For Calendar Year 2017

# Annual Site Environmental Report

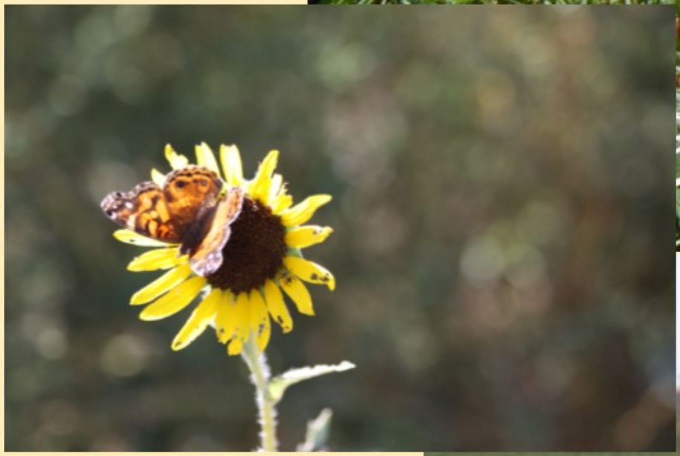
## Pantex Plant

consolidated nuclear security, llc

PANTEX PLANT | Y-12 NATIONAL SECURITY COMPLEX

NNSA PRODUCTION OFFICE · ONE NNSA · U.S. DEPARTMENT OF ENERGY

Right: Musk Thistle or Nodding Thistle (*Carduus nutans*)



Above: Common Sunflower (*Helianthus annuus*) and butter-fly.

Right: Great Blue Heron (*Ardea herodias*) at an on site Playa lake.

**On the cover: Pantex is situated in a short grass prairie called the Southern High Plains region of Texas. The area includes the Texas Panhandle and Eastern New Mexico. The dominate grasses in the region are blue gramma (Bouteloua gracillis) and buffalo (Buchloe dactyloides). The area also includes shallow ephemeral lakes called Playas, which create habitat for many species of plants and animals.**

# Site Environmental Report
# Pantex Plant 2017

**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

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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:

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JCDC 1008-02
Amarillo, TX 79120-0020
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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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Amarillo, TX 79120-0020

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## Abbreviations and Acronyms

| | |
|---|---|
| AEC | Atomic Energy Commission |
| AFV | Alternative Fuel Vehicle |
| ALARA | As Low As Reasonably Achievable |
| AQMR | Air Quality Management Requirement |
| ARPA | Archaeological Resource Protection Act |
| 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 |
| CoE | Center of Excellence |
| CP | Compliance Plan |
| 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 |
| ERA | Ecological Risk Assessment |
| 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 Explosives |
| HEPA | High-Efficiency Particulate Air |
| HEPF | High Explosives Pressing Facility |

| | |
|---|---|
| HPFL | High Pressure Fire Loop |
| HRO | High Reliability Organization |
| HVAC | Heating-Ventilation Air Conditioning |
| HWTPF | Hazardous Waste Treatment & Processing Facility |
| IAG | Interagency Agreement |
| ICRP | International Commission of Radiological Protection |
| IEDB | Integrated Environmental Database |
| ISB | In-Situ Bioremediation |
| ISM | Integrated Safety Management |
| ISO | International Organization for Standardization |
| IWQP | Inland Water Quality Parameter |
| LCR | Lead & Copper Rule |
| 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 |
| MOU | Memorandum of Understanding |
| MSGP | Multi-Sector General Permit |
| NCR | Non-conformance Report |
| 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 |
| PER | Problem Evaluation Report |
| PIDAS | Perimeter Intrusion Detection and Surveillance |
| PM | Particulate Matter |
| PMU | Playa Management Unit |
| PPOA | Pollution Prevention Opportunity Assessment |
| PQL | Practical Quantitation Limit |
| PRB | Permeable Reactive Barrier |
| PREP | Pantex Renewable Energy Project |
| PST | Petroleum Storage Tank |
| PTE | Potential to Emit |
| PTT | Platform Transmitter Terminal |
| PWS | Public Water System |
| QA | Quality Assurance |

| | |
|---|---|
| QC | Quality Control |
| RAO | Remedial Action Objective |
| RCRA | Resource Conservation and Recovery Act |
| RER | Replicate Error Ratio |
| ROD | Record of Decision |
| RRS | Risk Reduction Standard |
| RSD | Radiation Safety Department |
| SA | Supplement Analysis |
| SAP | Sampling & Analysis Plan |
| SARA | Superfund Amendments and Reauthorization Act |
| SDWA | Safe Drinking Water Act |
| SDS | Safety Data Sheets |
| SDZ | Surface Danger Zone |
| SEISB | Southeast In-Situ Bioremediation |
| SEPTS | Southeast Pump and Treat System |
| SHPO | State Historic Preservation Office |
| SOC | Synthetic Organic Chemicals |
| SMP | Site Management Plan |
| SOP | Standard Operating Procedures |
| SOW | Statement of Work |
| STEM | Science, Technology, Engineering, and Math |
| 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 |
| THM | 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 |
| TRI | Toxic Chemical Release Inventory |
| TSCA | Toxic Substances Control Act |
| TSS | Total Suspended Solids |
| TTRF | Texas Tech Research Farm |
| TTU | Texas Tech University |
| TWQP | Texas Water Quality Permit |
| TYSP | Ten Year Site Plan |
| UCL | Upper Confidence Limit |
| 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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## 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.

Report preparation was managed by K. E. Braughton.

The following people provided information and assistance for this year's report:

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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 *2017 Annual Site Environmental Report for Pantex Plant* was reviewed for classification and security issues; it was determined to be Unclassified.

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## 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 X $10^{-11}$ Ci.

**ALARA -** An acronym and phrase, "As Low As Reasonably Achievable," used to describe an approach to radiation exposures and emission control or management whereby the exposures and resulting doses to the public are maintained as far below the specified limits as economic, technical, and practical considerations will permit. ALARA is not a dose limit.

**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 -** The scientific discipline responsible for recovering, analyzing, interpreting, and explaining 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 the Pantex Plant.

**Background or control samples -** Samples obtained from a background sampling location for comparison with samples obtained at or near Pantex. Background or control samples are not expected to be affected by Pantex operations. The U.S. Department of Agriculture Research Station and the Texas Agri-Life Bush Research Farm at Bushland, Texas, have often been used as a control or background location.

**Background radiation -** Ionizing radiation which is in the natural environment, including cosmic rays and radiation from the naturally radioactive elements, both outside and inside the bodies of humans and animals.

**Becquerel (Bq) -** The Système International d'Unités (SI units) unit of radioactivity is the becquerel, defined as one nuclear disintegration per second; therefore, one Curie (Ci) is equivalent to 3.7 X $10^{10}$ Bq.

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

**Burning Ground -** The Pantex Plant location where thermal processing (burning) of high explosives (HE) is conducted.

**Calibration -** The adjustment of a measurement system and the determination of its accuracy using known sources and instrument measurements. Adjustment of flow, temperature, humidity, or pressure gauges and the determination of system accuracy should be conducted using standard operating procedures and sources that are traceable to the National Institute of Standards and Technology.

**Categorical Exclusion** – Categorical exclusions are categories of actions under the National Environmental Policy Act (NEPA) that DOE has determined, by regulation, do not individually or cumulatively have a significant effect on the human environment and for which; therefore, neither an environmental assessment nor an environmental impact statement normally is required.

**Cation** – A positively charged ion that in an electrolyte moves toward a negative electrode.

**Cell -** (1) This is the smallest unit capable of independent functioning. (2) A structure at Pantex in which certain nuclear explosive assembly or disassembly operations are conducted.

**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 -** The 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 the Pantex Plant.

**Dockum Group -** Triassic sedimentary rocks that underlie the Ogallala Formation at the 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 TCEQ to evaluate the potential impacts of air pollutant emissions including acute and chronic health effects, odor nuisance potential, vegetation effects or corrosion effects. ESLs 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 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 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 (HE) -** 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 also may be considered to be archeological resources when archeological work is involved in their 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 the Pantex Plant site boundary.

**On-site -** Within the 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 overlies the Triassic Dockum Group strata and underlies the Quaternary Blackwater Draw Formation.

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

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

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

**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. 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 the 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 the 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. It progresses to agitation, confusion, combativeness, increased salivation and decreased swallowing, followed by coma and death. It is transmitted to humans by the bite of an infected dog, cat, skunk, wolf, fox, raccoon, or bat.

**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 the 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/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/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/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 the 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 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 the 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 -** 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 specifically designed 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.

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## Chemicals and Units of Measure

| | |
|---|---|
| Ag | silver |
| As | arsenic |
| Ba | barium |
| Be | beryllium |
| Bq | Becquerel |
| °C | degrees Celsius |
| Ca | calcium |
| Cd | cadmium |
| cfm | cubic feet per minute |
| Ci | Curie |
| cm | centimeter |
| CO | carbon monoxide |
| Cr | chromium |
| Cu | copper |
| cu yd | cubic yard |
| DMSO | dimethyl sulfoxide |
| DNX | hexahydro-1,3-Dinitroso-5-Nitro 1,3,5-triazine |
| dpm | disintegrations per minute |
| dps | disintegrations per second |
| E ±n | exponential (E) is10± n where n is some number (see Appendix D: Helpful Information) |
| °F | degrees Fahrenheit |
| Fe | iron |
| ft | foot/feet |
| ft/sec | feet per second |
| $ft^2$ | 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 |
| Hg | mercury |
| hr | hour |
| HMX | octahydro-1,3,5,7-tetranitro 1,3,5,7-tetrazocine |
| in | inch(es) |
| $K_2O$ | potassium oxide |
| kg | kilogram |
| km | kilometer |
| kW | kilowatt |
| L | liter(s) |
| lb | pound |
| m | meter |
| m/s | meters per second |
| $m^2$ | square meter |
| $m^3$ | cubic meter (approx. 1.308 cubic yards) |
| Ma | million years ago |
| Mcf | thousand cubic feet |
| MEK | methyl ethyl ketone |
| 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 |
| $mi^2$ | square mile |
| min | minute |
| MMBtu | one million British Thermal Units |
| Mn | manganese |
| MNX | hexahydro-1-Nitroso-3,5-Dinitro-1,3,5-triazine |
| mph | miles per hour |
| mps | meters per second |
| mrem/hr | millirem per hour |
| mSv | millisievert |
| µCi | microcurie |
| µCi/ml | microcuries per milliliter |
| µg/L | micrograms per liter |
| $\mu g/m^3$ | micrograms per cubic meter |
| µL | microliter |
| µmho/cm | micromhos per centimeter |
| µR | microroentgen |
| $NO_2$ | nitrogen dioxide |
| NOx | nitrogen oxides |
| $O_3$ | ozone |
| Pb | lead |
| PCBs | polychlorinated biphenyls |
| pCi/g | picocuries per gram |
| pCi/mL | picocuries per milliliter |
| PETN | Pentaerythrithol tetranitrate |
| $PM_{10}$ | particulate matter with a mean aerodynamic diameter $\leq$10 micrometers |
| ppb | parts per billion |
| ppm | parts per million |
| psf | pounds per square foot |
| psi | pounds per square inch |
| R | Roentgen |
| rem | Roentgen equivalent man |
| RDX | hexahydro-1,3,5-trinitro-1,3,5-triazine |
| scfm | standard cubic ft per minute |
| sec | second |
| $SO_2$ | sulfur dioxide |
| SOx | sulfur oxides |
| SU | standard units |
| Sv | Sievert |
| TCE | trichloroethylene/ethene |
| THF | tetrahydrofuran |
| Ti | titanium |
| TNB | trinitrobenzene |
| TNT | trinitrotoluene |
| TNX | hexahydro-1,3,5-Trinitroso-1,3,5-triazine |
| TPY | tons per year |
| yr | year |
| Zn | zinc |
| µ | micro ($1.0 \times 10^{-6}$) |

# Executive Summary

*The U.S. Department of Energy (DOE) oversees the operation of the Pantex Plant through the National Nuclear Security Administration (NNSA) Production Office (NPO). Consolidated Nuclear Security, LLC (CNS Pantex) managed the environmental aspects of its operations in a manner consistent with Integrated Safety Management (ISM), applicable environmental regulations, and best management practices.*

## The Purpose of the Report

The 2017 Annual Site Environmental Report (ASER) for the Pantex Plant summarizes the efforts, data, and status of Pantex's environmental protection, compliance, and monitoring programs for calendar year 2017. This report is prepared in accordance with DOE Order 231.1B, Environment, Safety and Health Reporting (DOEf), and DOE Order 458.1, Radiation Protection of the Public and the Environment (DOEi). 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, located northeast of Amarillo, Texas, is the nation's primary facility for the assembly, dismantlement, modification, and maintenance of nuclear weapons. The Plant also supports the nuclear weapons stockpile by developing, testing, and fabricating high explosives components. The Pantex Plant site encompasses about 18,000 acres, although most operations are conducted on 2,000 acres of land. The Plant maintains its own water treatment, sewage, and steam-generating plants. All work at Pantex is carried out 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 Pantex Plant has a comprehensive environmental program. The environmental policy (pp. xxxiv) defines the program that contains components of environmental management including, but not limited to, regulatory compliance, pollution prevention, and environmental monitoring.

Data from the monitoring program obtained in past years are summarized in previous ASERs, which 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, have been made available on the Pantex website at http://www.pantex.energy.gov. Previous years copies of the Pantex ASER are available by contacting Pantex Communications at public_communications@cns.doe.gov.

The purpose of the environmental monitoring component of the Plant's Environmental Management System (EMS) is to provide indicators of potential impact to human health and the environment and to demonstrate compliance with applicable regulatory limits. The environmental monitoring program monitors air, groundwater, drinking water, surface water, wastewater, soil, vegetation, and fauna. Pantex also operates a meteorological monitoring program that supports several of the requirements. Samples for 2017 were routinely collected at diverse locations, and 24,159 analyses were performed for substances including explosives, metals, organic chemicals, inorganic chemicals, radionuclides, and water quality indicators.

The Pantex EMS provides the foundation to administer sound stewardship practices that protect natural and cultural resources while cost-effectively demonstrating compliance with environmental, public health and resource protection laws, regulations, and DOE requirements. Notable accomplishments in 2017 relating to the Pantex EMS include:

- Pantex was extremely 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, Earth Day activities, and a Science Bowl Competition for area Middle Schools and High Schools.
- In early 2018, the 2017 Presidential Migratory Bird Federal Stewardship Award was to be named from among three finalists: USDOE/NNSA/Pantex, the National Park Service, and the Bureau of Ocean Energy Management in Coordination with the United States Geological Survey.
- Pantex has diverted ~40% of Municipal Solid Waste, and construction & demolition material/debris originally earmarked for landfills and identified alternate pathways for beneficial reuse.
- Ninety-three percent of all electronics procured have met criteria for being environmentally sustainable.
- CNS has achieved sufficient energy savings to enable both Pantex and Y-12 to meet clean and renewable electric energy targets.

As required by DOE Order 436.1, Departmental Sustainability (DOEh), every three years the Pantex EMS has an audit conducted to determine the level of conformance with the International Organization for Standardization (ISO) 14001 Environmental Management Systems – Requirements with Guidance for Use (ISO). In March of 2014 an audit, consistent with instructions for implementing Executive Order (EO) 13423, Strengthening Federal Environmental and Transportation Management (EOa), was conducted. A "qualified" party outside the control or scope of the Pantex EMS Program performed the audit. The outcome of the audit indicated that Pantex has fully implemented an EMS program that conforms to ISO 14001 standards. The next validation audit is scheduled to be performed in 2018.

**Radiation Dose**

In 2017, the calculated annual radiation dose from releases to the atmosphere generated by Plant operations was $7.60 \times 10^{-6}$ mrem/yr ($7.60 \times 10^{-8}$ mSv/yr) for a hypothetical, maximally exposed member of the public (Table 1). This annual dose continues to be several orders of magnitude below the U.S. Environmental Protection Agency's (EPA's) standard for the air pathway of 10 mrem per year above background. The 2017 radiological monitoring results were consistent with those of previous years. The background radiation dose measured at control locations (excluding radon) were attributed to naturally occurring terrestrial and cosmic radiation, and averaged 95.0 mrem for the calendar year 2017 (Figure 1). This is consistent with historical data. No unplanned radionuclide releases occurred at the Pantex Plant in 2017. The ambient air monitoring results for 2017 were generally similar to those from previous years. All results were below the applicable DOE Derived Concentration Standard (DCS).

**Table 1 – Pantex Radiation Dose for 2017 Compared to Regulatory Dosage Allowances**.

| Pantex Radiation Dose (mrem) | EPA Standard Air Pathway (mrem) | DOE Standard All Pathways (mrem) |
|---|---|---|
| 0.00000760 ($7.60 \times 10^{-6}$) | 10 | 100 |

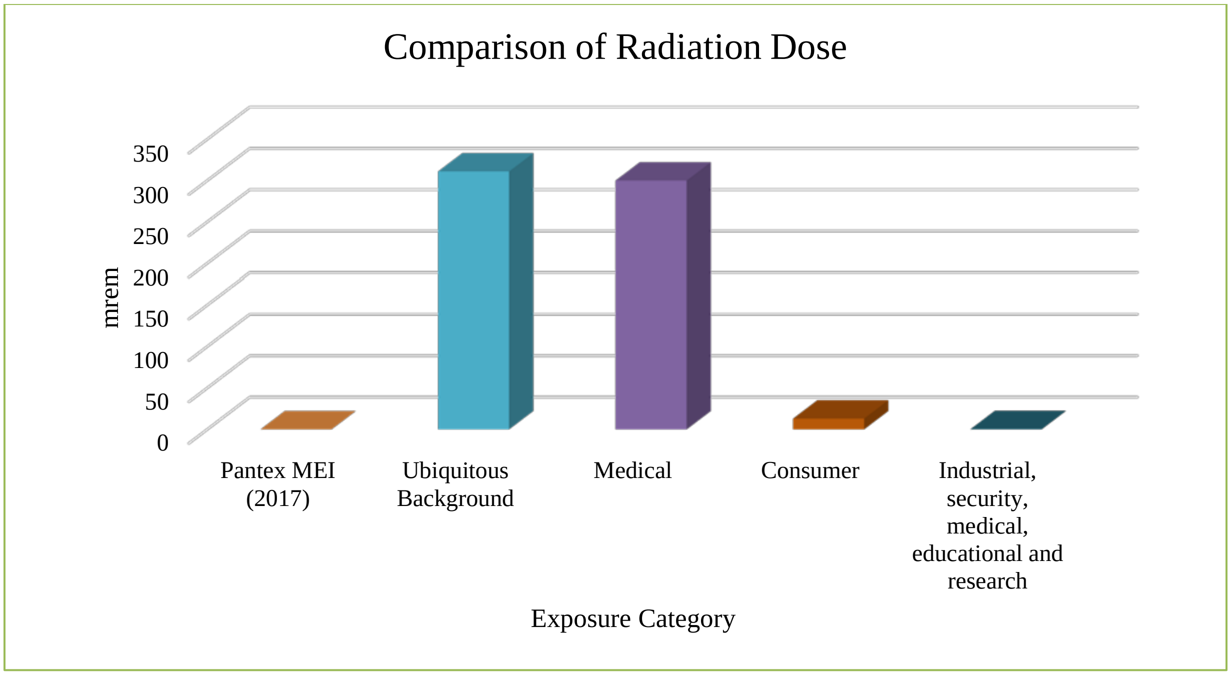


**Figure 1 – Comparison of Radiation Dose**

**Drinking Water Monitoring**

Results from routine drinking water compliance monitoring in 2017 confirmed that the drinking water system at the Pantex Plant met water quality regulatory requirements. All analytical results for bacteria, chemical compounds, lead & copper, and disinfection by-products were below regulatory limits, and adequate levels of disinfectant were maintained in the distribution system. The Pantex Public Water System continues to be recognized by the Texas Commission on Environmental Quality (TCEQ) as a "Superior" supply system.

**Wastewater Monitoring**

During 2017, the Pantex Plant discharged more than 60 million gallons of treated wastewater to the on-site playa lake. Pantex beneficially reused more than 91 million gallons of treated wastewater and treated groundwater for agricultural purposes.

**Storm Water Monitoring**

Storm water sampling of run-off involving industrial activities at the Pantex Plant is conducted in accordance with Texas Pollutant Discharge Elimination System (TPDES) Multi-sector General Permit No. TXR050000. Monitoring conducted during 2017 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 2017 were similar with past monitoring results. Playa lake results obtained during 2017 were similar with past monitoring results. The playa data continues to support the position that operations at the Pantex Plant are not negatively impacting the water quality of the playas.

**Soil Monitoring**

Results of soil monitoring conducted at the Pantex Burning Ground in 2017 were within established background comparison values. Results of soil monitoring conducted at the subsurface irrigation sites were consistent with previous year's results and indicate operations are having no negative impact to the environment.

**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. Flora and fauna monitoring results indicated that there were no detrimental impacts from Plant operations in 2017.

**Quality Assurance**

Chapter 13 of this report describes the Quality Assurance (QA) Program. QA is incorporated into all aspects of the CNS Pantex Environmental Program and includes performance checks, rigorous quality control checks, and intensive data management.

**Environmental Remediation**

Historical waste management practices at the Plant resulted in impacts to on-site soil and perched groundwater. High explosives, solvents, and metals were found in the soil in the main operational areas, the Burning Ground at the Plant, and in the perched groundwater beneath Pantex. Data collected in 2017 indicate that the main drinking water aquifer remains unaffected by migration of contaminants from soil and perched groundwater.

Pantex has completed investigations and soil cleanup of all solid waste management units, with the exception of units that remain in an active status. This allowed Pantex to transition to Long-Term Stewardship (LTS) in 2009. A Record of Decision (ROD) 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 operated and maintained the groundwater remediation systems, monitored the systems to determine effectiveness of the remedy, and maintained the soil remedies. Pantex installed two types of 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 2017. The soil vapor extraction (SVE) system located at the Burning Ground continued to operate during 2017 and extracted over 800 pounds 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 last 30 years. From 1987 to 2017, the Plant population and workload increased as the focus of the Plant's mission changed from weapons assembly during the Cold War to primarily dismantlement. During 2017, Pantex successfully recycled over 1.5 million pounds of materials including over 23,000 pounds of electronics.

Pantex
Managed and Operated by Consolidated Nuclear Security, LLC

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**(U) Pantex Environmental Policy**

Date: August 13, 2014

To: All Employees

Subject: Pantex Environmental Policy

It is the CNS Pantex environmental policy to protect and conserve the natural environment within which we perform the Plant mission. This policy is the basis for our Environmental Management System (EMS). The EMS is a significant component of the Pantex Integrated Safety Management System that holds superior the goal of protecting our employees, the community, and the environment. Important areas of focus within the EMS are environmental compliance, waste management, natural resource management, pollution prevention, recycling, environmental remediation, and sustainability.

This policy is a concise declaration of how we, the personnel that work within the boundaries of Pantex, will conduct work. The policy should be incorporated into each individual's personal commitment to protect the environment while accomplishing the Pantex mission.

**Pantex Environmental Policy**

To Excel in:

- Implementing appropriate controls and actions to minimize environmental impacts caused by our activities, products, and services
- Continual improvement of our protection of the environment in plant processes; including sustainability, pollution prevention, and recycling
- Strict compliance with relevant regulations and requirements
- Setting and reviewing environmental objectives and targets
- Documenting, implementing, and maintaining the EMS
- Communication of this policy to all employees
- Availability of the policy to the public

Michelle M. Reichert

Michelle M. Reichert
Pantex Site Manager

# Chapter 1 – Introduction

*The Pantex Plant site, consisting of 7,001 hectares (17,503 acres), is located 27 kilometers (17 miles) northeast of Amarillo, Texas, in Carson County. The 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 the Plant location, history and mission, and facility description, followed by the climate, geology, hydrology, seismology, land use, and population of the area around the Pantex Plant.*

## 1.1 Site Location and Environmental Setting

The Pantex Plant site is located in Carson County in the Texas Panhandle, north of U.S. Highway 60. The Plant is located 27 km (17 mi)[1] northeast of downtown Amarillo (Figure 1.1). It is centered on approximately 7,001 hectare (17,503 acres) site. The site consists of land owned and leased by the DOE. The DOE owns 4,681 hectares (11,703 acres), including 3,683 hectares (9,100 acres) in the main Plant area, 610 hectares (1,526 acres) in four tracts purchased in the latter part of 2008 (east of Farm-to-Market [FM] 2373 near the main Plant area), and 436 hectares (1,077 acres) at Pantex Lake[2], which is located approximately 4 km (2.5 mi) northeast of the main Plant area. There are no government industrial operations conducted at the Pantex Lake property. In addition, 2,347 hectares (5,800 acres) of land south of the main Plant area are leased from Texas Tech University (TTU) for a safety and security buffer zone.

The Pantex Plant is located on the Llano Estacado (staked plains) portion of the Great Plains at an elevation of approximately 1,067 m (3,500 ft.). The topography at the Pantex Plant is relatively flat, characterized by rolling grassy plains and numerous natural playa basins. The term "playa" is used to describe shallow lakes, mostly less than 1 km (0.6 mi) in diameter. The region is a semi-arid farming and ranching area. The Pantex Plant is surrounded by agricultural land, but several industrial facilities are located nearby.

## 1.2 Facility History and Mission

The Pantex Plant is a government-owned, contractor-operated facility. DOE oversees the operation of the Pantex Plant through the NNSA/NPO. At the end of 2017, approximately 4500 persons (including CNS contracted employees, federal employees and subcontracted employees) were employed at the Plant. Mason & Hanger Corporation (MHC) was the Operation & Maintenance (O&M) contractor of the 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, CNS became the O&M contractor of the 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 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 the 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.

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[1] This report will generally use the convention of identifying a unit of measure in Système Internationale (abbreviated SI) units and providing the "English unit" equivalent in parentheses, for example "X kilometers (Y miles)." Because radiological measurements are compared to several limits that are generally specified using "English units," the convention is reversed for those measurements, for example "X pCi/mL (Y Bq/$m^3$)." In a few instances only an "English" unit is indicated in accordance with the most common technical usage.

[2] Not illustrated herein.

