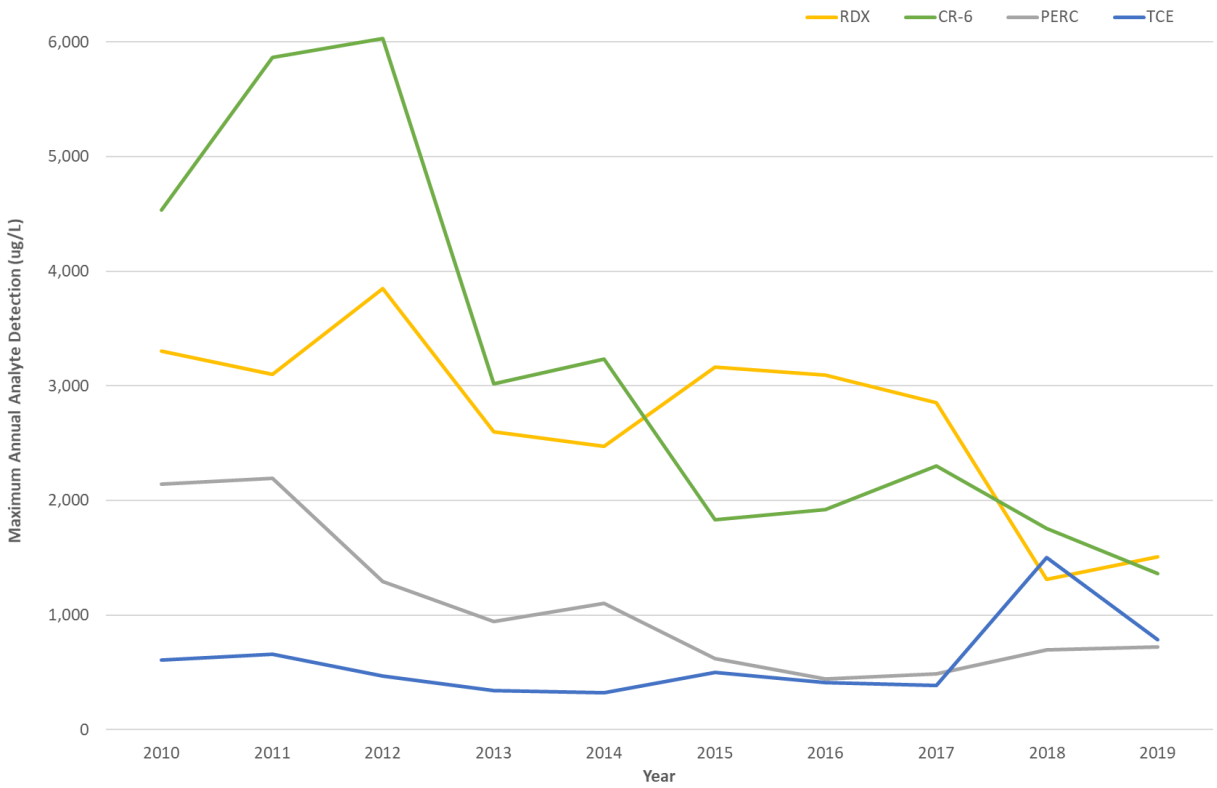


Figure 6.6 – Annual Maximum Concentration Trends in the Perched Aquifer

monitored for high explosives (HEs) and TCE breakdown products to gather data regarding natural attenuation and will be evaluated over time to attempt to estimate the rate of these processes.

6.4.2 In-Situ Bioremediation Systems

The ISB systems treat the impacted groundwater as it moves through the bioremediation zone with the goal of reducing concentrations below the Groundwater Protection Standard (GWPS) established in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) ROD. 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.

Three ISB systems (Zone 11 ISB, Southeast ISB, and Southeast ISB Extension) are installed at Pantex Plant. Overall, the Zone 11 and Southeast ISB have been effective in treating the primary COCs: RDX, hexavalent chromium, TCE, and perchlorate. Pantex Plant 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 and downgradient indicate that a reducing zone has been established at all ISB systems. The mild to strong reducing conditions found are expected for each ISB treatment zone. However, stronger reducing conditions may be required for the complete breakdown of TCE at the Zone 11 ISB.

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 Plant 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. In addition, 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 after the 2019 injection event.

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 continue to trend downward in downgradient wells.

The Southeast ISB Extension was installed in 2017 as an extension for remediation for the southeast-perched groundwater. Two injection events were completed for this system in 2019, with the latest injection completed in September 2019. Wells sampled within the treatment zone indicate that HEs are treated below the GWPS. Downgradient wells did not demonstrate treatment during 2019, but are expected to demonstrate treatment within one to two years after the first injection.

6.5 UNCERTAINTY MANAGEMENT AND EARLY DETECTION

Because the evaluation of uncertainty management and early detection well types is similar, they are evaluated together for unexpected conditions. The purpose of uncertainty management wells in perched groundwater is to confirm expected conditions identified in the Resource Conservation and Recovery Act (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.

Figure 6.7 depicts the perched and Ogallala aquifer wells used in this evaluation for 2019. Pantex Plant monitors for the most widespread and leachable contaminants at the uncertainty management and early detection wells. The monitoring lists for these wells are included in the *SAP* (PANTEXh) and consist of all HEs found in perched groundwater, degradation products of RDX, 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 stable or declining as expected in wells monitored for uncertainty management in 2019, with one exception. PTX04-1002 saw a probable increasing trend in RDX that is unrelated to a release from new source contamination. At this time, no action is required because current measured values are below the practical quantitation limit (PQL) for RDX. Other wells downgradient of source sites show plume movement from previous source areas but no new sources have been detected.

New perched groundwater wells installed outside the previously defined extent of the southeast lobe of the perched aquifer indicates that water and contamination have migrated further to the southeast. Results indicate the presence of the HEs 4-amino-2,6-DNT and RDX at concentrations exceeding the PQL and GWPS (up to 8.6 and 1,280 µg/L and GWPS of 1.2 and 2 µg/L, respectively). Movement of the plumes in this area appears to be associated with faster groundwater flow paths along channel-type features along the top of the FGZ.

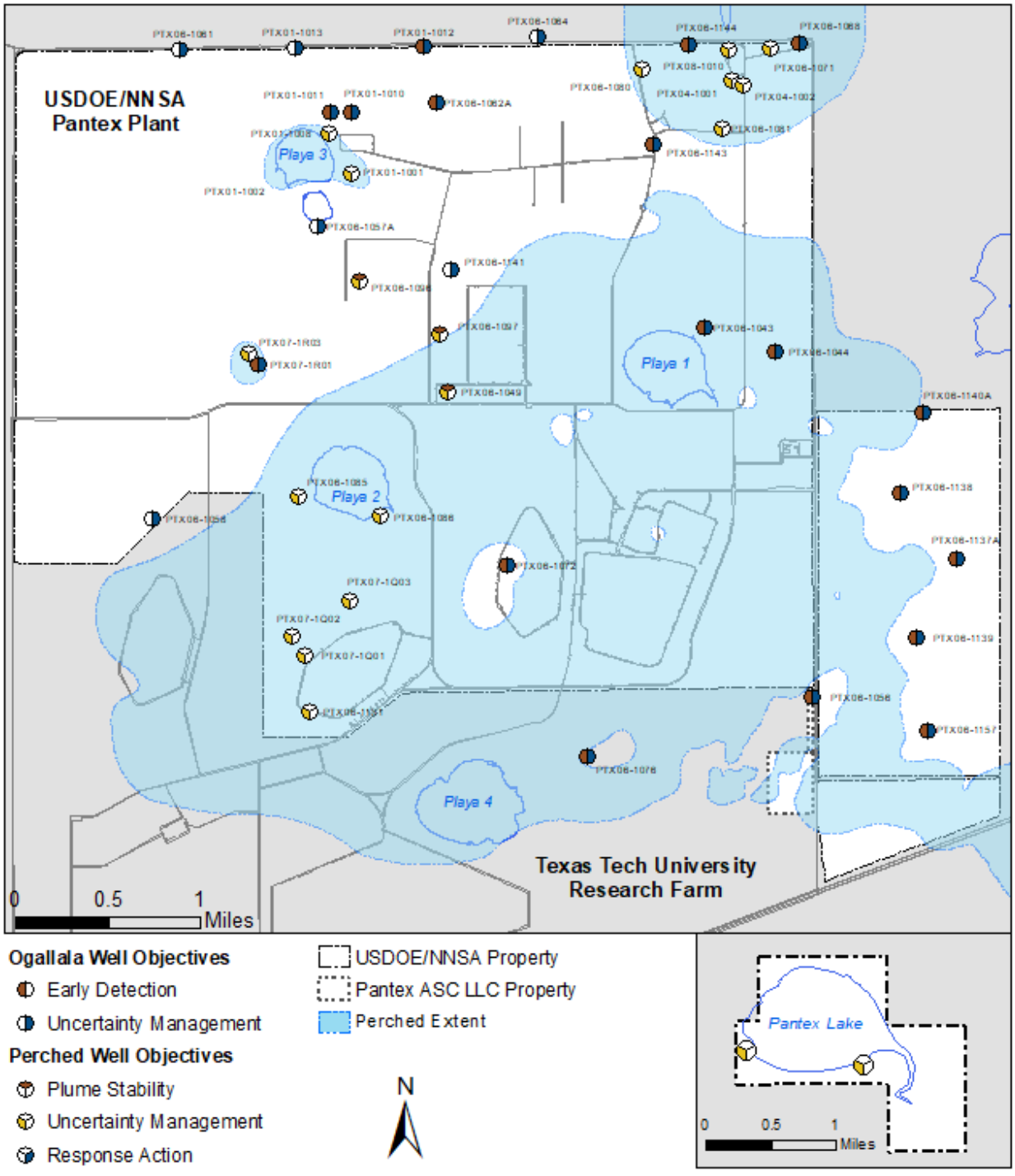


Figure 6.7 – Uncertainty Management and Early Detection Wells

Pantex Plant completed an electromagnetic geophysical study to attempt to identify the area with faster flow paths in the groundwater to assist in identifying the extent of contamination. The study indicated the possibility of channels extending through the ISB area with one primary channel leading off-site to the south and southwest. Following the results of the study, Pantex Plant drilled six new wells on the property to the south. Data from one well drilled in the area of the identified channel did not confirm the presence of water as proposed by the electromagnetic survey results. However, sampling of the newly installed wells indicates that the extent of HE contamination in this area of perched groundwater has been identified. With the identification of a potential preferential groundwater path, Pantex Plant updated the perched groundwater conceptual site model and fate and transport model. With the updated fate and transport models, a conceptual design for remedial action to address the off-site contamination has been implemented. Pantex Plant is recommending the installation of a new off-site ISB and pump and treat systems to clean up the southeastern plume.

6.5.2 Ogallala Aquifer Uncertainty Management and Early Detection

Unexpected conditions in the Ogallala Aquifer primarily involve detections of organic constituents at one well, PTX06-1056. While boron and hexavalent chromium were also detected in Ogallala wells, these detections are related to background fluctuations or corrosion. Other corrosion indicator metals were also detected in Ogallala wells above background. However, these detections are expected because of the use of stainless steel in Ogallala well construction. No detections exceeded the GWPS in the Ogallala Aquifer uncertainty management wells sampled during 2019.

PTX06-1056 continues to demonstrate detections of 4-amino-2,6-dinitrotoluene (DNT4A), a breakdown product of the HE 2,4,6-trinitrotoluene (TNT), and 1,2-dichloroethane, as shown in Figure 6.8. DNT4A was first detected in April 2014, and sample results collected since that time have been variable with a few values slightly exceeding the PQL. All values slightly exceeded the PQL in samples collected in 2019. 1,2-Dichloroethane has been variably detected since August 2015 but was not detected above the PQL in 2019. All detections were below the GWPS indicating that the water is still protective of human health.

Pantex Plant has proactively evaluated potential sources for the contamination and has plugged a nearby perched well that was drilled deeply into the FGZ to address that potential source. An external independent review indicated that the perched well was the most likely source of the contamination, based on fate and transport modeling. A cement bond log was used to evaluate the competency of the concrete seal at the FGZ and indicated that the seal is competent. Therefore, PTX06-1056 is not likely acting as a preferential pathway for contamination to reach the Ogallala Aquifer. As agreed with regulatory agencies, Pantex Plant will continue to monitor this Ogallala well quarterly to determine if a trend emerges, and will determine if further steps are necessary for the protection of the Ogallala Aquifer. Further actions will be determined based on results of sampling and in accordance with the *Ogallala Aquifer and Perched Groundwater Contingency Plan* (PANTEXi).

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 Plant to help determine where natural attenuation is occurring, under what conditions it is occurring, and to eventually determine rates of attenuation for various constituents.

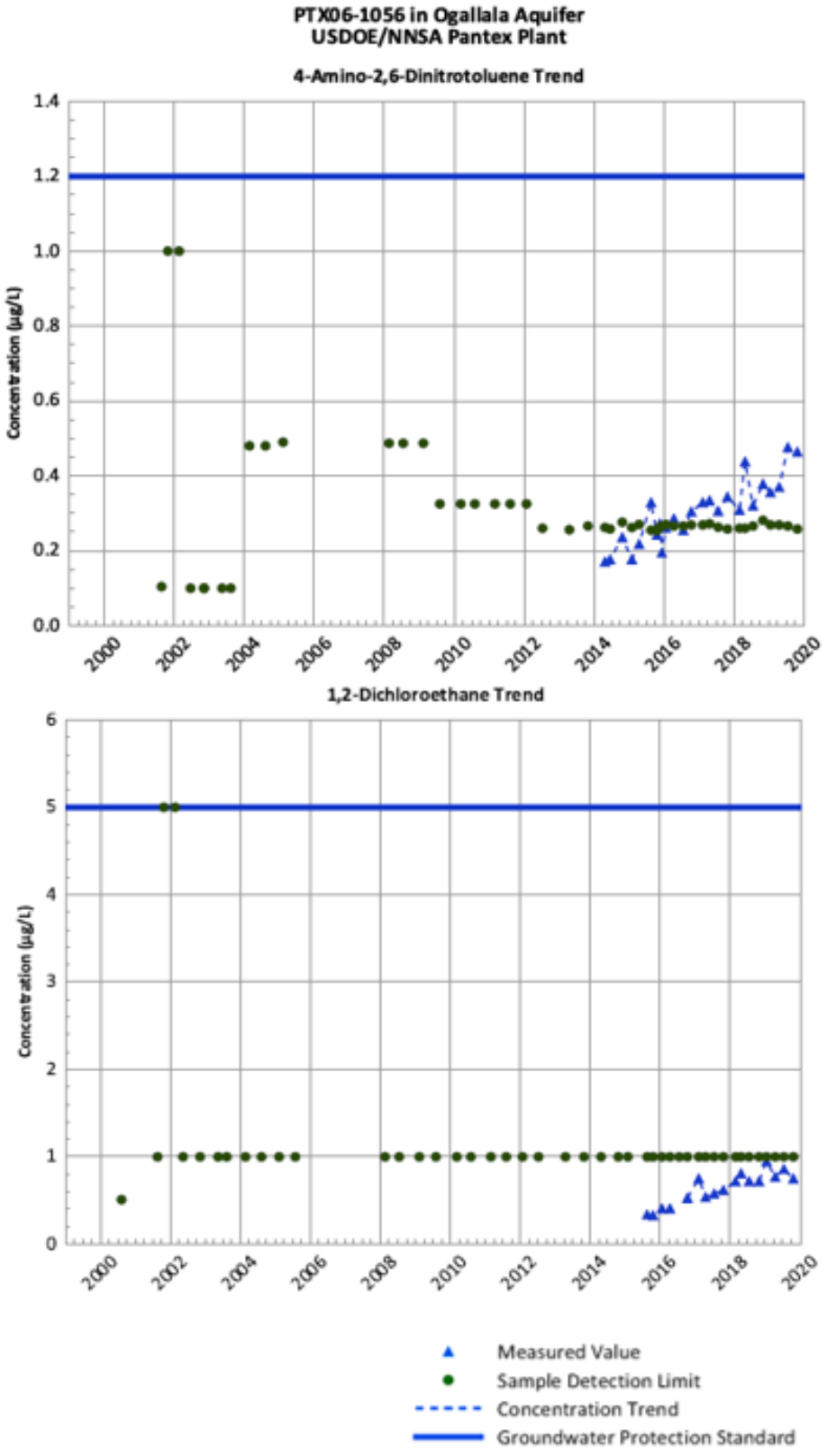


Figure 6.8 – Summary of Unexpected Conditions in Ogallala Aquifer Well PTX06-1056

Pantex Plant 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 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 Plant 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 are recently showing a decreasing or stable trend.

Perched groundwater sampling results for RDX and breakdown products (MNX, DNX, and 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, 2004). 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 TNX plume is similar in size and in extent to the RDX plume, but at much lower concentrations. Pantex Plant contracted for a project to evaluate lines of evidence for natural attenuation of RDX at Pantex Plant. 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 five 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 Plant 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 has started degrading in the Zone 11 ISB treatment zone. The SEPTS and the ISB treatment zones are actively treating the TCE plumes at Pantex Plant.