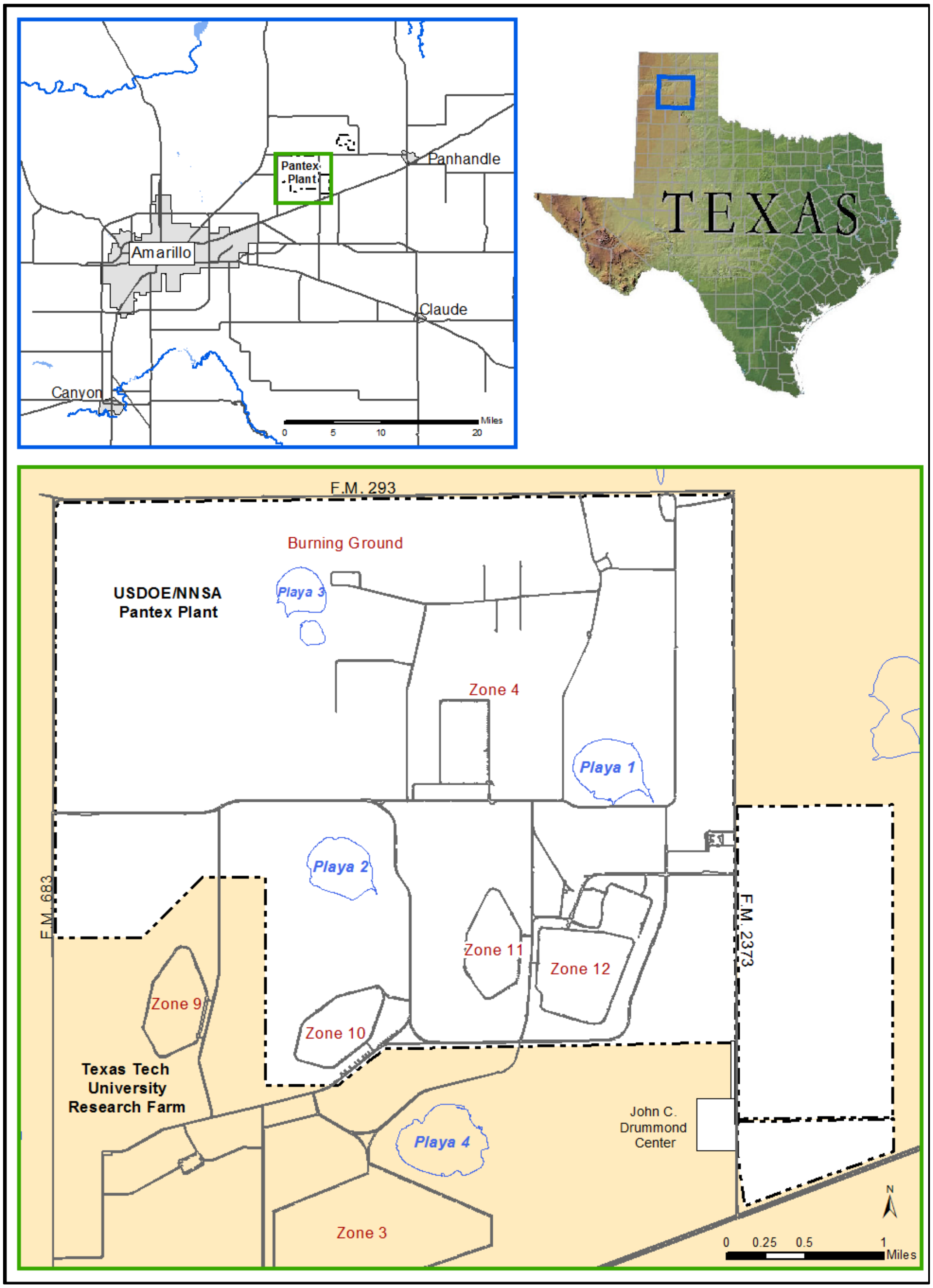


**Figure 1.1 – Pantex Plant Site Location and Zones**

The Pantex Plant's primary mission 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

The Plant is composed of several functional areas, commonly referred to as numbered zones (see the lower portion of Figure 1.1). Overall, there are more than 630 buildings at the Plant. Many of these areas are grouped into large functional zones. 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, 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. One functional area is currently used only for storage.

The weapons assembly/disassembly area covers approximately 80 hectares (200 acres) and contains more than 100 buildings. Nuclear components, parts received from other DOE plants, chemical explosive components, and metal parts fabricated at the Pantex Plant can be assembled into nuclear weapons in this zone. Nuclear weapons are also disassembled there.

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 the Pantex Center of Excellence (CoE) 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 supporting facilities for setting up test-shots, interpreting the results, and sanitizing some 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 of which currently receives nonhazardous solid wastes, primarily construction debris, and one that receives nonhazardous solid waste management unit debris. Before 1989, the 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 and 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 the Pantex Plant is routed through a sewer system to a wastewater treatment facility. On October 6, 2003, the TCEQ issued Pantex 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 in the system and use of the system was temporarily discontinued. Repairs are anticipated to be completed by the late 2018 so that the treated effluent from the wastewater treatment facility and from the perched aquifer pump and treat systems will once again be discharged to this subsurface irrigation system. Pantex 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 and is characterized by hot summers and relatively cold winters, with large variations in daily temperatures, low relative humidity, and irregularly spaced rainfall of moderate amounts. Three-fourths of the average precipitation (51.7 cm [20.4 in]) falls from April through September, generally occurring with thunderstorm activity. The average annual snowfall is 17.8 inches (DOCa). Snow usually melts within a few days after it falls. Heavier snowfalls of l0 inches or more, usually with near blizzard conditions, average once every five years and last two to three days. The potential gross lake surface evaporation in the area is estimated to be about 140 cm (55 in) (Bomar, 1995) or 280 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. Temperature drops of 50°F to 60° F within a 12-hour period are not uncommon. Temperature drops of 40° F have occurred within a few minutes.

Humidity averages are low, occasionally dropping below 20 percent in the spring. Low humidity moderates the effect of summer afternoon high temperatures, permits evaporative cooling systems to be very effective, and provides many pleasant evenings and nights. 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, particularly of roads and streets.

The Pantex Plant is located in an area with a relatively high frequency of tornadoes, convective wind events[3] 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 2015 (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 13 tornadoes reported in the Texas and Oklahoma Panhandles during 2017 (Scruggs, 2018), approximately ¼ 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 2017 was 15.1°C (59.2°F), slightly above the normal annual mean temperature in Amarillo of 14.1°C (57.3°F). During 2017, the official NWS rain gauge recorded 65.8 cm (25.9 in) of precipitation 14.0 cm (5.5 in) above normal (DOCa).

The Pantex Plant maintains a meteorological monitoring station on the northeast corner of the site. The monitoring station is an instrumented 60 m (197 ft.) tower located approximately 3.7 km (2.3 mi) north of the Zone 12 production area. The tower is equipped with two sets of sensors, located at the 10 and 60 m (33 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 10 m (33 ft.) level. A barometer measures the atmospheric pressure on the tower approximately 1.8 m (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 1 m (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[4] and transfers the meteorological data for the latest 15 minute interval to a remote server. The data from the Plant's meteorological tower are compared with those obtained from the Amarillo Airport NWS site located approximately 16 km (10 mi) to the west-southwest of the 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 speed during 2017 at the Pantex Plant are illustrated by the "wind rose" (graphical depictions of the annual frequency distribution of wind speed and the direction from which the wind has blown) in Figure 1.2. The figure indicates that, as in most previous years, a large percentage (approximately 25 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 2017 from the Pantex Plant or Amarillo Airport NWS meteorological instrumentation. The range of mean monthly temperatures during the year measured at the 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.

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

[4] 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".

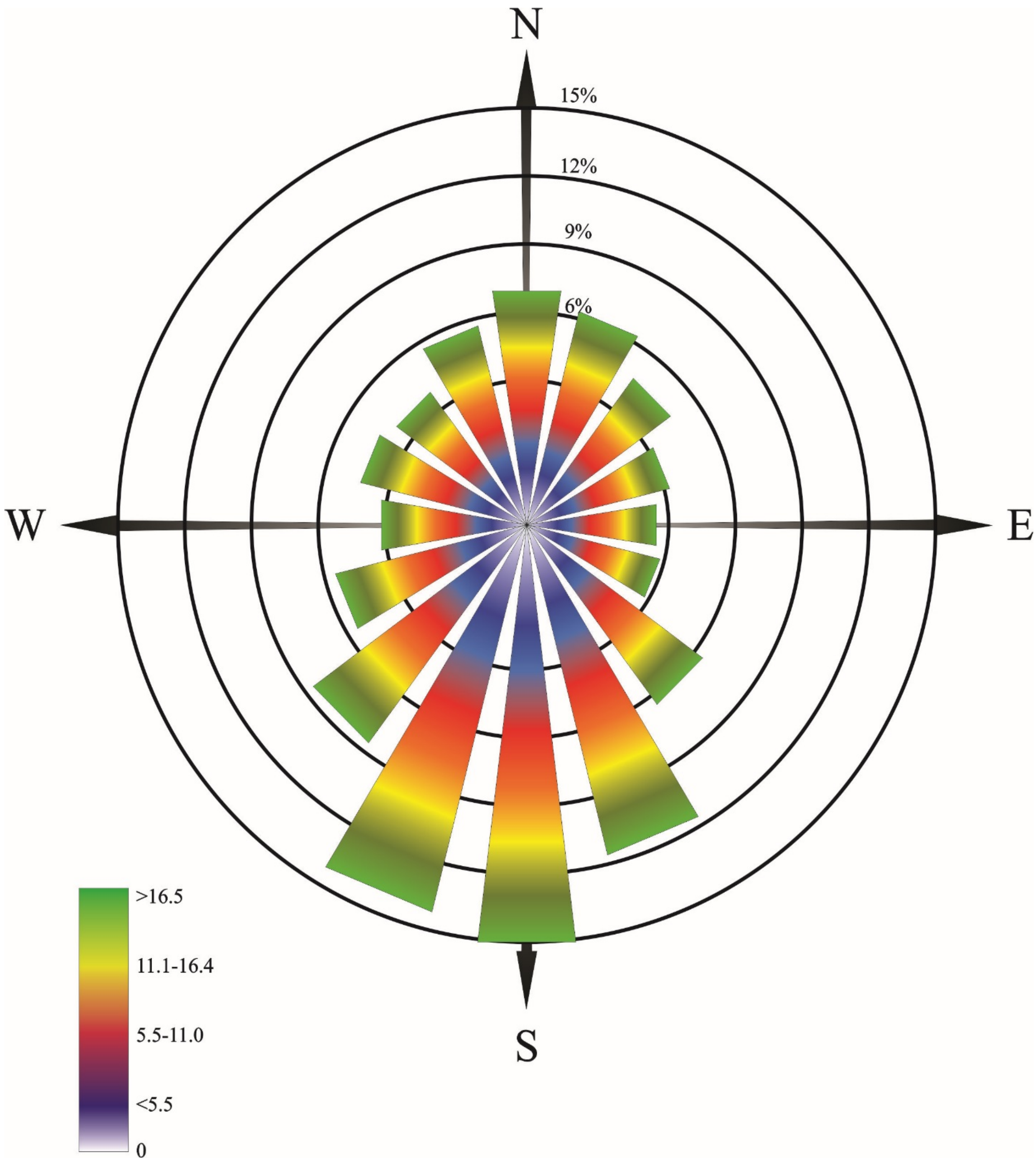



**Figure 1.2 – Pantex Plant Annual Wind Rose for 2017**

**Table 1.1 – Pantex 2017 Climatological Data by Month**

| Month | Temperature $^0$C ($^0$F) Maximum | Minimum | Mean Monthly | Mean Relative Humidity (percent) | Precipitation[a] mm (inches) | Wind Speed m/s (mph) Mean | Maximum |
|---|---|---|---|---|---|---|---|
| January | 23.5 (74.3) | -18.1 (-0.5) | 3.7 (38.6) | 58 | 80.52 (3.17) | 5.1 (11.3) | 16.8 (37.5) |
| February | 30.4 (86.7) | -8.9 (15.9) | 7.9 (46.2) | 47 | 12.95 (0.51) | 4.9 (11.9) | 17.1 (38.2) |
| March | 31.1 (88.0) | -5.2 (22.6) | 11.1 (52.0) | 49 | 50.29 (1.98) | 5.9 (13.2) | 16.9 (37.9) |
| April | 30.4 (86.8) | 0.1 (32.2) | 13.8 (56.8) | 56 | 19.81 (0.78) | 6.4 (14.3) | 16.2 (36.2) |
| May | 34.1 (93.4) | 2.3 (36.1) | 17.3 (63.1) | 50 | 29.21 (1.15) | 5.8 (13.0) | 17.3 (38.8) |
| June | 40.04 (104.0) | 12.8 (55.0) | 24.2 (75.6) | 53 | 35.10 (1.50) | 5.9 (13.1) | 137 (30.7) |
| July | 35.6 (96.0) | 16.1 (61.0) | 26.2 (79.2) | 49 | 97.28 (3.83) | 5.5 (12.3) | 14.8 (33.0) |
| August | 33.8 (92.9) | 13.8 (56.9) | 22.1 (71.8) | 70 | 187.96 (7.40) | 5.4 12.1) | 27.0 (60.3) |
| September | 33.4 (92.2) | 20.1 (68.8) | 10.2 (50.4) | 58 | 86.36 (3.40) | 4.2 (9.4) | 36.1 (80.7) |
| October | 28.5 (83.3) | -1.9 (28.6) | 14.3 (57.8) | 57 | 55.88 (2.20) | 5.8 (13.0) | 16.1 (36.0) |
| November | 27.3 (81.1) | -2.9 (26.8) | 10.2 (50.4) | 52 | 0.00 (0.00) | 5.5 (12.3) | 16.8 (37.6) |
| December | 23.9 (75.0) | -12.3 (9.9) | 3.0 (37.4) | 50 | 0.00 (0.00) | 5.1 (11.5) | 14.8 (33.0) |
| **Annual[b]** | | | **13.7 (56.6)** | **54** | **658.37 (25.92)** | **5.2 (11.7)** | |

[a] Includes water equivalent of snowfall. (Precipitation data from Amarillo Airport NWS site.)
[b] Total precipitation and the annual mean of parameter (when indicated) except for precipitation is indicated. Annual maximum and/or minimum values of temperature and wind speed may be obtained by reviewing the data in the appropriate column

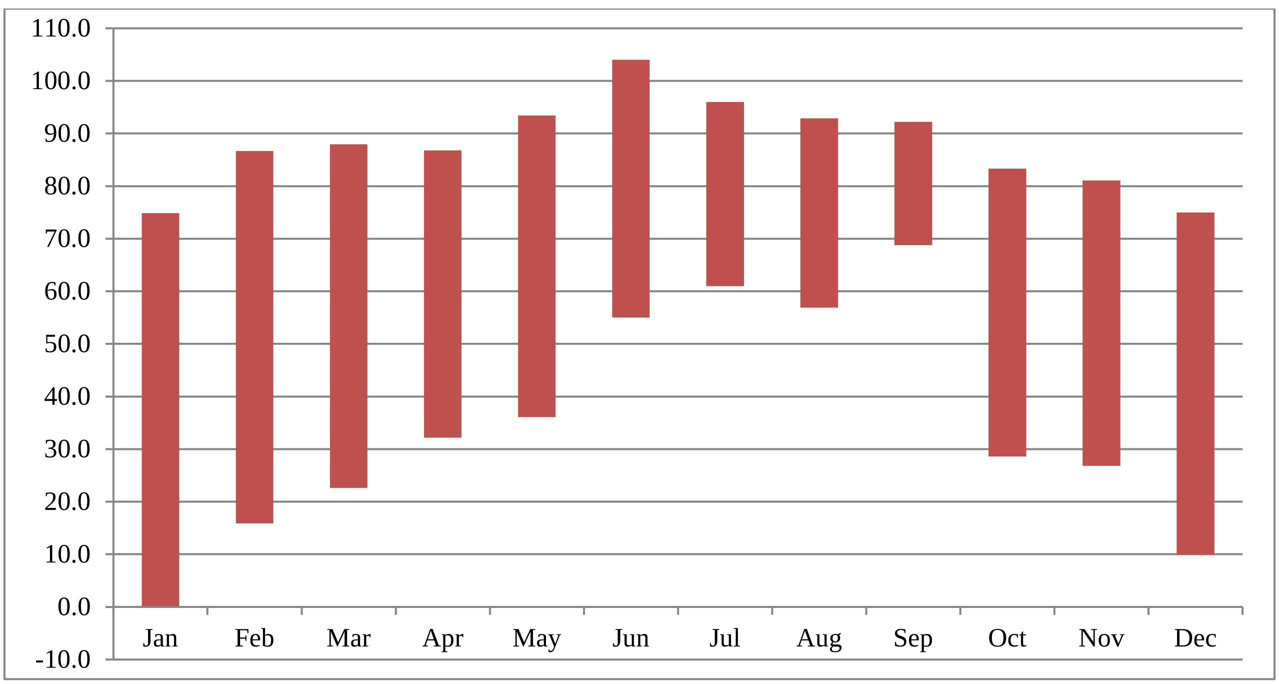



**Figure 1.3 – Pantex Plant Monthly Temperature Range During 2017 (°Fahrenheit)**

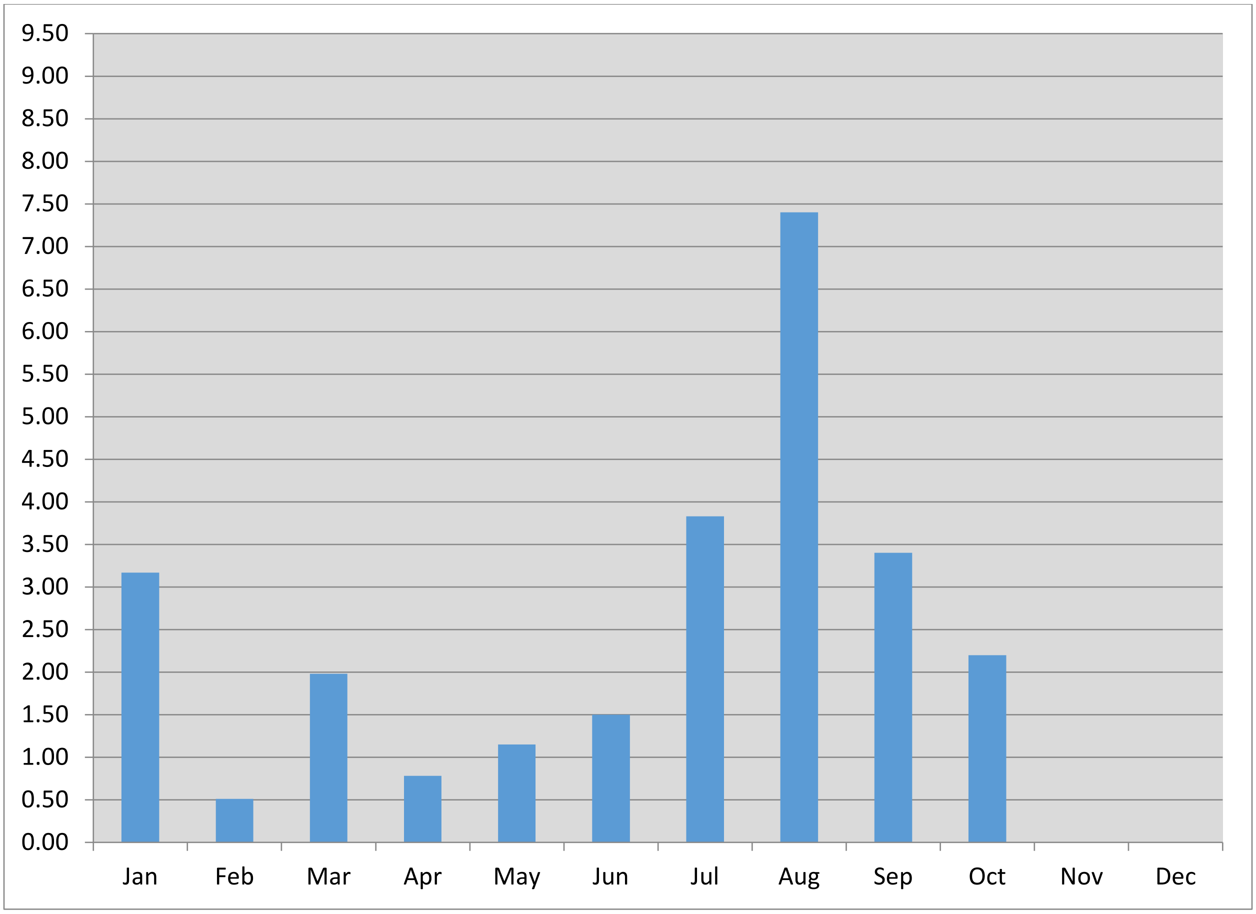



**Figure 1.4 – Amarillo National Weather Service (NWS) Precipitation During 2017 (in inches)**

## 1.5 Geology

The primary surface deposits at the Pantex Plant are the Pullman and Randall soil series, which grade downward to the Blackwater Draw Formation. This formation consists of about 15 m (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 the Pantex Plant, the vertical distance to the base of the Ogallala varies from 90 m (300 ft.) at the southwest corner to 220 m (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 (1,200 m or 4,000 ft.) below the Plant has a major influence on the natural radiation environment, because radon is released from the underlying granitic rocks.

## 1.6 Hydrology

The principal surface water feature on the Southern High Plains is the Canadian River, which flows southwest to northeast approximately 27 km (17 mi) north of the Plant. Plant surface waters 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 the 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 the 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 140 m (460 ft.) of sediment that lies between the land surface and the Ogallala Aquifer.

### 1.6.1 Ogallala Aquifer

The water-bearing units within the Ogallala Formation beneath the Pantex Plant are the perched aquifer in the vadose zone and the Ogallala Aquifer below. A discontinuous perched aquifer is present above the main zone of saturation. Perched aquifers form above clayey layers that have low permeability. Data collected from wells at the Pantex Plant indicate that the zone of saturation in the perched aquifer varies in thickness by as much as 15 to 25 m (~70 ft.). Depths from the surface to the perched aquifer range from 64 to 85 m (209 to 280 ft.).

The main Ogallala Aquifer lies beneath the perched water zones. Depth to the main Ogallala Aquifer ranges from 102 to 168 m (~325 to 500 ft.) below ground surface. The saturated thickness varies from 12 to 98 m (~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 High Plains. The regional gradient of the Ogallala Aquifer beneath the Pantex Plant trends from the southwest to the northeast, where the zone of saturation is thickest. The 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 the Pantex Plant's well field.

### 1.6.2 Dockum Group Aquifer

The Dockum Group Aquifer lies under the Ogallala Formation at the Pantex Plant. Water contained in sandstone layers within the Dockum Group supplies domestic and livestock wells south and southeast of the Pantex Plant. Other wells reaching the Dockum Group Aquifer are located 16 km (10 mi) south and west of the 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.

### 1.6.3 Water Use

The major surface water source near the Pantex Plant is the Canadian River, which flows into man-made Lake Meredith approximately 40 km (25 mi) north of the Plant. Many local communities use water from Lake Meredith for domestic purposes, when water depth is sufficient. The major groundwater source in the vicinity of the Plant is the Ogallala Aquifer, which is used as a domestic source by numerous municipalities, and by industries in the High Plains. Historical groundwater withdrawals, and long-term pumping from the Ogallala in Carson County and the surrounding eight-county area, have exceeded the natural recharge rate to the Ogallala. 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. The average change in “depth to water” from 1,209 Ogallala Aquifer observation wells in the Panhandle during 1988 to 1997 was 1.49 ft. Groundwater withdrawals from the Ogallala Aquifer in Carson County have averaged approximately 39 billion gallons over the last several years. This groundwater withdrawal rate is more than 10 times greater than the estimated annual recharge rate of 358 million gallons. Groundwater withdrawal rates are expected to decline each decade to approximately 21 billion gallons in 2060 (Crowell, 2007).

The City of Amarillo, the largest municipal Ogallala water user in the area, pumps water for public use from the Carson County Well Field north and northeast of the Plant. The Pantex Plant obtains water from five wells in the northeast corner of the site. In 2017, Pantex pumped approximately 130 million gallons of water from the Ogallala Aquifer. Most of the water used at the Pantex Plant is for domestic purposes. Through an agreement with TTU, the Pantex Plant provides water for its domestic and livestock uses.

## 1.7 Seismology

Seismic events have occurred infrequently in the region, and their magnitudes have been low. The stress conditions at the site are such that the possibility of high-order seismic events is extremely unlikely. A qualitative understanding of present conditions at the 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 the Pantex Plant is used mainly for winter wheat and grain sorghum farming, for ranching, and for mining (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 mainly 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 the Pantex Plant showed that most of the population is located west-southwest of the Pantex Plant in the Amarillo metropolitan area. Population data from the 2010 Census are now available at most tracking levels and were used to generate Figure 1.5 (NNSA, 2012), showing the population distribution at 5-mile intervals within 50 miles of the Plant. According to the 2010 Census, the total population within 50 miles of the Pantex Plant is 316,132 people.

The total population of the 20 county area (defined as the Texas Panhandle) surrounding the Plant is 389,721. The population of the City of Amarillo (190,695 in 2010) represents about 49 percent of the counties' population. Another approximately 32 percent of the population lives in other incorporated cities, and about 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 population density of these counties ranges from 12 to 132 persons per square mile. The 20 county areas can be described as sparsely populated, with Potter and Randall Counties being the exception. 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 (DOCd). Hartley, Moore, Roberts, Oldham, Deaf Smith, Donley, Dallam, Sherman, Hansford, Ochiltree, Lipscomb, Hemphill, Wheeler, and Collingsworth are the remaining counties of the defined area; although, the population contained in the northerly portions of Castro, Swisher, and Briscoe counties is also included in the 80 km (50 mi) population estimate described above.

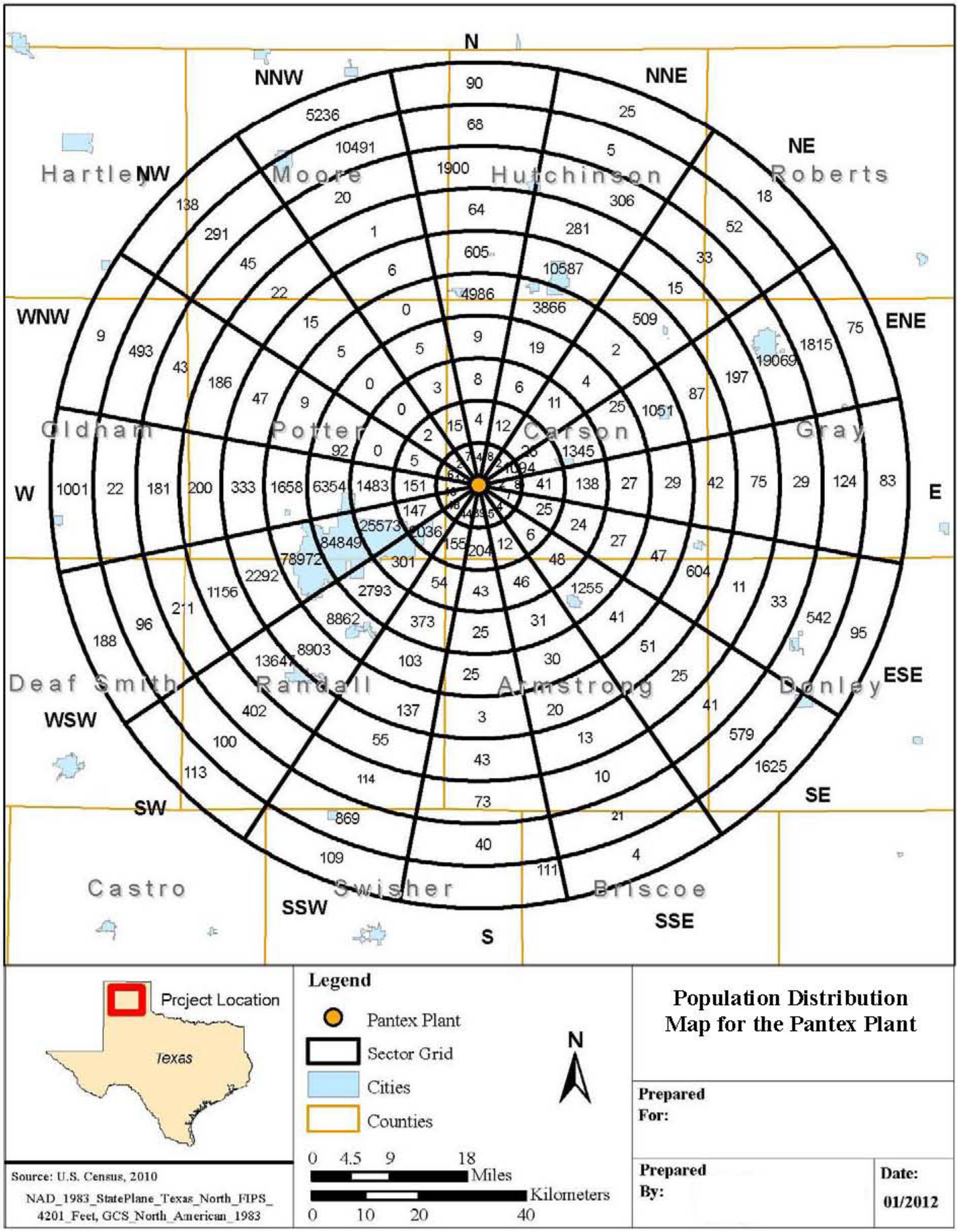



**Figure 1.5 – Population Distribution within 50 Miles of Pantex Plant (2010)**

## 1.9 Organization of the Report

The remainder of this report is organized into 12 chapters and four appendices:

Chapter 2 discusses regulatory requirements for environmental compliance during 2017 and describes the Plant's compliance-related issues and activities. It presents results of various regulatory inspections and environmental activities and lists the environmental permits issued to the Pantex Plant.

Chapter 3 provides a brief summary of the environmental programs that are conducted at the Pantex Plant. Overviews are provided for environmental management, pollution prevention, 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 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, and faunal and vegetation 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 2017 samples.

Chapter 13 reviews the Pantex Plant's quality assurance program for environmental monitoring efforts, as initiated in response to 10 CFR 830.120 and DOE Order 414.1D (DOEg). The chapter also includes an analysis of quality control samples collected during 2017 and a data validation summary.

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

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

Appendix C provides references.

Appendix D provides supplemental information.

# Chapter 2 – Compliance Summary

*Pantex policy is to conduct all operations in compliance with applicable environmental statutes, regulations, and the requirements of the various authorizations issued to the Plant. This chapter reviews current issues and actions related to these requirements.*

## 2.1 Environmental Regulations

This chapter summarizes the compliance status of the Pantex Plant for 2017. It describes initiatives and clean-up agreements in place, regulatory authorizations issued to the Plant, and measures to support the DOE environmental performance indicators. Table 2.1 presents the major environmental regulations applicable to operations at the Pantex Plant.

**Table 2.1 – Major Environmental Regulations Applicable to Pantex Plant**

| Regulatory Description | Authority | Codification | Status |
|---|---|---|---|
| ARCHAEOLOGICAL RESOURCE PROTECTION ACT (ARPA)<br><br>ARPA provides for the protection of archeological resources and sites located on public and Native American lands. | Federal: Advisory Council on Historic Preservation<br><br>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 the Pantex Plant conformed to ARPA standards. |
| CLEAN AIR ACT (CAA)<br>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. | Federal: EPA<br><br>State: TCEQ<br><br>Texas Department of State Health Services (TDSHS) | Federal: 40 CFR §50-§82<br><br>State: Title 30 of the Texas Administrative Code (TAC), Chapter 101 through Chapter 122 (30 TAC §101-§122) & §305<br>25 TAC §295 (Asbestos only) | The Pantex Plant complies with permits and Permits-by-Rule issued or promulgated by the TCEQ to authorize releases of pollutants to the atmosphere.<br><br>The 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).<br><br>Pantex is a self-certified “Minor” emission source under the Federal Operating Permit program. |
| COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA)<br><br>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 | Federal: EPA | Federal: 40 CFR §300, §302, §355, & §370 | The Pantex Plant has been on the National Priorities List since 1994. The EPA, TCEQ, and NPO have signed an Interagency Agreement (IAG) concerning the conduct of the remediation at the Pantex Plant.<br><br>A ROD was issued and approved in 2008 and Pantex was added to the Construction Completion List in 2010. Interested Co-Trustees have |

| Regulatory Description | Authority | Codification | Status |
|---|---|---|---|
| protection of natural resources on publicly owned property through designation of Natural Resource Trustees. | | | been involved in the planning and completion of the Ecological Risk Assessment (ERA) for Pantex, 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)<br><br>ESA prohibits federal agencies 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. |
| 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)<br><br>FIFRA governs the manufacture and use of biocides, specifically the use, storage, and disposal of all pesticides and pesticide containers and residues. | Federal: EPA<br><br>State: Texas Department of Agriculture; Structural Pest Control Board | Federal: 40 CFR §170-§171<br><br>State: 4 TAC §7.1-§7.40; Structural Pest Control Act (Art. 135b-5) | State-licensed personnel apply pesticides in accordance with applicable regulations.<br><br>The 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)<br><br>The Texas Water Code, through its implementing regulations, regulates the quality of water discharged to waters of the State of Texas. | Federal: EPA<br><br>State: TCEQ | Federal: 40 CFR §120-§136 & 40 CFR §300 - §583<br><br>State: 30 TAC §205-§299, §305, §309, §317 & §319 | As currently defined, the Pantex Plant does not discharge its wastewaters to 'Waters of the United States'.<br><br>The Pantex Plant discharges its industrial wastewaters pursuant to Permits WQ0002296000, WQ0004397000, and UIC 5W2000017.<br><br>The Pantex Plant has coverage under the TPDES Construction General Permit, for storm water via Permit No. TXR150000. It complies with requirements of the permit whenever applicable to a project. As of the end of |

| Regulatory Description | Authority | Codification | Status |
|---|---|---|---|
| | | | 2017, one active project had been registered with the TCEQ.<br><br>The Plant operates under TCEQ General Permit for Discharges of Storm Water from Industrial Sources Registration No. TXR05P506. |
| MEDICAL WASTE | Federal: U.S. Department of Transportation (DOT)<br><br>State: TDSHS | Federal: 49 CFR §173<br><br>State: 30 TAC §330.1201-1221 | The Plant manages medical waste in accordance with applicable regulations. |
| MIGRATORY BIRD TREATY ACT<br><br>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 the Pantex Plant are reviewed through the National Environmental Protection Act (NEPA) process, which considers impacts to migratory species.<br><br>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 the Pantex Plant are reviewed through the National Environmental Protection Act (NEPA) process, which considers impacts to migratory species.<br><br>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 the Pantex Plant are reviewed through the NEPA process, which considers impacts to migratory species. |
| NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)<br><br>NEPA establishes a broad national policy to conduct federal activities in ways that promote the general welfare of the environment. | Federal: DOE; Council for Environmental Quality (CEQ) | Federal: 10 CFR §1021, 40 CFR §1500-§1508 | In 2017, five Standard NEPA Review Forms, 34 Internal NEPA Review Forms, and four amendments were prepared. |

| Regulatory Description | Authority | Codification | Status |
|---|---|---|---|
| NEPA procedures must ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. | | | In 2017, two Environmental Assessments (EAs) were submitted to NPO for approval. Both should be approved in 2018. |
| 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<br><br>State: TPWD | Federal: 50 CFR §10<br><br>State: TPWD Code, §67, §71 | Actions being considered at the Pantex Plant are reviewed through the NEPA process, which considers impacts to all protected species. |
| 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<br><br>State: TCEQ | Federal: 40 CFR §260-§280<br><br>State: 30 TAC §305, §327, and §335<br><br>State: 30 TAC §334 | The 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 the Plant. Compliance Plan CP-50284 (now HW-50284) addresses corrective action requirements at the Plant.<br><br>The Plant operates five regulated underground storage tanks. |
| SAFE DRINKING WATER ACT (SDWA)<br><br>SDWA and the Texas Water Code govern public water supplies. | Federal: EPA<br>State: TCEQ | Federal: 40 CFR §141-§143<br>State: 30 TAC §290 | Pantex operates a Non-Transient, Non-Community Public Water Supply System (No. 0330007). The system is recognized as a Superior Public Water System by the TCEQ. |
| 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 | The Plant manages polychlorinated biphenyl (PCBs), asbestos, beryllium, and chemicals in compliance with applicable regulations. |

## 2.2 Clean Air Act (CAA)

Most requirements of the Federal CAA in Texas are implemented under the Texas Clean Air Act (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 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 by the EPA at 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 (10 mrem/yr) or 0.10 milliSievert per year (0.10 mSv/yr). Based upon evaluations using the most conservative assumptions about the emissions of radionuclides from several 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 2017 was 7.60 $x10^{-6}$ mrem/yr (7.60$x10^{-8}$ mSv/yr). Accordingly, Pantex is in compliance with the EPA standard. Continuous emission monitoring, as described in 40 CFR §61.93, is not required of any source at the Pantex Plant, based on each source's emission potential. The Plant does perform periodic confirmatory measurements, as well as 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 emission 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 2017, none of the evaluations resulted in the identification of exceedances of this reduced standard, and 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 files a "Notification of Consolidated Small Operations Removing Asbestos-Containing Material" with the TDSHS for maintenance activities to be conducted by the Plant in the next calendar year. To verify that operations are consistent with the notification, Pantex keeps a log of all its affected maintenance activities to track quantities of material disturbed.

Subcontractors at the 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 personnel that involve amounts that would require job-specific notifications. Pantex maintains the required certifications for the personnel who plan, oversee, and conduct these efforts. By filing the required forms and maintaining the described records, Pantex demonstrates that it is in compliance with 40 CFR §61, Subpart M.

### 2.2.3 40 CFR §68 (Chemical Accident Prevention)

Pantex has established and maintains controls on the introduction of new chemicals to any area of the Plant. Through this process, Pantex has been able 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 from having to perform risk management planning.

### 2.2.4 40 CFR §82 (Ozone Depleting Substances)

Pantex installs and maintains stationary and motor vehicle air conditioning systems at the Plant. The technicians that perform this work have been trained in the proper use of approved recycling devices while conducting these efforts. Pantex maintains records of training and maintenance activities to demonstrate compliance with these regulations.

### 2.2.5 Air Quality Permits and Authorizations

Pantex continues to use a combination of an air quality permit issued under 30 TAC §116 (Permit 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.

### 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 2017, Pantex 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 the Pantex Plant during 2017.

### 2.2.8 Emission Tracking and Calculation

#### 2.2.8.1 Scope of the Pantex Plant Emission Tracking System

The 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 the Plant's air emission tracking system is to monitor process emissions, in order to (a) maintain the facility designation of "Synthetic Minor" under the federal Title V program, and (b) demonstrate compliance with authorizations issued to the Pantex Plant. The 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 and their authorizations.

**Table 2.2 – Tracked Emission Sources at Pantex**

| 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 | | PBR 412 |
| Hazardous Waste Treatment & Processing Facility (HWTPF) Liquid Processing Facility | Permit 84802 | | |
| Pantex Site-wide Cooling Towers | Permit 84802 | | PBR 371 |
| Stationary Standby Emergency Engines | Permit 84802 | | PBR 511 for those engines added after issuance of Permit 84802 |

| Process:[a] | Authorization Permit # | Standard Exemption [b] | Permit By Rule |
|---|---|---|---|
| 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 minimus" |
| 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.

#### 2.2.8.2 Program Structure and Requirements

The Pantex Plant is categorized as a Synthetic Minor air emission source. The upper threshold of emission limits for a facility to remain in this category is 25 tons per year of Hazardous Air Pollutants (HAP) (or 10 tons of a single HAP) and 100 tons per year of nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC), sulfur oxides (SOx), lead (PB) particulate matter (PM), and HAPs. Under this designation, a facility is not required to declare its emissions every year to the TCEQ; however, a certification of Potential to Emit (PTE) is required by 30 TAC §122.122 when significant changes of emissions take place. The PTE, once submitted to the TCEQ, becomes a federally enforceable document for allowable emissions. Essentially, the PTE establishes emission limits that are administratively set by Pantex and authorized/enforceable by the TCEQ and the EPA.

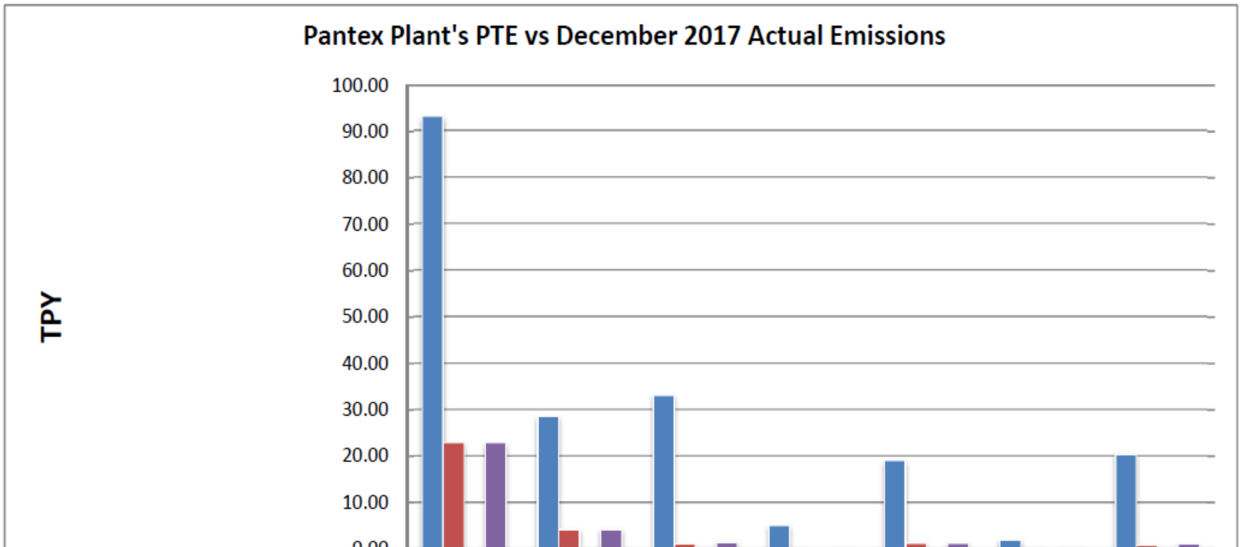
The Pantex Plant maintains a tracking process to verify compliance with certified emissions limits. This tracking process is implemented through Air Quality Management Requirement (AQMR) documents, which are placed into the every-day operational procedures/activities that have either point source or 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 both hourly and rolling 12-month emissions.

#### 2.2.8.3 Types and Tracking of Emissions

During 2017, Pantex tracked the emissions from 30 different processes both at specific locations and grouped sources across the Plant. Pantex personnel responsible for air program compliance gathered facility data on emissions of common air pollutants including nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC), 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 the Plant, to the annual limits set in the authorized PTE.

#### 2.2.8.4 Conclusions of Air Emission Tracking for 2017

Over the 12 months of air emission tracking for 2017, operations at the Pantex Plant remained well below the certified and authorized PTE levels for each of the pollutants tracked. Figure 2.1 below is a graphic presentation of the emission information gathered from January through December 2017, expressed in relation to the PTE certification in Tons per Year. It provides a demonstration that the 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-Feb. 2017 | 93.08 | 28.53 | 33.17 | 5.14 | 19.14 | 2.00 | 20.36 |
| Permit 84802 Emission Rates: | 22.86 | 4.29 | 1.18 | 0.10 | 1.39 | 0.13 | 0.83 |
| Exemption Authorization Emission Rates: | 0.00 | 0.00 | 0.35 | 0.00 | 0.01 | 0.00 | 0.25 |
| Plant Total Emission Rates: | 22.86 | 4.29 | 1.52 | 0.10 | 1.40 | 0.13 | 1.08 |

**Figure 2.1 – Pantex Plant's PTE vs 2017 Actual Emissions**

## 2.3 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund)

Because the Pantex Plant is listed on the National Priorities List, 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 the 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, EPA, and TCEQ. This agreement became effective in February 2008.

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

Accordingly, Pantex was added to the Construction Completion List, signifying the start of the 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 2017.

## 2.4 Endangered Species Act

The Pantex Plant provides habitat for several species protected by federal and state endangered species laws. In 1992, the 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. The current status of endangered or threatened species, as well as species of concern, known to appear on or near the Pantex Plant (Carson and Potter counties) is summarized in Table 2.3. The 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 2017 | Federal Status | State Status |
|---|---|---|---|---|
| **Birds** | | | | |
| Peregrine falcon[a] | *Falco peregrinus anatum/tundrius* | | Delisted | Threatened |
| Baird's sparrow | *Ammodramus bairdii* | | - | Concern |
| Bald eagle | *Haliaeetus leucocephalus* | Yes | Delisted | Threatened |
| Ferruginous hawk | *Buteo regalis* | | - | Concern |
| Interior least tern | *Sterna antillarum athalassos* | | Endangered | Endangered |
| Lesser prairie chicken[b] | *Tympanuchus pallidicinctus* | | | Concern |
| Mountain plover | *Charadrius montanus* | | - | Concern |
| Western Snowy plover | *Charadrius alexandrinus* | | - | Concern |
| Western burrowing owl | *Athene cunicularia hypugea* | Yes | - | Concern |
| Prairie falcon | *Falco mexicanus* | | | Concern |
| White-faced ibis | *Plegadis chihi* | Yes | - | 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] *F.p. tundrius* is classified as threatened based only on similarity.
[b] Status has changed during the past year ("Candidate" to "Threatened").

Several species are listed for Carson County or surrounding counties, are not included in Table 2.3 because of their dependence on habitat that are not found on High Plains soils, or because they are considered extirpated from the region. The Red Knot (*Calidris carnutus rufa*) is long-distance migrant birds that would not likely ever be observed on the High Plains soils. The Arkansas River shiner (*Notropis girardi*) and peppered chub (*Macrhybopsis tetranema*) would only be expected in streams on the Canadian River floodplain located in adjacent Potter County. The Wiest's Sphinx Moth (*Euproserpinus wiesti*) is listed, but its host plants are restricted to aeolian dunes in the Canadian River valley. The Mexican mud-plantain (*Heteranthera mexicana*) is an aquatic plant that grows sporadically and has been documented a few times growing in Panhandle ditches and ponds. The gray wolf (*Canis lupus*) and black-footed ferret (*Mustela* *nigripes*) are listed but are considered extirpated in this area. Ferret releases are being made in surrounding states, as the captive-reared program has resulted in an ample captive population. Captive ferret numbers are so high that the USFWS is relaxing protocol concerning requirements for acceptable release sites. Thus, dispersing ferrets could potentially occur in the region. The American black bear (*Urus americanus amblyceps*; New Mexico subspecies) occasionally wonders into and through the region (one record at Pantex); but only the Louisiana subspecies (*U.a. luteolus*) is considered truly threatened (state; threatened). Due to similarity in appearance both are listed as threatened (state).

## 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, Chapter 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 the Pantex Plant.

### 2.5.1 Agricultural Pesticide Use in 2017

Texas Tech Research Farm (TTRF) submitted 23 agricultural spray requests during the 2017 growing season. All 23 agricultural spray requests were reviewed and approved by Pantex and NPO Production Office. TTRF and their cooperators completed 18 of the 23 spray requests during the 2017 growing season. Table 2.4 shows the number of pesticide applications conducted at Pantex since 2007.

**Table 2.4 – Number of Pesticide Applications Conducted at Pantex**

| Year of Pesticide Applications | Texas Tech Research Farm | Maintenance Department | Contractors | Total |
|---|---|---|---|---|
| 2007 | 25 | 84 | 13 | 122 |
| 2008 | 28 | 105 | 2 | 135 |
| 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 |

### 2.5.2 Maintenance Department and Contractor Pesticide Use in 2017

CNS Pantex made 59 applications during 2017. 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 made zero applications to control or suppress weeds and prairie dogs, as specified in the contract work completed at Pantex in 2017.

## 2.6 Federal Water Pollution Control Act (or Clean Water Act) and Texas Water Code

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

During 2017, Pantex maintained two permits and one authorization issued by the TCEQ authorizing the disposal of treated industrial and domestic wastewaters. Through June 2017, Pantex disposed all of its treated industrial and domestic wastewaters via a subsurface irrigation system. This system is authorized by Permit WQ0004397000 (Texas Land Application Permit [TLAP]) and Underground Injection Control (UIC) Authorization 5W2000017. Combined, these authorizations supported the production of approximately 400 acres 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 the Playa Lake 1, per Texas Water Quality Permit WQ0002296000. Texas Water Quality Permit WQ0002296000 was renewed on August 24, 2016. Repairs are anticipated to be completed in the future so that the treated effluent from the wastewater treatment facility and from the perched aquifer pump and treat systems will once again be discharged to the subsurface irrigation system.

Pantex is authorized to discharge storm water from the Plant-site under authorization of TPDES Storm Water Multi-Sector General Permit TXRO5CD31.

Pantex obtains coverage as needed from the TPDES Storm Water General Permit for Construction Activities (Permit TXR150000). The Notices of Intent for individual projects that were filed pursuant to the permit and active in 2016 and other Pantex environmental authorizations and permits are listed 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 | 09/21/2011 | 05/04/2019 |
| All other small sources | Standard Exemptions 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<br>30459 | EPA<br>TCEQ | 10/30/1980<br>10/30/1980 | None<br>None |
| Industrial and Solid Waste Management Site Permit<br>RCRA Compliance Plan | HW-50284 | TCEQ | 05/30/2014 | 05/30/2024 |

| Building or Activity | Permit Number | Issuing Agency | Effective Date | Expiration Date |
|---|---|---|---|---|
| Underground Injection Control (UIC) TLAP associated<br>UIC- Environmental Restoration Program<br>UIC - Environmental Restoration Program | 5W2000017<br>5X2600215<br>5X2500106 | TCEQ<br>TCEQ<br>TCEQ | 11/29/2004<br>10/23/2001<br>11/28/2005 | When cancelled.<br>When cancelled.<br>When cancelled. |
| **Water** | | | | |
| Texas Water Quality Permit | WQ0002296000 | TCEQ | 08/24/2016 | 12/1/2020 |
| TLAP | WQ0004397000 | TCEQ | 04/12/2013 | 01/01/2020 |
| TPDES Multi-Sector (Industrial) Storm Water Permit | TXRO5CD31 | TCEQ | 06/19/2017 | 08/14/2021 |
| TPDES Storm Water General Permit for Construction Activities<br>Pantex ASC Offsite Utilities | TXR150000<br>TXR150030531 | TCEQ<br>TCEQ | 03/01/2013<br>12/27/2016 | 03/01/2018<br>Upon completion |
| **Natural Resources** | | | | |
| Scientific Permit | SPR-1296-844 | TXPWD | 12/05/2011 | 12/05/2017 |
| 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 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 WQ0004397000 during calendar year 2017.

## 2.7 Medical Waste

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

## 2.8 National Environmental Policy Act

The 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, in part, detailed information concerning potential significant environmental impacts. To minimize environmental impacts from operations at the Pantex Plant, proposed activities are reviewed for NEPA requirements.

At Pantex, the NEPA process is initiated by completing a NEPA Review Form (NRF). The NRF includes a description of the proposed action and subject matter experts review for potential environmental concerns. The levels of NEPA documentation range from internal reviews that tier off previously approved NEPA documents, categorical exclusions, 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 (SA). 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 will be made available in the appropriate DOE Information Repositories, the Pantex website, and the DOE Office of NEPA Policy and Compliance website for a reasonable time. The most current SA for the Pantex Plant was approved by NPO in January 2013. A contract was issued in 2017 to prepare the next required SA.

In 2017, five Standard NRFs (Categorical Exclusion determinations), 34 Internal NRFs, and four amendments were prepared and approved. Categorical Exclusion determinations for five Standard NRFs and four amendments were posted on the Pantex website. In 2017, two Environmental Assessments (EA) were submitted to NPO for review and approval. Both should be approved in 2018.

## 2.9 National Historic Preservation Act, Archaeological Resource Protection Act, and Native American Graves Protection and Repatriation Act

In October 2004, NPO, Pantex, 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) (PANTEXj). This PA/CRMP ensures compliance with Sections 106 and 110 of the NHPA, providing for more efficient and effective review of 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 the Plant's compliance program. The PA/CRMP provides for the systematic management of all archeological and historic resources at the 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 the Plant, compliance with the Native American Graves Protection and Repatriation Act is also addressed in the plan. Both archeological and natural resources at the 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 the Plant's archeological sites.

Fulfilling the Plant's cultural resource management obligations under Section 106 of the NHPA, 37 projects were evaluated in 2017 under the PA/CRMP. Of these projects, 35 did not involve either National Register-eligible properties or possible adverse effects. For the remaining two 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 the Pantex Plant include hazardous waste, universal waste, non-hazardous industrial solid waste, waste regulated by the Toxic Substance Control Act (TSCA), low-level radioactive waste, mixed low-level radioactive waste, and sanitary waste. Wastes generated from the operation, maintenance, and environmental cleanup at the Pantex Plant in calendar year 2017 are summarized in Table 2.6. Overall, the amount of waste generated in 2017 decreased 11.9 percent from 2016. This is due primarily to decreased activity in the environmental restoration projects and deactivation and decommissioning of excess facilities and construction projects.

During 2017, 398.9 cubic meters ($m^3$) of hazardous waste was generated at the 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-gallon waste accumulation sites), less than 90-day waste accumulation sites, 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. During the year, environmental restoration projects and deactivation and decommissioning of excess facilities and construction projects contributed 24.5 percent of the total hazardous waste generated. Hazardous wastes and residues from hazardous waste processing are shipped to commercial facilities authorized for final treatment and disposal or, as applicable, recycling.

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

| Waste Type | 1993 | 2014 | 2015 | 2016 | 2017 | Percent Increase or (Decrease) from 1993 | Percent Increase or (Decrease) from 2016 |
|---|---|---|---|---|---|---|---|
| Non-hazardous Industrial Solid Waste | 10,885 | 4,461.8 | 4,497.7 | 3,641.0 | 2,693.0 | (75.3) | (26.0) |
| Sanitary Waste | 612 | 984.1 | 908.4 | 965.2 | 927.3 | 51.5 | (3.9) |
| Hazardous Waste | 369.6 | 551.8 | 418.5 | 460.2 | 398.9 | 7.9 | (13.3) |
| Low-Level Waste | 287 | 60.3 | 28.1 | 36.2 | 47.6 | (83.4) | 31.5 |
| Mixed Waste | 37.5 | 0.3 | 20.5 | 0.12 | 0.45 | (98.8) | 275 |
| TSCA Waste | 112.9 | 66.4 | 82.8 | 3.3 | 430.9 | 281.7 | 12,957.6 |
| Universal Waste[a] | - | 15.1 | 18.3 | 13.8 | 13.2 | - | (4.3) |
| Total | 12,304 | 6,139.8 | 5,974.3 | 5,119.8 | 4,511.3 | (63.3) | (11.9) |

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

During 2017, 2,693.0 $m^3$ of non-hazardous industrial solid waste was generated at the Pantex Plant. Non-hazardous industrial solid wastes generated were characterized as either Class 1 non-hazardous industrial solid waste or Class 2 non-hazardous industrial solid waste, as defined by Title 30 of the Texas Administrative Code, Chapter 335. Class 1 non-hazardous industrial solid wastes generated at Pantex were managed in a similar manner as hazardous waste, including shipment to off-site treatment and/or disposal facilities. Some Class 2 non-hazardous industrial solid wastes (inert and insoluble materials such as bricks, concrete, glass, dirt, and certain plastics and rubber items that are not readily degradable) were disposed in an on-site Class 2 non-hazardous industrial solid waste landfill. Other Class 2 non-hazardous industrial solid wastes, generally liquids, were shipped to commercial facilities for treatment and disposal.

The Pantex Plant's environmental restoration projects and deactivation and decommissioning of excess facilities and construction projects contributed 22.0 percent of the total non-hazardous industrial solid waste generated during 2017. In addition, during the year, 927.3 $m^3$ of sanitary waste (cafeteria waste and general office trash) was generated at the Pantex Plant. Sanitary wastes were also characterized as Class 2 non-hazardous industrial solid wastes and disposed of at authorized off-site landfills.

The Pantex Plant generated 430.9 $m^3$ of waste regulated by TSCA, during 2017. These wastes include asbestos, asbestos-containing material, and materials containing or contaminated by PCBs. During the year, environmental restoration projects and deactivation and decommissioning of excess facilities and construction projects contributed to 99.4 percent of the total TSCA waste generated. All TSCA wastes were shipped off-site for final treatment and disposal.

During 2017, 13.2 $m^3$ of waste that were managed as universal wastes was generated at the 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 0.9 percent of the total universal waste generated. These wastes are shipped off-site for final treatment, disposal, or, as applicable, recycling.