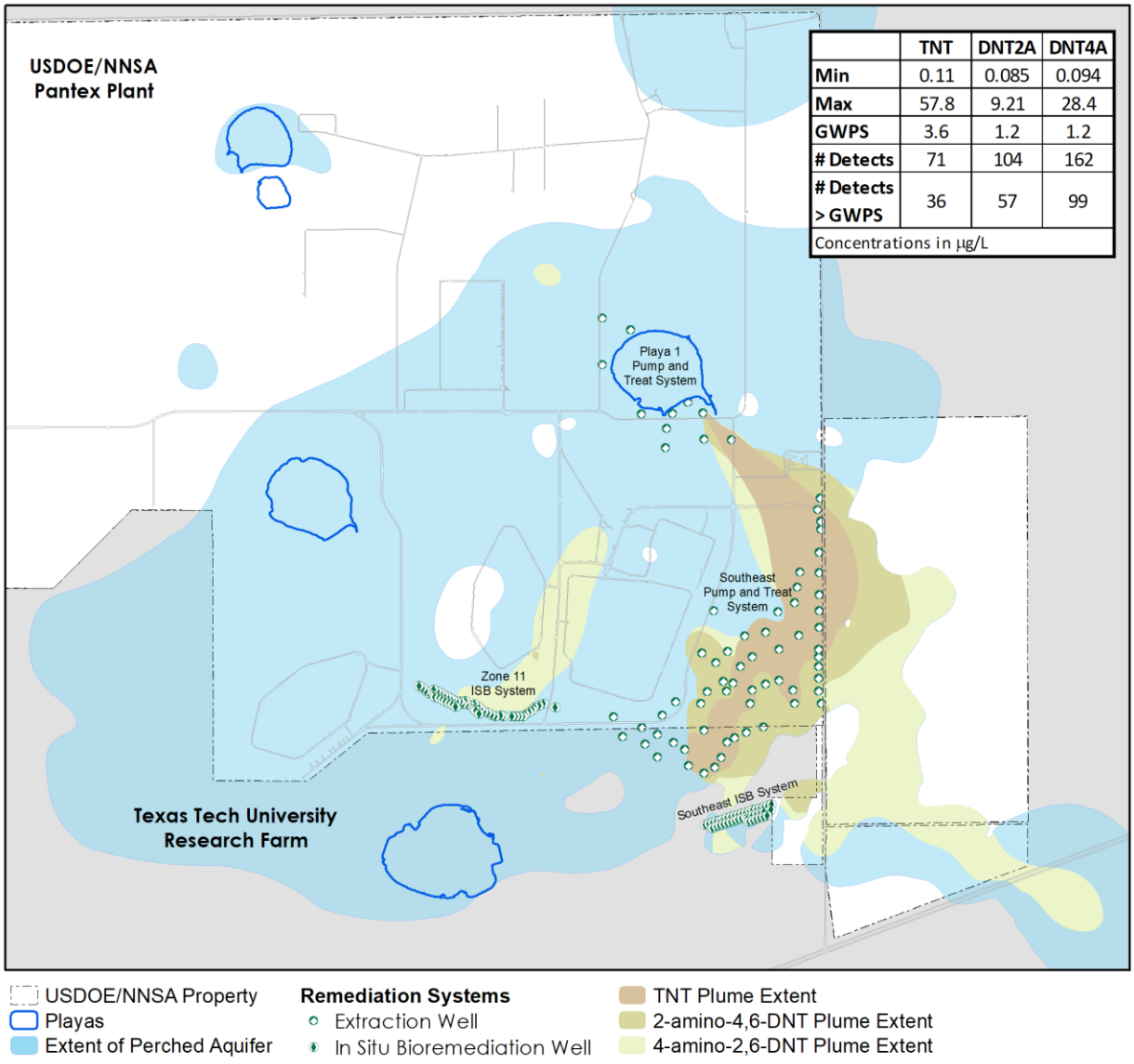


Figure 6.9 – TNT and Degradation Product Plumes

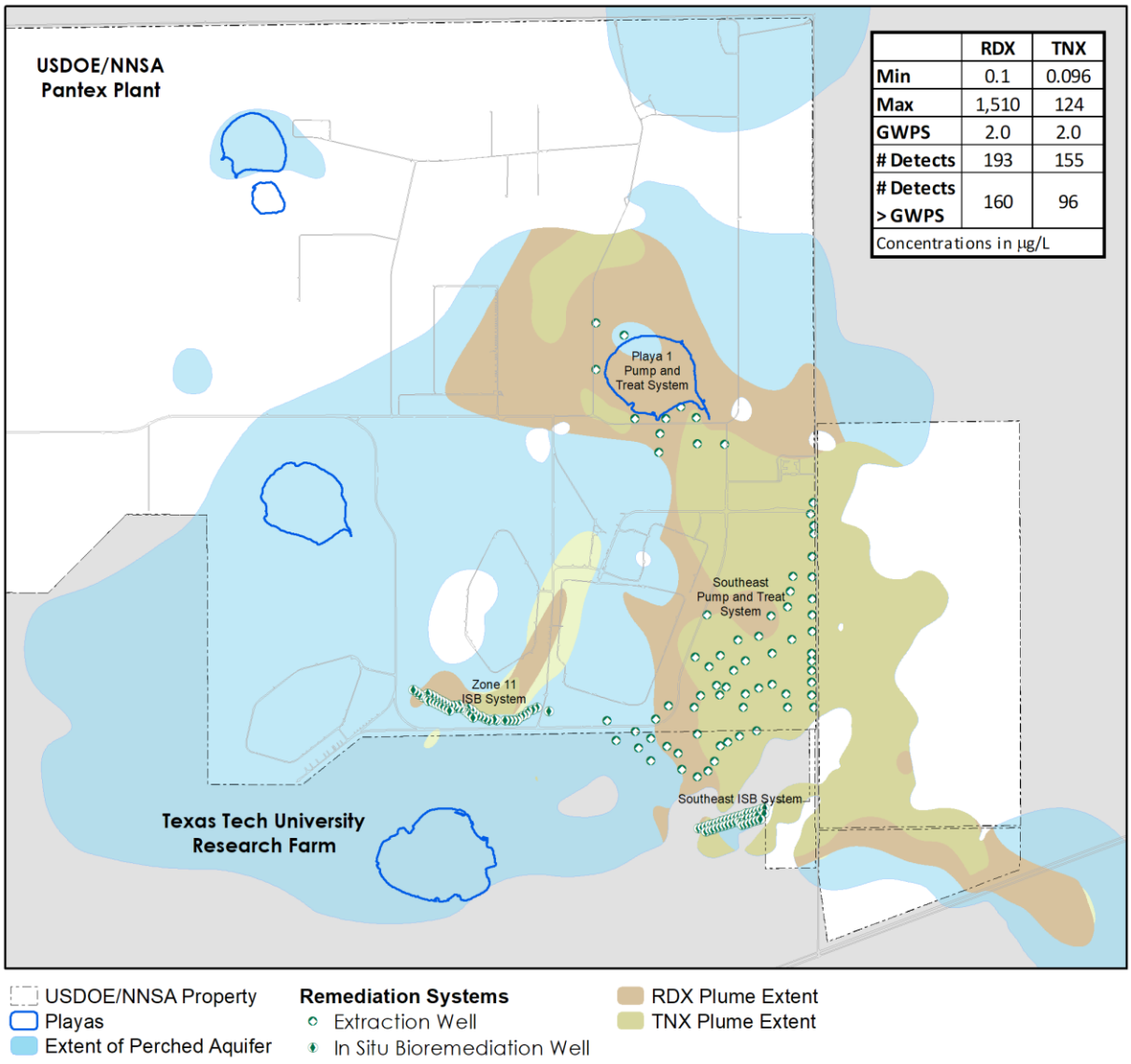


Figure 6.10 – RDX and Degradation Product Plume

6.7 CONCLUSIONS

Overall, the groundwater remedial actions continued to be effective in 2019. 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 WWTF water. 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.

New perched groundwater wells installed outside the previously defined extent of the southeast lobe of the perched aquifer indicate that water and contamination have migrated further to the southeast and to off-site property. With the identification of a preferential pathway, Pantex Plant is recommending the installation of a system to address the migration of the southeast plume.

One Ogallala Aquifer well had continued COC detections slightly above the laboratory PQL, but below the GWPS, indicating possible migration of perched groundwater to the Ogallala Aquifer. In response to these detections, Pantex Plant has fully implemented the conditions specified in Pantex Plant *Ogallala Aquifer and Perched Groundwater Contingency Plan* (PANTEXi). It will continue sampling in accordance with the approved *SAP* (PANTEXh) for HEs and volatile organic compounds at this well. Pantex Plant has proactively evaluated potential sources for the contamination and plugged a nearby well that may have served as a migration pathway for perched groundwater.

Pantex Plant evaluated lines of evidence for natural attenuation of RDX at the Plant. 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 Plant's drinking water system (State of Texas Public Water System I.D. No. 0330007) is considered a non-transient, non-community public water system (PWS) under the Safe Drinking Water Act (SDWA) regulations. The Environmental Protection Agency (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 consumes water supplied by such systems daily over long periods.

Chapter Highlights

- There was an increase of four million gallons (gal) produced/pumped from the Ogallala Aquifer.
- The discharge of treated wastewater an on-site playa lake has continued through 2019 due to the system failure associated with the subsurface fluid distribution system.
- Results from the routine drinking water compliance monitoring in 2019 confirmed that the drinking water system at Pantex Plant met water quality regulatory requirements.
- All analytical results for bacteria, chemical compounds, and disinfection by-products were below regulatory limits, and adequate levels of disinfectant were maintained in the distribution system.
- The Pantex PWS continues to be recognized by the Texas Commission on Environmental Quality (TCEQ) as a "Superior" supply system.

7.1 DRINKING WATER AT PANTEX PLANT

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

Samples from the drinking water system are collected and analyzed monthly for biological contaminants. The drinking water system is also sampled annually and triennially for various chemical contaminants as required by the SDWA and its implementing regulations (Title 40 of the Code of Federal Regulations (CFR), Chapter 141 and 143, and Title 30 of the Texas Administrative Code (TAC), Chapter 290). Analytical results 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

There were no new regulatory requirements or changes implemented in 2019.

7.3 WATER PRODUCTION AND USE

During 2019, Pantex Plant produced/pumped approximately 115 million gal of water from the Ogallala Aquifer. This was an increase of four million gal compared to water produced in 2018.

Pantex Plant 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. Typically, Pantex Plant beneficially reuses 100 percent of its treated wastewater to grow crops in the northeast portion of the Plant. Pantex Plant environmental compliance personnel continue to investigate other reuse opportunities. In July 2017, Pantex Plant began discharging treated wastewater to an on-site playa lake due to a system failure associated with the subsurface fluid distribution system. Surface discharge has continued throughout 2019. Efforts are underway to restore the beneficial reuse of treated wastewater.

7.4 SAMPLING

Pantex Plant collected routine drinking water samples at 11 locations. Nine 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 Plant coverage. The sampling locations are representative of drinking water at Pantex Plant and are listed in Table 7.1.

Table 7.1 – Drinking Water Sampling Locations, 2019

DESCRIPTION	LOCATION
Chemical & Water Quality Monitoring	Building 15-27 (Entry Point to the Distribution System) Building 16-12 (TTHM2 site[28])
Biological and Disinfectant Level Monitoring	Building 12-103 Building 18-1 Building 12-6 Building 16-12 Building 12-70 Building 11-2 Building 15-27 Building 16-1 Building 10-9

7.5 RESULTS

In 2019, the TCEQ sampled the water system at Pantex Plant. Results for this drinking water sampling were within regulatory limits for chlorine (disinfectant) and below regulatory limits for disinfection byproducts, microbial contaminants, inorganic contaminants, nitrate, pesticides, and volatile organic compounds (VOCs). Appendix B shows the water quality results from the Pantex Plant water system as measured by the TCEQ.

7.5.1 Inorganic Contaminants

Monitoring for inorganic contaminants in the PWS is required under the SDWA and the TAC. 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

[28] The TTHM2 site is the location within the distribution system with the potential for high disinfection byproducts (Total Trihalomethanes {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.

amounts greater than the drinking water standard set by the EPA. All inorganic contaminant results from monitoring conducted in 2019 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 2019, all microbial sample results were negative for coliform and E. coli bacteria.

7.5.3 Radiological Monitoring

Radiological monitoring is not required for the non-transient, non-community public water supply at Pantex Plant. During 2019, no radiological monitoring was conducted.

7.5.4 Disinfection By-Products

All drinking water at Pantex Plant 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 byproducts. All PWSs where chlorine is used are required to maintain residual levels between 0.2 and 4.0 milligrams per liter (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, bromo-dichloromethane, and bromoform concentrations in milligrams per liter. Haloacetic acids are reported as the sum of the monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid concentrations in milligrams per liter. All tests for DBPs were at or below SDWA maximum contaminant levels (MCLs).

7.5.5 Water Quality Parameters

Water quality parameter testing was conducted in 2019. Testing included constituents such as metals. Typically, detection of these constituents does not indicate that the water is unsafe to drink; rather they may have aesthetic effects on the water such as salty tasting water.

7.5.6 Synthetic Organic Contaminants

Synthetic organic chemicals (SOCs) 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. The TCEQ did not monitor the water system for SOCs during 2019.

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 did monitor the water system for VOCs during 2019. 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 corrosivity of the water. Pantex Plant is on a triennial monitoring schedule for lead and copper. Compliance monitoring for lead and copper was conducted during 2018 and is not scheduled for sampling until 2021.

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 TCEQ did not monitor for select contaminants on the CCL during 2019.

7.6 INSPECTIONS

The TCEQ monitors the water supply in accordance with the drinking water standards. In August 2019, a TCEQ-contractor collected samples from Pantex Plant public water supply system. The report generated from that event indicated that Pantex Plant met or exceeded all requirements for operating a Public Water Supply. The TCEQ did not perform a Comprehensive Compliance Inspection of the Pantex Plant Drinking Water system in 2019.

7.7 CONCLUSIONS

All sample results were below applicable regulatory limits under the SDWA. Monitoring results demonstrate that Pantex Plant continues to provide safe drinking water while the water supply system maintains a “Superior Rating.”

Chapter 8 - Wastewater

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

Chapter Highlights

- During 2019, Pantex Plant discharged approximately 145 million gallons (gal) of treated wastewater to the on-site playa lake.
- Pantex Plant had two unauthorized discharges of untreated wastewater from the sanitary sewer system. TCEQ was notified and both instances were remediated as required.
- The discharge of treated wastewater to the on-site playa has continued due to the ongoing repairs of the subsurface irrigation system.
- Analytical results for wastewater at the permitted outfall were all within permitted limits.

8.1 WASTEWATER AT PANTEX PLANT

Domestic and industrial wastewaters generated at Pantex Plant are treated at an on-site WWTF. Industrial effluents from Pantex Plant 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 an underground irrigation system or an on-site playa lake. 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) is a clay-lined, facultative lagoon that covers approximately 3.94 acres (ac) and has a capacity of 11 million gal. In addition to the WWTF, there are two storage lagoons (Figure 8.3 and 8.4) that are utilized 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.

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, algal photosynthesis, and by solar-powered mechanical aerators. 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.

Figure 8.2 – Wastewater Treatment Facility, Facultative Lagoon

8.2 OPERATIONAL DESCRIPTION AND METRICS

During 2019, Pantex Plant had three authorizations from TCEQ for wastewater disposal. Each required analytical monitoring and periodic reporting to the TCEQ.

Under the Texas Land Application Permit (TLAP), WQ 0004397000, Pantex Plant is permitted to dispose of treated wastewater by means of a subsurface irrigation system into agricultural fields for beneficial reuse. This permit was modified and reissued on April 5, 2012, and will expire on December 1, 2020. 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 (ac) in size.

Figure 8.3 – East Wastewater Storage Lagoon

Figure 8.4 – Wastewater Storage Lagoon

The irrigation area consists of agricultural land owned by the Department of Energy and farmed by Texas Tech University (TTU). Crops grown in this area may include winter wheat, sorghum, soybeans, cotton, corn, oats, and opportunity wheat. Crops will vary from field to field, depending on the cropping needs of TTU. The subsurface irrigation system was not utilized during 2019 due to ongoing repairs. However, two of the four tracts were planted as dry land crops with winter wheat (Figure 8.5).

Figure 8.5 – Irrigation Tract 101

During periods when the agricultural fields are fallow, Pantex Plant is authorized to apply limited quantities of wastewater to the irrigation area under Underground Injection Control (UIC) Authorization 5W2000017. There is no expiration date on this authorization.

Finally, Pantex Plant maintains a Texas Water Quality Permit (TWQP), WQ0002296000, which allows for the discharge of treated wastewater to an on-site playa. This permit was renewed by the TCEQ on August 10, 2016 and will expire on December 1, 2020. Through compliance with these three authorizations, Pantex Plant manages and discharges treated effluent in a manner that is beneficial to the environment.

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 done 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.

8.4 ANALYTICAL RESULTS

During 2019, Pantex Plant discharged approximately 145 million gal of treated wastewater through Outfall 001A. Water quality results through this outfall are shown in Table 8.1.

Table 8.1 – Water Quality Results from Outfall 001A, 2019

Analyte	Maximum Discharge Limits[a] (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detected Concentration (mg/L)	Permit Exceedance/ Violation[b]	Percent Compliance
Copper	1.0	0.004	0.010	0/0	100
Manganese	2.0	0.005	0.013	0/0	100
Zinc	2.0	0.003	0.021	0/0	100
HMX	Report	<0.001	<0.001	0/0	100
RDX	Report	<0.001	<0.001	0/0	100
PETN	Report	<0.001	<0.001	0/0	100
TNT	Report	<0.001	<0.001	0/0	100
BOD	70	2.7	16.4	0/0	100
COD	150	16.7	102	0/0	100
TSS	90	1.3	41.6	0/0	100
Oil/Grease	15	2.6	7.2	0/0	100
pH[c]	6.0 Min. 10.0 Max.	6.5	9.2	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.

8.5 PERMIT VIOLATIONS

During 2019, Pantex Plant had two unauthorized discharges of untreated wastewater from the sanitary sewer system. An unauthorized discharge is defined as either a discharge of untreated wastewater prior to treatment or a discharge to the environment at any location other than through a permitted outfall. In both instances, actions were taken to remediate the areas of concern and notification was submitted to TCEQ.

8.6 CONCLUSIONS

At Outfall 001A, the 2019 results for explosives, metals, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), and oil/grease were all within expected ranges and did not exceed permit limits. The values are consistent with the previous year. Discharges to the on-site playa had not occurred in over 10 years prior to 2017. As such, no long-term comparisons could be made.

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Chapter 9 - Surface Water

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

CHAPTER HIGHLIGHTS

- Data from the surface water program collected during 2019 was consistent with historical data from past monitoring activities, indicating that operations at Pantex Plant did not adversely affect the environment.
- No significant changes were made to the surface water-sampling program during calendar year 2019.

9.1 SURFACE WATER AT PANTEX PLANT

Pantex Plant 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 playas 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. Playas 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 playas located on Department of Energy (DOE) owned or leased property. Two are located on property leased from Texas Tech University (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 storm water flows to off-site playas at the outer periphery of the site which are mostly a considerable distance from most Pantex Plant operations. Figure 9.1 is a map of Pantex Plant that shows the locations of the six playas with their respective drainage basins (watersheds).

Effluent from the wastewater treatment facility (WWTF) and storm water runoff from Zones 4, 12, and the northeastern portion of Zone 11 are permitted to discharge to Playa 1. Storm water runoff from the northwestern portions of Zone 11 is channeled to Playa 2 via a ditch system. Storm water runoff from the Burning Ground flows, primarily as sheet-flow, into Playa 3. Storm water runoff from the southern portions of Zones 10, 11, and 12 discharge into Playa 4 on TTU property. There are no discharges from Pantex Plant 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 storm water runoff from surrounding pastures and agricultural operations.