The Pantex Plant generated 47.6 $m^3$ of low-level radioactive waste during 2017. The low-level radioactive wastes were generated by weapons-related activities.

Assembly and disassembly of weapons also resulted 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 2017, 0.45 $m^3$ of mixed waste was generated at the Pantex Plant.

### 2.10.2 Hazardous Waste Permit Modifications

The Pantex Plant did not submit an application to amend or renew Permit HW-50284 during 2017.

### 2.10.3 Annual Resource Conservation and Recovery Act Inspection

The annual RCRA waste site inspection was conducted by the TCEQ on June 21-22, 2017. The inspection included facility walk-downs of all hazardous waste permitted locations, all less-than-90-day waste accumulation sites, all satellite accumulation areas, and various non-hazardous waste accumulation sites. The inspection also included a records review to ensure compliance with the Pantex Plant hazardous waste permit and the applicable requirements from the Code of Federal Regulations and the Texas Administrative Code. This year's inspection concluded with no findings and no issues.

Additionally, during the RCRA TCEQ inspection, the inspector completed a Texas Tier Two 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 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 (TCEQ, 2014) and Article 16.4 of the Pantex IAG, were submitted to both the TCEQ and EPA in 2017. The annual report contained a full reporting of all monitoring information for 2016. Quarterly progress reports were also submitted in 2017 in accordance with the schedule in the approved Sampling and Analysis Plan (SAP) and Table VII of Permit HW-50284. These reports focused on the continued operation of the remedies and on monitoring results from key groundwater wells.

### 2.10.5 Underground Storage Tanks

The Plant operated five regulated underground Petroleum Storage Tanks (PSTs) during 2017. Of the five regulated underground storage tanks at Pantex, two are used for emergency generator fuel storage. Three other PSTs at the Plant are used for vehicle fueling. These tanks store unleaded gasoline, diesel, and a gasoline–ethanol mix (E-85).

## 2.11 Safe Drinking Water Act

The 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. The 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 September 1, 2017, 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 Public Water System during 2017.

### 2.11.2 Drinking Water System Achievements

On December 17, 2009, the TCEQ notified Pantex that its PWS had achieved a "Superior Rating". Organizations receiving the Superior Public Water System Rating are recognized for their overall excellence in all aspects of operating a PWS. The Pantex Plant maintained its Superior Public Drinking Water System Rating during 2017.

## 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 not to regulate all chemicals that pose a risk, but to regulate those 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 the Pantex Plant.

As a user of chemical substances, Pantex 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 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 the 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 the Pantex Plant file several annual reports with the EPA (Table 2.7) and participate in Local Emergency Planning Committee activities. The Pantex Plant remains in compliance with provisions of this statute.

## 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 calendar year 2017, all proposed activities at the Pantex Plant were evaluated during the NEPA process for potential impacts on floodplains and wetlands and other criteria required by 10 CFR §1022.

**Table 2.7 – 2017 Activities for Compliance with the Emergency Planning and Community Right-to-Know Act**

| Requirement | Applicable | Comment |
|---|---|---|
| Planning Notification (SARA 302-303) | Yes | Five chemicals defined as "Extremely Hazardous Substance" by SARA 302-303 were stored at Pantex in quantities above the threshold planning quantities in 2017. |
| 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 2017. |
| Material Safety Data Sheet/Chemical Inventory (SARA 311-312) | Yes | This requirement was satisfied by the Texas Tier Two Report[a]. Twenty chemicals were listed in the report for 2017. |
| Toxic Chemical Release Inventory Reporting (SARA 313) | Yes | A Toxic Chemical Release Inventory Report was required for calendar year 2017. |

[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.

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# Chapter 3 – Environmental Management Information

*To implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by CNS operations, a comprehensive EMS has been developed. The Pantex EMS is a major component of the Integrated Safety Management System (ISM). These integrated systems envelop all personnel that work at the Plant and all of the Plant's activities, products, and services and are the means by which DOE cost effectively meets or exceeds compliance with applicable environmental, public health, and resource protection requirements.*

## 3.1 Environmental Management System

The ultimate goal of the CNS ISM is to achieve a strong safety culture. This requires the implementation and effective integration of safety, environmental, security, and quality programs so that missions are accomplished while protecting the public, the worker, and the environment. Figure 3.1 represents the CNS work activity structure. The Core Functions define how CNS safety management functions are performed and provide structured methodology for the ISM Program. The ISM Core Functions apply at the enterprise, site, facility, and activity/task levels. Each level has defined processes that integrate with the other levels. This assures safety and provides feedback about the effectiveness of the overall ISM Program. The levels are as follows:

- **The Enterprise and Site Level** represents the management and operation of CNS sites as authorized by the Prime Contract.
- **Facility Level** represents the work of providing and maintaining facilities and equipment to support CNS missions and associated processes.
- **Activity/Task Level** represents work/activities on individual mission projects.

This system promotes the active protection of personnel doing work and the environment in which work is performed. The ISM core functions are the framework which ensures work processes at the activity, facility, and site levels, methodically and formally assess hazards and implement appropriate controls to mitigate hazards and any potential negative consequences.

On March 25, 2015, EO 13693 superseded previous Executive Orders that focused on energy, environmental, and economic performance while continuing to stipulate the use of formal Environmental Management Systems (EMS) that are appropriately implemented and maintained for the purpose of achieving performance necessary to meet the goals of the Order. The new EO 13693 promotes a clean energy economy that will sustain prosperity and the health of the environment for the generations to come. Pantex has an EMS that meets the requirements of DOE Order 436.1 *Departmental Sustainability* (DOEh). The EMS provides for systematic planning, integrated execution, and evaluation of programs for: 1) public health and environmental protection, 2) environmental sustainability, 3) Pollution Prevention (P2), 4) recycling, and 5) compliance with applicable environmental protection requirements. It includes policies, procedures, and training to identify activities with significant environmental impacts, to manage, control, and mitigate the impacts of these activities, and to 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, the Plant's EMS is modeled on the ISO 14001, *Environmental Management Systems – Requirements with Guidance for Use*, 2004 (ISO 14001:2004).

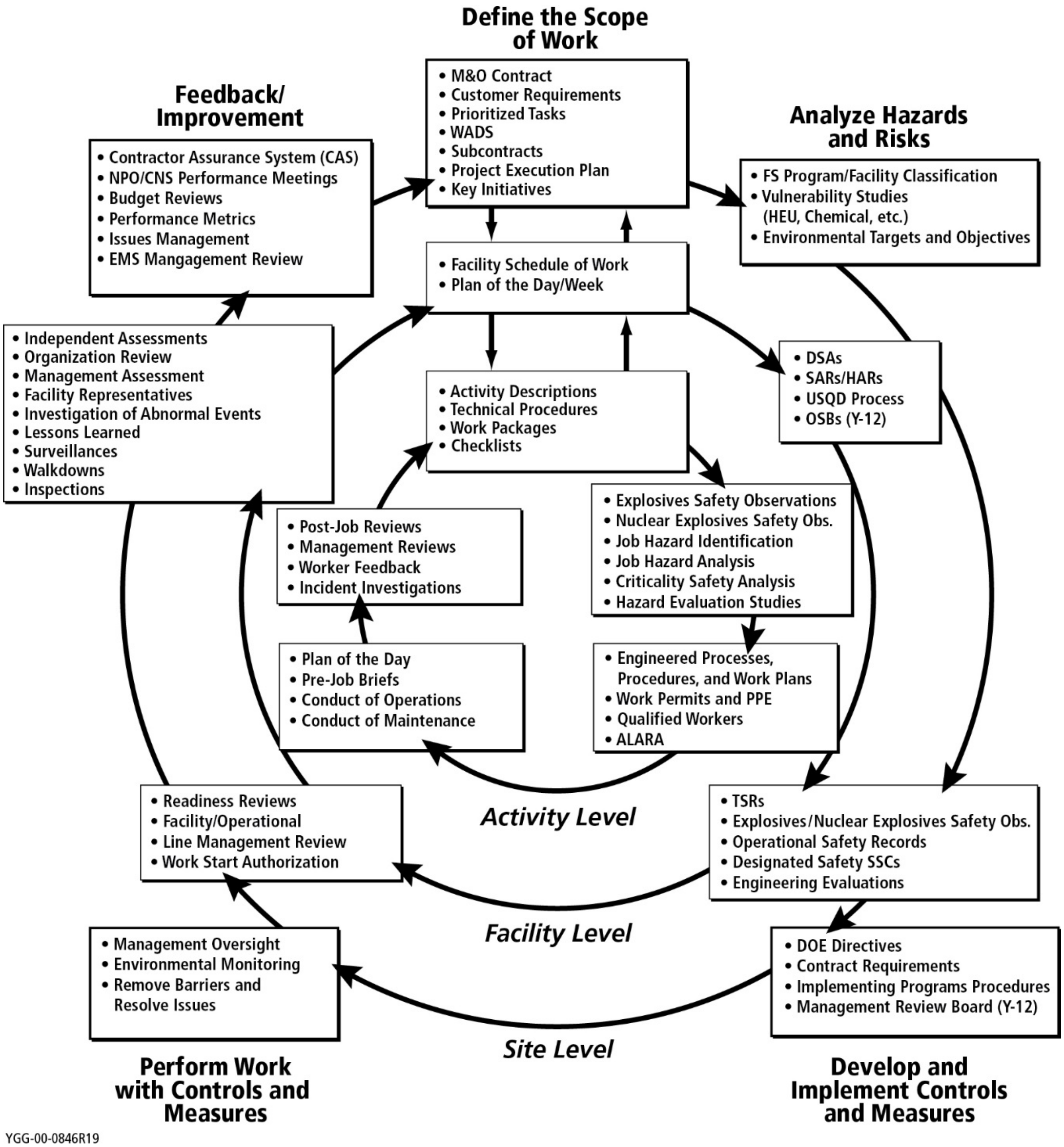


**Figure 3.1 – CNS Integrated Safety Management Program**

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 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 Plant operations are evaluated to determine potential goals for the following year. The objectives and associated specific targets are set to improve the management of identified environmentally significant aspects related to Pantex activities, products, and services. By adopting objectives, the 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 final status of Objectives and Targets for FY 2017.

**Table 3.1 – CNS Pantex Objectives and Targets for 2017**

| Objective | Target(s) | Status/Comments |
|---|---|---|
| Maximize reduction of fossil /greenhouse gases by management of lighting | Compare and contrast traditional exterior lighting with emerging and state of the art options. Compare currently used energy use with new technology requirements with prepared recommendation. [High Mast, Perimeter/PIDAS] | Target Met:<br>- PIDAS bed LED lighting (Zone 4 & 12 MAA) was awarded 9/2017.<br>- Recommendation to pursue LED High Mast lighting estimates. |
| Maintain Compliance with ISO 14001 | Transition Ready the CNS Pantex EMS from ISO 14001:2004 to ISO 14001: 2015 strategy. (Per DOE O 436.1 Attachment 1 CRD 2.b. requirement) | Target Met:<br>DOE 436.1A remains in draft, ISO 14001:2004 continues as contract language per DOE O 436.1. Pantex & Y-12 will share EMS strategies and Policy, although site specific activities will remain particular to each site. |

### 3.1.1 EMS Accomplishments for 2017

In accordance with the current DOE Order 436.1 *Departmental Sustainability*, Pantex 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 the Pantex EMS has been the subject of required formal triennial audits by qualified auditors outside the control or scope of the EMS on four occasions and has successfully been 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. Special attention has been provided to assist DOE and Pantex subcontractors in the subcontractor lay-down yards to maintain compliance with EMS expectations and to instill in the subcontractors that the quality of an EMS is also their concern.

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

- Pantex continues to promote sustainable acquisition and procurement to maximum extent practicable, ensuring bio-preferred and bio-based provisions and clauses are included in 95% of applicable contracts.
- Pantex has diverted ~40% of Municipal Solid Waste, and construction & demolition material/debris originally earmarked for landfills and identified alternate pathways for beneficial reuse.
- CNS has achieved sufficient energy savings to enable both Pantex and Y-12 to meet clean and renewable electric energy targets.
- Ninety-three percent of all electronics procured have met criteria for being environmentally sustainable.

- Pantex beneficially reused more than 91 million gallons of reclaimed/treated water for on-site agricultural purposes in 2017.
- Pantex recognized as the Department of Energy Award Winner Migratory Bird Federal Stewardship Award: *Conservation of Migratory Birds: Of Partnerships and Hemispheres*.

### 3.1.2 Energy

Success in reducing energy use at Pantex has historically been realized from energy savings activities such as: (1) utilizing the Energy Management Control System (EMCS) to implement and maintain night, weekend and holiday setbacks; (2) installation of occupancy sensors to control lighting in areas in several facilities with low occupancy rates (conference rooms, break rooms, restrooms); (3) 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 U.S. EPA's Portfolio Manager building benchmarking system; (4) procurement of equipment such as Energy Star products that are more energy efficient and (5) continuous and retro-building commissioning. Other innovative building strategies, such as cool roofs and low-flow fixtures, are also used to minimize the consumption of energy, water, and materials. In 2017, the Pantex Plant continued to use an alternate work schedule (9X80s) which has helped reduce energy consumption for a large number of administrative personnel. Relocation of approximately 1,100 employees to a newly constructed energy-efficient facility (John C. Drummond Center) during April 2018 and the resulting reduction of "footprint" after the demolition of legacy facilities over the next 10 years will also reduce energy consumption in the future. However, the major source of reductions in energy intensity has been the installation of the Pantex Renewable Energy Project (PREP) (see Figure 3.2) in the summer of 2014.

**Figure 3.2 – Pantex Renewable Energy Project**[1]

[1] Pantex Renewable Energy Project (PREP) consists of five 2.3-MW-Siemens wind turbines

Since 2016 a new goal (included in guidance from the U.S. Department of Energy Sustainability Performance Office[2]) requires a 25% reduction in energy intensity by FY 2025 from a FY 2015 baseline. Pantex has achieved a 10% reduction in energy intensity from the 2015 baseline as the energy intensity decreased from 164.9 kBtu/$ft^2$/year for FY 2015 to 149.3 kBtu/$ft^2$/year for FY 2017. Again, the decrease in energy intensity is primarily attributable to the renewable energy production from PREP.

Another new (two-part) goal requires that: (1) the percentage of an agency's total electric and thermal energy accounted for by renewable and alternative energy (also known as "Clean Energy"[3]) shall not be less than 10% in FY 2016-2017, working towards 25% by FY 2025; and (2) renewable electric energy account for not less than 10% of a total agency electric consumption in FY 16-17, working towards 30% of total agency electric consumption by FY 2025.

During FY 2017 the PREP supplied 24,436 MWh (equivalent to 83,376 MMBtu) of electricity. As currently configured, the PREP was credited with the production of 34,360 MWh (equivalent to 83,376 117,237 MMBtu) of electricity. Because this renewable energy was produced on-site, EPAct 2005 Section 203 allows for a double bonus and 234,474 MMBtu of renewable electrical energy can be used in calculations of compliance with target percentages. There are currently no alternative energy technologies used at Pantex. Accordingly, the magnitude of "Renewable Electric Energy" and "Clean Energy" are equivalent.

The total electric and thermal energy consumed at Pantex during FY 2017 was 541,922 MMBtu. Accordingly the percentage of "Clean Energy" during FY 2017 was 32.0%[4]. For the second year in a row, Pantex has exceeded the FY 2016-2017 interim target for "Clean Energy". The total electrical consumption during FY 2017 was 57,017 MWh (equivalent to 194,540 MMBtu). Using the same double bonus, the percentage of "Renewable Electric Energy" (the ratio of energy accounted for by renewable electric energy to the total electric energy consumed) during FY 2017 was 89.3%. Accordingly, Pantex has also exceeded the FY 2016-2017 interim target for "Renewable Electric Energy".

Pantex progress towards meeting the above goals is illustrated in Figures 3.3 and 3.4 below. In both figures, "down time" due to increased PREP maintenance during FY 2017 caused a reduction in the quantity of renewable electrical energy and clean energy respectively from the quantities used in FY 2016. Since there are only two years of data, longer term trends are difficult to identify. If the current trends continue for the next several years, it is likely that Pantex may need to explore additional "alternative energy" technologies and/or renewable electrical energy sources to ensure that the FY 2025 goals are met.

### 3.1.3 Greenhouse Gases

Guidance from the U.S. Department of Energy Sustainability Performance Office has expanded upon the energy reduction and environmental performance requirements of EO 13423 and EO 13514 by setting requirements in several areas, including the management of Greenhouse Gases[5] (GHGs). The guidance requires a 50% reduction of Scope 1 & 2 GHG emissions and 25% reduction of Scope 3 GHG emissions by FY 2025 from their respective 2008 baselines.

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[2] Scheduled to be incorporated in a future revision to DOE O 436.1

[3] See the definition of these several terms in the glossary.

[4] The ratio of energy accounted for by renewable and alternative energy, using the EPAct 2005 Section 203 double bonus, to the total electric and thermal energy consumed.

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

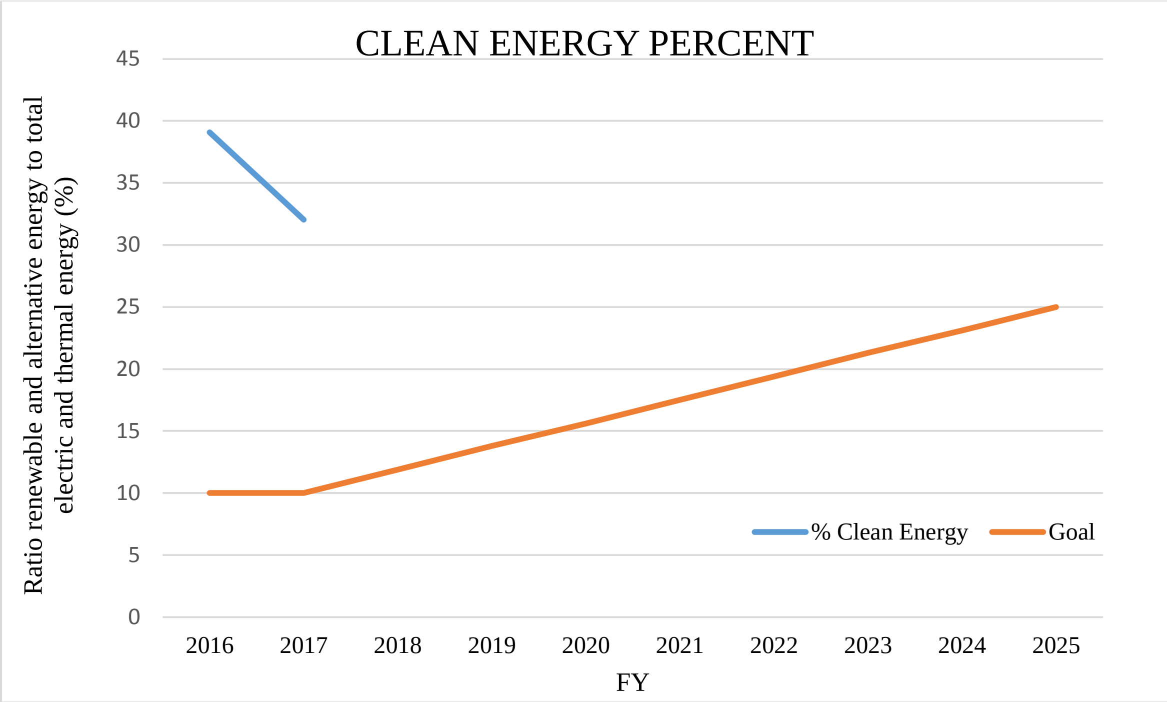



**Figure 3.3 – Annual Clean Energy Performance and Goals**

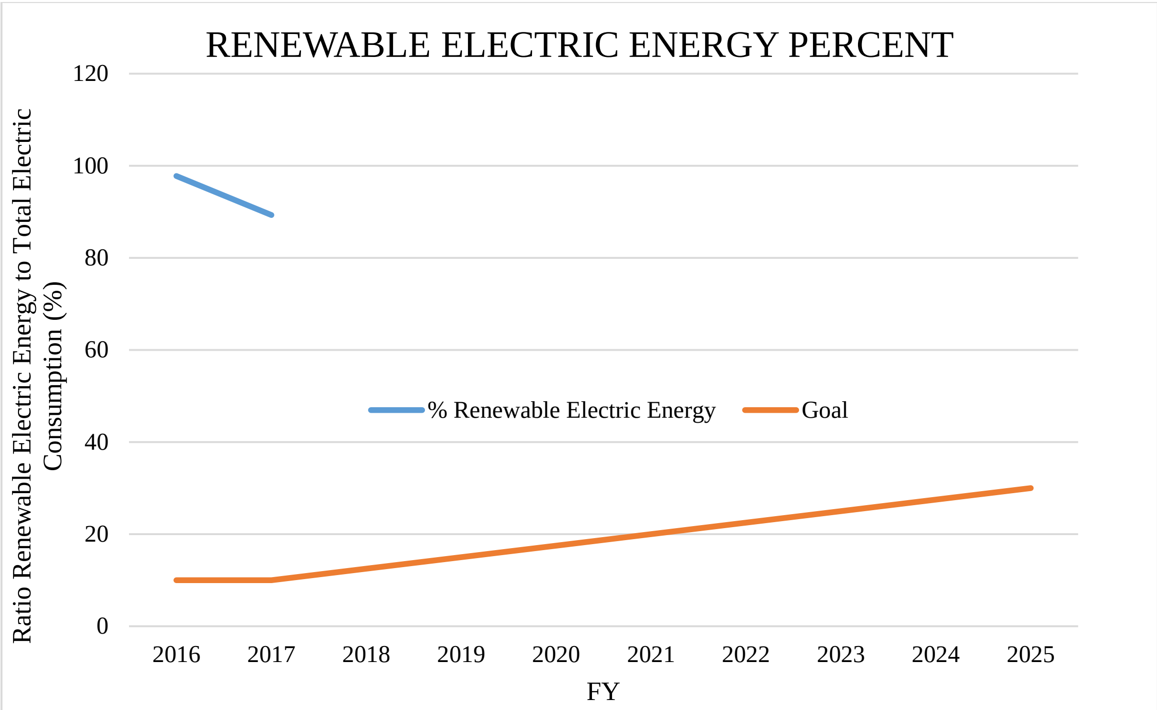



**Figure 3.4 – Annual Renewable Energy Performance and Goals**

The largest component of the GHG emissions accredited to the Pantex Plant are those generated through the purchase and use of electricity generated off-site (Scope 2 or Energy Indirect GHG emissions). These emissions and Scope 1 GHGs (those from federally owned or controlled sources such as the combustion of natural gas used to produce steam onsite and the use of petroleum fuels in fleet and other vehicles and equipment as well as fugitive emissions from refrigerants and wastewater treatment operations) yielded more than 74,747[6] metric tons $CO_2$ equivalent ($MtCO_2e$) of GHGs in 2008. During FY 2017, the operation of Pantex yielded a total of 59,354 $MtCO_2e$. Of this total, 16,687 $MtCO_2e$ was due to the combustion of natural gas, 2,212 $MtCO_2e$ due to other Scope 1 sources, 23,011 $MtCO_2e$ due to the purchase and use of electricity generated off-site (Scope 2 sources) and 17,445 $MtCO_2e$ was due to Scope 3 GHG emissions. These emissions are illustrated at Figure 3.5 below.

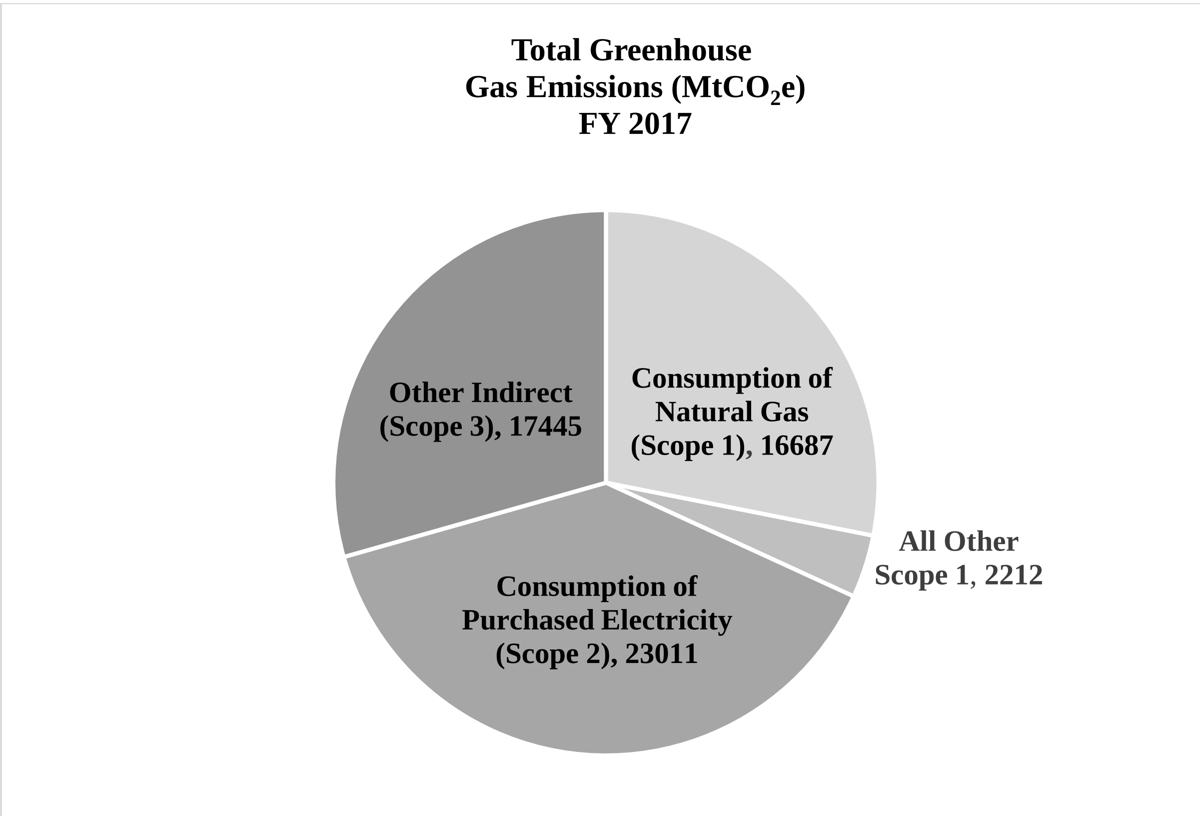



**Figure 3.5 – Total FY 2017 GHG Emissions**

By the operation of the PREP during FY 2017, Pantex did not need to purchase as much electricity and the quantity of Scope 2 GHG emissions continued to be significantly reduced from baseline year (FY 2008) levels. In addition by reducing energy consumption by the means discussed in Section 3.1.2 above, Pantex has concurrently reduced the generation of Scope 2 GHGs. Although some components of Scope 1 emissions such as fugitive emissions and emissions associated with on-site wastewater treatment have remained fairly constant, the Plant also continued efforts to reduce Scope 1 emissions by improving operations of the Pantex fleet, reducing petroleum fuel use, using more hybrid vehicles for better gas

[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 a total of 99,802 $MtCO_{2e}$ GHGs was associated with Pantex operations during FY 2008, the baseline year for goals relating to GHGs.

mileage, using Alternative Fuel Vehicles (AFVs) and ensuring the fleet is the right size for the NNSA mission. During FY 2017, Pantex generated 41,909 $MtCO_2e$ of Scope 1 and Scope 2 GHGs, which was a reduction of 45.1 percent since 2008. Figure 3.6 illustrates the levels of Scope 1 and Scope 2 GHGs during FYs 2016 and 2017.