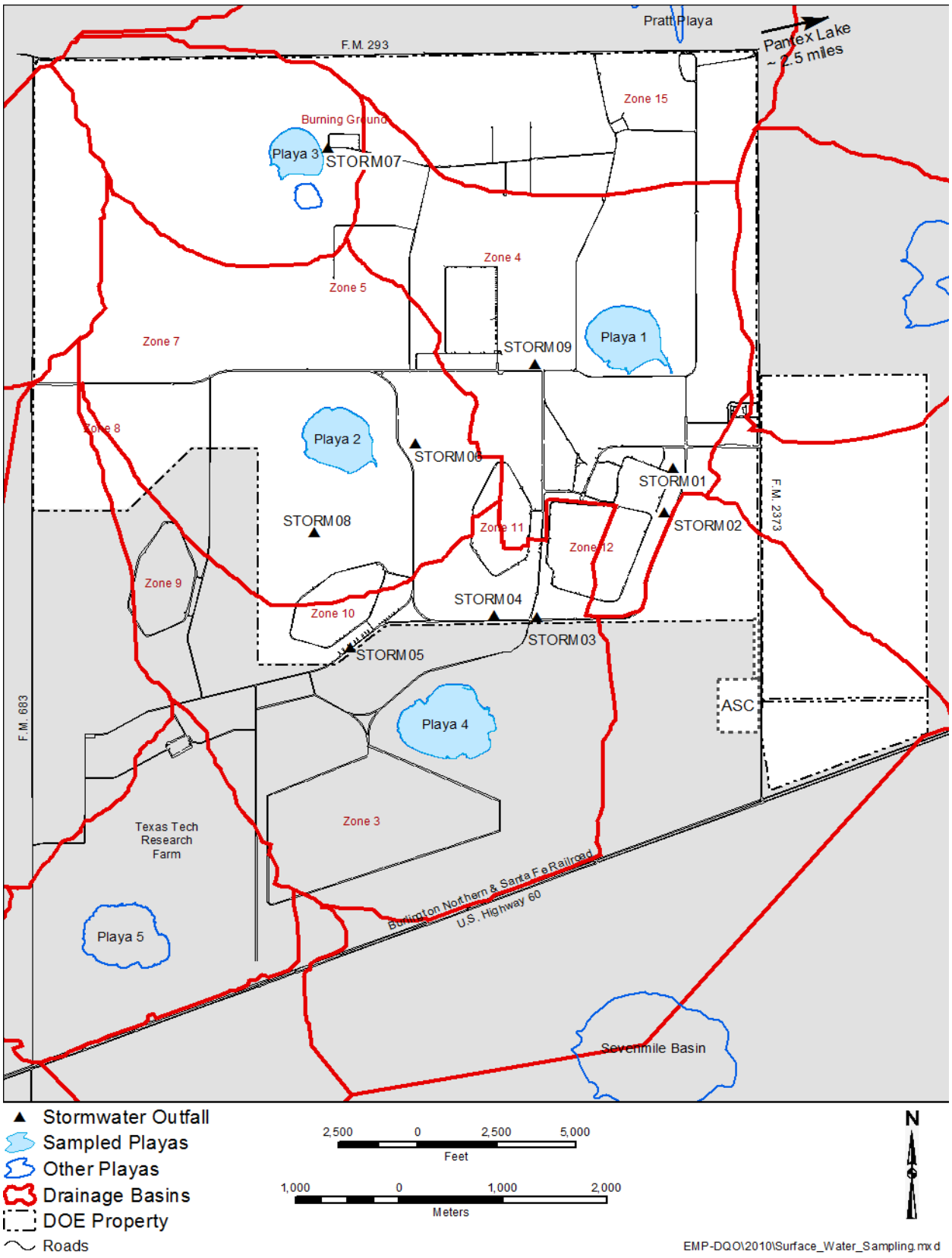

Figure 9.1 – Drainage Basins, Playas, and Storm Water Outfalls at Pantex Plant

9.2 SAMPLING LOCATIONS AND MONITORING RESULTS

Surface water sampling occurs in response to precipitation or discharge events. During 2019, sampling was conducted in accordance with permits issued by the Texas Commission on Environmental Quality (TCEQ) and the Data Quality Objective documents developed by Pantex Plant media scientists. The TCEQ is the permitting authority for storm water discharges for waters in the state of Texas.

Storm water runoff at Pantex Plant is sampled in accordance with Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector General Permit (MSGP) TXR050000 for storm water. During 2019, Pantex Plant performed sampling in compliance with the MSGP that was issued in 2016. Pantex Plant filed for coverage under the MSGP on November 7, 2016. General permits are typically active for five years with the most recent MSGP expiring in August 2021. Storm water sampling locations, known as outfalls, are conveyances in which storm water accumulates and discharges. Locations have been selected based on their proximity to operational areas of Pantex Plant.

The TCEQ issued the five-year general permit, TPDES General Permit No. TXR150000, relating to storm water discharges associated with construction activities. The most recent general permit expires in March of 2023. There were four construction projects filed under the general permit in effect at Pantex Plant at the end of 2019. These permits do not require analytical monitoring, but rely on best management practices, such as storm water pollution prevention plans, erosion controls, soil stabilization controls, and routine field inspections.

Environmental surveillance monitoring is also conducted at the on-site playas as a best management practice. Appendix C contains a list of the surface water analytes that were monitored during 2019. In addition to routine sampling at four on-site playas, Pantex Plant also monitors storm water quality at eight different outfalls (shown on Figure 9.1). The flow diagram in Figure 9.2 depicts how storm water and treated industrial effluents discharge through the outfalls, and ultimately to the playas or the subsurface drip irrigation system.

During 2019, sampling was conducted at eight storm water outfalls and four playas. Based on data from the National Weather Service – Amarillo, located northeast of Amarillo and southwest of Pantex Plant, rainfall during 2019 was above average with approximately 25.9 inches (in) for the year. The average annual rainfall for Amarillo is typically 19.7 in.

Storm water monitoring required by the TPDES MSGP in 2019 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 storm water including color, clarity, odor, oil sheen, solids, and foam. Visual samples taken and examined in 2019 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 (TAC), 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. Table 9.1 lists the results for metals from the storm water outfalls in 2019 and compares them with the IWQPs.

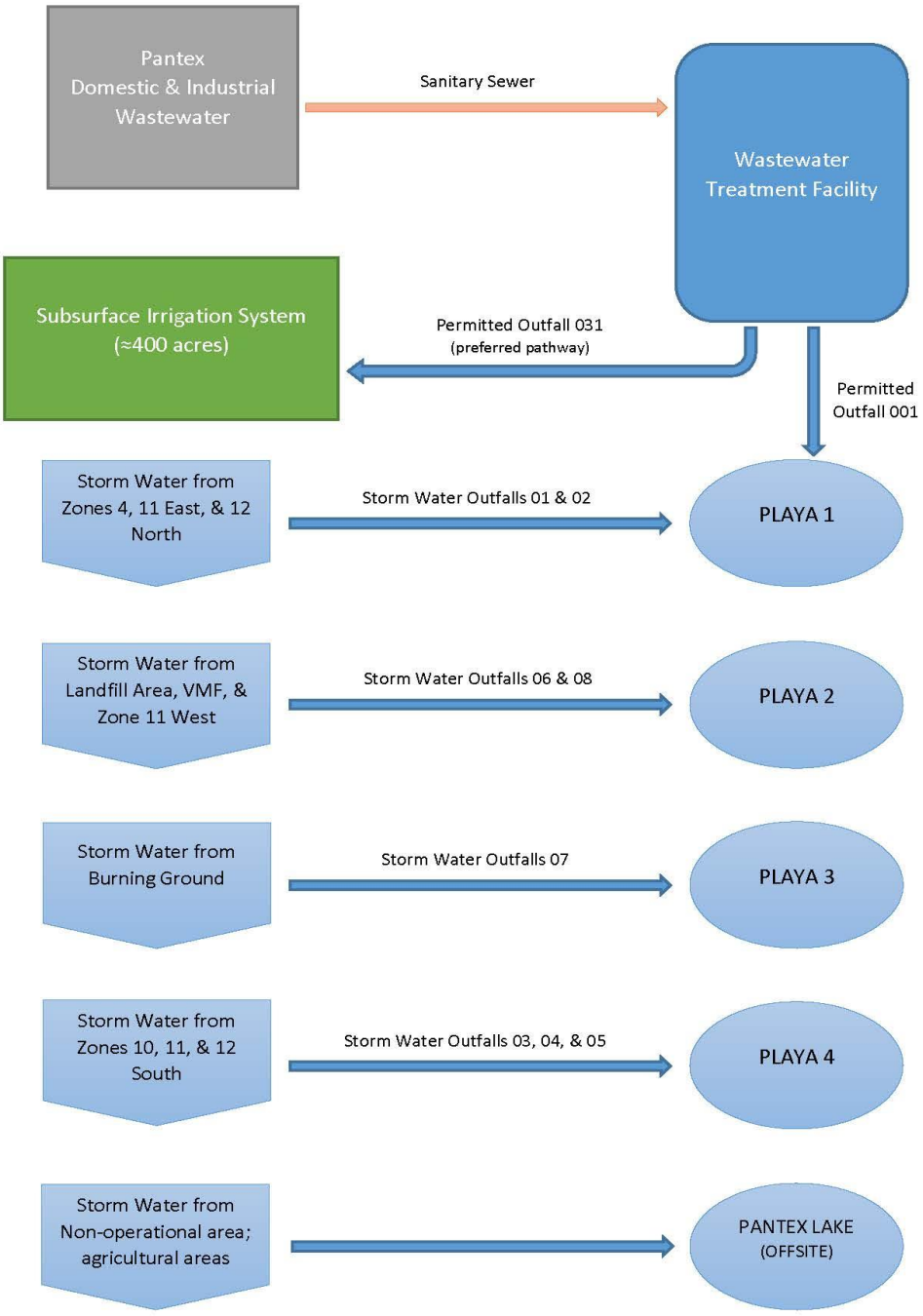

Figure 9.2 – Pantex Plant Surface Water Schematic

Table 9.1 – Annual Storm Water Results (metals), 2019 (mg/L)

	Outfall STORM01	Outfall STORM02	Outfall STORM03	Outfall STORM04	Outfall STORM05	Outfall STORM06	Outfall STORM07	Outfall STORM08	IWQP[a]
Arsenic	0.014	<0.010	<0.010	<0.010	<0.010	<0.010	0.008	0.004	**0.3**
Barium	0.730	0.160	0.190	0.083	0.091	0.076	1.2	0.160	**4.0**
Cadmium	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	0.0002	0.0008	<0.0005	**0.2**
Chromium	0.061	0.010	0.011	<0.010	0.005	<0.010	0.038	0.010	**5.0**
Copper	0.049	0.009	0.009	0.014	0.008	0.006	0.034	0.010	**2.0**
Lead	0.036	0.005	0.005	0.002	0.003	0.003	0.023	0.005	**1.5**
Manganese	0.720	0.110	0.110	0.067	0.044	0.049	0.590	0.120	**3.0**
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	**0.01**
Nickel	0.041	0.007	0.008	0.004	0.004	0.003	0.029	0.008	**3.0**
Selenium	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	**0.2**
Silver	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.2**
Zinc	0.310	0.055	0.057	0.026	0.036	0.027	0.140	0.042	**6.0**

[a] IWQP = Inland Water Quality Parameter limits, 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.

9.2.1 Playa 1 Basin

Playa 1 is approximately 79.3 acres (ac) in size and may receive treated wastewater effluent and storm water runoff from several small drainages. One of the drainages to the playa is associated with Pantex Plant operations (permitted Industrial Wastewater Outfall 001). The other drainages receive only storm water runoff from agricultural and operational areas. There are three drainages along the southern perimeter of Playa 1. All three include storm water from both agricultural and operational areas. Storm Water 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 storm water runoff from the Zone 4 area. Two additional drainages transport storm water runoff from agricultural areas that are north of the playa. In 2019, monitoring was conducted at Playa 1 and within the Playa 1 basin at both Storm Water Outfalls 01 and 02.

During the second and fourth quarter of 2019, Playa 1 was sampled 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 Derived Concentration Standard (DCS) for ingested water. Tritium was also below the DCS for ingested water, as well as the more conservative Maximum Containment Level (MCL) for the drinking water standards. Explosives were detected in trace amounts. Both explosives (HMX and RDX) have been detected at these levels historically at Playa 1 and are legacy contaminants from operations conducted years ago.

9.2.1.1 Storm Water 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 storm water that originates in the operational areas of Zone 12 North. The storm water flows northward from the outfall through the BN5A ditch, and on northward to Playa 1 where it finally discharges.

MSGP-required monitoring at Storm Water Outfall 01 was conducted during all four quarters of 2019. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP and pH was normal (6.0 – 9.0 s.u.). All metal concentrations were below their respective IWQP in 2019.

9.2.1.2 Storm Water Outfall 02 – Zone 12 East at S. 15th Street

Storm water discharges that flow through Storm Water Outfall 02 originate from the eastern portions of Zone 12 South, which include some of the operational areas of Pantex Plant.

Permit-required monitoring at Storm Water Outfall 02 was conducted during the first, second, and fourth quarters of 2019. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP and pH was normal. All metal concentrations were below their respective IWQP in 2019.

9.2.2 Playa 2 Basin

Playa 2 is approximately 74 ac and receives only storm water 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 fields. Two storm water outfalls, Outfalls 06 and 08, are within the Playa 2 basin. In 2019, monitoring was conducted at Playa 2 and within the Playa 2 basin at Storm Water Outfalls 06 and 08.

During the fourth quarter, Playa 2 was sampled for metals, radionuclides, and explosives. Metal analyses during the year were consistent with historic levels found at the playa and were all 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 and the more conservative MCL for drinking water standards. The explosive HMX was detected at trace amounts. This explosive has been detected at these levels historically at Playa 2 and is a legacy contaminant from operations conducted years ago.

9.2.2.1 Storm Water Outfall 06 – Vehicle Maintenance Facility (VMF)

Storm Water Outfall 06 receives storm water runoff from an area that includes the VMF and portions of the parking lot around the VMF where vehicles awaiting maintenance are staged. The refueling stations for Pantex Plant fleet are also located in this drainage area. The drainage area is primarily a paved lot utilized for parking and staging vehicles on the south side of the VMF.

Permit-required monitoring at Storm Water Outfall 06 was conducted during the third and fourth quarters of 2019. 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. TPH results were below detection limits for both quarters, indicating that runoff from the VMF staging area and refueling operations is not contributing significant hydrocarbon pollutants to the environment. All metal concentrations were below their respective IWQP in 2019.

9.2.2.2 Storm Water Outfall 08 – Landfill

This outfall receives storm water runoff from an area within Pantex Plant's active landfill. Runoff from active open landfill cells is retained within each cell. Storm water at this outfall consists of runoff over the landfill area, including runoff over closed cells. Storm water from this area eventually makes its way northward to Playa 2.

Permit-required monitoring at Storm Water Outfall 08 was conducted during all four quarters of 2019. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP and pH was normal. All metal concentrations were below their respective IWQP in 2019. Sector-specific monitoring is required at this location and includes total suspended solids (TSS) and iron. TSS concentrations averaged 115 milligrams per liter (mg/L) for the year, which is above the benchmark level of 100 mg/L. Iron concentrations averaged 8.0 mg/L for the year, which is above the benchmark level of 1.3 mg/L. Both of these analytes have been above benchmark levels historically and are consistent with past results. These results are not indicative of a contaminant problem, but reflect the characteristics of storm water from this area. However, specific projects are planned for 2020 to reduce these levels.

9.2.3 Playa 3 Basin

Playa 3, the smallest playa at Pantex Plant, is approximately 54 ac and receives storm water 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. Storm Water Outfall 07 is located within the basin and is northeast of Playa 3 between the playa and the Pantex Plant Burning Ground. In 2019, monitoring was conducted at Playa 3 and within the Playa 3 basin at Storm Water Outfall 07.

During the fourth quarter, Playa 3 was sampled for radionuclides, metals, and explosives. Isotopic radiological analyses for uranium were all below their respective DCS for ingested water. Tritium was also below the DCS for ingested water and the more conservative MCL for drinking water standards. Metal

analyses during the year were consistent with historic levels found at the playa and were all below their respective IWQP. The explosive HMX was detected at trace amounts. This explosive has been detected at these levels historically at Playa 3 and is a legacy contaminant from operations conducted years ago.

9.2.3.1 Storm Water Outfall 07 – Burning Ground

Storm Water Outfall 07 receives storm water runoff from the Burning Ground operational area through a culvert under a circumferential road around the Burning Ground, a relatively small land area. For this reason, sampling at the outfall can be a challenge.

Permit-required monitoring at Storm Water Outfall 07 was conducted during the first and second quarters of 2019. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP and pH was normal. All metal concentrations were below their respective IWQP in 2019.

9.2.4 Playa 4 Basin

Playa 4 is approximately 112.5 ac and is located on property owned by TTU. This playa receives runoff primarily from pasture areas but does receive storm water runoff from portions of Zone 10 (through Storm Water Outfall 05), Zone 11 (through Storm Water Outfall 04), and Zone 12 South (through Storm Water Outfall 03). Discharges from Zone 12 are predominately storm water runoff; however, Fire Department personnel flush firewater storage tanks or test fire hydrants in sufficient volumes to reach Storm Water Outfall 03. In 2019, monitoring was conducted at Playa 4 and within the Playa 4 basin at Storm Water Outfalls 03, 04, and 05.

During the second and fourth quarters, Playa 4 was sampled for metals, radionuclides, and explosives. Metal analyses during the year were consistent with historic levels found at the playa and were all 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 and the more conservative MCL for drinking water standards. All explosive analyses were below laboratory detection limits.

9.2.4.1 Storm Water Outfall 03 – Zone 12 South

Surface water monitored at Storm Water Outfall 03 is primarily storm water runoff from the west half of Zone 12 South. Periodically, water from the fire protection system is discharged through this outfall. There are no industrial effluents discharged through this outfall.

Permit-required monitoring at Storm Water Outfall 03 was conducted during all four quarters of 2019. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP. The pH was normal. All metal concentrations were below their respective IWQP in 2019.

9.2.4.2 Storm Water Outfall 04 – Zone 11 South

Surface water monitored at Storm Water Outfall 04 is entirely storm water runoff from the southern half of Zone 11. Storm water from this area discharges southward through the outfall to Playa 4. There are no industrial effluents discharged through this outfall.

Permit-required monitoring at Storm Water Outfall 04 was conducted during the second and fourth quarters of 2019. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP. The pH was normal. All metal concentrations were below their respective IWQP in 2019.

9.2.4.3 Storm Water Outfall 05 – Zone 10 South

Surface water monitored at Storm Water Outfall 05 is entirely storm water runoff from the southern half of Zone 10. This area also includes several contractor laydown yards. Some of the laydown yards contain material staging areas, waste bins utilized primarily for scrap metal, and double-walled, aboveground storage tanks utilized for equipment refueling. Drainage in this vicinity is very flat and there are no industrial effluents discharged through this outfall.

Permit-required monitoring at Storm Water Outfall 05 was conducted during all four quarters of 2019. Monitoring included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP. The pH was normal. All metal concentrations were below their respective IWQP in 2019.

9.2.5 Pantex Lake

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

9.3 HISTORICAL COMPARISONS

Sampling results from the storm water outfalls during 2019 showed no significant changes from the results of previous years. All monitoring results for metals were below their respective IWQP established by the State of Texas. Sample results continue to indicate that the storm water discharges at Pantex Plant are of relatively good quality and that current operations at Pantex Plant are not degrading storm water quality.

Playa lake sample results obtained during 2019 were very similar with past monitoring results. This playa data continues to support the premise that operations at Pantex Plant are not negatively affecting the water quality of the playas.

9.4 CONCLUSIONS

Monitoring storm water runoff at Pantex Plant is performed as required by the TCEQ's general permits. The playa lakes at Pantex Plant are monitored as a best management practice, but monitoring is often limited due to the semi-arid climate of the Texas Panhandle. Based on the data collected in 2019, surface water monitoring continues to support the premise that continuing operations are having no detrimental effect to the quality of the surface waters at Pantex Plant.

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Chapter 10 - Soils

In accordance with Pantex Plant Hazardous Waste Permit and Pantex Plant Land Application Permit, 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 previous year's results.
- On-site Burning Ground surface soil monitoring results were within the concentration ranges of the established background levels.

10.1 SOIL SAMPLING AT PANTEX PLANT

Surface soil samples are collected at the Pantex Plant Burning Ground and analyzed for metals and explosives in accordance with Provision VI.C of Pantex Plant's Hazardous Waste Permit HW-50284 (Permit HW-50284) (TCEQa). Subsurface soil samples are also collected from four subsurface irrigation tracts and analyzed for various parameters in accordance with Provision V.O of Pantex Plant Texas Land Application Permit (TLAP) WQ0004397000 (TCEQb). All samples are analyzed by off-site contract laboratories that meet Environmental Protection Agency (EPA) requirements as discussed in Chapter 13, Quality Assurance. Specific analytes are listed in Appendix C.

10.2 BURNING GROUND SURFACE SOIL SAMPLING AND ANALYSIS

In 2019, surface soil samples were collected from two general landscape positions: playa bottoms and inter-playa uplands. The characteristic soil types for these landscape positions are Randall clay in playas, 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 inches (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 by Permit 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 Permit HW-50284, the background value was set at the MDL or the Practical Quantitation Limit (PQL), whichever was greater. If less than 50 percent 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 percent of the background samples for a particular constituent at any location were greater than the MDL, the background value was calculated using a 95 percent upper tolerance limit with 99.9 percent coverage.

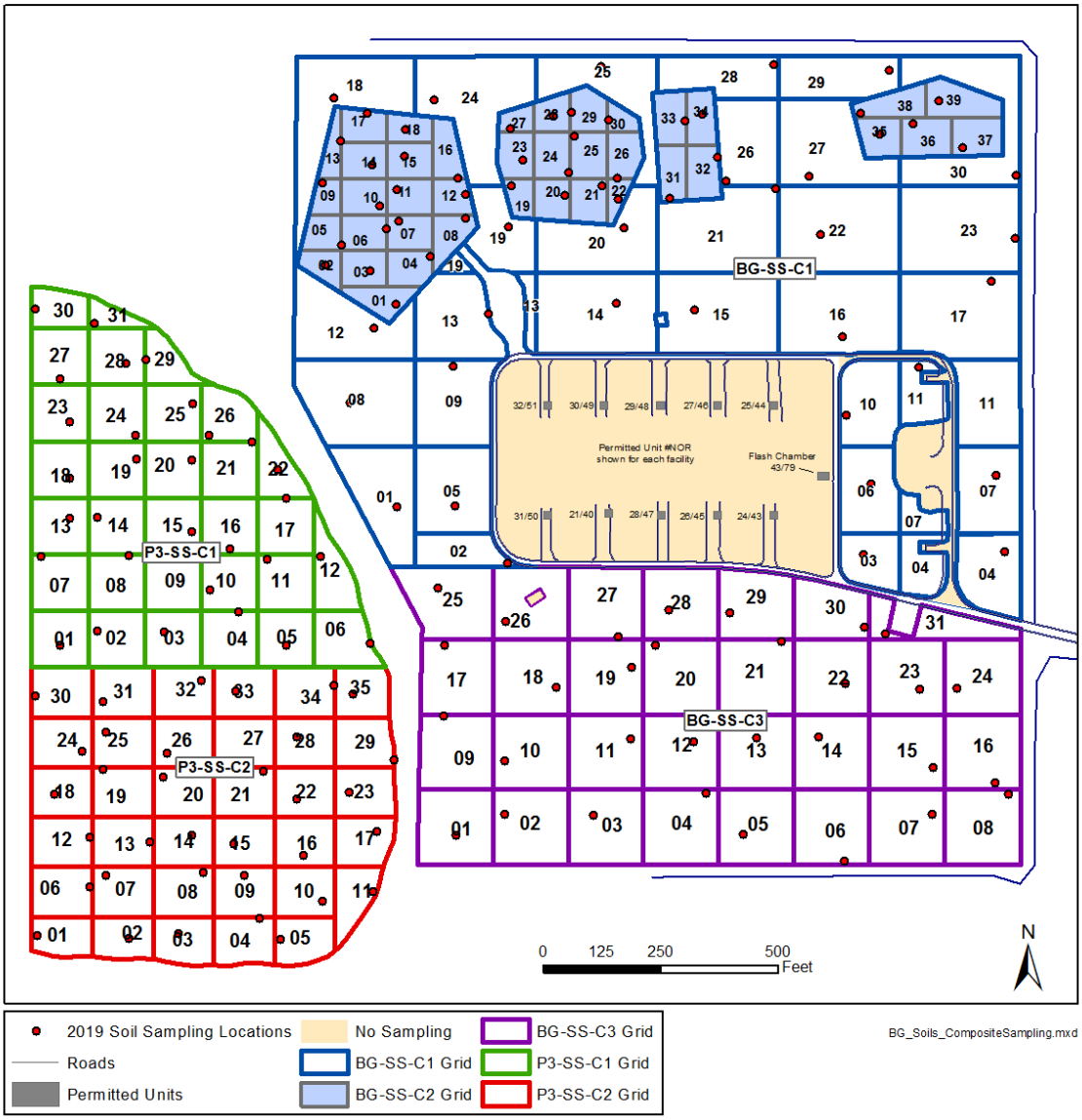

Figure 10.1 – Burning Ground Multi-Incremental Soil Sampling Locations for 2019

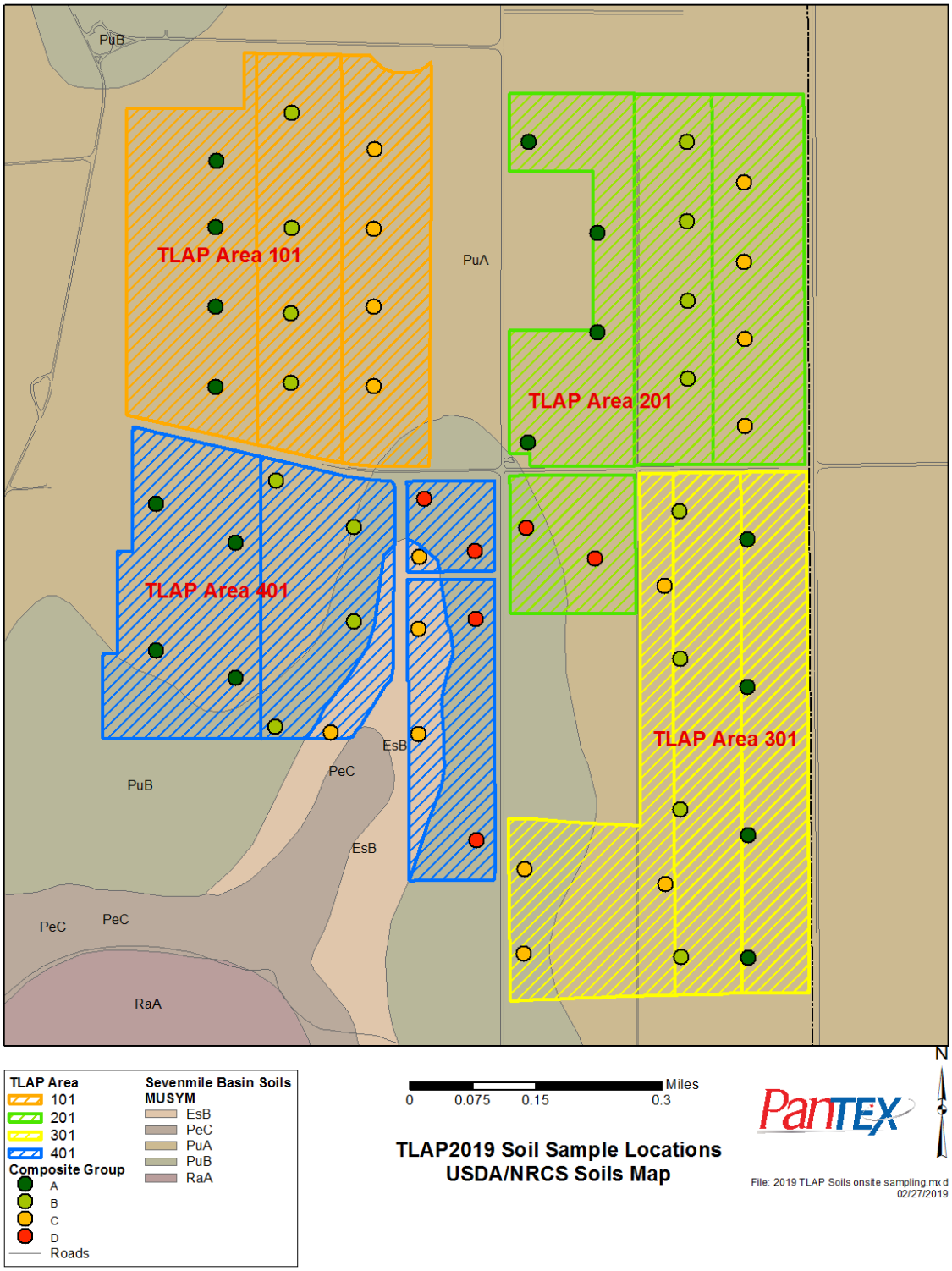

Figure 10.2 – TLAP Soil Sampling Locations for 2019

10.2.2 Surface Soil Metals Analysis

Soil samples collected from the Burning Ground and Playa 3 were analyzed for 10 metals (See the "BG Soil" column in Appendix C). Initial sample results for P3-SS-C1 indicated a potential Statistically Significant Increase (SSI) for chromium. The measured value of chromium in the sample was 38.0 g/kg with the background comparison level being 36.35 mg/kg. As provided for in Provision VI.F.2 of Permit HW-50284, the chromium value of 38.0 mg/kg is substantially below the risk-based standard established by the Pantex Corrective Action Program pursuant to Section XI of Permit HW-50284 for soil and sediment. As provided for in the provision, the comparison provides a determination that corrective action is not necessary. However, as provided for in Provision VI.D.1(b), Pantex Plant scheduled resampling of the grid location but due to continued water level issues in Playa 3, resampling had was delayed until Jun 1, 2020. Water level in the playa had been too low for boat access and wading into the playa to collect 25 subsamples creates a safety hazard for Pantex Plant Sampling Technicians. On June 1, 2020, resampling was conducted. The resampling results for chromium of 13.0 mg/kg at location P3-SS-C1 did not confirm the potential SSI. All metal concentrations observed in 2019 were below the established permit background concentrations.

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 2019 were below the established permit background concentrations as shown in Tables 10.1 through 10.5 in Appendix D.

10.3 SUBSURFACE DRIP IRRIGATION SYSTEM SOIL SAMPLING AND ANALYSIS

In 2019, the annual TLAP subsurface drip irrigation system soil samples were collected from four locations: Tract 101; Tract 201; Tract 301; and Tract 401. Each tract represents 100 acres (ac). 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 40 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 12 in and 12 to 24 in for analysis and reporting (Figure 10.2). These composite samples were analyzed for agricultural parameters, reactivity, two high explosives (HE), and one semi-volatile organic compound (SVOC). See the TLAP Soil column in Appendix C for specific analytes.

10.3.1 Subsurface Drip Irrigation System Soil Sampling Results

The 2019 subsurface soil sampling results for HE, reactivity, and SVOC were all non-detects. The results of the agricultural parameters (nutrient parameters analyzed on a plant available or extractable basis) are presented in Tables 10.6 through 10.9 in Appendix D. The TLAP subsurface soil sampling results are reported annually to the Texas Commission on Environmental Quality (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 CONCLUSIONS

On-site Burning Ground surface soil monitoring results for 2019 were within the concentration ranges of the established background levels. Results of soil monitoring conducted at the subsurface irrigation for 2019 were consistent with previous year's results.

Chapter 11 - Fauna

Fauna surveillance is a complementary program to air, flora, and water monitoring. The program is utilized in the assessment of potential short-term and long-term effects to the environment as a result of operations at Pantex Plant. The program utilizes the sampling of animals at Pantex Plant to determine whether Plant activities have an impact on them.

Chapter Highlights

- Comparisons of radionuclide concentrations in faunal samples indicated no detrimental effects from Pantex Plant operations in 2019.

11.1 FAUNA SELECTION AT PANTEX PLANT

Due to their interactions with both primary (air, water) and secondary (vegetation) environmental media, black-tailed prairie dogs and cottontail rabbits were the species selected for sampling. Radionuclide concentrations in faunal samples are compared to historical values and control locations sample values.

11.2 RADIOLOGICAL SURVEILLANCE IN FAUNA

Semi-annual radionuclide surveillance of fauna at Pantex Plant was scheduled at eight on-site locations and one control location. The sites were:

- Burning Ground,
- Firing Site 4 (FS-4),
- Zone 4,
- west of Zone 4,
- Zone 12 South,
- Playa 2,
- Playa 3,
- Zone 8, and
- Control site, Buffalo Lake National Wildlife Refuge (BLNWR) near Umbarger, TX.

BLNWR was chosen as the control site because fauna populations there are far enough from Pantex Plant (41 miles) to be unaffected by Plant operations, and more so than on private lands, affords a dependable availability of prairie dogs, cottontails, and property access. In 2019, prairie dogs were only available west of Zone 4, in Zone 8, near Playa 2, the Burning Ground, at FS-4, and at BLNWR. Cottontails were secured from Zone 4 and BLNWR.

Sample animals are live-trapped, humanely euthanized, and shipped to the analytical lab. Whole-body composites are prepared for determination of tritium, uranium-233/234 (U-233/234), and uranium-238 (U-238) activities. These radionuclides are associated with activities at Pantex Plant, but are also naturally occurring in soils at and around Pantex Plant.

Analytical results of the 2019 faunal sampling are presented in Table 11.1 (prairie dogs) and 11.2 (cottontails), as are historical means (prairie dogs, 1997-2000; cottontails, 2007-2010). The range of years established as historical data is consistent among the soil, flora, and fauna media programs, allowing for comparison. The ranges represent the first four years of overlap of sampling under the three programs. Sampling of cottontails began in 2007.

Table 11.1 – Tritium, U-233/234, and U-238 in Prairie Dogs in 2019, in pCi/g Dry Weight

Location	No. of Samples (# ≤ MDA)	Maximum[a]	Minimum[a]	Mean ± Std.[b]	No. of Samples in 1997-2000	1997-2000[c] Mean ± Std.
Tritium						
Zone 4 (W)	1 (1)	-0.175 ± 0.340[d]	--	--	10	0.012 ± 0.279
Zone 8	4 (4)	0.425 ± 0.525	0.134 ± 0.499	0.288 ± 0.122	14	0.017 ± 0.065
Playa 2	4 (4)	0.582 ± 0.538	0.038 ± 0.429	0.199 ± 0.259	14	0.055 ± 0.136
Burning Ground	2 (2)	0.342 ± 0.473	0.247 ± 0.433	0.295 ± 0.067	11	0.152 ± 0.300
Playa 3	--[e]	--	--	--	14	0.019 ± 0.070
FS-4	3 (3)	0.630 ± 0.475	-0.171 ± 0.316	0.256 ± 0.403	8	0.313 ± 0.321
12-36	--	--	--	--	10	-0.065 ± 0.365
Buffalo Lake	4 (4)	0.422 ± 0.562	-0.309 ± 0.337	0.119 ± 0.326	14	0.015 ± 0.055
U-233/234						
Zone 4 (W)	1 (1)	0.015 ± 0.014	--	--	10	0.018 ± 0.011
Zone 8	4 (4)	0.026 ± 0.013	0.001 ± 0.016	0.011 ± 0.012	14	0.012 ± 0.019
Playa 2	4 (4)	0.017 ± 0.012	0.000 ± 0.012	0.008 ± 0.008	14	0.013 ± 0.022
Burning Ground	2 (2)	0.023 ± 0.017	0.012 ± 0.012	0.017 ± 0.008	11	0.018 ±0.040
Playa 3	--	--	--	--	14	0.020 ±0.022
FS-4	3 (3)	0.022 ± 0.016	0.013 ± 0.013	0.017 ± 0.005	8	0.017 ± 0.018
12-36	--	--	--	--	10	0.021 ± 0.025
Buffalo Lake	4 (3)	0.037 ± 0.020	0.010 ± 0.011	0.021 ± 0.012	14	0.017 ± 0.025
U-238						
Zone 4 (W)	1 (1)	0.012 ± 0.011	--	--	10	0.012 ± 0.008
Zone 8	4 (4)	0.027 ± 0.012	0.012 ± 0.008	0.018 ± 0.006	11	0.010 ± 0.021
Playa 2	4 (4)	0.015 ± 0.010	0.000 ± 0.011	0.007 ± 0.006	11	0.009 ± 0.009
Burning Ground	2 (2)	0.020 ± 0.014	0.016 ± 0.009	0.018 ± 0.002	9	0.013 ± 0.026
Playa 3	--	--	--	--	11	0.011 ± 0.015
FS-4	3 (3)	0.008 ± 0.012	0.000 ± 0.012	0.005 ± 0.004	8	0.012 ± 0.015
12-36	--	--	--	--	10	0.009 ± 0.006
Buffalo Lake	4 (4)	0.022 ± 0.011	0.010 ± 0.009	0.014 ± 0.005	11	0.015 ± 0.029

[a] Counting error at 95 percent confidence level. The second of each paired set of values in the "Maximum" and "Minimum" columns

[b] Standard deviation.

[c] Historical data period for Zone 4 (W), FS-4 and 12-36 is 2007-2010 due to these being newer sampling areas.

[d] Negative values indicate results below the (statistically determined) background level from the counting system used at the analytical laboratory.

[e] Prairie dogs unavailable.

Table 11.2 – Tritium, U-233/234, and U-238 in Cottontail Rabbits in 2019, in pCi/g Dry Weight

Location	No. of Samples (# ≤ MDA)	Maximum[a]	Minimum[a]	Mean ± Std.[b]	No. of Samples 2007-2010	2007-2010 Mean ± Std.
Tritium						
Zone 4	2 (1)	0.862 ± 0.490	-0.121 ± 0.377[c]	0.371 ± 0.695	12	0.087 ± 0.274
Zone 12 South	--[d]	--	--	--	13	0.346 ± 0.397
Buffalo Lake	2 (2)	0.422 ± 0.536	-0.061 ± 0.335	0.181 ± 0.342	10	0.175 ± 0.260
U-233/234						
Zone 4	2 (2)	0.015 ± 0.018	0.005 ± 0.010	0.010 ± 0.007	12	0.014 ± 0.013
Zone 12 South	--	--	--	--	13	0.012 ± 0.008
Buffalo Lake	2 (2)	0.021 ± 0.017	0.016 ± 0.013	0.018 ± 0.004	10	0.042 ± 0.031
U-238						
Zone 4	2 (2)	0.008 ± 0.017	0.003 ± 0.007	0.005 ± 0.003	12	0.009 ± 0.011
Zone 12 South	--	--	--	--	13	0.005 ± 0.005
Buffalo Lake	2 (2)	0.005 ± 0.010	0.000 ± 0.012	0.003 ± 0.004	10	0.029 ± 0.022

[a] Counting error at 95 percent confidence level. The second of each paired set of values in the "Maximum" and "Minimum" columns is the "error."
[b] Standard deviation.
[c] Negative values indicate results below the (statistically determined) background level for the counting system used at the analytical laboratory.
[d] Cottontail rabbits unavailable.

Eighteen prairie dogs and four cottontails were sampled during 2019. Results for prairie dogs and cottontails were similar to or less than historic data. Most results were below minimal detection activity (MDA; 94.4 percent for prairie dogs, and 75.0 percent for cottontails). None of the results exceeded any of the Biota Concentration Guides for the analyzed radionuclides and thus would not be expected to cause a dose exceeding 0.1 rad/day for terrestrial animals.

11.3 CONCLUSIONS

Radionuclide concentrations in fauna samples (prairie dogs and cottontails) were comparable to values observed in samples from control locations and historical data. Thus, results indicate that the fauna-monitoring program continues to provide information that supports the hypothesis that current operations do not have a detrimental effect on the quality of the environment at or near Pantex Plant.