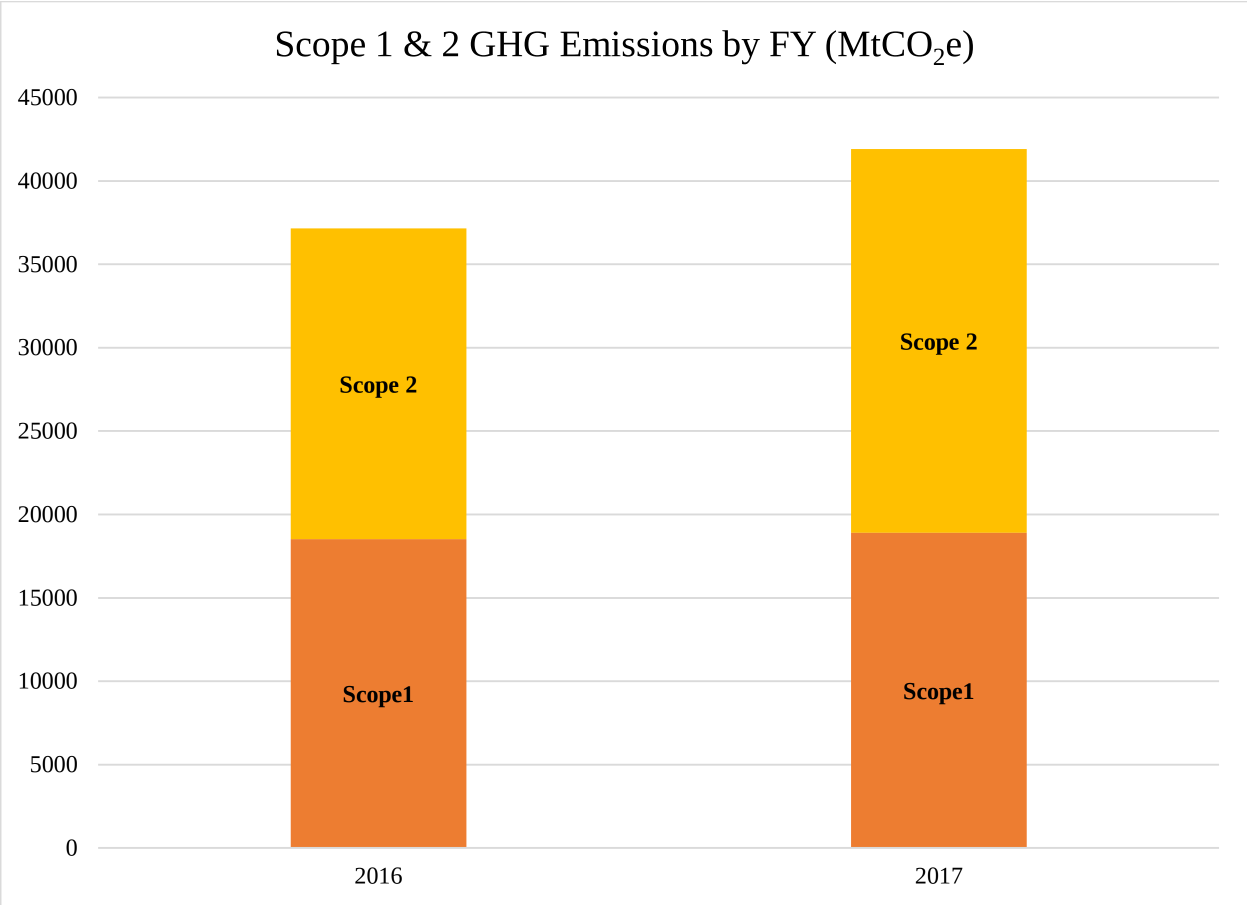



**Figure 3.6 – Scope 1 & 2 GHG Emissions by FY ($MtCO_2e$)**

Although the emissions of Scope 2 GHGs increased slightly from FY 2016 to FY 2017 due to periods when the PREP experienced "downtime" for repairs and/or system calibration, potential future reductions in the generation of Scope 2 GHGs are anticipated to occur as operation of the PREP continues. Configured correctly, the production of electricity from that renewable source on-site will allow the Plant to significantly reduce GHG emissions associated with the purchase of power from non-renewable sources such as coal-fired generators. The potential exists for Pantex to avoid the emission of more than 36,300 $MtCO_2e$ per annum from the operation of the PREP.

Pantex also continues to reduce Scope 3 (Other Indirect) GHG emissions compared to the FY 2008 baseline. FY 2017 Scope 3 GHG emissions, illustrated in Figure 3.7, have decreased by approximately 25.5 percent. The FY 2017 emissions reduction is primarily due to reductions in travel. In addition, a reduction in the quantity of emissions associated with employee commuting has occurred with the conversion of all CNS personnel to 9/80s and the encouragement of telecommuting programs in certain select organizations. With less energy being directly purchased from the regional vendor, transmission and distribution losses as well as the associated Scope 3 GHG emissions have also been diminished.

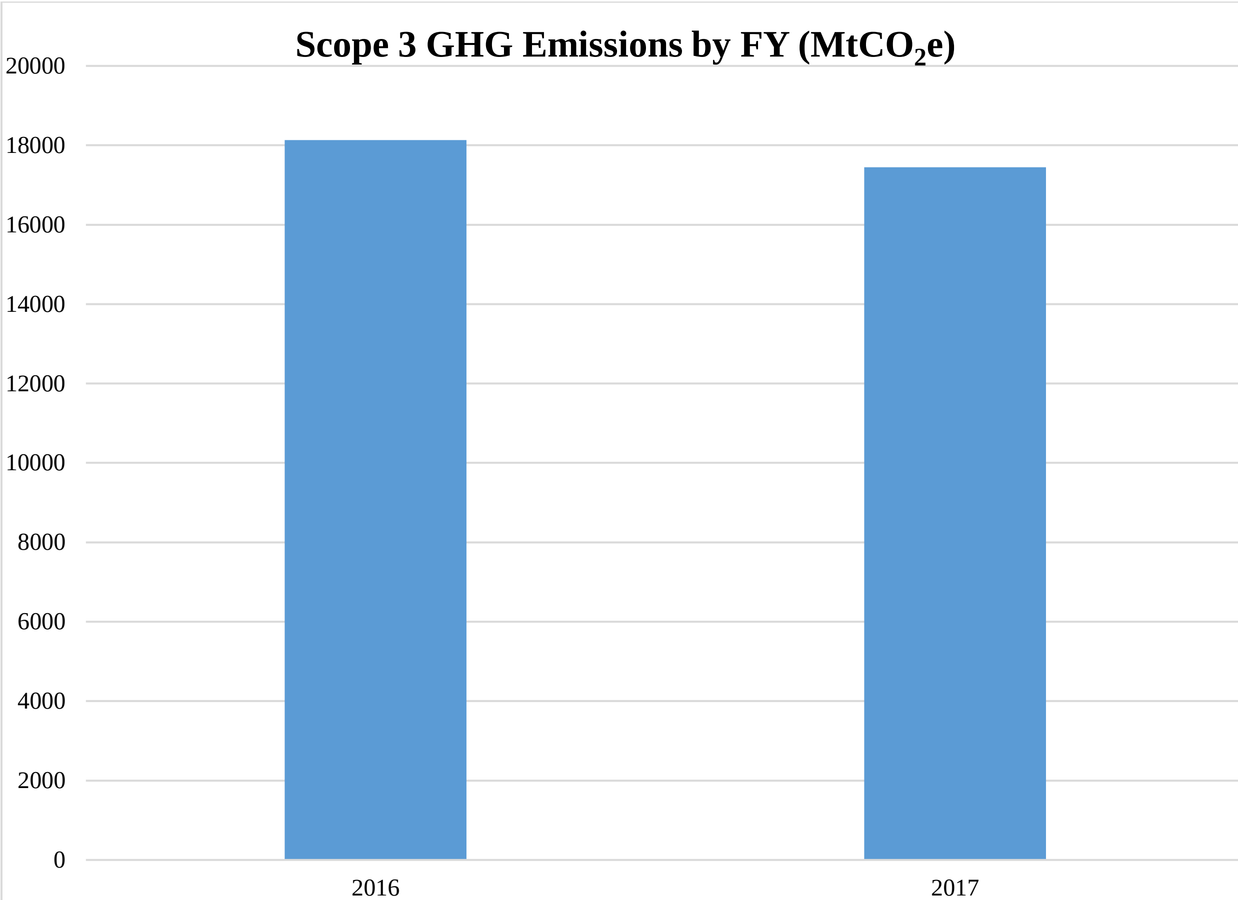



**Figure 3.7 – Scope 3 GHG Emissions in FY 2016 and FY 2017**

### 3.1.4 Water

EO 13423 (2007) required Pantex, beginning in 2008, to reduce water intensity[7] relative to the baseline of the Plant's water consumption in 2007 (~128,500,000 gallons). The challenge was to focus on conservation awareness and life-cycle cost-effective measures to reduce annual use by 2% per year through the end of 2015 (16%). Subsequent requirements in DOE O 436.1 established that Pantex support commitments to respective contributions in meeting sustainability goals as integrated into our Site Sustainability Plan (SSP). The Pantex SSP progressively challenges facilities to increase the goal by reducing an additional 20% by 2025, equating to a 36% reduction in intensity overall.

During 2017, water consumption was approximately 134,000,000 gallons. While Pantex shows about a 5.0% increase in square footage since the baseline year, Pantex reduced water intensity by about 0.5 gallons per square foot during 2017. Accordingly, water intensity has decreased about 1.1% from the baseline year while the reduction goal at the end of the tenth year since the baseline year is 20% (Figure 3.8).

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

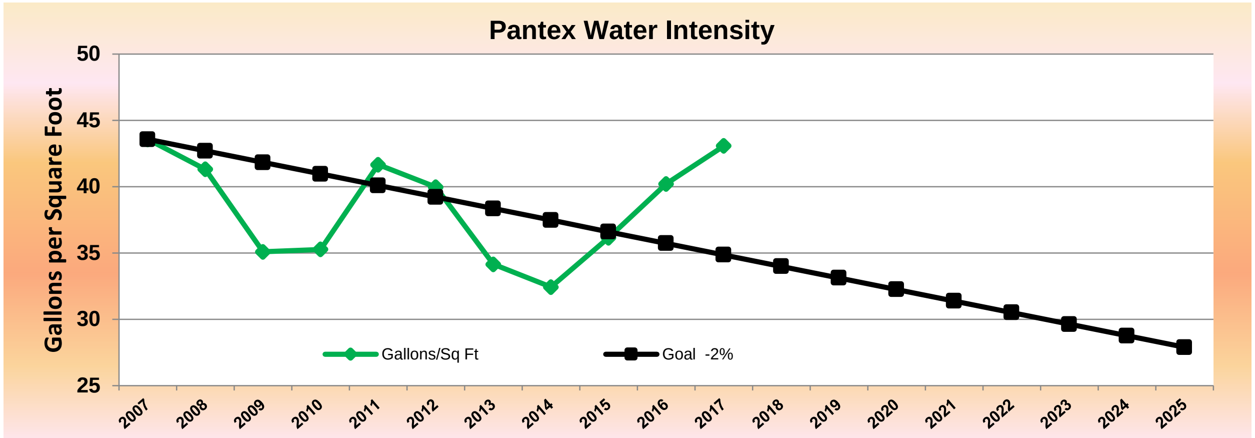



**Figure 3.8 – Water Target Compared to Actual Use**

Although some repair and replacement has occurred during the last several years, leaking WWII era water lines, inefficient water-cooled equipment, and other factors caused a noticeable increase in water intensity during 2015 thru 2017. Increase of water production during 2017 is partially attributed to water provided to ongoing construction of the new John C. Drummond Center. During 2018 the ASC will be complete and will host the relocation of approximately 1,100 employees, roughly a third of the Pantex population. Relocation to the ASC will allow the opportunity to reduce 52 inadequate legacy facilities that require costly maintenance and are well past their intended life. This move will enable Pantex to eliminate deferred maintenance activities for these outdated facilities.

## 3.2 Oversight

### 3.2.1 Federal Agencies

The results of compliance inspections and/or other oversight activities conducted by the EPA in 2017 are discussed in Chapter 2 of this document.

### 3.2.2 State of Texas

The results of compliance activities conducted by various state agencies in are discussed in Chapter 2 of this document. An additional oversight mechanism was initiated in 1989 when the Secretary of Energy invited the host State of each DOE facility to oversee the evaluation of environmental impacts from facility operations. As a result, the DOE entered into a five-year Agreement in Principle with the State of Texas in August 1990, which was re-negotiated 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), and the Texas Department of Public Safety (DPS)-Division of Emergency 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 2017. 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 the 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 and water conservation. Pantex performs Pollution Prevention Opportunity Assessments (PPOAs) on Plant processes to identify new ideas for waste reduction. The team that performs the PPOA works with the owner of the process to implement the waste reduction recommendations. In 2017, four PPOAs were performed.

In accordance with DOE O 436.1, Pantex has continued an active recycling program, which reduces the waste disposal volumes and saves taxpayers' money. Results of ongoing recycling initiatives in 2017 are shown in Table 3.2.

**Table 3.2 – Pantex Plant Site-wide Recycling for 2017**

| 2017 Totals | | |
|---|---|---|
| **Recycled Material** | **Pounds** | **Kilograms** |
| Aluminum Cans | 860 | 390 |
| Batteries | 95,042 | 43,110 |
| Computers & Other Electronics | 23,462 | 10,642 |
| Concrete & Asphalt | 339,440 | 153,966 |
| Corrugated Cardboard | 481,572 | 218,437 |
| Engine Oils | 35,160 | 15,948 |
| Fluorescent Bulbs | 4,650 | 2,109 |
| Newspapers/Magazines/Phonebooks | 20,296 | 9,206 |
| Non-Suspension Scrap Metals | 346,138 | 157,005 |
| Office and Mixed Paper | 153,420 | 69,590 |
| Oil Filters | 2,250 | 1,020 |
| Plastic | 7,520 | 3,411 |
| Tires/Scrap Rubber | 37,500 | 17,009 |
| **Total** | **1,547,310** | **701,843** |

In 2006, Pantex joined and became an ongoing partner of the EPA Federal Electronics Challenge (FEC) and pledged to make progress toward meeting all FEC criteria for environmentally responsible management of electronic equipment. The Pantex process for computer disposition meets the FEC criteria for recycling and reuse of computer equipment. Through these ongoing efforts Pantex has demonstrated an environmentally friendly approach to lifecycle management of electronic equipment while ensuring the protection of national security information from unauthorized disclosure. Pantex reused/recycled a total of 23,462 pounds of electronics during 2017.

## 3.4 Natural Resources

### 3.4.1 Flora and Fauna

As across most of the Southern High Plains, cultivation and other developments have reduced the acreage of native habitat at the Pantex Plant. The remaining areas of near-native habitat at the Plant are small, and include wetlands and shortgrass prairie uplands, which are primarily around the playas.

A biological assessment at the Pantex Plant, completed in 1996, addressed the impacts of continuing Plant operations on endangered or threatened species and species of concern that may occur in or migrate through the area. The assessment was approved by the U.S. Fish & Wildlife Service (USFWS), and it concurred with the conclusion that continued Plant operations would not be likely to adversely affect any federally-listed threatened or endangered species (PANTEXb) and this was verified in subsequent Supplement Analyses (2003, 2009, and 2013) for the 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 plant and animal sampling are discussed in Chapters 11 and 12.

### 3.4.2 Fauna (Mammals)

At least 12 species of mammals were recorded at the Pantex Plant in 2017 during field activities and nuisance animal responses (Table 3.3). The all-time mammal list for Pantex includes 46 species.

**Table 3.3 – Mammals Identified at Pantex Plant During 2017**

| Common Name | Scientific Name | Playa 1 | Playa 2 | Playa 3 | Pantex Lake | East Property | Other Area |
|---|---|---|---|---|---|---|---|
| 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 |
| Deer mouse | *Peromyscus maniculatus* | | | | | | X |
| Domestic dog | *Canis lupus familiaris* | | | | | | X |
| Feral Cat | *Felis catus* | | | | | | X |
| Mule deer | *Odocoileus hemionus* | X | | | | | X |
| Pronghorn | *Antilocapra americana* | | | | | | X |
| Southern plains woodrat | *Neotoma micropus* | | | | | | X |
| Striped skunk | *Mephitis mephitis* | | X | | | | X |
| White-tailed deer | *Odocoileus virginianus* | | X | | | | X |

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

### 3.4.3 Fauna (Birds)

Migratory birds are an important part of the Pantex Plant's natural resources. A bird checklist for the Pantex Plant compiled by Seyffert (1994) indicates the species and their abundances expected in the Pantex Plant area during various seasons of the year, based on habitat types and knowledge of migrations through the local area. The *Integrated Plan for Playa Management at Pantex Plant and Wildlife Management at Pantex* (PANTEXf) provides for monitoring of birds across the Plant. Fifty-seven species of birds were recorded at Pantex during 2017 (Appendix B) and the all-time bird list for Pantex includes 202 species.

Pantex was the DOE/NNSA's sole-allotted nomination for the 2017 Presidential Migratory Bird Federal Stewardship Award, which included elements of management, research, collaborations, and outreach. Pantex continued to promote bird conservation through public outreach such as articles, presentations and the Purple Martin Banding and Outreach Program. The DOE/Pantex nomination is among the three finalists, and the awardee is expected to be chosen in 2018.

A multifaceted project on the effects of wind energy development on migratory birds through a contract with West Texas A&M University (WTAMU) was concluded in 2017. The project included pre- and post-turbine installation monitoring of birds and monitoring of bat and bird mortality at turbines and associated infrastructure. Raptor surveys were conducted during the winter, spring and fall, and surveys for other birds were conducted during spring and summer. Five towers with Anabat™ equipment monitored for the presence and height of feeding and migrating bats between 2010 and 2014.

Eagles were present in the study area only during winter. No eagles were detected during summers from 2010-2017 while WTAMU conducted full time research activity (June-August; approximately 400 hours per season) including intensive point count surveys for birds and other activities by research crews. Bald (*Haliaeetus leucocephalus*) and, less frequently, golden eagles (*Aquila chrysaetos*) were detected during winter raptor surveys (~0.25 bald eagles/survey, pre- and post-construction of the wind turbines) at prairie dog colonies and playa wetlands but never on the site selected for turbine placement.

The majority of bird mortalities found during 82 searches for carcasses under the turbines were species common to the area. Exotic species, songbirds, shorebirds, waterfowl, and birds-of-preys were represented among carcasses found. The exotic house sparrow *(Passer domesticus*) was the most common species encountered (n=10). House sparrows may view the turbine structures as habitat (cavity-nesting), increasing their time and risk around turbines. Carcasses of horned larks, a year-round resident, were the only other carcasses found with any consistency (n=7) and were found in all seasons. An American kestrel (*Falco sparverius*) and a short-eared owl (*Asio flammeus*) comprised the only birds-of-prey species among the carcasses found during the study. Bats made up approximately 25 percent of mortalities with most of these being the tree-roosting hoary bat ([*Lasiurus cinereus*]; n=14). Hoary bats are likely encountering Pantex turbines during migration and most mortalities were discovered in August and September. This tree-roosting species is known to inspect turbines as they do for roosting spaces/cavities in trees, making them susceptible to collisions with the moving blades. Brazilian free-tailed bats ([*Tadarida brasiliensis*]; n=3) were the only other species of bat identified during mortality surveys.

Night filming using thermal cameras revealed birds and bats flying through the turbine rotor sweep zone on numerous occasions indicating risk of collision exists throughout the year for birds and from at least March through November for bats. Carcass-disappearance studies, including with trailcams, indicated a high level of carcass scavenging under the turbines by carnivores and this included a domestic dog (*Canis familiaris*). Turkey vultures (*Cathartes aura*) visited placed-carcasses, but only those located away from the wind turbines.

A contract with the U. S. Geological Survey's Texas Cooperative Fish and Wildlife Research Unit at Texas Tech University includes satellite-tracking of Swainson's hawks (*Buteo swainsoni*) with PTT/satellite transmitters. Adult and juvenile Swainson's hawks are tracked in relation to turbine fields, nesting territories, fall migration, and wintering areas. Location and monitoring of Swainson's hawk nests in and around the proposed and existing turbine fields, as well as radiating outwards to include hawks that would likely be unassociated with turbine fields. Although data suggests that wind farms might not be impacting breeding parameters yet, they may pose a significant risk along the migratory pathway, and risk of disrupting breeding and behaviors may increase as turbines become denser on the landscape. Turbines may force hawks to change patterns and feeding areas and, thus potentially impacting the birds in ways other than direct mortality. Migration velocity and altitude of location points are being assessed to continue assessment of the risks the wind energy industry poses to this species, and birds of similar ecology.

Pantex collaborates with York University, University of Manitoba, and the Purple Martin Conservation Association and maintains a study site for deployment of geolocator and G.P.S. data-loggers on purple martins (*Progne subis*) as part of an international collaboration studying this declining songbird. G.P.S. technology confirms roosts locations and habitat throughout the migrations and winter.

During 2017, the Pantex collaborations work resulted in two technical articles appearing in the Journal of Avian Biology (purple martins), and Journal of Ornithology (purple martins). Three popular-style articles on birds and bird work at Pantex, and feral cat impacts on birds appeared in the Texas Bird Annual (Texas

Ornithological Society). Presentations were given at the Texas Chapter of The Wildlife Society (one each, purple martins and Swainson's hawks), Florida Chapter of the Wildlife Society (Purple Martins), Texas Tech Annual Biological Symposium (Swainson's hawks), The Wildlife Society Annual Meeting (one each on purple martins and Swainson's hawks), and the Raptor Research Foundation Conference (two on Swainson's hawks). The Wild Pantex blog is popular, with lots of feedback, and oftentimes covers migratory bird species and projects.

## 3.5 Cultural Resources

Cultural resources identified at the 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 the 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 the 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 NHPA and related Cultural Resource Management (CRM) requirements. The Plant's CRM program ensures compliance with all applicable state and federal requirements.

The goal of the CRM program is to manage the Plant's cultural resources efficiently and systematically, taking into account both the Plant's continuing mission and historic preservation concerns. This goal is achieved through coordination with the Plant's project review process for compliance with the NEPA, and through consultation with the SHPO and the President's Advisory Council on Historic Preservation (Advisory Council). In October 2004, DOE, the Pantex Plant, the Texas SHPO, and the Advisory Council completed execution of a Programmatic Agreement/Cultural Resource Management Plan (PA/CRMP) (PANTEXj). This PA/CRMP ensures compliance with Section 106 of the NHPA, providing for more efficient and effective review of 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 the Plant's compliance program. The PA/CRMP provides for the systematic management of all archeological and historic resources at the Pantex Plant under a single document. No changes were made to the program in 2017.

### 3.5.1 Archeology

The Pantex Plant lies within the southern Great Plains archeological province; specifically, within the High Plains Ecological Region of the Texas Panhandle. Approximately half of the DOE-owned and leased land at the Pantex Plant has been systematically surveyed for archeological resources and based upon those surveys, a site-location model was developed. In 1995, a 960-hectare (2,400-acre) survey confirmed that prehistoric archeological sites at the Pantex Plant are situated within approximately 0.4 kilometer (0.25 mile) of playas or their major drainage locations. Conversely, such sites do not occur in interplaya upland areas (Largent, 1995).

The 69 archeological sites identified at the Pantex Plant consist of 57 Native American prehistoric sites represented by lithic scatters of animal bone artifacts and 12 Euro-American farmstead sites represented by foundation remains and small artifact scatters. In consultation with the SHPO, Pantex determined that the 12 historic sites are not eligible for inclusion in the *National Register*. Pantex and the SHPO concluded that two of the 57 prehistoric sites (41CZ66 and 41CZ23) are potentially eligible for the *National Register*, but that additional field work would be required to make a final eligibility determination. Pantex will continue to protect these two sites and monitor them on a regular basis, as though they are eligible. 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 archeological methods. All archeological reports, records, photographs, maps and artifacts will be archived at the 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, 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 and preserved. Today, the bison bones have been placed in a permanent exhibit within the Pantex Visitor Center located in Building 16-12.

For Calendar Year 2017, staff members monitored archeological sites on four separate occasions. In September 2017, staff members located 10 bones after cattle entered the enclosed area and eroded the soil due to a fallen fence. The area is usually enclosed by a fence to keep out cattle. Shortly after the discovery, maintenance personnel fixed the fallen fence. Personnel documented the bones and sent photographs and descriptions to an archeologist meeting the Secretary of Interior's qualifications. The Archeologist reviewed the photographs and concluded the bones were probably from a smaller mammal possibly an antelope or deer.

### 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-acre industrial Pantex Ordnance Plant, designed and constructed in only nine months, sprang up in the middle of a traditional rural farming and ranching community, bringing with it great social and demographic change. It was constructed by the USACE and operated by the Certain-teed Products Corporation to produce bombs and artillery shells.

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

The 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 impact on Pantex. Pantex collaborated with the Panhandle Plains Historical Museum in Canyon, Texas on an exhibit which focused on women's contributions during WWII along with a respirator and metal badge frame which were on loan from the Pantex Plant between March 2014 and August 2015 to make up part of the exhibit.

The Records Operation Center continues to identify, maintain and store historical records and a variety of different media for preservation purposes. A new storage area for unclassified records and small artifacts has been obtained. Collections include facility maps, aerial maps and additional Cold War as-built drawings, as well as 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" (National Park Service [NPS] Bulletin 15, 1997). However, 69 buildings that were 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 the 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, the Pantex Plant lies at the very heart of Cold War history.

The period of Cold War operations at the Pantex Plant date from 1951, when the Plant was reclaimed by the AEC as part of the expanding nuclear weapons complex, to the September 1991 address to the nation by then-President, George H.W. Bush directing the dismantlement of a portion of the nation's nuclear weapon stockpile; thereby, changing the Pantex mission from one of nuclear weapon assembly to one of disassembly. The Cold War-era historical resources of the Pantex Plant consist of approximately 650 buildings and structures and a large inventory of process-related equipment and documents. The historical resources of this period are among the Plant's most significant, and offer a valuable contribution to the nation's cultural heritage.

Ten buildings designated for in-situ preservation were specifically listed in the "Twenty-Five Year Site Plant FY2013-FY2037." (PANTEXe). This critical planning document helps guide and shape infrastructure decisions including both new construction and demolition for the foreseeable future. As stated, "This plan identifies a range of preservation activities for 173 eligible facilities including preservation in-situ of 10 mission-related buildings." Historical equipment tooling, trainers and other components were acquired and have been inventoried and moved into a historical facility until funding can be obtained for a classified exhibit. These projects strengthen continued use of the historical facilities, which confirms Pantex's pledge for implementing preservation activities.

Preservation activities continue through identification and evaluation of facilities by maintaining the Pantex Visitor Center and railcar displays, collection of artifacts and records, monitoring archeological sites, educational outreach, and other preservation activities. Thirty-four outreach activities for Pantex history occurred in Calendar Year 2017.

## 3.6 Educational Resources and Outreach Opportunities at Pantex Plant

Pantex employees continued public outreach efforts and P2 education during 2017. Pantex partnered with local communities to help expand their recycling efforts including the ongoing partnership with the City of Panhandle in which Pantex provides magazines, newspapers, phonebooks, and some cardboard. The City of Panhandle includes these materials with city wastes that are sold to recyclers, with the revenue from these sales being reinvested into the City's recycling program. This win-win partnership supports the community's recycling efforts while saving Pantex disposal costs.

Pantex scientists, engineers, and wildlife specialists continued to donate their time and talent to area schools by speaking to students about science careers and helping stimulate student's interest in science, technology, engineering, and math (STEM). The most notable event each year is the Pantex Science Bowl where middle school and high school students from all across the Texas Panhandle compete for a chance to advance to the National Science Bowl in Washington, D.C. Pantex also supported four area schools advance their STEM education through donations made to their robotics programs. Pantexans provided several presentations to school, community, and professional groups on a variety of topics including the history and importance of Pantex, wildlife management and research, the world of engineering, and other topics such as “phases of matter”.

## 3.7 Environmental Restoration

Historical waste management practices at the 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 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 and in the uppermost (perched) groundwater beneath the Pantex Plant. Pantex 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 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 3.9 depicts the location and status of the units. The 15 units still in active use will be closed in accordance with 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 unit is now inactive and funding has been requested to address the 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 (ROD), (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.

### 3.7.1 Environmental Restoration Milestones

During 2017, Pantex 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. Remedial Action systems at Pantex are depicted in Figure 3.10 and the Major Milestones for the 2017 Remedial Actions are shown in Figure 3.11.

**<u>Pump and Treat Systems</u>**: The Pump and Treat Systems were installed to address contamination in areas where there is generally greater than 15 ft. of saturation in the perched groundwater. These systems are designed to remove and treat groundwater to achieve contaminant mass reduction and reduction in the saturated thickness of the perched aquifer. Reduction in saturated thickness will significantly reduce the migration of contaminants both vertically and horizontally so that natural breakdown processes can occur over time. To achieve the remediation goals, the Pump and Treat Systems treat the extracted water to remove contaminant mass from the water before the effluent is sent to the Wastewater Treatment Facility (WWTF) and irrigation system for beneficial use, although the Southeast Pump and Treat System (SEPTS) retains the capability for injection back into the perched zone when necessary. The SEPTS has been operating since 1995 when it was started as a treatability study. It has been expanded with more extraction wells and the capacity to treat boron and hexavalent chromium to continue to address the southeastern portion of the groundwater plumes. Construction of the Playa 1 Pump and Treat System (P1PTS) was started in late 2008, and the system became fully operational in January 2009.

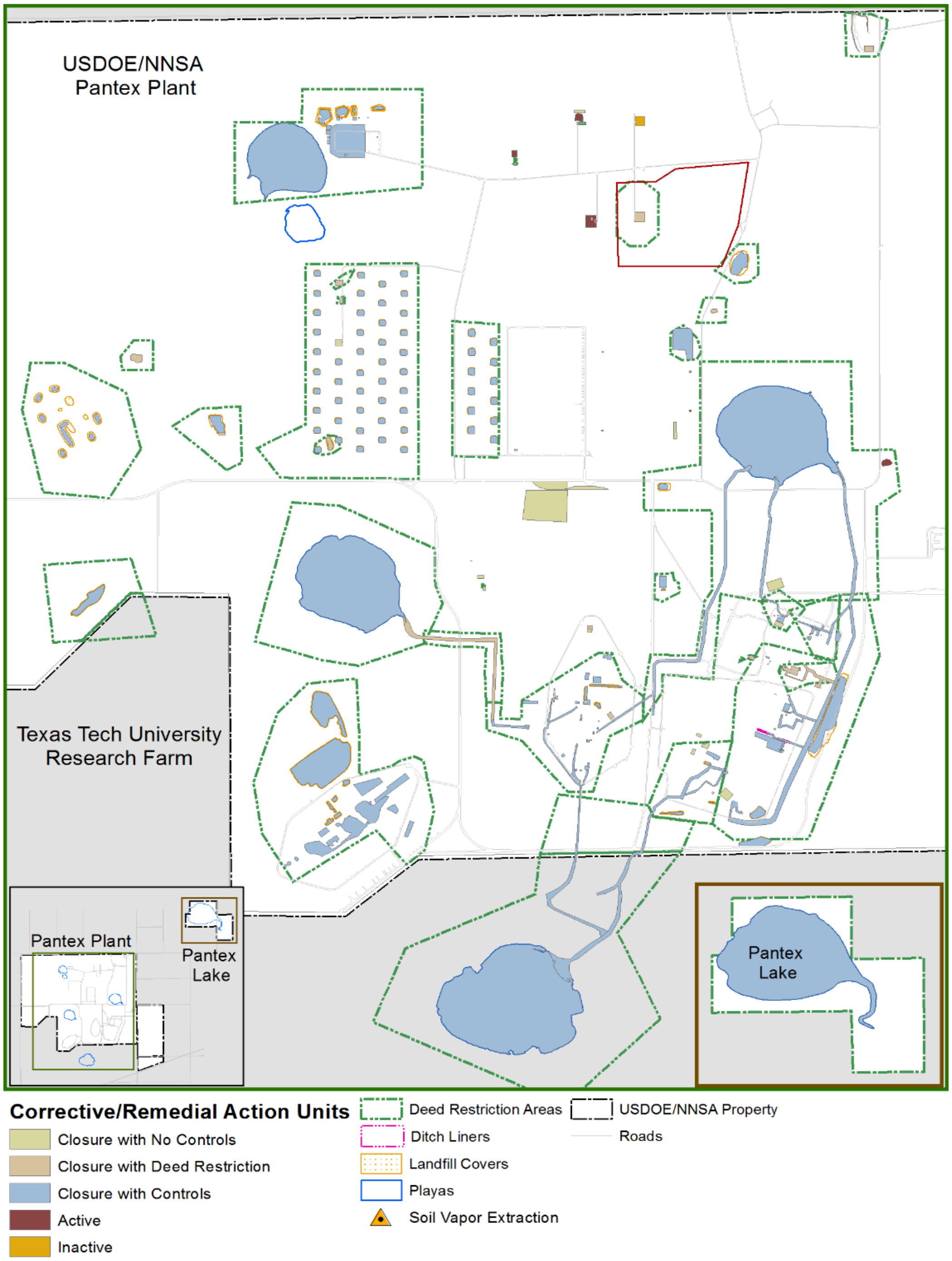
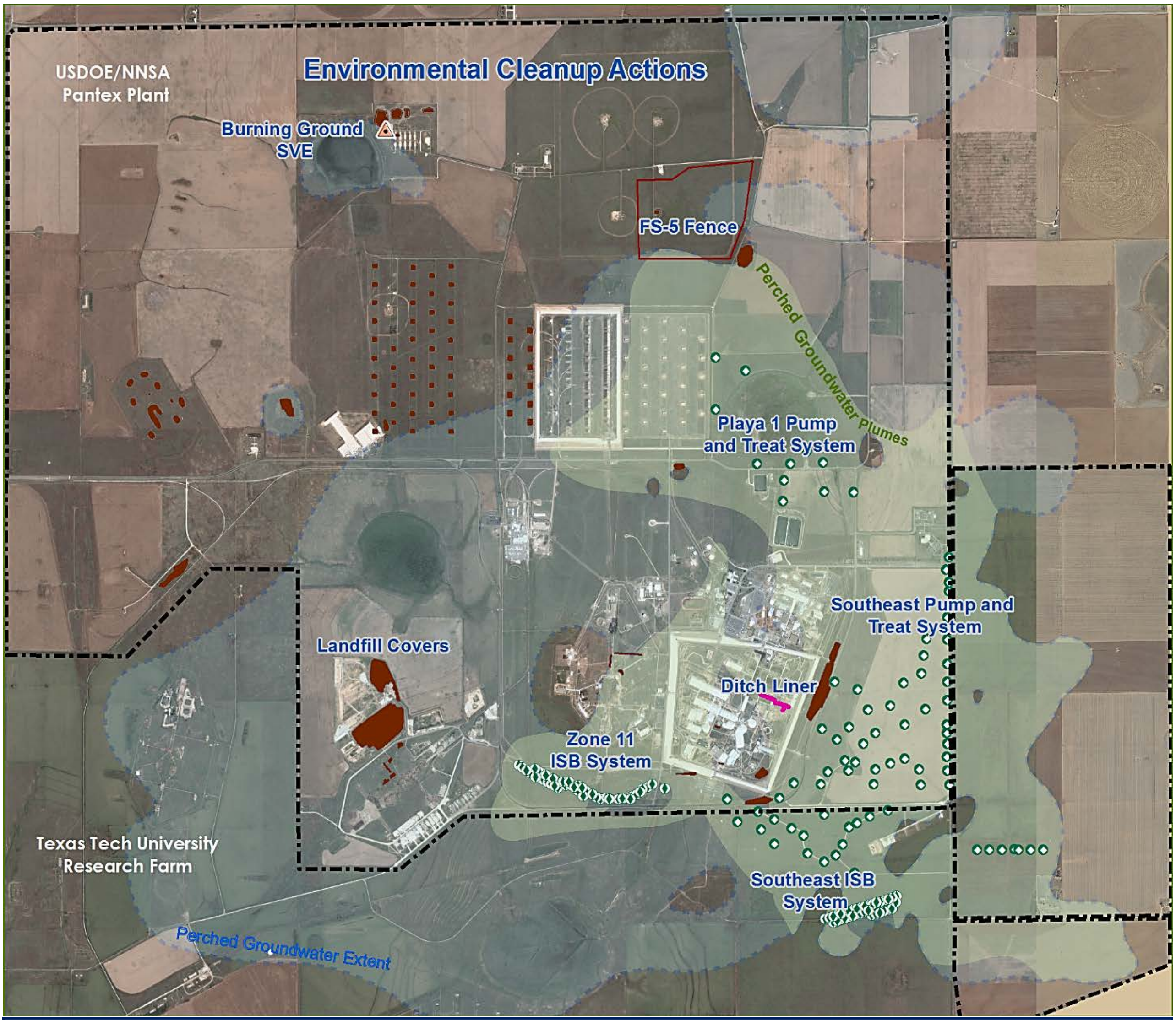



**Figure 3.9 – Location and Status of Solid Waste Management Units**




Groundwater Remedies:

2 Pump & Treat Systems
- Playa 1 Pump and Treat
- Southeast Pump and Treat

2 In-Situ Bioremediation (ISB) Systems
- Zone 11 ISB
- Southeast ISB

Institutional Controls

Soil Remedies:

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

**Figure 3.10 – Remedial Actions at Pantex**

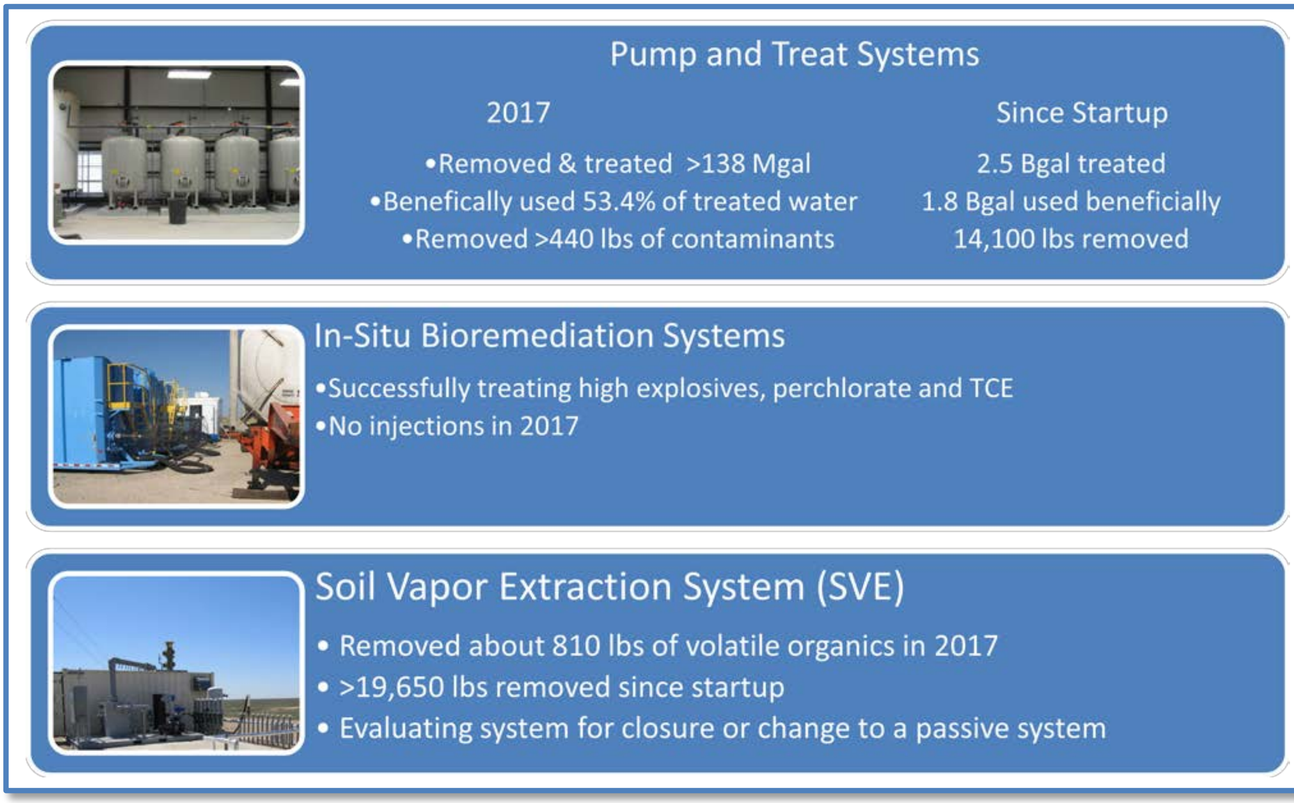



**Figure 3.11 – Major Milestones for 2017 Remedial Actions**

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% of treatment capacity if the WWTF and irrigation system can receive all of the treated water. Pantex revised the goals during 2014 to prioritize treatment and use of the water to align operation with the goal of reducing saturated thickness. During 2017, 53% of the treated water was beneficially used. Performance of the Pump and Treat Systems for 2017 is depicted in Figure 3.12. Operation and beneficial reuse of water from the systems was low during 2017 due to a break at the filter bank at the irrigation system in late June and repairs at the WWTF that affected throughput or required the systems to remain down. Engineering evaluation of the irrigation filter bank break indicates that repairs will be complex and will take an extended period of time. For this reason, treated water is released to Playa 1. Since the release to Playa 1 does not align with goals to reduce water infiltration to the perched aquifer, Pantex has reduced throughput and operation of both systems. The SEPTS is injecting treated water into the perched aquifer while repairs are designed and completed. Pantex is also evaluating other methods of beneficial use of the treated water from the Pump and Treat Systems.

In addition to removing impacted water from the perched aquifer, the pump and treat systems remove contaminant mass from the groundwater that is extracted from the aquifer. The P1PTS primarily removes the high explosive RDX and the SEPTS primarily removes RDX and hexavalent chromium ($Cr^{+6}$). Figure 3.13 provides the mass removal for HEs and chromium for 2017, 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 much higher at that system.

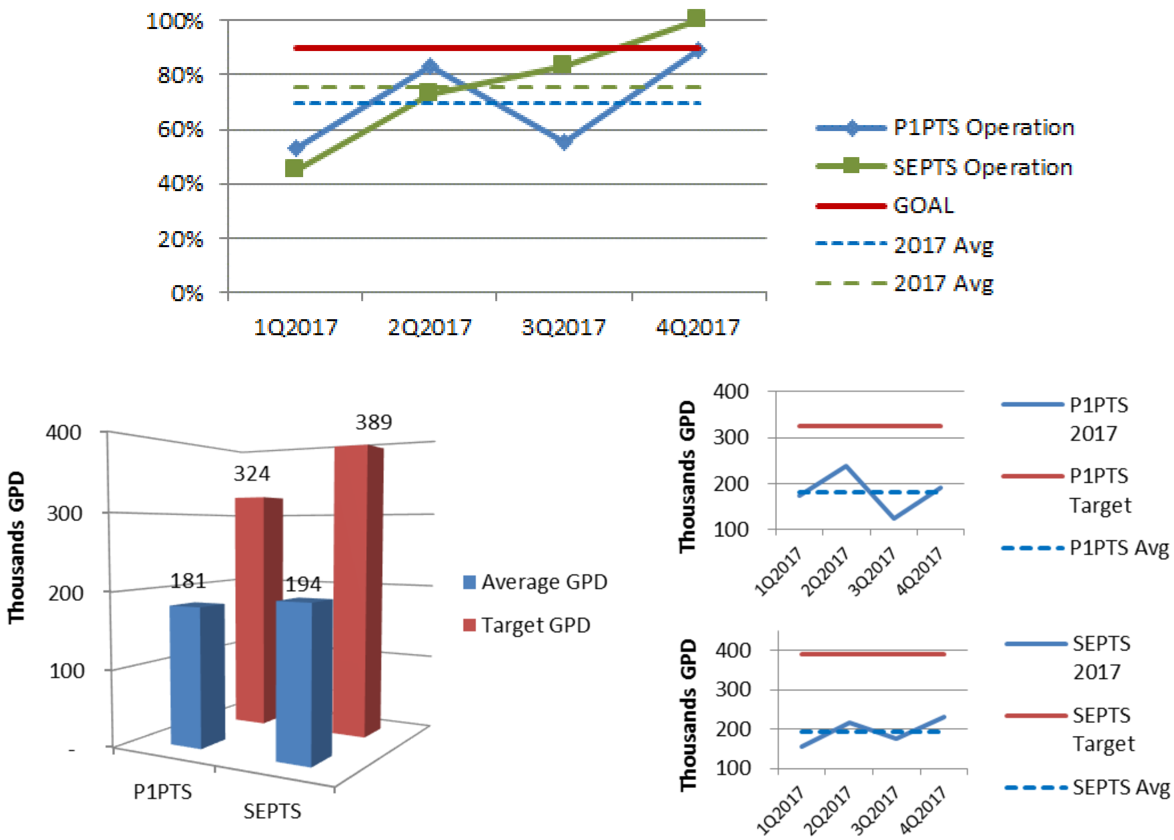
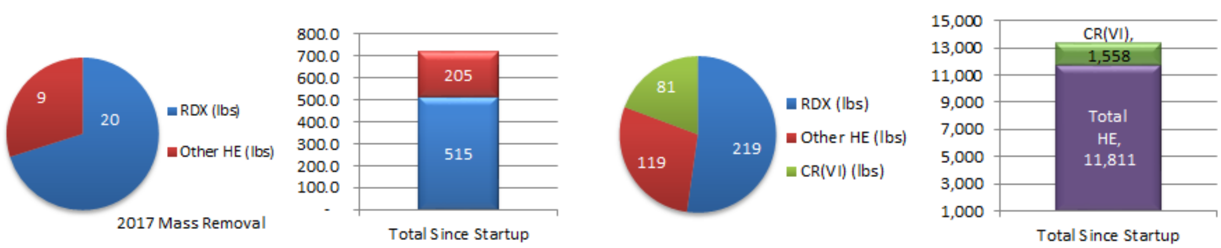



**Figure 3.12 – Pump and Treat Systems Performance**




**P1PTS Mass Removal** **SEPTS Mass Removal**

**Figure 3.13 – Pump and Treat Systems Mass Removal**

**In-Situ Bioremediation (ISB) Systems**: Two ISB systems (Zone 11 ISB and Southeast ISB) are in operation at Pantex 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 to TTU property south of Zone 11 or where the area is sensitive to vertical migration of contaminants of concern (COCs) to the underlying aquifer. 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. Injection of amendment was lengthened in response to changes in the ISB systems that indicate that frequent injections are not necessary to maintain a treatment zone and to account for continued loss of saturation in the Southeast ISB. The Zone 11 ISB will be injected every two years in the established portion of the system, with a one year frequency in the expanded portion until reducing conditions indicate that a longer injection frequency is appropriate. Pantex plans to inject the Southeast ISB three years from the last injection and then re-evaluate the need for further injections every 2-3 years thereafter. A discussion of treatment zone effectiveness and downgradient performance monitoring well information is included in Chapter 6.

Pantex did not inject the Zone 11 or Southeast ISB system in 2017. An injection is planned in the first half of 2018 for the expanded portion of the system and the original portion of the system will be injected in 2019. The Southeast ISB will be injected again in 2019.

**Burning Ground Soil Vapor Extraction (SVE):** An 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 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 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 3.14, the SVE system removed about 813 lbs of volatile organics during 2017.

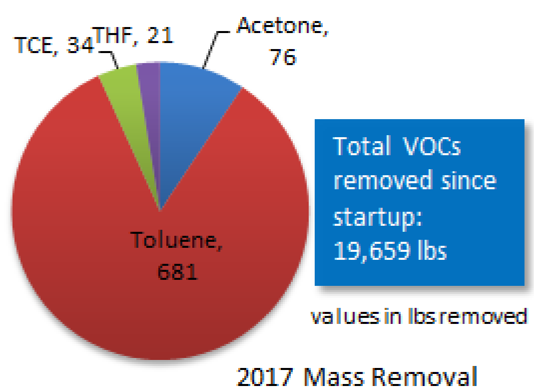



**Figure 3.14 – 2017 SVE Mass Removal**

**Soil Remedies and Institutional Controls:** Institutional controls are required as part of the LTS of soil remedial action units at Pantex. Deed restrictions have been placed on all soil units with the exception of the active units. All SWMUs at Pantex are restricted to industrial use. To support the deed restrictions, Pantex maintains long-term control of any type of soil disturbance in SWMUs to protect human health and to prevent spread of contaminated soils. Pantex also regularly inspects and maintains soil covers on landfills to prevent infiltration of water into the landfill contents and migration of impacted water to groundwater.

**Second Five-Year Review:** The five-year review is conducted to ensure that Remedial Actions for soils and groundwater at the Pantex Plant remain protective of human health and the environment. Pantex started the second five-year review in May 2017. The final regulatory approved report is scheduled to be complete by September 2018.

### 3.7.2 Long-Term Groundwater Monitoring

Pantex 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 to:

- assess impacts and characterize exposures and doses to individual members of the general public, to the population, and to biota in the vicinity of the Pantex Plant,
- detect, characterize and respond to releases from DOE activities, and
- 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*. Another document which was useful in continuous improvement of the design of the Pantex monitoring program was National Council on Radiation Protection (NCRP) Report No. 169 published by the National Council on Radiation Protection and Measurements. Although this document specifically addresses radiological effluent monitoring and surveillance, the authors of the report 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 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* (EPAa). This process requires subject matter experts to consider several factors including the purpose of the monitoring program, the trend of historical results from previous sampling, the predominant wind direction, and the presence of a sufficient quantity of a target species for analysis when planning sample collection locations and frequencies for the various environmental media. Specification of sampling locations and frequencies by a regulatory body (such as TCEQ or EPA) in a permit issued to the Pantex Plant has 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 the other media and determine the usability of his/her data. It should be noted that, 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.

[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.

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

Several data assessment processes were employed by Pantex to verify that the data collected for all of the monitoring programs met the specified data acceptance criteria. These processes included evaluation of sampling quality assurance; laboratory technical performance and quality assurance; 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.

Media-specific descriptions of the sampling locations and the results of the monitoring program for samples collected during 2017 are contained in Chapters 4-12 of this report.[12]

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[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.

[12] Appendix A indicates (by environmental media) the analytes which were monitored during 2017. Frequency of monitoring varies from weekly to quarterly depending upon the objectives of the several environmental monitoring programs.

# Chapter 4 – Environmental Radiological Program

*Monitoring results for the environmental radiological pathways in 2017 indicated levels below relevant standards, similar to results from previous years, and consistent with background conditions.*

This chapter summarizes radiological emissions from normal Plant operations. There were no emissions due to unplanned releases during the reporting period. This section would evaluate these releases in the unlikely event an unplanned incident were to occur.

During, 2017 the Pantex Plant's environmental radiological monitoring program was conducted according to the DOE Order 458.1, *Radiation Protection of the Public and the Environment* (DOEi). The program involved measuring radioactivity in environmental samples in addition to calculating the potential radiological dose to the off-site public. The program monitored for the principal radionuclides associated with Plant operations: tritium ($^{3}$H), uranium$^{234}$ ($^{234}$U), uranium$^{238}$ ($^{238}$U), and plutonium$^{239}$ ($^{239}$Pu) in air, groundwater, drinking water, surface water, flora, and fauna samples. The radionuclides $^{234}$U, $^{238}$U, and $^{239}$Pu emit primarily alpha particles[1] 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.

## 4.1 Radiological Discharges and Doses[2]

### 4.1.1 Doses to Members of the Public

DOE Order 458.1 requires radiological activities to be conducted in a manner so that the exposure of members of the public to 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 the 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* (DOEk).[3]

#### 4.1.1.1 External Radiation Pathways

DOE Order 458.1 requires evaluations to demonstrate compliance with the aforementioned dose limit consider several exposure pathways including direct external radiation from sources located on-site, external radiation from airborne radioactive material, and external radiation from radioactive material deposited on surfaces off-site. At Pantex, external gamma radiation is measured at several locations at or near the site to determine the magnitude of doses from these pathways. As will be discussed below, the results of these measurements are of the same magnitude as those measured at a background or control location in Bushland, Texas, 35 miles west of the Plant. Accordingly, DOE radiological activities at Pantex

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[1] The alpha energies of $^{233}$U (4.82 MeV and 4.78 MeV) and $^{234}$U (4.77 MeV and 4.72 MeV) are very similar. Alpha-spectroscopy techniques used to perform analyses cannot distinguish between the two isotopes. Accordingly a single analysis result will indicate both isotopes in the “pair” as $^{233/234}$U. Similarly, the alpha energies of $^{239}$Pu (5.16 MeV and 5.11 MeV) and $^{240}$Pu (5.17 MeV and 5.12 MeV) are not distinguishable by alpha-spectroscopy and analysis will indicate both isotopes in a single analysis result as $^{239/240}$Pu.

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

[3] 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. The DCS values were derived in accordance with dose limitation systems recommended by the International Commission on Radiological Protection (ICRP) in its several publications (ICRP, 2007) and used by the 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.

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.

#### 4.1.1.2 Air Pathway

DOE Order 458.1 further requires that internal doses[4] 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 40 CFR 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 the Pantex Plant by calculating the effective dose equivalent received by the maximally exposed individual (MEI)[5] member of the general public by the use of the CAP-88-PC (EPAb) model.

Since 1994, the meteorological data used in this modeling effort have been obtained from the meteorological tower at the Pantex Plant. Sensors at the tower automatically record average wind speed and direction, and several other parameters, every 15 minutes. Information about average tropospheric mixing height is obtained 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 (e.g., calibration of radiation detection instrumentation, sanitization[6] 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 (1.12 percent) of these calculated emissions is due to emissions of $^{238}U$ and other radionuclides from various routine Plant activities, while the balance is due to emissions of $^{3}H$.[7] These emissions are summarized in Table 4.1 below.

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

| Tritium | Total Uranium | Total Plutonium | Total Other Actinides | Other |
|---|---|---|---|---|
| $4.66 \times 10^{-4}$ ($1.72 \times 10^{7}$) | $5.25 \times 10^{-6}$ ($1.94 \times 10^{5}$) | None | None | None |

Based on the 2017 operational data, the results of the CAP-88-PC modeling indicate that the maximally exposed individual (MEI) for 2017 (located approximately 1,150 meters [0.71 miles] northeast [NE] of Burning Ground) would have received a dose of $7.60 \times 10^{-6}$ mrem ($7.60 \times 10^{-8}$ mSv). This dose is significantly below (is $7.6 \times 10^{-5}$ percent of) 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 $7.6 \times 10^{-6}$ 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 kilometers (50 miles) of the Pantex

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

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

[6] See the definition of this term in the glossary.

[7] The overwhelming majority (97.3 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.

Plant would have been 1.04 x $10^{-5}$ person-rem/year (1.04 x $10^{-7}$ person-sievert/year) in 2017. The majority of this collective population dose equivalent is contributed by $^3$H.