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Chapter 12 - Flora

Flora surveillance is a complementary program to air, fauna, and water monitoring. The program is utilized in the assessment of potential short-term and long-term effects to the environment as a result of operations at Pantex Plant. The program utilizes radionuclide analyses on both native vegetation and crops.

CHAPTER HIGHLIGHTS

- Flora samples indicated no detrimental effects from operations at Pantex Plant in 2019.

12.1 FLORA AT PANTEX PLANT

Flora at Pantex Plant consists of native vegetation and crops. Native vegetation species on the Southern High Plains consists primarily of prairie grasses and forbs. Crops are defined as any agricultural product harvested or gathered for animal or human food, including garden produce, forage, or fiber. Radionuclide concentrations in vegetation samples, from on-site and off-site locations, are compared to historical and control location sample values. 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.

12.2 RADIOLOGICAL SURVEILLANCE OF VEGETATION

Surveillance of vegetation and crops at on-site and off-site locations is used to monitor potential impacts from current Pantex Plant operations at the Burning Ground, the Firing Sites, Zone 12, off-site at the immediate perimeter of the Plant site and out to approximately five miles from the center of the Plant (Figures 12.1 and 12.2). Rotational crops are also sampled (Figure 12.3). Background samples of crop and native vegetation species were collected from control locations at Bushland, Texas. The control locations were selected because of their distance and direction from Pantex Plant, ease of access, lack of industrial activity, and the presence of typical Southern High Plains vegetation.

Sampling locations are circles, approximately 33 feet 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, uranium-233/234 (U-233/234), and uranium-238 (U-238). Analytical data were corrected for moisture content and reported in picocuries per gram (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 Department of Energy 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.

12.2.1 Native Vegetation

Native vegetation samples, consisting primarily of stem and leaves from grasses and forbs, were collected from 1 control location, 11 on-site locations, and nine off-site locations. Sampling occurred during the growing season, no more frequently than once per month in 2019.

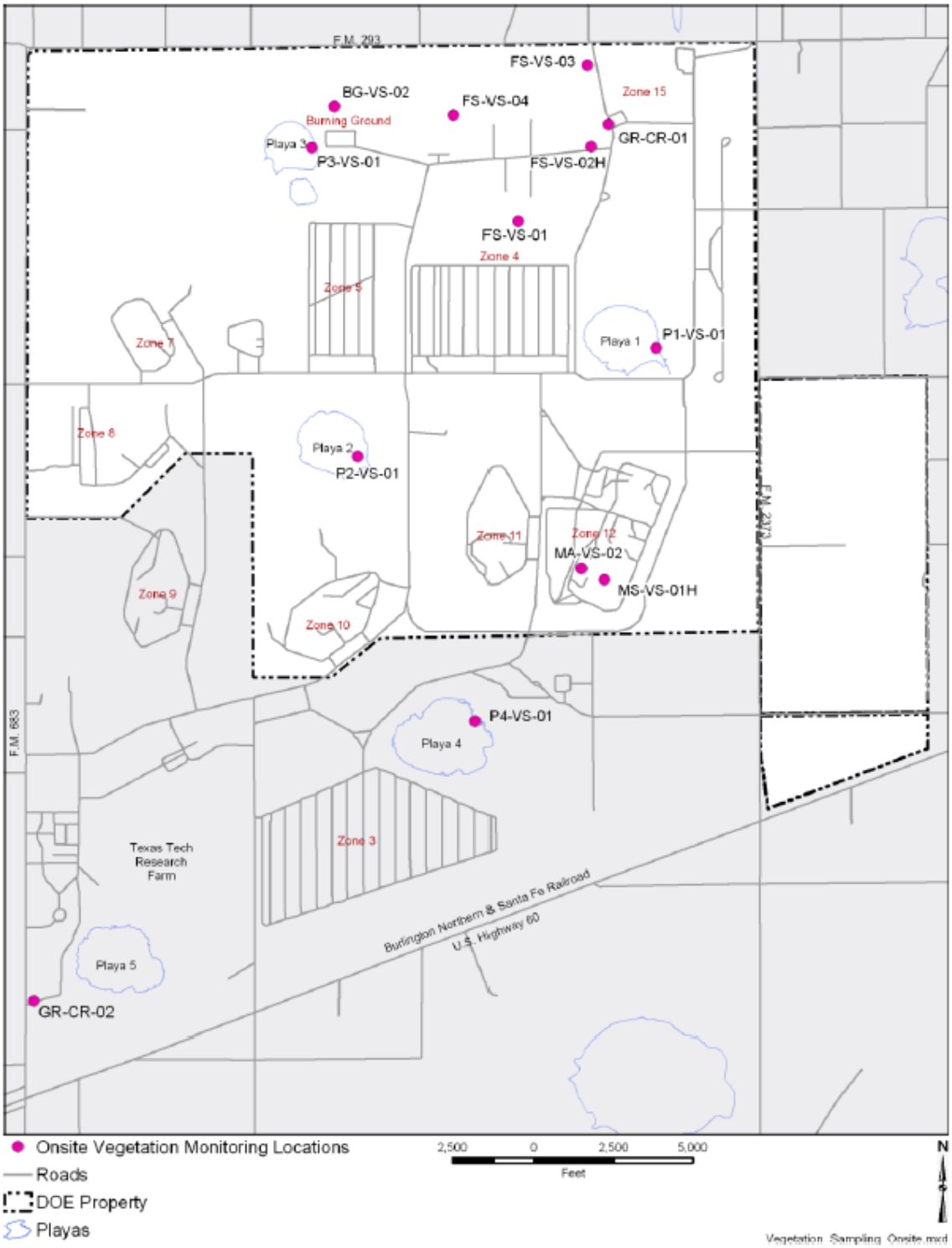

Figure 12.1 – On-site Vegetation Monitoring Locations

NOTE: On Figures 12.1, 12.2, and 12.3, note 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.

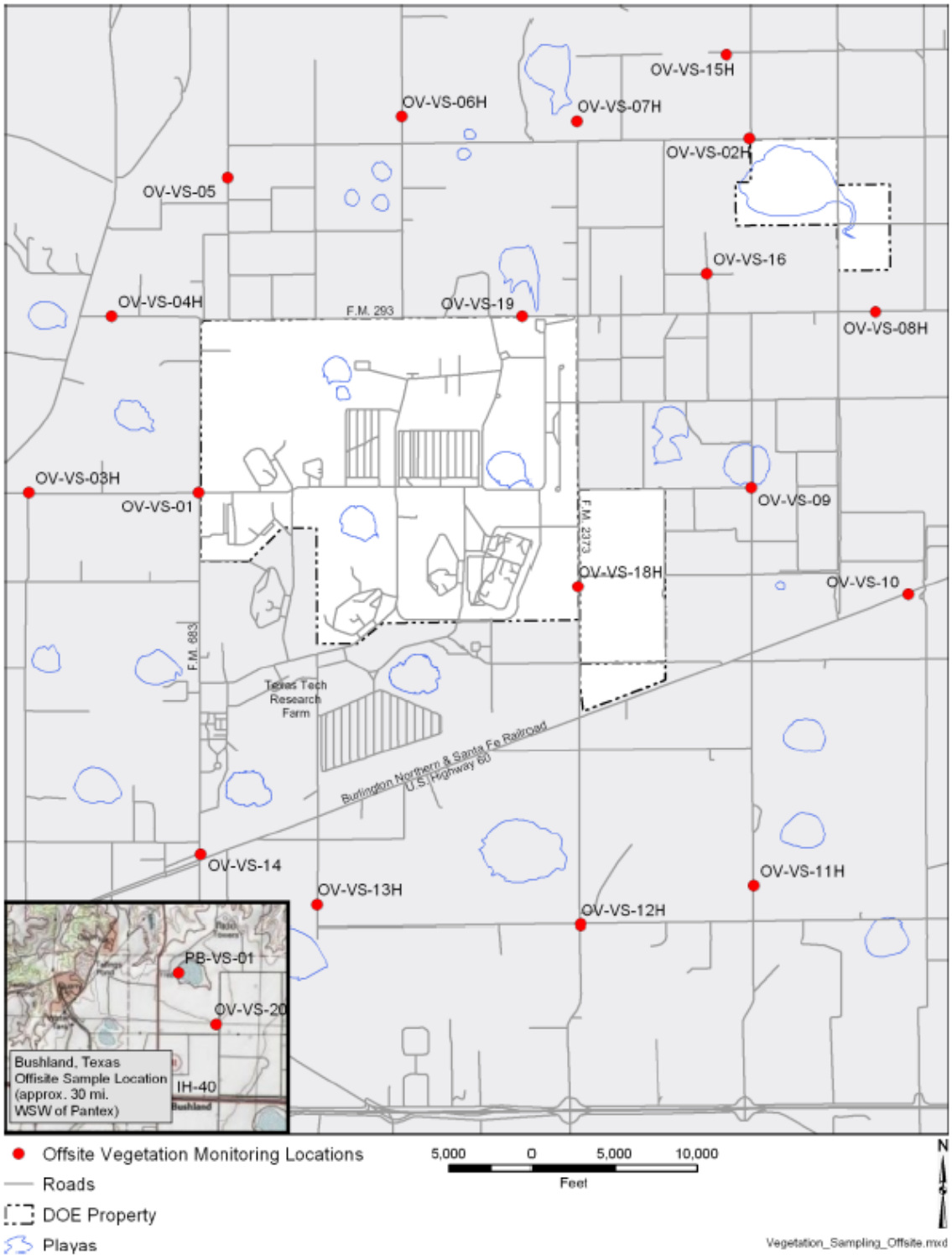

Figure 12.2 – Off-site Vegetation Monitoring Locations

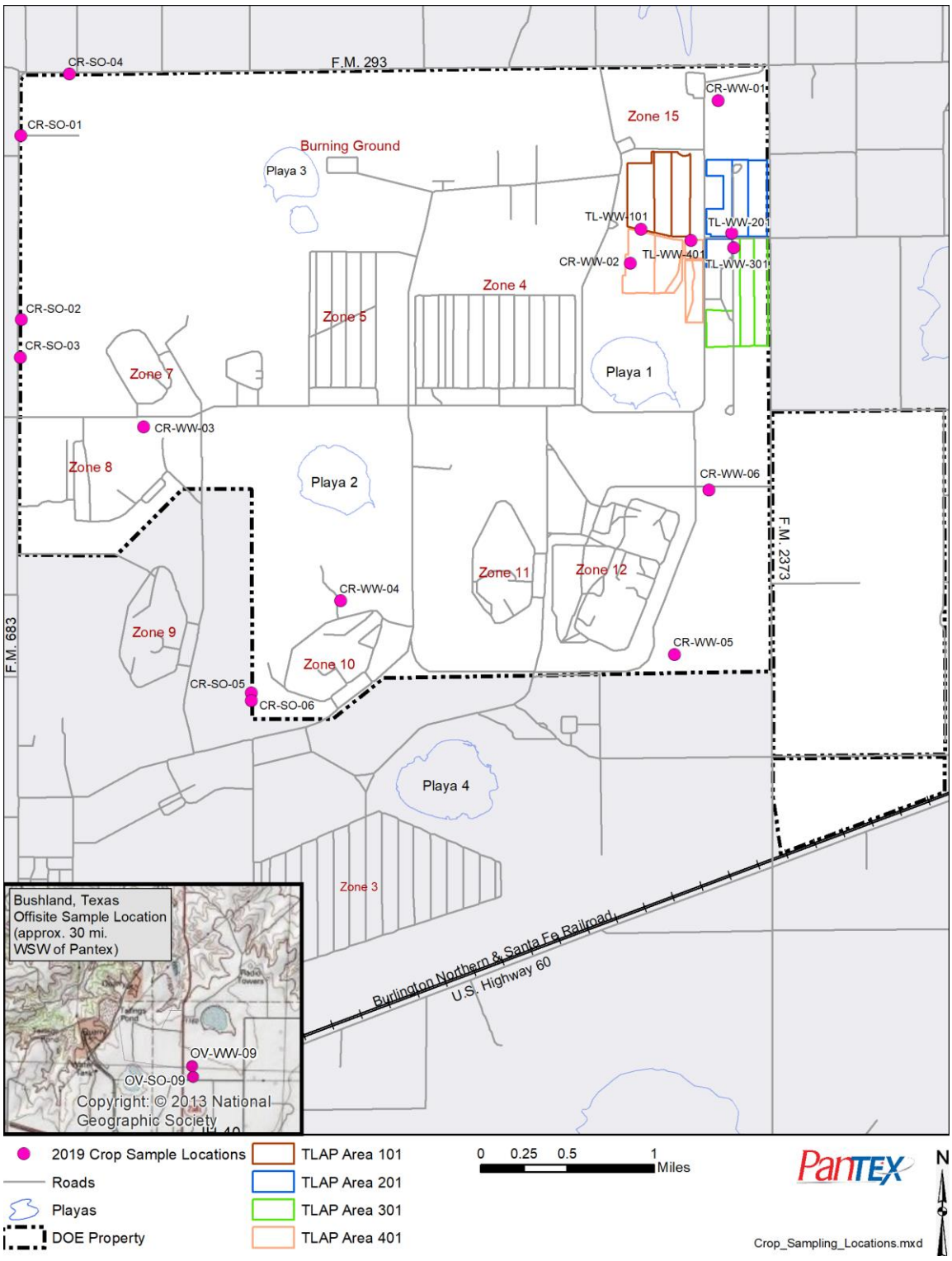

Figure 12.3 – Crop Monitoring Locations for 2019

Tritium results from 81 percent of on-site and off-site sample locations were at or below minimum detection activity (MDA) levels. The mean results from tritium analyses at all other on-site and off-site locations were similar to the results at the control location OV-VS-20 (Figure 12.1) and the historical mean (calendar years 1997-2017).

Table 12.1 – Native Vegetation Comparison of Tritium 2019, Control Location, and Highs for the Year

Sampling Location	Tritium pCi/g + Error (2019)	Tritium Mean + 1 St. Dev. (2019)
OV-VS-14	0.58±0.50	0.34±0.33
BG-VS-02	0.49±0.44	0.44±0.63
OV-VS-20 (control)	0.17±0.46	0.14±0.05

The percentage of vegetation samples at or below the MDA level for U-233/234 and U-238 in all vegetation were 56 and 53 percent, respectively. Usually the percentage of vegetation samples at or below the MDA level is near 50 percent. The measured values in general for locations for the year were not significantly elevated and were comparable to the control location (Table 12.2). 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 12.2 – Native Vegetation Comparison of U-233/234 2019 and the Control Location

Sampling Location	U-233/234 pCi/g	U-233/234 Mean + 1 St. Dev.
P2-VS-01	0.04±0.05	0.026±0.016
P1-VS-01	0.03±0.03	0.028±0.004
PB-VS-01 (control)	0.04±0.04	0.032±0.013

12.3 CROPS

Crop surveillance enables the evaluation of potential impacts to humans and livestock from Pantex Plant operations. Samples of stems and leaves from dryland and irrigated winter wheat 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 the Pantex Plant property and one on the southwest side of the Texas Tech University (TTU) property (Figure 12.1).

Six dryland winter wheat samples, four Texas Land Applied Permit (TLAP) area winter wheat samples, a duplicate sample from on-site and one control sample from the control site (Bushland, Texas) were collected in May 2019. Six dryland grain sorghum samples, a duplicate sample from on-site, and a control sample from the control site were collected in August 2019. The majority of on-site winter wheat sampling locations were on the south and east side of the property with no samples from the TLAP area. Dryland grain sorghum sampling locations were on the west side of the property, and none were from the TLAP area (Figure 12.3). Fruits and leaves from garden plants were sampled in September 2019.

All crop and garden samples were analyzed for tritium, U-233/234 and U-238. All crop and garden produce analyses in 2019 were at or below the MDA level for tritium, U-233/234, and U-238 and were comparable to the off-site control location. Results for all crop and garden results were similar to historical data with

the exception of the garden and two sorghum sample (GR-CR-01, GR-CR-02, CR-SO-03, and CR-SO-04). Results for these crop and garden locations are in (Table 12.3). Concentration of U-233/234 and U-238 in crop and garden vegetation indicates no uptake of U-233/234 and U-238 into vascular plants has occurred, and that the radiological dose to terrestrial plant of 1 rad/day, as indicated in DOE-STD-1153-2002 (DOEf), has not been exceeded.

Table 12.3 – Crop Comparison of U-233/234 and U-238 2019 and the Control Locations

Sampling Location	U-233/234 (pCi/g)	U-233/234 Mean + 1 St. Dev.	U-238 (pCi/g)	U-238 Mean + 1 St. Dev.
GR-CR-01	0.02±0.03	0.007±0.009	0.03±0.03	0.023±0.007
GR-CR-02	0.07±0.05	0.016±0.035	0.02±0.03	0.005±0.013
CR-SO-03	0.02±0.03	N/A[a]	0.03±0.03	N/A
CR-SO-04	0.03±0.03	N/A	0.03±0.03	N/A
OV-SO-09 (control)	-0.01±0.01	N/A	0.01±0.02	N/A

[a] No Mean or Standard Deviation because there was only one observations for that location.

12.4 CONCLUSIONS

Radionuclide concentrations in flora samples were comparable to values observed in samples from control locations or historical data. This indicates there were no detrimental effects from Pantex Plant operations in 2019.

Chapter 13 - Quality Assurance

Due to its unique mission and service to the country, Pantex Plant must strive to become 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 Plant maintain an unparalleled QA and quality control (QC) program that meets our need for high reliability.

Chapter Highlights

- More than 99 percent of the 2019 analytical results were useable for making environmental decisions.
- All Pantex Plant requirements for subcontract laboratories were met.

13.1 QUALITY ASSURANCE AT PANTEX PLANT

Pantex Plant has an established 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:

- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Record of Decision,
- Texas Commission on Environmental Quality permits,
- Department of Energy (DOE) Order 414.1D *Quality Assurance* (DOEd), and
- International Organization for Standardization (ISO)-2004 *Environmental Management Systems – Requirements with Guidance for Use, 2004* (ISO, 2004).

During 2019, 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 Plant 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 useable environmental data based on technical acceptance criteria for chemical and radiochemical measurements. By providing consistently useable data, Pantex Plant fosters a high degree of confidence for regulatory compliance and protection of human health and the environment with stakeholders. This approach also allows Pantex Plant to provide maximum value for the resources utilized to acquire environmental monitoring data.

13.2 ENVIRONMENTAL DATA ACQUISITION, PLANNING AND EXECUTION

Acquisition of environmental monitoring data is planned with its end use in mind. Each media or subject matter expert defined the data collection requirements based on program needs and used guidance, such as Environmental Protection Agency (EPA) *QA/G4 Guidance for Data Quality Objective Process* (EPAc), 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 2019, 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.

13.3 ENVIRONMENTAL DATA QUALITY ASSURANCE AND CONTROL

Pantex Plant relies on a robust quality system described in the Pantex Plant *Environmental Monitoring Program Management and Quality Plan, QPLAN-0010* (PANTEX$_j$). 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.