The effective dose equivalent for the MEI is less than that calculated for CY 2016 but are roughly equivalent to those over the last 5 years as illustrated in Table 4.2 below. Variation in the doses between years is due to changes in the emissions of $^3$H (and isotopes of uranium) as operations such as instrument calibration, sanitization of certain high explosive (HE) 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 2013-2017**

| Year | Maximally Exposed Individual Dose (mrem) | Population Dose (Person-rem/yr) |
|---|---|---|
| 2013 | 7.00 x $10^{-7}$ | 8.05 x $10^{-6}$ |
| 2014 | 2.62 x $10^{-7}$ | 3.40 x $10^{-6}$ |
| 2015 | 1.35 x $10^{-7}$ | 3.21 x $10^{-6}$ |
| 2016 | 2.70 x $10^{-5}$ | 9.94 x $10^{-4}$ |
| 2017 | 7.60 x $10^{-6}$ | 1.04 x $10^{-5}$ |

### 4.1.1.3 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 activities, with the exception of tritium, is demonstrated by comparing measured concentrations of radionuclides in drinking water to four percent of the Derived Concentration Standard (DCS) values for ingested water.[8] The results of these measurements as well as those for other water monitoring programs did not indicate releases to any water pathway and thus no contribution to the total effective dose from Pantex activities during 2017.

### 4.1.1.4 Other Pathways

The 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). The results of the faunal monitoring measurements[9] and monitoring of native vegetation and crops[10] did not indicate releases to either pathway from Pantex activities during 2017.

[8] 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 one percent of the ingested water DCS for tritiated water listed in DOE-STD-1196-2011[DOEk].
[9] See Chapter 11
[10] See Chapter 12

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.

#### 4.3.1.5 Public Doses from All Pathways

The dose equivalent received by the MEI during 2017, the 2017 collective population dose, and the 2017 natural background population dose are presented in Table 4.3. Because there were no releases from the Pantex Plant to the water or other pathways, the air pathway dose represents the public dose from all pathways.

**Table 4.3 – Pantex Radiological Doses in 2017**

| Dose to Maximally Exposed Individual from Pantex Operations (mrem) | (mSv) | Percent of DOE 100-mrem Limit | Estimated Population Dose from Pantex Operations (person-rem) | ( person-Sv) | Population within 80 km (50 miles) | Estimated Background Radiation Population Dose at Pantex Plant (person-rem) |
|---|---|---|---|---|---|---|
| $7.60 \times 10^{-6}$ | ($7.60 \times 10^{-8}$) | $7.60 \times 10^{-6}$ | $1.04 \times 10^{-5}$ | $1.04 \times 10^{-7}$ | 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 the 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 5400.5 pre-approved clearance limits.

**Table 4.4 – Surface Activity Limits -Allowable Total Residual Surface Activity (dpm/100 cm²)**

| Radionuclides | Average | Maximum | Removable |
|---|---|---|---|
| Group 1 - Transuranics, $^{125}I$, $^{129}I$, $^{277}Ac$, $^{226}Ra$, $^{228}Ra$, $^{228}Th$, $^{230}Th$, $^{231}Pa$ | 100 | 300 | 20 |
| Group 2 - Th-natural, $^{90}Sr$, $^{126}I$, $^{131}I$, $^{133}I$, $^{223}Ra$, $^{224}Ra$, $^{232}U$, $^{232}Th$ | 1,000 | 3,000 | 200 |
| Group 3 - U-natural, $^{235}U$, $^{238}U$ 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 $^{90}$Sr and others noted above | 5,000 | 15,000 | 1,000 |
| Tritium (applicable to surface and subsurface) | NA | NA | 10,000 |

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

- Radiation Safety Department (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; and/or
- PX-2189, "Radiation Safety Material Clearance," for M&E not covered by one of the preceding methods.
- PX-3134, 'Process Knowledge" for non-radioactive M&E having no potential for radioactive contaminated surfaces.

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

DOE Order 458.1 requires that verification be performed by personnel independent of contractor personnel conducting property clearance activities. At Pantex, 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 during 2017 is discussed in Chapter 2. As there were no releases of real property containing residual radioactive material during 2017, those values represent the quantities of personal property released from the Pantex Plant in 2017.

## 4.3 Radiation Protection of Biota

While DOE Order 458.1 contains no specific limits for radiation doses to aquatic animals, terrestrial plants, and terrestrial animals, it requires the use of DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOEa) or equivalent methodologies, to demonstrate that radiological activities are conducted in a manner that protects these populations from adverse effects due to radiation and radioactive material released from DOE operations. This requirement has the effect of limiting the dose to 1 rad/day (10 mGy/day) for aquatic animals and terrestrial plants and to 0.1 rad/day (1 mGy/day) for terrestrial animals[11].

[11] 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) (IAEA).

During 2017, there was sufficient precipitation in the vicinity of Playa 1, in addition to discharge from the Waste Water Treatment Facility (WWTF), for the collection of surface water and/or sediment samples. These samples were analyzed for $^{3}$H, $^{234}$U, $^{235}$U, $^{238}$U, and $^{239/240}$Pu. To implement the aforementioned standard, DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOEa), 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. As the sum of fractions for the aquatic system and the terrestrial system are 1.53 x $10^{-3}$ and 4.12–x $10^{-4}$ respectively, applicable BCGs were met for both evaluations. It can, therefore, be concluded that populations of aquatic and terrestrial biota on and near the Pantex site are not being exposed to doses in excess of the existing DOE dose limits.

**Table 4.5a – Evaluation of Dose to Aquatic Biota in 2017**

| 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) |
|---|---|---|---|---|---|---|---|
| $^{3}$Hydrogen | 115 | 2.6x$10^{8}$ | 4.34x$10^{7}$ | 0.41 | 4.0 x$10^{5}$ | 1.09x$10^{-6}$ | 1.53x$10^{-6}$ |
| $^{234}$Uranium | 0.08 | 2.0x$10^{2}$ | 3.97x$10^{-4}$ | 0.28 | 5.0x$10^{3}$ | 5.32x$10^{-5}$ | 4.50x$10^{-4}$ |
| $^{235}$Uranium | 0.02 | 2.2x$10^{2}$ | 4.60x$10^{-5}$ | 0.02 | 4.0x$10^{3}$ | 5.37x$10^{-6}$ | 5.13x$10^{-5}$ |
| $^{238}$Uranium | 0.19 | 2.2x$10^{2}$ | 8.51x$10^{-4}$ | 0.31 | 2.0x$10^{3}$ | 1.25x$10^{-4}$ | 9.75x$10^{-4}$ |
| $^{239}$Plutonium | 0.01 | 1.9x$10^{2}$ | 5.36x$10^{-5}$ | 0.01 | 6.0x$10^{3}$ | 1.71x$10^{-6}$ | 5.35x$10^{-5}$ |
| Sum of Fractions | | | 1.35x$10^{-3}$ | | | 1.86x$10^{-4}$ | 1.53x$10^{-3}$ |

**Table 4.5b – Evaluation of Dose to Terrestrial Biota in 2017**

| 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) |
|---|---|---|---|---|---|---|---|
| $^{3}$Hydrogen | 115.0 | $2.31x10^{8}$ | $4.98x10^{-7}$ | 0.31 | $1.71x10^{5}$ | $1.81x10^{-6}$ | $2.31x10^{-6}$ |
| $^{234}$Uranium | 0.08 | $4.04x10^{5}$ | $1.98x10^{-7}$ | 0.43 | $5.13x10^{3}$ | $8.38x10^{-5}$ | $8.40x10^{-5}$ |
| $^{235}$Uranium | 0.01 | $4.19x10^{5}$ | $2.39x10^{-8}$ | 0.02 | $2.83x10^{3}$ | $7.06x10^{-6}$ | $7.08x10^{-6}$ |
| $^{238}$Uranium | 0.19 | $4.06x10^{5}$ | $4.68x10^{-7}$ | 0.50 | $1.58x10^{3}$ | $3.17x10^{-4}$ | $3.17x10^{-4}$ |
| $^{239}$Plutonium | 0.01 | $2.00x10^{5}$ | $4.99x10^{-8}$ | 0.01 | $6.11x10^{3}$ | $1.64x10^{-6}$ | $1.69x10^{-6}$ |
| Sum of Fractions | | | $1.24x10^{-6}$ | | | $4.11x10^{-4}$ | $4.12x10^{-4}$ |

## 4.4 Unplanned Releases

No unplanned releases of radioactive material occurred at the Pantex Plant during 2017.

## 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 2017, 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 the Pantex Plant. This program has been conducted at several locations in parallel with monitoring conducted by the Texas Department of State Health Services (TDSHS)[12] since the early 1980s. Figure 4.1 shows the locations of the Plant's dosimeters during 2017.

The 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. The data provide the cumulative radiation exposure at each location over approximately 90 days of uninterrupted deployment they receive while exposed to the environment at the various locations.

Table 4.6 lists results for 2017 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 2017 was approximately 20.8 mrem. The equivalent average annual dose is 83.0 mrem/year (0.83 mSv/year). The average quarterly dose at the TLD monitoring locations which are located in the direction of the predominant wind direction at the Pantex Plant was 21.0 mrem (equivalent to 83.8 mrem/year or 0.84 mSv/year), while the quarterly dose at upwind locations averaged 22.3 mrem (equivalent to 89.1 mrem/yr or 0.89 mSv/year). These average quarterly measurements are less than but of the same magnitude as the quarterly average dose of 23.8 mrem (equivalent to 95.0 mrem/year or 0.95 mSv/year) measured at the background or control location at Bushland, Texas, for the same period. The quarterly

[12] The TDSHS used optically stimulated luminescence devices similar in function to the TLDs used by Pantex.

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), and the equivalent average annual doses are of the same magnitude as the sum of the external components of ubiquitous background.[13]

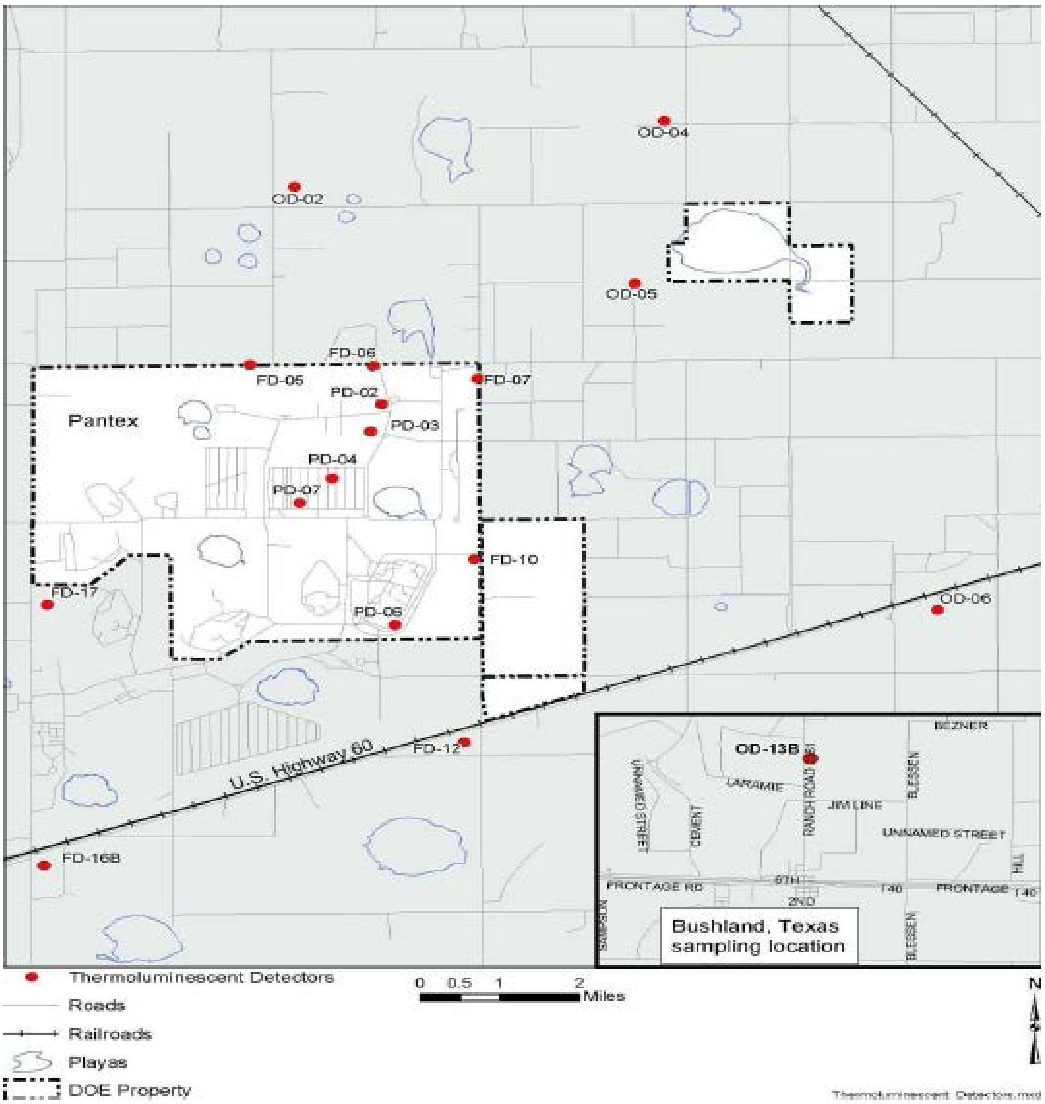


**Figure 4.1 – Locations of Pantex Plant Thermoluminescent Dosimeters**

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[13] Although on the average, these sources are of approximately equal magnitude, soil concentrations of the principal sources of terrestrial radiation are variable (NCRPb).

**Table 4.6 – Environmental Doses Measured by Thermoluminescent Dosimeters in 2017 in Millirem[14]**

| Location | 1st Qtr | 2nd Qtr | 3rd Qtr | 4th Qtr | Avg. Qtr |
|---|---|---|---|---|---|
| **On-site** | | | | | |
| PD-02 | 16.5 | 20.0 | 17.5 | 27.0 | 20.2 |
| PD-03 | 17.5 | 13.0 | 11.5 | 25.0 | 16.5 |
| PD-04 | 18.5 | 21.0 | 18.5 | 32.0 | 22.5 |
| PD-06[a] | 22.5 | 22.0 | 12.5 | 31.0 | 22.0 |
| PD-07 | 17.5 | 20.0 | N/S[b] | 30.0 | 22.5 |
| **"Upwind"** | | | | | |
| FD-02 | 17.5 | 23.0 | 19.5 | 30.0 | 22.5 |
| FD-12[a] | 20.5 | 22.0 | 17.5 | 30.0 | 22.7 |
| FD-16B[a] | 16.5 | 20.0 | 16.5 | 30.0 | 20.8 |
| FD-17[a] | 18.5 | 23.0 | 16.5 | 32.0 | 22.5 |
| OD-06 | 20.5 | 19.0 | 19.5 | 33.0 | 23.0 |
| **"Downwind"** | | | | | |
| FD-06[a] | 20.5 | 25.0 | 12.5 | 30.0 | 22.0 |
| FD-07[a] | 17.5 | 21.0 | 15.5 | 29.0 | 18.0 |
| OD-02 | 18.5 | 19.0 | 17.5 | 27.0 | 20.5 |
| OD-04[a] | 20.5 | 16.0 | 17.5 | 29.0 | 20.8 |
| OD-05 | 21.5 | 21.0 | 18.5 | 33.0 | 23.8 |
| **Control** | | | | | |
| OD-13B | 22.5 | 25.0 | 13.5 | 34.0 | 23.8 |
| Blank Correction | 3.5 | 8.0 | 8.5 | 4.0 | |

[a] Locations co-sampled with TDSHS.

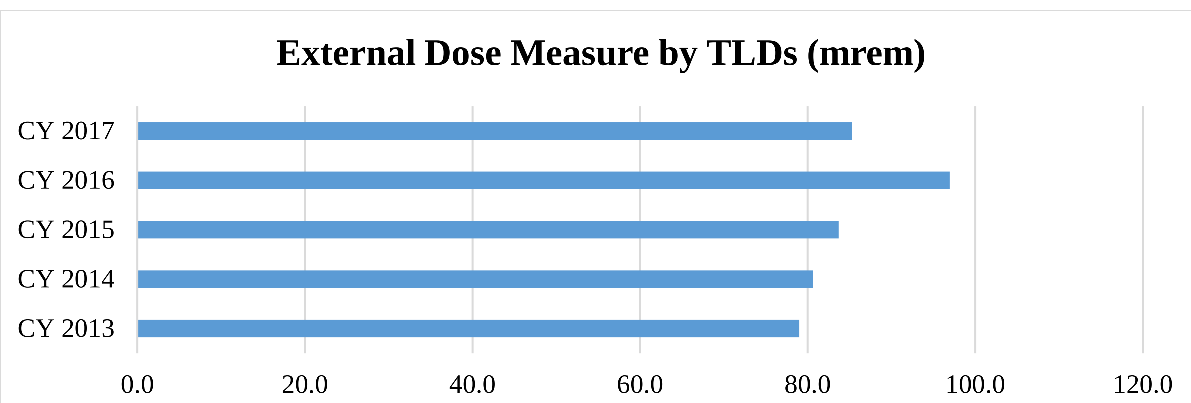


**Figure 4.2 – Environmental Doses Measured by Thermoluminescent Dosimeters CY 2013-2017**

[14] 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 (the blank correction for each quarter) which was subtracted from the raw data of the deployed dosimeters is indicated in the table.

### 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 in the vicinity of the Pantex Plant. The subject matter experts develop (or revise previously existing) monitoring requirements using a process based upon EPA guidance documents and consider potential releases from 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 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. The Pantex measured and/or calculated effective doses are several orders of magnitude smaller than the smallest doses indicated. None of the doses measured is distinguishable from the external components of ubiquitous[15] background radiation levels during the past five years in the Texas Panhandle (about 100 mrem).

The environmental radiological monitoring program at the 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. The Pantex Plant's monitoring results for the environmental radiological pathways in 2017 indicated levels below relevant standards, similar to results from previous years, and consistent with background conditions[16].

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

| Exposure Category | Effective Dose per Individual (mrem) | Collective effective dose (person-rem) |
|---|---|---|
| Ubiquitous background | 311 | $9.33x10^4$ |
| Medical | 300 | $8.99x10^4$ |
| Consumer | 13 | $3.99x10^3$ |
| Industrial, security, medical, educational and research | 0.30 | $1.00x10^2$ |

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

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

[16] In a similar manner, analysis performed by TDSHS laboratories for samples obtained by the TDSHS on or around the Pantex facility during 2017 indicated no exceedances of any regulatory limits. (TDSHS, Pantex Facility Environmental Sample Results for 2017).

# Chapter 5 – Air Monitoring

*All radiological air monitoring data indicated results were not distinguishable from background.*

## 5.1 The Scope of the Program

Monitoring and sampling to detect possible airborne emissions of radiological material or hazardous pollutants at the Pantex Plant is conducted at on-site and off-site locations as a part of an environmental surveillance program. The monitoring program at the Pantex Plant has been described in several documents (e.g., the *Environmental Information Document* [PANTEXc]). Some Pantex Plant operations are sources or potential sources of airborne emissions. Monitoring of ambient air[1] for releases of airborne emissions from the Pantex Plant facilities has historically been done at fixed remote locations, primarily because of the lack of discrete release points at the facilities.

During current operations at the 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 the 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 the Pantex Plant are tritium releases. Very small amounts of tritium escape as gas or vapor during normal operations, although some tritium vapor continues to be released into the atmosphere from the area of the accidental release that occurred in 1989. This incident is described in the *Environmental Information Document* (PANTEXc).

## 5.2 Non-radiological Monitoring

As noted in previous annual reports, Pantex has not routinely operated non-radiological monitors since 2003. However, a qualitative monitoring system has continued to operate at the Pantex Plant. During CY 2017 no Visual Emission Evaluations (VEEs) were conducted.

## 5.3 Routine Radiological Air Monitoring

During 2017 air monitors were operated according to the schedule shown in Table 5.1, wherein several monitors were operated continuously (the four on-site locations as well as the control location), others operated less frequently, and a few were not operated at all during the year. See Figures 5.1 and 5.2 for the location of all air monitoring stations.

### 5.3.1 Collection of Samples

A total of 18 air monitoring stations were used to monitor for radionuclides in the air in 2017. Four on-site monitoring stations designated as PA-AR-XX (for Plant air) in the tables and as PA on the figures, are placed near the several operating areas where radiological material is used and/or stored. Stations PA-AR-03 and PA-AR-04 are located near the firing sites where testing and sanitization of nuclear weapons components contaminated with tritium are conducted. Station PA-AR-04 is adjacent to the north fence of Zone 4 East. Since the predominant wind direction is from the south-southwest, this station is also used to monitor ambient air near the 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. Station PA-AR-07 is located near areas where shipping and receiving operations are conducted in Zone 4.

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[1] Ambient air monitoring refers to the monitoring of air at remote locations where it is assumed that the material (either radioactive material or hazardous pollutants) being measured and compared to some risk-based standard is well mixed in the atmosphere and that any concentration present represents what might be inhaled by an individual.

**Table 5.1 – 2017 Schedule for Air Sampling and Analysis**

| Location | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| **On-site** | | | | | | | | | | | | |
| PA-AR-03 | X | X | X | X | X | X | X | X | X | X | X | X |
| PA-AR-04 | X | X | X | X | X | X | X | X | X | X | X | X |
| PA-AR-06 | X | X | X | X | X | X | X | X | X | X | X | X |
| **Fence line** | | | | | | | | | | | | |
| FL-AR-01 | X | | X | X | | | X | | | X | | |
| FL-AR-02 | | X | | | X | X | | X | | | X | |
| FL-AR-04 | X | | X | | | X | | X | | | X | X |
| FL-AR-05 | | X | X | | X | | X | | X | | X | |
| FL-AR-07 | | | X | X | | X | X | | X | | X | |
| FL-AR-08 | X | | | X | X | | | X | X | | | X |
| FL-AR-09 | | X | | | X | X | | X | | X | X | |
| FL-AR-10 | X | | X | | | X | X | | X | | X | |
| FL-AR-14 | X | | | X | | | X | | X | | | X |
| FL-AR-16 | | X | | | X | | | X | | | X | |
| FL-AR-17 | | | X | | | X | | | X | X | | X |
| **Off-site** | | | | | | | | | | | | |
| OA-AR-02 | X | | | | X | | X | | | X | | X |
| OA-AR-04 | | X | | X | | X | | X | | X | | X |
| **Control** | | | | | | | | | | | | |
| OA-AR-13B | X | X | X | X | X | X | X | X | X | X | X | X |

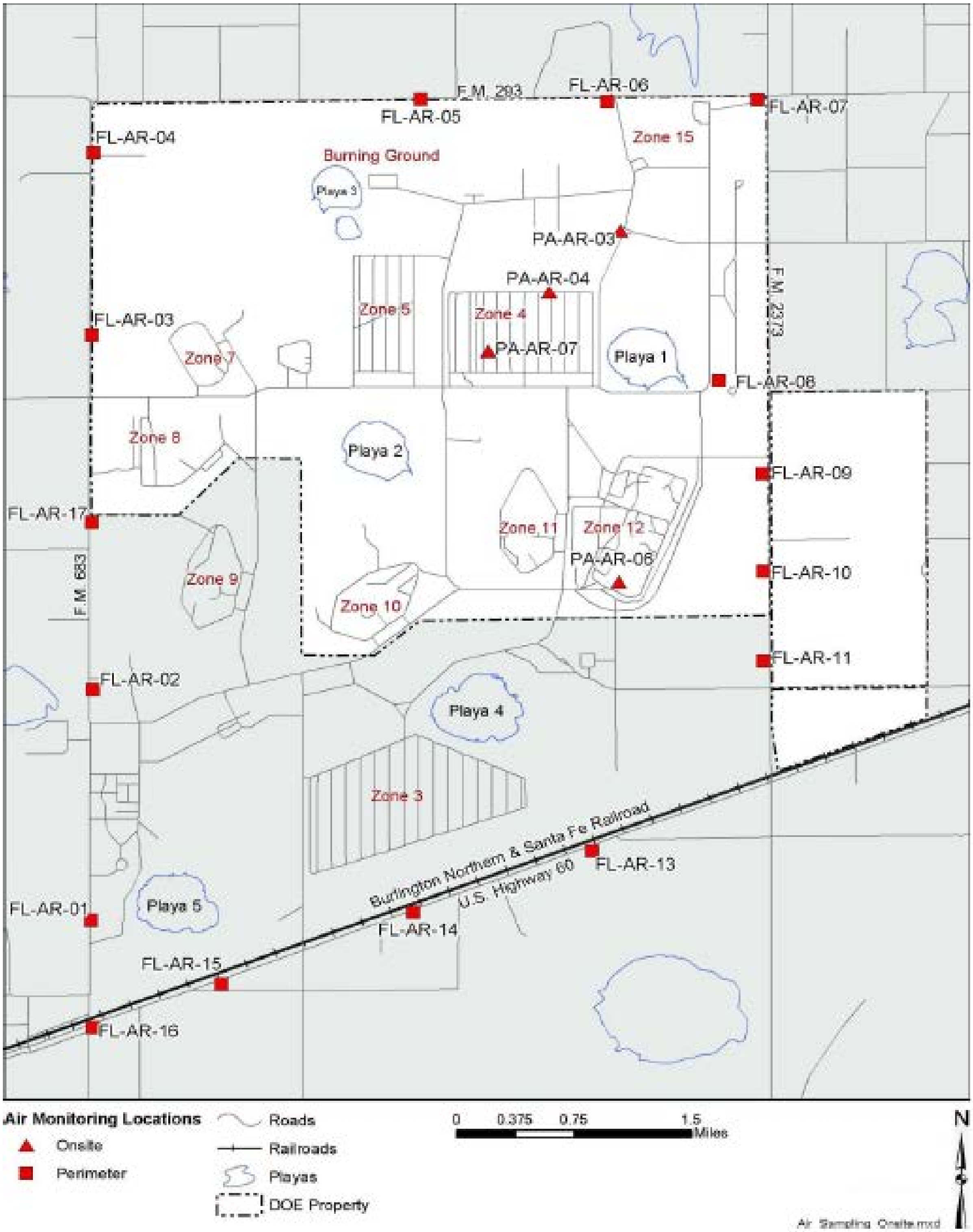



**Figure 5.1 – Locations of On-site and Fence Line Air Monitoring Stations**

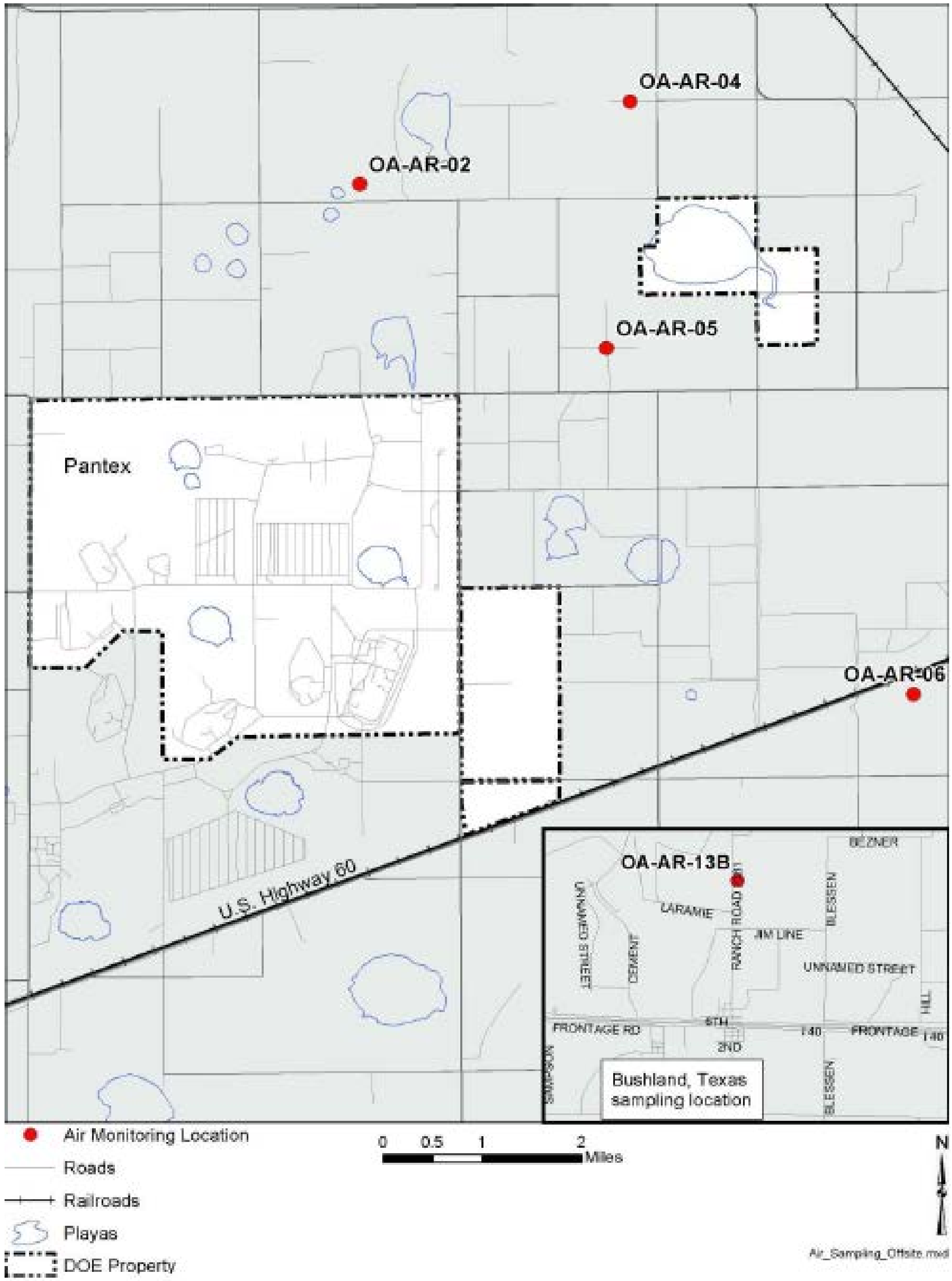



**Figure 5.2 – Off-site Air Sampling Stations**

The 17 available fence line radiological monitoring stations designated as FL-AR-XX (for Fence line), are located along the Plant perimeter (as it existed prior to the purchase of property east of FM 2373 in the latter part of 2008) in the principal compass directions and in directions where residences are located.