13.3.1 Field and Laboratory Assessments

Internal assessments are conducted annually, at a minimum, on representative field and laboratory operations. The assessments on field operations are performed on both liquid and solid media sampling programs. 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 (COC) procedures, sample documentation, and sample transfer to the laboratory. Activities reviewed for laboratory operations may include quality systems, sample receiving, handling, COC, storage procedures, analytical instruments condition, analytical instruments calibrations, and sample disposal. It may also include documentation for laboratory procedures such as run logs, data reduction, and standard operating procedures.

Other assessments, including management and independent assessments, are also conducted. Most assessments are performed using checklists with specific criteria for each procedure observed. Checklists from the United States Department of Energy Consolidated Audit Program (DOECAP) are used as guidance in developing the checklists for the laboratory assessments. An exit meeting is conducted at the end of an audit to discuss the findings. The findings are summarized in a report, and a Corrective Action Plan (CAP) is submitted by the laboratory for all the findings, including the root cause, corrective action, personnel responsible for the corrective action implementation, and projected date for completion of the corrective action. A nonconformance report (NCR) is generated when a departure from documented requirements, such as procedures, sampling plans, and QC criteria, occurs. A formal Corrective Action Report (CAR) may be necessary depending on the severity, repetitiveness, and impact to reported data. Corrective actions are required to be implemented in a timely manner by the appropriate personnel who are knowledgeable about the work.

13.3.2 Annual Review of all Operations

Pantex Plant personnel conduct an annual review of the sampling operations, administrative functions, and quality systems to assure their continued effectiveness. The items reviewed include the suitability of policies and procedures, outcome of internal and external assessments, trending of NCRs and CARs, client complaints, changes in volume of work, staffing, and resources.

13.3.3 Recordkeeping

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

13.3.4 Quality Plan Requirements for Subcontract Laboratories

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

Each subcontract laboratory must be qualified by Pantex Plant 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 DOECAP accrediting agency, National Nuclear Security Administration (NNSA), Analytical Management Program, or Pantex Supplier Quality Department.

In addition to the initial systems audit, all subcontract laboratories must submit to annual systems audits 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 (DPA) 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 subcontract 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 *Pantex Statement of Work (SOW) for Analytical Laboratories* (PANTEXk).

Qualified subcontract laboratories must successfully analyze PE samples semi-annually in order to maintain qualified status, and they may be subject to submission of PE samples from Pantex Plant 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. If the subcontract laboratory performs any combination of inorganic, organic, and radiological testing, participation in two semi-annual inter-laboratory comparison PE programs is required. One program must be the Mixed Analyte Performance Evaluation Program (MAPEP), and the other program should be from a vendor accredited by the National Institute of Standards and Technology (NIST) under TNI Proficiency Test Standards. Participation in additional inter-laboratory comparison PE programs is necessary if the laboratory provides other unique services, such as asbestos or lead in paint.

NCRs 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 SOW.

13.4 LABORATORY QUALITY ASSURANCE

During 2019, the Pantex Plant Laboratory Quality Assurance Program (LQAP) continued to provide qualified laboratory auditors to participate in DPAs. All Pantex Plant requirements for the subcontract laboratories were met. All of the subcontract laboratories had the proper certifications for analyzing

environmental samples from Pantex Plant. 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 SOW requirements consistent with industry standards.

13.4.1 Data Review and Qualification

Historically, the vast majority of analytical results are useable 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 useable). Based on industry standard conventions, sample results are qualified as useable 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. 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 high explosives 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 method detection limit.
- Sample or Blank Contamination. The sensitivity of modern analytical techniques makes it virtually impossible 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 (COC). There was a failure to maintain proper custody of samples, as documented on COC 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 Plant.
    - 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.

The Pantex Plant media scientist was alerted to any limitations in the use of the data, based on the DQO requirements. Of the 26,226 individual results obtained in 2019 from all laboratory analyses, 99.26 percent

were deemed to be of suitable quality for the intended end use of the data. Figure 13.1 graphically summarizes the causes for the 0.74 percent of data rejected.

13.4.2 Laboratory Technical Performance

All subcontract laboratories were required to participate in inter-laboratory comparison studies administered by DOE and EPA. In 2019, Pantex Plant off-site subcontract laboratories participated in MAPEP PE sample analysis, sponsored by the DOE/Idaho Operations Office.

The MAPEP samples include radiological, inorganic, and organic compounds in matrices including water, soil, air filters, and vegetation. Under MAPEP, the DOE Idaho Operations Office publishes evaluation reports, rating the analyses from each participating laboratory. MAPEP results, particularly the results for MAPEP Series 40 and 41, for all participating subcontract laboratories used by Pantex Plant in 2019 (GEL and TestAmerica) are presented in Figure 13.2. Both subcontract laboratories had acceptable MAPEP results in 2019.

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. The SOW and DOECAP have requirements that all labs shall participate in several PE programs, including the potable and non-potable water programs (EPA Supply and Water Pollution), and MAPEP.

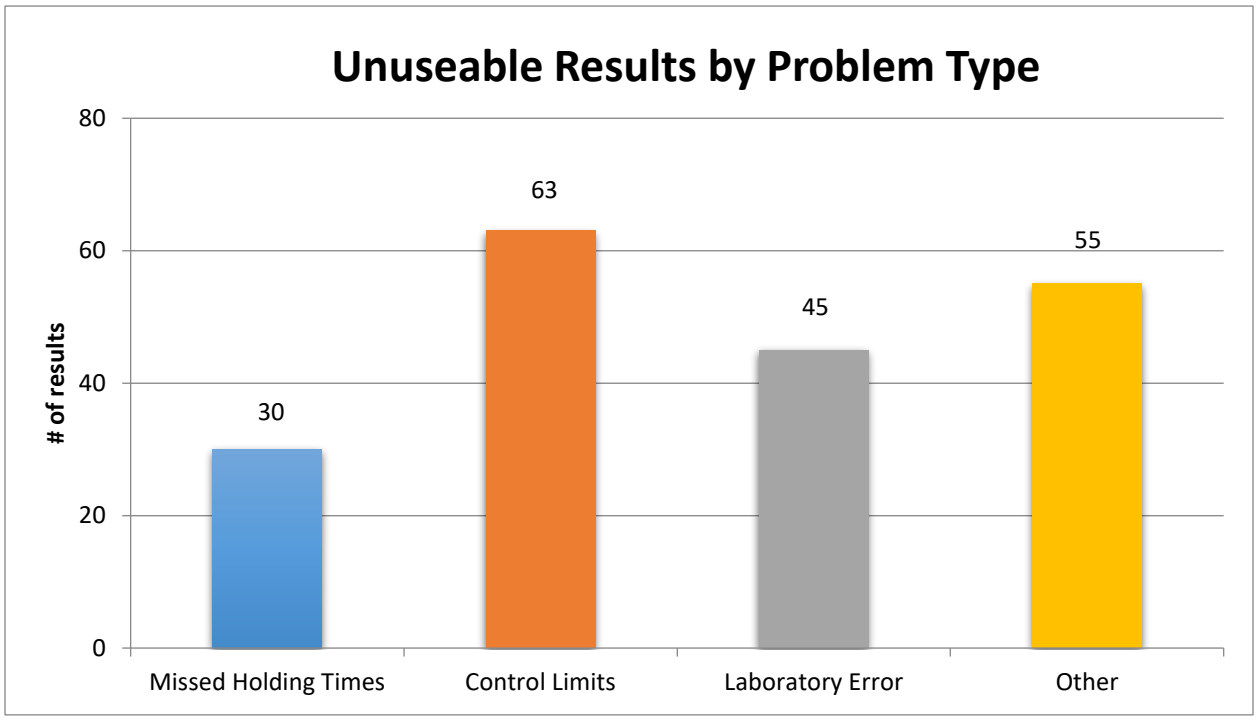

Figure 13.1 – 2019 Data Rejection Summary

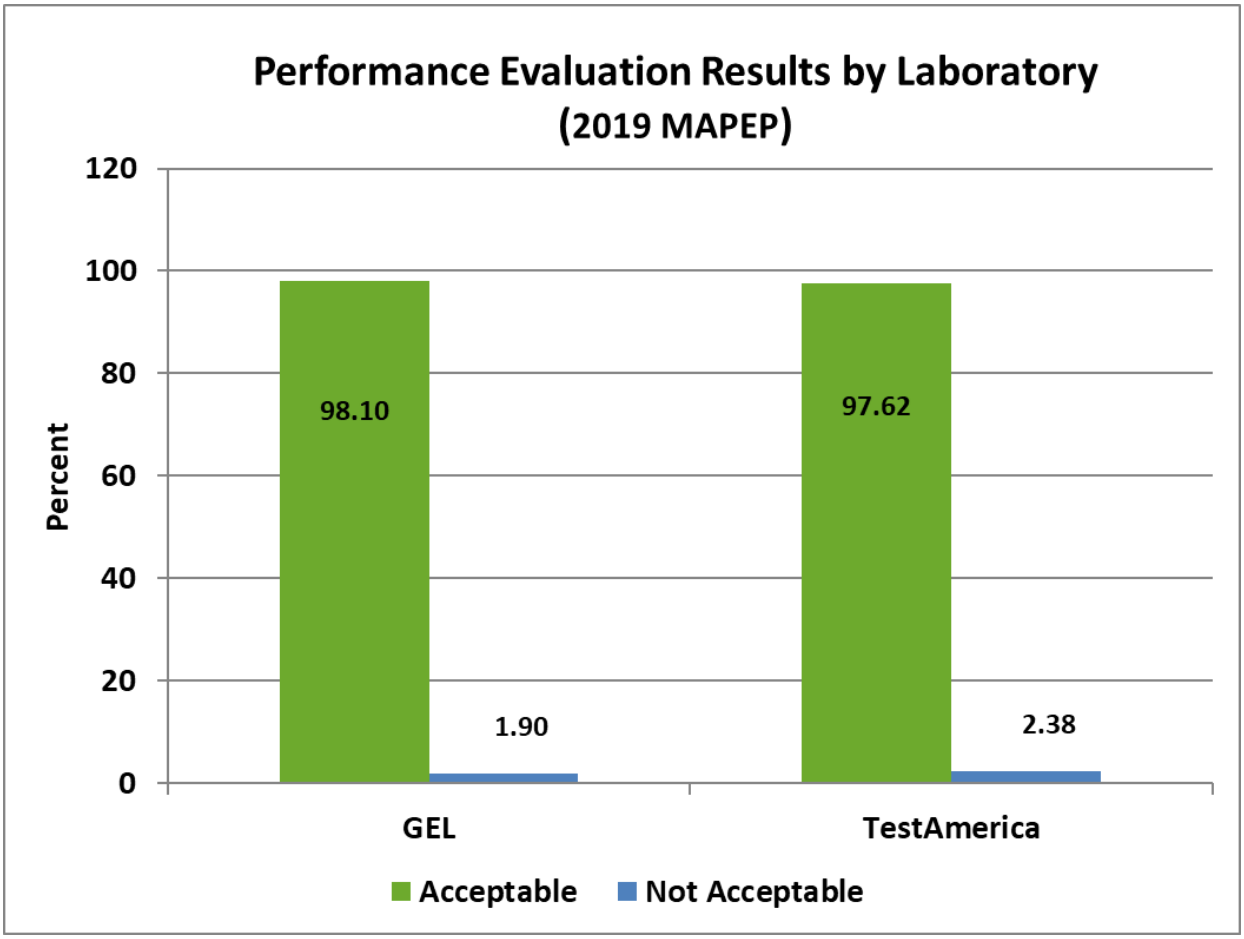

Figure 13.2 – 2019 MAPEP Results

13.5 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.

13.5.1 Duplicate and Replicate Analyses

During 2019, Pantex Plant 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 sub-samples 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:

$$RER = | S - R | / (\sigma 95S + \sigma 95R);$$

Where:

RER = replicate error ratio
S = sample value (original)
R = replicate sample value
σ95S = sample uncertainty (95 percent)
σ95R = replicate uncertainty (95 percent)

An RER of less than or equal to one indicates that the replicates are comparable within the 95 percent confidence interval. For 2019, the average RER value for vegetation data was 0.366 with an associated standard deviation of 0.308. The 2019 vegetation sample RER analysis indicated that field replicate sample precision accurately reflects the actual sample value. Figure 13.3 summarizes the RER data.

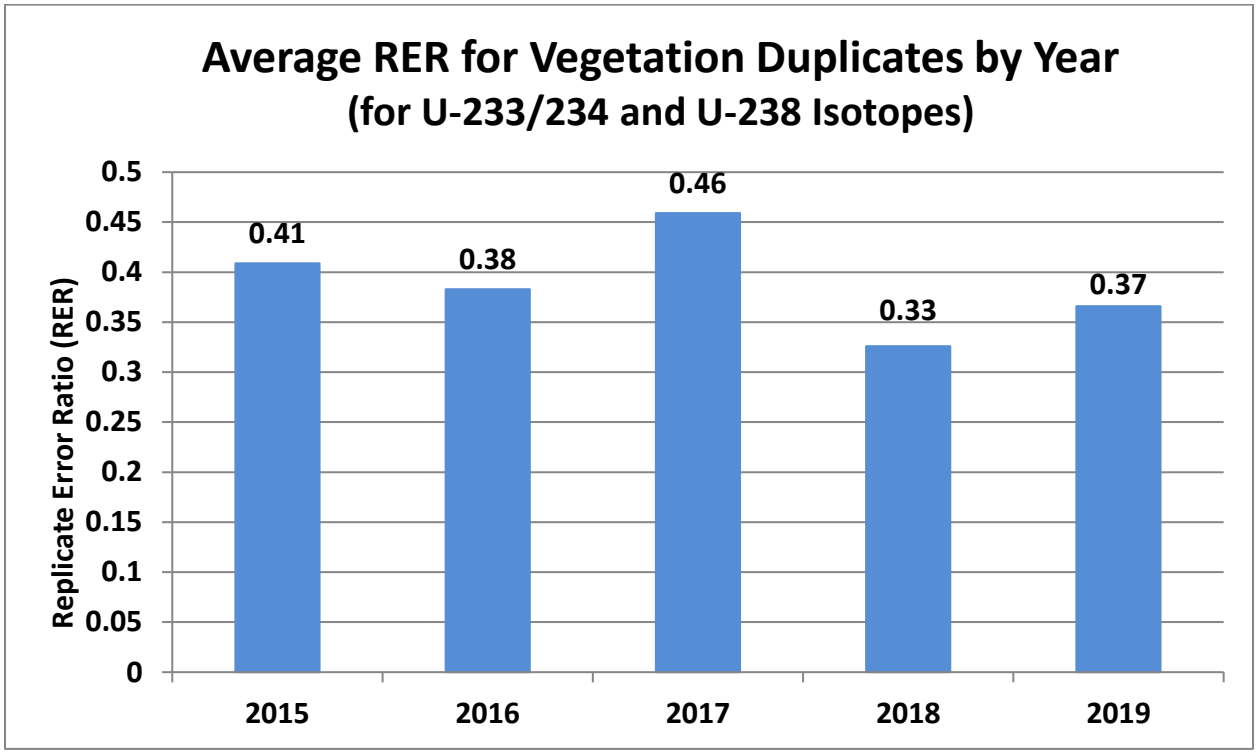

Figure 13.3 – Five Year Average Replicate Error Ratio for Vegetation Duplicates

13.5.2 Blanks and Rinsates

During 2019, 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. VOCs, such as chloroform and 1,2-dichloroethane, were detected in trip blanks in 2019. These compounds are indicative of common laboratory solvents. The frequency of detection was 0.65 percent.

13.6 ON-SITE ANALYTICAL LABORATORIES

A limited number of samples were analyzed on-site during 2019, using approved EPA or standard industry methods. On-site analyses included the following:

- Pantex Plant Materials and Analytical Services Laboratory performed analysis of samples for alkalinity, asbestos, hardness, nitrate, nitrite, 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 the Plant's 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.

13.7 CONTINUOUS IMPROVEMENT

During 2019, Pantex Plant 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 useable data acquired over the past 20+ years (Figure 13.4). Using 1996 as the base year, a 95 percent 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 the annual site environmental report.

A well-established quality framework exists at Pantex Plant 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.

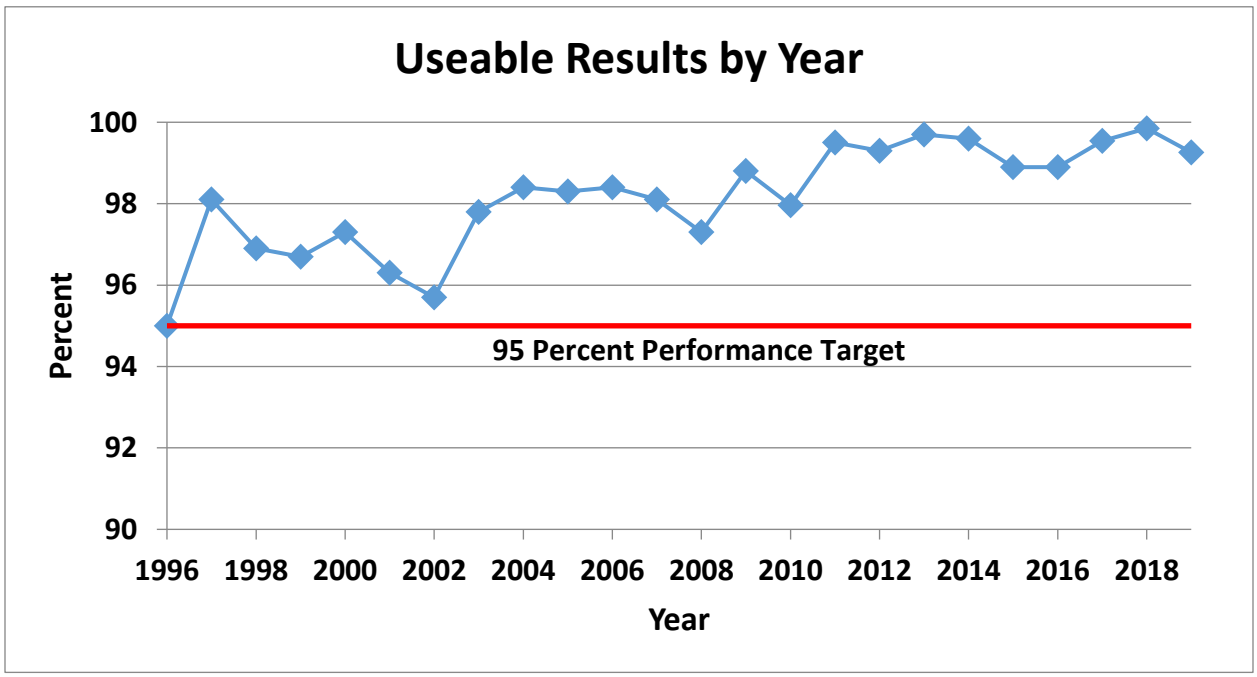

Figure 13.4 – History of Useable Results Data

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Appendix A - Birds Identified at Pantex Plant in 2019

Common Name	*Scientific Name*
Cattle egret	*Bubulcus ibis*
Great blue heron	*Ardea herodias*
Sandhill crane	*Grus canadensis*
Canada goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Blue-winged teal	*Anas discors*
American avocet	*Recurvirostra americana*
Black-necked stilt	*Himantopus mexicanus*
Killdeer	*Charadrius vociferus*
Wilson's phalarope	*Phalaropus tricolo*
Long-billed dowitcher	*Limnodromus scolopaceus*
Upland sandpiper	*Bartramia longicauda*
American kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Prairie falcon	*Falco mexicanus*
Red-tailed hawk	*Buteo jamaicensis*
Swainson's hawk	*Buteo swainsoni*
Rough-legged hawk	*Buteo lagopus*
Ferruginous hawk	*Buteo regalis*
Northern harrier	*Circus cyaneus*
Osprey	*Pandion haliaetus*
Turkey vulture	*Cathartes aura*
Golden eagle	*Aquila chrysaetos*

Appendix A - Birds Identified at Pantex Plant in 2019

Common Name	*Scientific Name*
American bald eagle	*Haliaeetus leucocephalus*
Northern bobwhite	*Colinus virginianus*
Ring-necked pheasant	*Phasianus colchicus*
Mourning dove	*Zenaida macroura*
White-winged dove	*Zenaida asiatica*
Eurasian collared dove	*Streptopelia decaocto*
Rock pigeon (feral)	*Columba livia*
Great-horned owl	*Bubo virginianus*
Burrowing owl	*Athene cunicularia hypugea*
Common nighthawk	*Chordeiles minor*
Western kingbird	*Tyrannus verticalis*
Scissor-tailed flycatcher	*Tyrannus forficatus*
Horned lark	*Eremophila alpestris*
Barn swallow	*Hirundo rustica*
American crow	*Corvus brachyrhynchos*
Chihuahuan raven	*Corvus cryptoleucus*
Loggerhead shrike	*Lanius ludovicianus*
Northern mockingbird	*Mimus polyglottos*
Curve-billed thrasher	*Toxostoma curvirostre*
European starling	*Sturnus vulgaris*
Blue grosbeak	*Guiraca caerulea*
Brown towhee	*Pipilo fuscus*
Grasshopper sparrow	*Ammodramus savannarum*
Lark sparrow	*Chondestes grammacus*
Chipping sparrow	*Spizella passerina*
White-crowned sparrow	*Zonotrichia leucophrys*
Lincoln’s sparrow	*Melospiza lincoinii*
Dickcissel	*Spiza americana*

Common Name	***Scientific Name***
Lark bunting	*Calamospiza melanocorys*
Western meadowlark	*Sturnella neglecta*
Common grackle	*Quiscalus quiscula*
Great-tailed grackle	*Quiscalus mexicanus*
Red-winged blackbird	*Agelaius phoeniceus*
House sparrow	*Passer domesticus*
House finch	*Carpodacus mexicanus*

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Appendix B - 2019 Drinking Water Analytical Results

CONTAMINANT CATEGORY	ANALYTE	MEASURED VALUE	ACTION LEVEL/MAX CONTAMINATE LEVEL
DISINFECTANT	Residual Chlorine	1.3 mg/L	4.0 mg/L
TRIHALOMETHANES[29] TTHM2	Bromodichloromethane	5.04 µg/L	N/A
	Dibromochloromethane	4.66 µg/L	N/A
	Bromoform	2.01 µg/L	N/A
	Chloroform	3.94 µg/L	N/A
TOTAL TRIHALOMETHANES[30]		**13.7 µg/L**	**80 µg/L**
HALOACETIC ACIDS[31] TTHM2	Bromochloroacetic acid	1.80 µg/L	N/A
	Dibromoacetic acid	1.50 µg/L	N/A
	Dichloroacetic acid	1.60 µg/L	N/A
	Monobromoacetic acid	<1.00 µg/L	N/A
	Monochloroacetic acid	<1.00 µg/L	N/A
	Trichloroacetic acid	<1.00 µg/L	N/A
TOTAL HALOACETIC ACIDS[32]		**3.10 µg/L**	**60 µg/L**
Volatile Organic Compounds	Vinyl chloride	<0.500 µg/L	2 µg/L
	1,1-Dichloroethene	<0.500 µg/L	7 µg/L
	Methylene chloride	<0.500 µg/L	5 µg/L
	trans-1,2-Dichloroethene	<0.500 µg/L	100 µg/L
	cis-1,2-Dichloroethene	<0.500 µg/L	70 µg/L
	1,1,1-Trichloroethane	<0.500 µg/L	200 µg/L
	Carbon tetrachloride	<0.500 µg/L	5 µg/L
	1,2-Dichloroethane	<0.500 µg/L	5 µg/L
	Benzene	<0.500 µg/L	5 µg/L
	Trichloroethene	<0.500 µg/L	5 µg/L
	1,2-Dichloropropane	<0.500 µg/L	5 µg/L
	Toluene	<0.500 ug/L	1000 ug/L
	1,1,2-Trichloroethane	<0.500 µg/L	5 µg/L
	Tetrachloroethene	<0.500 ug/L	5 ug/L
	Chlorobenzene	<0.500 µg/L	100 µg/L
	Ethyl Benzene	<0.500 µg/L	700 µg/L

[29] Individual disinfection by-products are not regulated.
[30] Only Total Trihalomethanes are regulated.
[31] Individual disinfection by-products are not regulated
[32] Only Total Haloacetic Acids are regulated.

CONTAMINANT CATEGORY	ANALYTE	MEASURED VALUE	ACTION LEVEL/MAX CONTAMINATE LEVEL
Volatile Organic Compounds	m,p-Xylene	<0.500 µg/L	N/A
	Styrene	<0.500 µg/L	100 µg/L
	1,4-Dichlorobenzene	<0.500 ug/L	75 ug/L
	1,2-Dichlorobenzene	<0.500 µg/L	600 µg/L
	1,2,4-Trichlorobenzene	<0.500 µg/L	70 µg/L
	Xylene (total)	<0.500 µg/L	10,000 µg/L
	Dichlorodifluoromethane	<0.500 ug/L	N/A
	Chloromethane	<0.500 µg/L	N/A
	Bromomethane	<0.500 µg/L	N/A
	Chloroethane	<0.500 µg/L	N/A
	4-Chlorotoluene	<0.500 ug/L	N/A
	Trichlorofluoromethane	<0.500 ug/L	N/A
	Acetone	<5.00 µg/L	N/A
	Methyl iodide	<0.500 ug/L	N/A
	Tert-Butyl methyl ether (MTBE)	<0.500 ug/L	N/A
	Carbon disulfide	<0.500 µg/L	N/A
	Acrylonitrile	<0.500 µg/L	N/A
	1,1-Dichloroethane	<0.500 µg/L	N/A
	Vinyl acetate	<0.500 µg/L	N/A
	2,2-Dichloropropane	<0.500 µg/L	N/A
	2-Butanone	<0.500 ug/L	N/A
	Bromochloromethane	<0.500 µg/L	N/A
	Tetrahydrofuran	<0.500 µg/L	N/A
	Chloroform	<1.00 ug/L	N/A
	1,1-Dichloropropene	<0.500 µg/L	N/A
	Methyl methacrylate	<0.500 µg/L	N/A
	Dibromomethane	<0.500 µg/L	N/A
	Bromodichloromethane	<1.00 µg/L	N/A
	cis-1,3-Dichloropropene	<0.500 µg/L	N/A
	4-Methyl-2-pentanone	<0.500 ug/L	N/A
	Trans-1,3-Dichloropropene	<0.500 µg/L	N/A
	Ethyl methacrylate	<0.500 µg/L	N/A
	1,3-Dichloropropane	<0.500 µg/L	N/A
	2-Hexanone	<0.500 µg/L	N/A
	Dibromochloromethane	<1.00 ug/L	N/A
	1,1,1,2-Tetrachloroethane	<0.500 µg/L	N/A
	o-Xylene	<0.500 ug/L	N/A
	Bromoform	<1.00 ug/L	N/A

CONTAMINANT CATEGORY	ANALYTE	MEASURED VALUE	ACTION LEVEL/MAX CONTAMINATE LEVEL
Volatile Organic Compounds	lsopropylbenzene (Cumene)	<0.500 µg/L	N/A
	1,1,2,2-Tetrachloromethane	<0.500 ug/L	N/A
	Bromobenzene	<0.500 µg/L	N/A
	1,2,3-Trichloropropane	<0.500 µg/L	N/A
	n-Propylbenzene	<0.500 µg/L	N/A
	2-Chlorotoluene	<0.500 ug/L	N/A
	1,3,5-Trimethylbenzene	<0.500 µg/L	N/A
	tert-Butylbenzene	<0.500 µg/L	N/A
	1,2,4-Trimethylbenzene	<0.500 µg/L	N/A
	sec-Butylbenzene	<0.500 µg/L	N/A
	1,3-Dichlorobenzene	<0.500 µg/L	N/A
	4-lsopropyltoluene	<0.500 µg/L	N/A
	n-Butylbenzene	<0.500 µg/L	N/A
	Hexachlorobutadiene	<0.500 ug/L	N/A
	Naphthalene	<0.500 ug/L	N/A
	1,2,3-Trichlorobenzene	<0.500 µg/L	N/A
INORGANICS WATER QUALITY CONSTITUENTS	Nitrate (as N)	1.47 mg/L	10 mg/L
	Aluminum	<0.005 mg/L	N/A
	Antimony	<0.001 mg/L	0.006 mg/L
	Arsenic	0.0022 mg/L	0.01 mg/L
	Barium	0.11 mg/L	2 mg/L
	Beryllium	<0.001 mg/L	0.004
	Cadmium	<0.001 mg/L	0.005
	Calcium	38.2 mg/L	N/A
	Chromium	0.004 mg/L	0.1 mg/L
	Copper	0.0024 mg/L	1 mg/L
	Iron	<0.050 mg/L	N/A
	Lead	<0.001 mg/L	0.015 mg/L
	Magnesium	23.2 mg/L	N/A
	Manganese	<0.001 mg/L	N/A
	Mercury	<0.0002 mg/L	0.002 mg/L
	Nickel	<0.001 mg/L	N/A
	Potassium	5.71 mg/L	N/A
	Selenium	<0.005 mg/L	0.05 mg/L
	Silver	<0.001 mg/L	N/A
	Sodium	37.9 mg/L	N/A
	Thallium	<0.001 mg/L	0.002 mg/L
	Zinc	<0.005 mg/L	N/A
PESTICIDES	Aroclor-1016	<0.07 ug/L	0.5 ug/L
	Aroclor-1221	<0.1 ug/L	0.5 ug/L
	Aroclor-1232	<0.1 ug/L	0.5 ug/L
	Aroclor-1242	<0.1 ug/L	0.5 ug/L

CONTAMINANT CATEGORY	ANALYTE	MEASURED VALUE	ACTION LEVEL/MAX CONTAMINATE LEVEL
PESTICIDES	Aroclor-1248	<0.1 ug/L	0.5 ug/L
	Aroclor-1254	<0.1 ug/L	0.5 ug/L
	Aroclor-1260	<0.1 ug/L	0.5 ug/L
	PCB, Total	<0.1 ug/L	N/A
	Chlordane	<0.1 ug/L	2 ug/L
	Toxaphene	<0.1 ug/L	3 ug/L
	Benzo(a)pyrene	<0.02 ug/L	0.2 ug/l
	trans-Nonachlor-chlordane	<0.1 ug/L	N/A
	Alachlor	<0.1 ug/L	2 ug/L
	Aldrin	<0.1 ug/L	N/A
	Alpha-Chlordane	<0.1 ug/L	2 ug/L
	Atrazine	<0.1 ug/L	3 ug/L
	Bromacil	<0.1 ug/L	N/A
	Butachlor	<0.1 ug/L	N/A
	Dieldrin	<0.1 ug/L	N/A
	Endrin	<0.01 ug/L	2 ug/L
	gamma-BHC (Lindane)	<0.02 ug/L	0.2 ug/L
	gamma-Chlordane	<0.1 ug/L	2 ug/L
	Heptachlor	<0.03 ug/L	0.4 ug/L
	Heptachlor epoxide	<0.02 ug/L	0.2 ug/L
	Hexachlorobenzene	<0.1 ug/L	1 ug/L
	Hexachlorocyclopentadiene	<0.1 ug/L	50 ug/L
	Methoxychlor	<0.1 ug/L	40 ug/L
	Metolachlor	<0.1 ug/L	N/A
	Metribuzin	<0.1 ug/L	N/A
	Propachlor	<0.1 ug/L	N/A
	Simazine	<0.06 ug/L	4 ug/L
	Bis(2-Ethylhexyl)adipate	<0.5 ug/L	400 ug/L
	Bis(2-Ethylhexyl)phthalate	<0.5 ug/L	6 ug/L

Appendix C – Analytes Monitored in 2019

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]	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Cadmium	7440-43-9	-	+	+	+	-	+	-	-	+	-
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]	-	-	-
Ferric Iron	N/A	-	+	-	-	-	-	-	-	-	-
Ferrous Iron	1345-25-1	-	+	-	-	-	-	-	-	-	-
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	-	+	+	+	-	+	-	-	+	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Sodium	7440-23-5	-	+	+	-	-	-	+ [i]	-	-	-
Strontium	7440-24-6	-	-	-	-	-	-	-	-	-	-
Thallium	7440-28-0	-	+	+	-	-	-	-	-	+	-
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	1946-51-0	-	+	-	+	-	-	-	-	-	-
4-nitrotoluene	99-99-0	-	-	-	+	-	-	-	-	-	-
HMX	2691-41-0	-	+	-	+	+	+	-	-	+	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Nitrobenzene	98-95-3	-	-	-	+	-	-	+	-	-	-
PETN	78-11-5	-	-	-	+	+	+	-	-	+	-
RDX	121-82-4	-	+	-	+	+	+	-	-	+	-
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			+						-	

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Pesticides											
Alachlor	15972-60-8	-	-	+	-	-	-	-	-	-	-
Aldrin	309-00-2	-	-	+	-	-	-	-	-	-	-
Atrazine	1912-24-9	-	-	+	-	-	-	-	-	-	-
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	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Sevin (carbaryl)	63-25-2	-	-	-	-	-	-	-	-	-	-
Simazine	122-34-9	-	-	+	-	-	-	-	-	-	-
Toxaphene	8001-35-2			+						-	
trans-Nonachlor-chlordane	57-74-9			+						-	
Herbicides											
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	-	-	-	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	+	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Sodium Adsorption Ratio	NA	-	-	-	-	-	-	+ [i]	-	-	-
Specific conductance	10-34-4	-	-	-	-	-	-	-	-	+	-
Sulfate	14808-79-8	-	+	-	-	-	-	-	-	+	-
Sulfide	18496-25-8	-	+	-	-	-	-	-	-	-	-
Sulfur	NA	-	-	-	-	-	-	+ [i]	-	-	-
Temperature	NA	-	+	+	+	+	-	-	-	+	-
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	-	-	+	+	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	+	+	-	-	-	-	-	-
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	-	-	+	+	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	+	+	-	-	-	-	-	-
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	-	-	+	+	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	+	+	-	-	-	-	-	-
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	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	-	+	-	-	-	-	-	-
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	-	-	+	+	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	-	-	-	-	-	-	-	-
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	-	-	-	+	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	-	+	-	-	-	-	-	-
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	-	-	+	+	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	+	-	-	-	-	-	-	-
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	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	-	+	-	-	-	-	-	-
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	-	-	-	+	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
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	-	-	-	-	-	-	-	-	-	+
Hanta virus	NA	-	-	-	-	-	-	-	-	-	+
Plague bacteria	NA	-	-	-	-	-	-	-	-	-	+
Pseudorabies	NA	-	-	-	-	-	-	-	-	-	+
Tuleremia	NA	-	-	-	-	-	-	-	-	-	+
Volatile Fatty Acids[h]											
Acetic Acid	64-19-7	-	+	-	-	-	-	-	-	-	-
Butyric Acid	107-92-6	-	+	-	-	-	-	-	-	-	-
Hexanoic Acid	142-62-1	-	+	-	-	-	-	-	-	-	-
i-Hexanoic Acid	646-07-1	-	+	-	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
i-Pentanoic Acid	503-74-2	-	+	-	-	-	-	-	-	-	-
Lactic Acid and HIBA	50-21-5	-	+	-	-	-	-	-	-	-	-
Pentanoic Acid	109-52-4	-	+	-	-	-	-	-	-	-	-
Propionic Acid	79-09-4	-	+	-	-	-	-	-	-	-	-
Pyruvic Acid	127-17-3	-	+	-	-	-	-	-	-	-	-
Dissolved Gases[h]											
Ethane	74-84-0	-	+	-	-	-	-	-	-	-	-
Ethene	74-85-1	-	+	-	-	-	-	-	-	-	-
Methane	74-82-8	-	+	-	-	-	-	-	-	-	-

[a] Groundwater
[b] Drinking water
[c] Storm water 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 – 2019 Soil Sampling Monitoring Results

Table 10.1 – Sampling Location: BG-SS-C1

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	1.5	8.4	No
Boron (B)	13	50	No
Cadmium (Cd)	0.69	1	No
Cobalt (Co)	9.9	17.6	No
Chromium (Cr)	17	19.9	No
Copper (Cu)	26	67.3	No
2,4-dinitrotoluene (2,4-DNT)	<0.098	0.5	No
2,6-dinitrotoluene (2,6-DNT)	<0.098	0.5	No
Mercury (Hg)	0.13	0.3	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	89	858.2	No
Nickel (Ni)	21	29.8	No
Lead (Pb)	23	54.8	No
Pentaerythritol tetranitrate (PETN)	<0.59	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.05	2.6	No
Triaminonitrobenzene (TATB)	7.56	23.3	No
1,3,5-trinitrobenzene (TNB135)	<0.098	10	No
Trinitrotoluene (TNT)	<0.098	10	No
Zinc (Zn)	76	160.6	No

Table 10.2 – Sampling Location: BG-SS-C2

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	<0.47	1	No
Boron (B)	13	50	No
Cadmium (Cd)	0.28	1	No
Cobalt (Co)	7.4	8.8	No
Chromium (Cr)	13	16.2	No
Copper (Cu)	25	75.4	No
2,4-dinitrotoluene (2,4-DNT)	< 0.095	0.5	No
2,6-dinitrotoluene (2,6-DNT)	< 0.095	0.5	No
Mercury (Hg)	<0.04	0.2	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	< 0.095	1	No
Nickel (Ni)	16	24.5	No
Lead (Pb)	13	77.8	No
Pentaerythritol tetranitrate (PETN)	< 0.57	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	< 0.14	1	No
Triaminonitrobenzene (TATB)	< 0.391	3	No
1,3,5-trinitrobenzene (TNB135)	< 0.095	10	No
Trinitrotoluene (TNT)	< 0.095	10	No
Zinc (Zn)	99	317.3	No

Table 10.3 – Sampling Location: BG-SS-C3

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	<0.46	1	No
Boron (B)	12	50	No
Cadmium (Cd)	0.37	1	No
Cobalt (Co)	9.7	18.7	No
Chromium (Cr)	13	28.9	No
Copper (Cu)	32	53.8	No
2,4-dinitrotoluene (2,4-DNT)	< 0.097	0.5	No
2,6-dinitrotoluene (2,6-DNT)	< 0.097	0.5	No
Mercury (Hg)	0.03	0.2	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	49	367.1	No
Nickel (Ni)	21	30.9	No
Lead (Pb)	17	54.9	No
Pentaerythritol tetranitrate (PETN)	< 0.58	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	<0.15	1.8	No
Triaminonitrobenzene (TATB)	1.63	26.9	No
1,3,5-trinitrobenzene (TNB135)	< 0.097	10	No
Trinitrotoluene (TNT)	< 0.097	10	No
Zinc (Zn)	130	168	No

Table 10.4 – Sampling Location: P3-SS-C1

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	<0.47	1	No
Boron (B)	11	50	No
Cadmium (Cd)	0.68	1	No
Cobalt (Co)	9.7	35.8	No
Chromium (Cr)	13	36.4	No
Copper (Cu)	26	44.2	No
2,4-dinitrotoluene (2,4-DNT)	<0.097	0.5	No
2,6-dinitrotoluene (2,6-DNT)	<0.097	0.5	No
Mercury (Hg)	0.03	0.2	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	<0.097	1	No
Nickel (Ni)	22	43.4	No
Lead (Pb)	25	54.1	No
Pentaerythritol tetranitrate (PETN)	<0.58	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	<0.15	1	No
Triaminonitrobenzene (TATB)	<0.395	3	No
1,3,5-trinitrobenzene (TNB135)	<0.097	10	No
Trinitrotoluene (TNT)	<0.097	10	No
Zinc (Zn)	95	129.8	No

Table 10.5 – Sampling Location: P3-SS-C2

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	<0.45	1	No
Boron (B)	11	50	No
Cadmium (Cd)	0.57	1	No
Cobalt (Co)	11	37.2	No
Chromium (Cr)	41	49.3	No
Copper (Cu)	24	43.9	No
2,4-dinitrotoluene (2,4-DNT)	<0.1	0.5	No
2,6-dinitrotoluene (2,6-DNT)	<0.1	0.5	No
Mercury (Hg)	0.03	0.2	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	<0.1	1	No
Nickel (Ni)	23	53.2	No
Lead (Pb)	24	24.4	No
Pentaerythritol tetranitrate (PETN)	<0.6	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	<0.15	1	No
Triaminonitrobenzene (TATB)	<0.399	3	No
1,3,5-trinitrobenzene (TNB135)	<0.1	10	No
Trinitrotoluene (TNT)	<0.1	10	No
Zinc (Zn)	86	139.9	No

Table 10.6 – Sampling Location: TLAP Tract 101

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)	7.6	8.3	7.7	8.3	7.7	8.3	pH Units
Total Nitrogen	630.1	483.3	761.5	535	811.3	433	mg/kg
Nitrate (as Nitrogen)	10.1	3.3	11.5	5	11.3	3	mg/kg
Total Kjeldahl Nitrogen	620	480	750	530	800	430	mg/kg
Ortho Phosphate (Plant-available)	18	4	16	3	12	2	mg/kg
Calcium (Plant-available)	3566	6993	3616	6946	3667	8005	mg/kg
Magnesium (Plant-available)	686	868	766	896	751	930	mg/kg
Sodium (Plant-available)	124	184	158	193	132	180	mg/kg
Sodium Absorption Ratio (SAR)	1.4	1.9	1.7	1.9	1.4	2	Percent
Potassium (Plant-available)	498	336	519	334	488	306	mg/kg
Conductivity (Sat Paste ECe)	0.62	0.52	0.63	0.52	0.60	0.59	µmho/cm
Calcium (Water-soluble)	55	39	48	38	52	46	mg/L
Magnesium (Water-soluble)	14	10	13	10	14	13	mg/L
Sodium (Water-soluble)	45	52	50	50	46	58	mg/L
Sulfur (Plant-available)	9	12	10	12	11	15	mg/kg

Table 10.7 – Sampling Location: TLAP Tract 201

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)	7.9	8.3	7.9	8.3	7.5	8.2	7.5	8.2	pH Units
Total Nitrogen	1116.2	691.1	758.3	487.1	877.3	650.5	773.2	587.2	mg/kg
Nitrate (as Nitrogen)	16.2	11.1	18.3	7.1	17.3	10.5	23.2	17.2	mg/kg
Total Kjeldahl Nitrogen	1100	680	740	480	860	640	750	570	mg/kg
Ortho Phosphate (Plant-available)	14	5	16	4	17	3	36	4	mg/kg
Calcium (Plant-available)	3975	7002	4720	6524	2873	5162	3075	5629	mg/kg
Magnesium (Plant-available)	792	869	705	644	589	671	604	712	mg/kg
Sodium (Plant-available)	165	202	127	145	130	169	107	153	mg/kg
Sodium Absorption Ratio (SAR)	1.8	2.2	1.6	2.1	1.7	2.1	1.3	1.7	Percent
Potassium (Plant-available)	513	346	545	248	438	275	422	277	mg/kg
Conductivity (Sat Paste ECe)	0.72	0.61	0.7	0.54	0.63	0.53	0.66	0.72	µmho/cm
Calcium (Water-soluble)	60	44	62	39	52	40	58	48	mg/L
Magnesium (Water-soluble)	17	12	16	10	14	10	15	12	mg/L
Sodium (Water-soluble)	63	66	54	56	53	58	44	51	mg/L
Sulfur (Plant-available)	9	12	9	10	8	10	8	9	mg/kg

Table 10.8 – Sampling Location: TLAP Tract 301

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)	7.5	8.3	7.8	8.1	7.5	8.1	pH Units
Total Nitrogen	718.7	474.2	680.9	497.3	669.3	455.5	mg/kg
Nitrate (as Nitrogen)	8.7	4.2	10.9	7.3	9.3	5.5	mg/kg
Total Kjeldahl Nitrogen	710	470	670	490	660	450	mg/kg
Ortho Phosphate (Plant-available)	24	4	21	5	20	5	mg/kg
Calcium (Plant-available)	2547	6045	4226	6170	3503	7179	mg/kg
Magnesium (Plant-available)	580	795	673	690	805	958	mg/kg
Sodium (Plant-available)	109	183	135	163	118	189	mg/kg
Sodium Absorption Ratio (SAR)	2.4	2.3	1.9	2.1	1.7	2.3	Percent
Potassium (Plant-available)	315	209	438	243	423	337	mg/kg
Conductivity (Sat Paste ECe)	0.49	0.48	0.59	0.47	0.38	0.5	µmho/cm
Calcium (Water-soluble)	107	38	53	34	52	35	mg/L
Magnesium (Water-soluble)	33	11	13	10	17	11	mg/L
Sodium (Water-soluble)	114	64	59	54	56	60	mg/L
Sulfur (Plant-available)	6	11	7	10	6	12	mg/kg

Table 10.9 – Sampling Location: TLAP Tract 401

Analyte (Agricultural Parameters)	Tract 401A Measured Value		Tract 401B Measured Value		Tract 401C Measured Value		Tract 401D 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)	7.6	8.1	7.7	8.2	7.8	8.0	7.7	8.2	pH Units
Total Nitrogen	779.2	434	760	674.9	1014	660.3	836.7	543.7	mg/kg
Nitrate (as Nitrogen)	9.2	4	10	4.9	14	10.3	6.7	3.7	mg/kg
Total Kjeldahl Nitrogen	770	430	750	670	1000	650	830	540	mg/kg
Ortho Phosphate (Plant-available)	11	5	10	4	31	11	14	6	mg/kg
Calcium (Plant-available)	3256	6211	4466	9032	4776	6523	4453	8088	mg/kg
Magnesium (Plant-available)	664	783	558	666	522	666	645	876	mg/kg
Sodium (Plant-available)	116	150	79	110	75	127	99	149	mg/kg
Sodium Absorption Ratio (SAR)	1.6	1.8	1.3	1.2	1.0	1.3	1.2	1.5	Percent
Potassium (Plant-available)	409	289	340	203	571	339	488	331	mg/kg
Conductivity (Sat Paste ECe)	0.56	0.45	0.60	0.22	0.45	0.48	0.44	0.38	µmho/cm
Calcium (Water-soluble)	48	36	70	35	67	49	47	37	mg/L
Magnesium (Water-soluble)	14	11	16	8	13	10	11	11	mg/L
Sodium (Water-soluble)	50	49	45	30	35	38	35	40	mg/L
Sulfur (Plant-available)	6	11	7	10	8	9	7	11	mg/kg

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Appendix E – Glossary

Activity - The rate of disintegration or transformation of radioactive material, generally expressed in units of Curies (Ci). The official SI unit is the Becquerel (Bq). One Bq (one disintegration or transformation per second) is equivalent to 2.7×10^{-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.

Aliquot – Contained an exact number of times in something else – used of a divisor or part.

Alpha particle - Type of particulate radiation (identical to the nucleus of the helium atom) consisting of two protons and two neutrons.

Ammonium nitrate - A colorless crystalline salt (NH_4NO_3) used in explosives, fertilizers, and veterinary medicine.

Anion - A negatively charged ion that migrates to an anode, as in electrolysis.

ANSI - American National Standards Institute, a voluntary standards organization; Administrator, U.S. Technical Advisory Group to the International Organization for Standardization (ISO).

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.

Archeology - Scientific discipline responsible for the recovery, analysis, interpretation, and explanation of the unwritten portion of the prehistoric and historic past.

Archival - Relating to, held in, or constituting archives, which are places where public records or historic documents are preserved.

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 Plant.

Background or control samples - Samples obtained from a background sampling location for comparison with samples obtained at or near Pantex Plant. Background or control samples are not expected to be affected by Pantex Plant 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 Système International d'Unités (SI units) unit of radioactivity defined as one nuclear disintegration per second; therefore, one Curie (Ci) is equivalent to 3.7×10^{10} Bq.

Best Management Practices - Practices that are not required by law, regulation, or permit, but are designed to help ensure that Pantex Plant 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.

Biomass - Literally, "living weight," refers to mass having its origin as living organisms.

Biome - Recognizable community units formed by the interaction of regional climate, regional biota, and substrate, e.g., the same biome units generally can be found on different continents at the same latitudes with approximately the same weather conditions and where topography is similar. Biomes are the largest land community units recognized.

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 analogue to the Derived Concentration Guide (DCG) 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 Plant.

Burning Ground - Pantex Plant location where thermal processing (burning) of high explosives 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 Plant in which certain nuclear explosive assembly or disassembly operations are conducted.

Central flyway - A major migratory route used by large numbers of migrating birds in fall and spring that crosses the central portion of North America from Canada to Mexico.

Centripetal drainage - The flow of water in a basin toward a central drain or sink, such as a pond or lake.

Code of Federal Regulations (CFR) - Final federal regulations in force: published in codified form.

Composite samples – Samples that contain a certain number of subsamples.

Council on Environmental Quality (CEQ) - Created, in the Executive Office of the President, by the National Environmental Policy Act (NEPA), such that its members are exceptionally well qualified to analyze and interpret environmental trends and information of all kinds; to appraise programs and activities of the federal government in the light of the policy set forth in Title I of NEPA; to be conscious of and responsive to the scientific, economic, social, aesthetic, and cultural needs and interests of the Nation; and to formulate and recommend national policies to promote the improvement of the quality of the environment.

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.

Depleted uranium - Uranium for which the content of the isotope of ^{235}uranium is smaller than 0.7 percent; the level found in naturally occurring uranium (and thus generally synonymous with isotope ^{238}uranium).

Derived Concentration Guide - 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 2011; Derived Concentration Technical Standard.

Dismantlement - The disassembly of a nuclear weapon no longer required by the DOD. This process takes place at Pantex Plant.

Dockum Group - Triassic sedimentary rocks that underlie the Ogallala Formation at Pantex Plant. 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.

Effects Screening Levels (ESL) - Guideline concentrations established by the Texas Commission on Environmental Quality (TCEQ) to evaluate the potential impacts of air pollutant emissions including acute and chronic health effects, odor nuisance potential, vegetation effects or corrosion effects. These are set to provide a margin of safety below levels at which adverse effects are reported in scientific literature. This margin of safety is added to protect sensitive sub-populations, such as children, the elderly, and persons with pre-existing illnesses.

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.

Emissions standards - Legally enforceable limits placed on the quantities and/or kinds of air contaminants that can be emitted into the atmosphere.

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 detailed written statement that is required by Section 102(2)(C) of NEPA for a proposed major federal action significantly affecting the quality of the human environment.

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 Protection Agency (EPA) - Federal agency created to protect the nation's water, land, and air from pollution or environmental damage.

Environmental Restoration (ER) Program - Program at Pantex Plant responsible for investigation and remediation of Solid Waste Management Units.

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.

Evapotranspiration - The sum of evaporation, the process by which water passes from the liquid to the vapor state, and transpiration, the process by which plants give off water vapor through their leaves.

Extirpate – To destroy completely.

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

Fecal coliform bacteria - Simple organisms associated with the intestine of warm-blooded animals that are commonly used to indicate the presence of fecal material and the potential presence of organisms capable of causing human disease.

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.

Grab sample - A single sample, collected at one time and place.

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.

Hantavirus Pulmonary Syndrome - The Hantavirus is found in saliva, urine, or feces of various rodent species and is transmitted to humans by inhalation. It causes rapidly progressive pulmonary symptoms that result in serious illness. Human-to-human transmission has not been demonstrated.

Hazardous material - A material, including a hazardous substance, as defined by 49 CFR 171.8 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).

Hemoglobin - A protein found in red blood cells that transports oxygen.

Herpesvirus - Any virus belonging to the family Herpesviridae. It is basically a wildlife disease, and offers possible implications to research on human viruses.

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

Herpetofauna - Reptiles (snakes, turtles, lizards, etc.) and amphibians (frogs, toads, salamanders).

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 archeological resources when archeological 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.

Interim Stabilization Measure (ISM) - Action taken to control or abate threats to human health and/or the environment from releases and/or to prevent or minimize the further spread of contamination while long-term remedies are pursued.

International System of Units - An internationally accepted coherent system of physical units, derived from the Meter, Kilogram, Second, Ampere (MKSA) System, using the meter, kilogram, second, ampere, kelvin, mole, and candela as the basic units (SI units) of the fundamental quantities length, mass, time, electric current, temperature, and luminous intensity. Abbr.: SI from the French “Système International d’Unités.”

Invertebrate - Animals characterized by not having a backbone or spinal column, including a wide variety of organisms such as insects, spiders, worms, clams, crayfish, etc.

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.

Lacustrine - Pertaining to, produced by, or inhabiting a lake or lakes.

Lagomorph - Any of the various gnawing mammals in the order Lagomorpha, including rabbits, hares, and pikas.

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.

Matrix spike duplicates - Used to evaluate the precision of a specific analysis.

Maximum Contaminant Levels (MCLs) - 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.

Mitigation - The alleviation of adverse impacts on resources by avoidance through project redesign or project relocation.

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 Clean Air Act 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, archeology, 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-Normal Event - Abnormal or unplanned events or conditions that adversely affect, potentially affect, or are indicative of degradation in, the safety, security, environmental or health protection performance or operation of a facility.

Off-site - Outside Pantex Plant site boundary.

On-site - Within Pantex Plant 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 Plant 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 Plant.)

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.

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 - 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, manmade 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.

Potentially interested parties - Under the National Historic Preservation Act (NHPA), organizations that have requested to be informed of Federal actions at a particular site.

Practical Quantitation Limit (PQL) - The Final Risk Reduction Rule Guidance is used to identify the quantifiable limit of detection for sampled constituents at Pantex Plant. 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 Plant before the long-term Cultural Resource Management Plan was implemented. The parties to the agreement were the U.S. Department of Energy, 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 interplaya areas at Pantex Plant.

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 bottoms at Pantex Plant.

Raptor - Birds of prey including various species of hawks, falcons, eagles, vultures and owls.

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.

Sedimentation - The process of deposition of sediment, especially by mechanical means from a state of suspension in air or water.

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 (archeological) - 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 archeological remains.

Slug test - An aquifer test made either by pouring a small instantaneous charge of water into a well or by withdrawing a slug of water from the well. The rate of recovery of the water table to equilibrium conditions is monitored as the stress is applied to the aquifer. Information from slug tests can be used to estimate the hydraulic conductivity of the aquifer.

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.

Storm water - A precipitation event that leads to an accumulation of water; it includes storm water runoff, snowmelt runoff, surface runoff, and drainage.

Supplement 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 CEQ NEPA regulations (40 CFR 1502.9(c)).

Surface water - Water that is open to the atmosphere and subject to surface runoff. Surface water includes storm water.

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 Plant.

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.

Transuranic waste (TRU) - Waste, without regard to source or form, that is contaminated with alpha-emitting radionuclides of atomic number greater than 92 (uranium) and with half-lives greater than 20 years in concentrations greater than 100 nanocuries per gram.

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 a high explosive and in chemical synthesis.

Trip blanks - Provided for each shipping container to be analyzed for volatile organice compounds (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.

Tularemia - A disease caused by *Francisella tularensis* and transmitted to humans by rodents through the bite of a deer fly, *Chrysops discalis*, and other bloodsucking insects; it can also be acquired directly through the bite of an infected animal or through handling of an infected animal carcass.

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 percent, 0.71 percent, and 99.28 percent, 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 Plant.

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.

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Appendix F – Elements and Chemicals

Ag	silver
As	arsenic
Ba	barium
Be	beryllium
Ca	calcium
Cd	cadmium
CO	carbon monoxide
Cr	chromium
Cu	copper
DMSO	dimethyl sulfoxide
DNX	hexahydro-1,3-Dinitroso-5-Nitro 1,3,5-triazine
Fe	iron
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
PETN	Pentaerythrithol tetranitrate
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
TCE	trichloroethylene/ethene
THF	tetrahydrofuran
Ti	titanium
TNB	trinitrobenzene
TNT	trinitrotoluene
TNX	hexahydro-1,3,5-Trinitroso-1,3,5-triazine
SO_x	sulfur oxides
Zn	zinc

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Appendix G - Units of Measure

ac	acres
Bq	becquerel
°C	degrees Celsius
cfm	cubic feet per minute
Ci	curie
cm	centimeter
cu yd	cubic yard
dpm	disintegrations per minute
dps	disintegrations per second
E ±n	exponential (E) is10± n where n is some number (see Appendix F: Conversion Information)
°F	degrees Fahrenheit
ft	foot/feet
ft/sec	feet per second
ft²	square foot
ft^3	cubic feet
g or gm	gram
g/dL	grams per deciliter
gal	gallon
gpd	gallons per day
gpm	gallons per minute
ha	hectares
hr	hour
in	inch(es)
kg	kilogram
km	kilometer
kW	kilowatt
L	liter(s)
lb	pound
m	meter
m/s	meters per second
m²	square meter
m^3	cubic meter (approx. 1.308 cubic yards)
Ma	million years ago
Mcf	thousand cubic feet
MeV	Megavolt (a.k.a. Million electron volts)
mg/dL	milligrams per deciliter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mi	mile
mi²	square mile
min	minute

MMBtu	one million British Thermal Units
mph	miles per hour
mps	meters per second
mrem/hr	millirem per hour
mSv	milliSievert
pCi/g	picocuries per gram
pCi/mL	picocuries per milliliter
ppb	parts per billion
ppm	parts per million
psf	pounds per square foot
psi	pounds per square inch
R	Roentgen
rem	Roentgen equivalent man
scfm	standard cubic ft per minute
sec	second
SU	standard units
Sv	Sievert
TPY	tons per year
yr	year
µ	micro (1.0×10^{-6})
µCi	microcurie
µCi/ml	microcuries per milliliter
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
µL	microliter
µmho/cm	micromhos per centimeter
µR	microroentgen

Appendix H - Conversion Factors

Units of Radiation Measurement

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

Scientific Notation Used for Units

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

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.					

Prefixes Used in the Metric System

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

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

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