The concerns of the TDSHS and other stakeholders were considered in establishing the locations. The fence line samplers at the southern end of the Plant are located south of U.S. Highway 60. These locations were chosen for convenient access, to avoid the collection of dust generated by activities on the railroad (which is located adjacent to the southern boundary of the Plant), and to better represent air quality near actual residences. Eleven of these stations were operated at various times during 2017.

The off-site air monitoring stations are designated as OA-AR-XX. (Figure 5.2). Stations OA-AR-02 and OA-AR-04, are about 8 kilometers (5 miles) from the center of the Pantex Plant. The third off-site station, designated as OA-AR-13B, is a control station and is located upwind at Bushland, Texas. Stations OA-AR-02, OA-AR-04, and OA-AR-13B were used in monitoring activities in 2017. Stations OA-AR-05 and OA-AR-06 were not used in monitoring activities in 2017.

The air monitoring schedule shown in Table 5.1 was designed to reduce costs associated with environmental monitoring while still ensuring that any hypothetical releases of radiological material to the atmosphere from operations at the Pantex Plant could still be adequately characterized[2]. Several fence line monitoring stations (those designated as FL-AR-04, -05, -07, -08, and -09) in addition to those designated as OA-AR-02 and -04 are located in the downwind direction of the predominant wind at the Pantex Plant (the expected direction in which hypothetical releases of radiological material from Pantex would be expected to travel) and were operated more frequently than those located opposite the predominant wind direction (i.e., those located upwind from the Pantex Plant). Monitoring stations designated as FL-AR-01, -02, -10, -14, -16, and-17 are included in the latter category.

Each monitoring station was equipped with a high-volume air sampler and a low-volume air sampler (Figure 5.3). At far-left in this figure is a container for the co-located thermoluminescent dosimeters (TLD) discussed in Chapter 4. The high-volume sampler is located on the left and a "doghouse" containing the low-volume sampler is on the right. The samplers (when operated) ran continuously, and filters or silica gel samples were collected from the samplers on a weekly basis. Operational characteristics of the samplers, such as the length of the sample collection period (known as the "run time"), the beginning and 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 1.13 cubic meters per minute (40 $ft^3$ per minute [$ft^3$/min or more commonly cfm]). During sampling, particles were collected on 20 × 25- centimeter (8 × 10-inch) filters. Each air filter sample included particulate matter from about 11,400 cubic meters of air (~ 403,000 $ft^3$). Weekly[3] samples for a given month[4] were combined as one sample for later analysis for $^{234}$U, $^{238}$U, and $^{239}$Pu by a radiological analysis laboratory.

[2] This schedule is modified annually in a manner to ensure that each location other than the four on-site locations and the control location is scheduled for sample collection at least once every three years.
[3] The sample collection period is nominally one week. However in same cases due to the inability of the sampling technician to access a monitoring location due to weather, or due to modifications of the sampling schedule due to holidays or periods where no activities which could cause releases of radiological material to the atmosphere were occurring, samples were collected for longer periods.
[4] A sample collection "month" might commence several days prior to the designated month or extend into the following month. For example, the sampling period denoted as "May" represents samples collected during the period from April 27 through June 1 wherein the majority of the period of collection (31 of 35 days) occurred during May.

**Figure 5.3 – Typical Air Monitoring Site**

Nominal airflow through the low-volume air samplers was much smaller than that for the high-volume samplers, being 42.5 liters per minute (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.

**Figure 5.4 – Low-Volume Sampling Apparatus**

### 5.3.2 Sample Analysis Results

All analytical results obtained from the laboratory were converted to concentrations in air by dividing the quantity of radionuclide 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 5.2 summarizes 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 and the standard deviation; the maximum value and its associated counting error; the historical background[5] and the Derived Concentration Standard (DCS)[6] for comparison.

**Table 5.2 – Concentrations of Radionuclides in Air for 2017 at (a) On-site Locations; (b) Upwind Locations; (c) Downwind Locations; and (d) Background Location**

**a.**

| Radionuclide | Number of Samples Analyzed/Planned | Mean ±Std. Dev. | Max ± Counting Error | Historical Background | DCS |
|---|---|---|---|---|---|
| $^{3}$H | 147/150 | 0.02±0.21 | 1.21±0.59 | 1.32 | 14,000 |
| $^{234}$U | 36/36 | 12.73± 4.34 | 19.85±3.83 | 30.40 | 400,000 |
| $^{238}$U | 36/36 | 12.20 ±4.36 | 22.59±4.12 | 28.96 | 470,000 |
| $^{239}$Pu | 36/36 | 0.22 ±0.44 | 1.80±1.03 | 0.93 | 240,000 |

**b.**

| Radionuclide | Number of Samples Analyzed/Planned | Mean ±Std. Dev. | Max ±Counting Error | Historical Background | DCS |
|---|---|---|---|---|---|
| $^{3}$H | 121/123 | 0.04±0.24 | 1.53±0.39 | 1.32 | 14,000 |
| $^{234}$U | 24/30 | 19.14±14.97 | 77.54±9.72 | 30.40 | 400,000 |
| $^{238}$U | 24/30 | 21.14 ±18.45 | 77.94±9.52 | 28.96 | 470,000 |
| $^{239}$Pu | 24/30 | 0.32±0.58 | 1.55-±1.06 | 0.93 | 240,000 |

**c.**

| Radionuclide | Number of Samples Collected/Planned | Mean ±Std. Dev. | Max ±Counting Error | Historical Background | DCS |
|---|---|---|---|---|---|
| $^{3}$H | 171/178 | 0.02±0.20 | 1.22 ±0.52 | 1.32 | 14,000 |
| $^{234}$U | 38/43 | 18.04 ±9.51 | 46.09 ±5.74 | 30.40 | 400,000 |
| $^{238}$U | 38/43 | 17.87 ±9.35 | 47.01 ±5.80 | 28.96 | 470,000 |
| $^{239}$Pu | 38/43 | 0.10 ±0.55 | 1.72±1.22 | 0.93 | 240,000 |

[5] This parameter is the upper confidence limit (UCL) for a population consisting of all data for the specified radionuclide from the control location during the period from 2013-2015. UCL = x-bar + sK, where x-bar is the mean of the population, s is the standard deviation and K is a statistical parameter (approximately equal to 3) tabulated for specific numbers of samples, and the percent confidence that a user of the data is willing to accept (usually 95 percent) for statistical conclusions drawn from the data. When used to compare non-control results to the "historical background", a user will have 95 percent confidence that any single analysis result from a non-control location which is greater than the derived value is "different than background".

[6] 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 (DOEk) lists several values of DCS for air inhalation for each radionuclide based upon the chemical form or the absorption class of the isotope. Since information concerning the chemical form is not available, the most restrictive (i.e. smallest in magnitude) of the several values is used in accordance with guidance in the technical standard. The values for the isotopes for which analysis is conducted as discussed in §5.3.1 above are $^{3}$H: 1.4 x $10^{-8}$ µCi/mL; $^{234}$U: 4.0 x $10^{-13}$ µCi/mL; $^{238}$U: 4.7 x $10^{-13}$ µCi/mL; and $^{239}$Pu: 2.4 x $10^{-13}$ µCi/mL.

**d.**

| Radionuclide | Number of Samples Collected/Planned | Mean ±Std. Dev. | Max ±Counting Error | Historical Background | DCS |
|---|---|---|---|---|---|
| $^{3}H$ | 50/50 | 0.01±0.17 | 0.55±0.44 | 1.32 | 14,000 |
| $^{234}U$ | 12/12 | 19.84 ±8.25 | 35.01 ±5.36 | 30.40 | 400,000 |
| $^{238}U$ | 12/12 | 19.70 ±8.19 | 30.82 ±4.53 | 28.96 | 470,000 |
| $^{239}Pu$ | 12/12 | 0.16±0.25 | 0.62 ±1.09 | 0.93 | 240,000 |

[a] Units in all tables are x $10^{-12}$ µCi/mL (or aCi/mL) for $^{3}H$ measurements and x $10^{-18}$ µCi/mL (or yCi/mL) for α-emitting radionuclides ($^{233/234}U$, $^{238}U$, and $^{239/240}Pu$).

Figure 5.5 below illustrates the average concentrations in air of $^{3}H$ during 2013 through 2017. When compiling the data used to produce this graph, the category of monitoring station described above has been ignored and the average of all $^{3}H$ monitoring data collected during the indicated year calculated. A similar process was used for determining the average concentrations in air of $^{234}U$, $^{238}U$, and $^{239}Pu$ during the same period. When preparing Figure 5.6, the calculated annual averages for each of the aforementioned radionuclides has been divided by their respective DCS and expressed as a percentage.

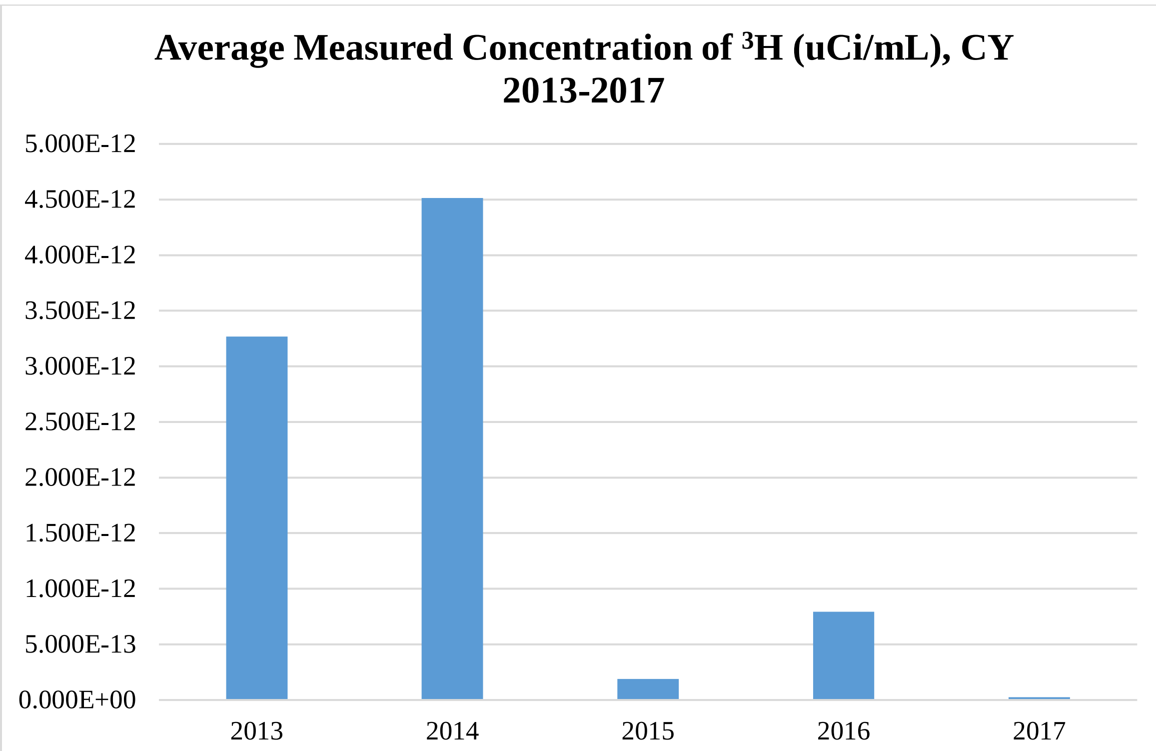



**Figure 5.5 – Average Measured Concentration of $^{3}H$ (uCi/mL), CY 2013-2017**

During CY 2017, as in most previous years, Pantex collected and analyzed approximately 95 percent of the planned samples at all locations. 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. In August and September, rainfall caused muddy road conditions at several remote locations and consequent non-collection of samples.

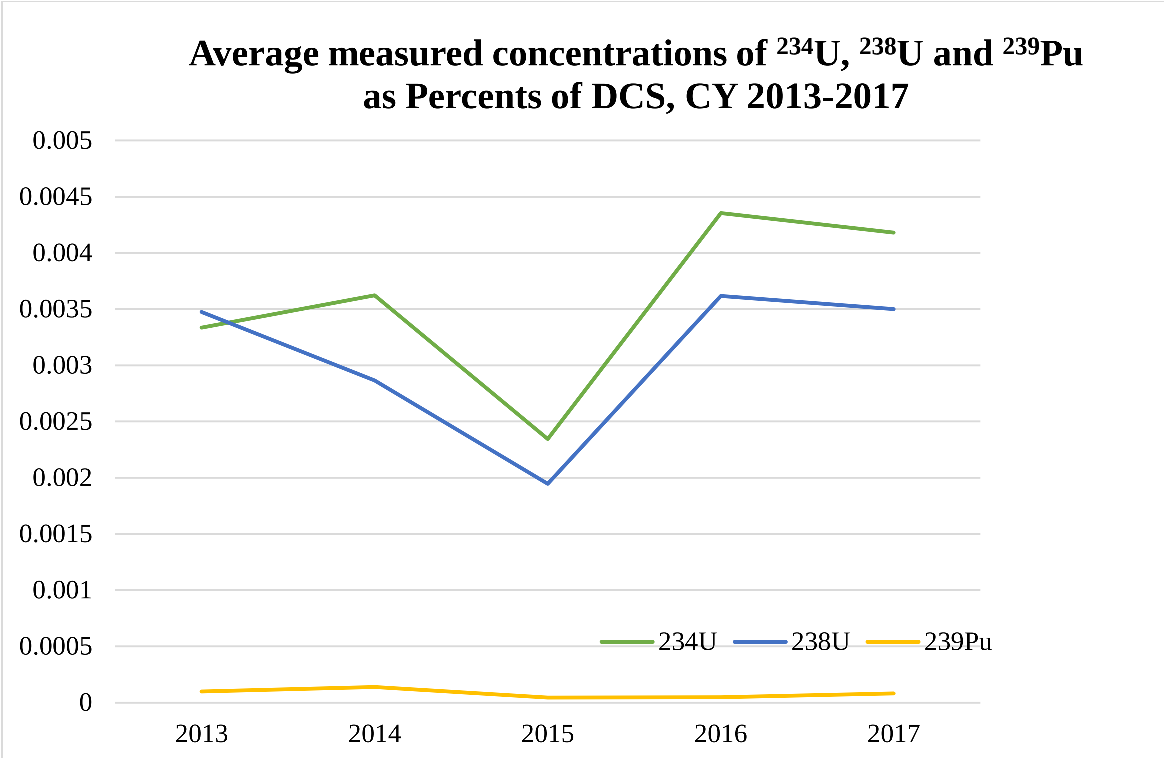



**Figure 5.6 – Average Measured Concentrations of $^{234}U$, $^{238}U$ and $^{239}Pu$, CY 2013-2017**

### 5.3.3 Data Interpretation

During 2017, the maximum measurements for the α-emitting radionuclides ($^{234}U$, $^{238}U$, and $^{239}Pu$) during the year occurred during periods in the spring and summer when high wind speeds were observed in the Texas Panhandle and increased re-suspension of dust into the atmosphere could occur. Because the relative maxima were observed to be occurring both upwind and downwind from the Pantex Plant, it is likely that many of the maximum measurements represent the collection of increased quantities of naturally occurring radioactive material during these periods.

A review of the ratio of the mean values of the concentrations of $^{234}U$ and $^{238}U$ in each of the four categories of locations as well as the same statistical parameter for all results during CY 2013 through 2017 shows good correlations between the calculated means for CY 2017 and for CY2013 through CY 2017 as illustrated in Figure 5.6. The fact that the ratio of the activities of $^{234}U$ and $^{238}U$ is not much different from unity indicates radiological equilibrium between the two radionuclides and is another indication of the absence of any anthropogenic discharges of uranium during Pantex operations.

Statistical comparison of the $^{234}U$ and $^{238}U$ sampling data for each of the several categories of monitoring stations (on-site, upwind, downwind, and control (or background)) during CY 2017 indicates that all results are of the same magnitude (i.e., results from areas potentially affected by Pantex operations are not distinguishable from background). The $^{239}Pu$ measurement data is of such low magnitude (more than 80% is indicated as "below detection" by the analysis laboratory) that apparent statistical differences between the "on-site" and "up-wind" categories and the other two categories during CY 2017 may be the result of the use of this "uncensored" data set. As noted above, average concentrations are a very small fraction of levels that would cause a 100 mrem effective dose.

A similar equivalency to that noted for $^{234}U$ and $^{238}U$ sampling data exists for comparisons between categories of the tritium data collected during 2017. 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 CY 2013 through CY 2017. No tritium concentration in ambient air during 2017 (or any of the indicated years) exceeded the DCS. In fact, no radiological concentration in ambient air exceeded the applicable DCS for the radiological materials analyzed.

## 5.4 Conclusions

Results indicate that the air monitoring program at the 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 the Pantex Plant.

# Chapter 6 – Groundwater Monitoring

*Groundwater monitoring at the Pantex Plant began in 1975 when the first investigative wells were installed. Pantex completed its investigations in 2005 with the identification of contaminant plumes in the perched groundwater beneath the Pantex Plant and TTU property. Monitoring wells in the perched groundwater are being used to monitor two remedial actions: two pump and treat systems, with 72 operating extraction wells and two injection wells and three ISB systems consisting of a total of 115 active treatment zone wells. Pantex also monitors 26 wells in the deeper drinking water aquifer (Ogallala Aquifer) to verify the remedial actions remain protective of this resource. Groundwater data collected in 2017 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 EPA drinking water standards or cleanup standards established for the Pantex Remedial Action.*

## 6.1 Groundwater at Pantex

Groundwater beneath the Pantex Plant and vicinity occurs in the Ogallala and Dockum Formations at two intervals (Figure 6.1). The first water-bearing unit below the Pantex Plant in the Ogallala Formation is a discontinuous zone of perched groundwater located at approximately 200 to 300 feet below ground surface and 100 to 200 feet 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 feet beneath Playa 1. Perched groundwater is formed 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 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 the Plant) and near the Old Sewage Treatment Plant in the northeast corner of Pantex.

The second water-bearing zone, the High Plains Aquifer (also known as and referred to herein as 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 the Plant is approximately 400-500 feet below ground surface with a saturated thickness of approximately one to 100 feet in the southern regions of the Plant and approximately 250 to 400 feet in the northern regions. In the vicinity of the 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 north of the Plant.

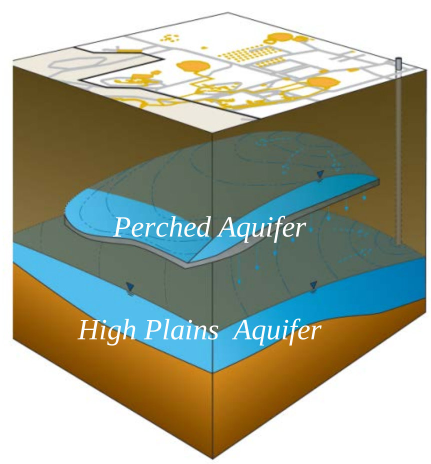



**Figure 6.1 – Groundwater Beneath Pantex**

Historical operations at the Pantex Plant resulted in contamination of the larger perched groundwater area, and the contaminant plume has migrated past the 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 the Pantex Plant, no public or private water supply wells are completed in the perched groundwater in the immediate vicinity of the Pantex Plant. The domestic well north of the Plant is in an area that has not been impacted by historic operations.

Perched groundwater is not used for industrial purposes at Pantex, although the treated perched groundwater is routed through the Waste Water Treatment Facility (WWTF) and is beneficially used for subsurface irrigation of crops. Because concentrations of contaminants in the perched groundwater beneath the 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. On-site use of perched groundwater is restricted by the Pantex Plant. 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 is currently working with offsite landowners to the southeast to gain access agreements and ensure water supplies are protected.

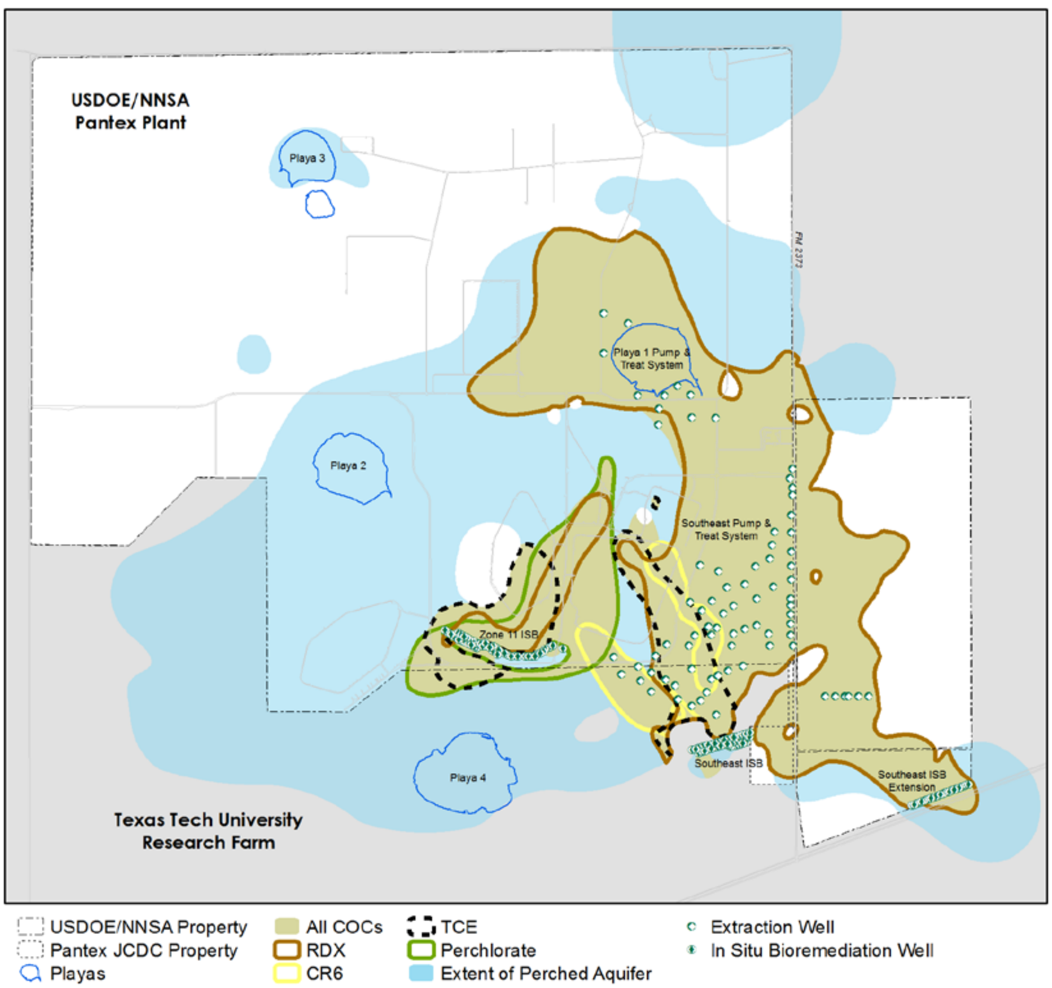



**Figure 6.2 – Major Perched Groundwater Plumes and Remediation Systems**

## 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<br>❖ Achieve cleanup standard for perched COCs<br>❖ Prevent growth of perched groundwater contaminant plumes<br>❖ Prevent COCs from exceeding cleanup standards in the drinking water aquifer | ❖ Remedial action effectiveness<br>❖ Plume stability<br>❖ Uncertainty management<br>❖ Early detection |

To ensure that the RAOs are achieved, 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 developed an *LTM System Design Report* (PANTEXh) and a Sampling and Analysis Plan (SAP) (PANTEXl) to detail the LTM network and monitoring. The network monitoring information is evaluated quarterly, annually, and on a 5-year basis, with evaluations increasing in detail and complexity for each type of report.

## 6.3 The Scope of the Groundwater Monitoring Program

Groundwater is monitored at the Pantex Plant in accordance with requirements of the TCEQ HW-50284 (TCEQa). Pantex 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, by function, sampled in 2017 that are currently used in monitoring of the remedial actions and the total number of analytes assessed.

**Table 6.1 – Summary of Well Monitoring in 2017**

| Well Type | Drinking Water Aquifer | | Perched Groundwater | |
|---|---|---|---|---|
| | # Wells | # Analytes Assessed | # Wells | # Analytes Assessed |
| **Long-Term Monitoring Well** | 26 | 1,361 | 85 | 6,417 |
| **Other Wells** | 4 | 100 | 1 | 22 |
| **Pump & Treat Extraction Well** | -- | -- | 67 | 1,077 |
| **ISB Treatment Zone Monitoring Wells** | -- | -- | 26 | 2,939 |
| **Total** | 30 | 1,461 | 179 | 9,486 |

## 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 that, 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 its saturated thickness to lessen the potential for impacted perched groundwater to migrate to the drinking water aquifer below it. The systems were designed to remove and treat perched groundwater and reuse the treated water for beneficial use. The SEPTS has the capability to inject the treated water back into the perched aquifer when beneficial use is not possible. Operational priorities for the pump and treat systems emphasize beneficial use of water.

The pump and treat systems' operation and throughput were variable in 2017. The P1PTS annual average operation was 70%. The monthly system operation was primarily affected by repairs at the WWTF early in the year and a break at the irrigation filter bank that occurred in late June. P1PTS operation was heavily affected by the break as the only method for release of treated water is through the WWTF. The SEPTS annual average operation in 2017 was 75% with system operation affected by various repairs or carbon change-out at the facility, various repair issues at the WWTF, and the filter bank break at the irrigation system. Both systems remained down during part of June and July while an alternate method of water release was prepared since the irrigation system could no longer be used. WWTF treated water is now being routed to Playa 1 until repairs are completed at the irrigation system. SEPTS operation now continues, but primarily at lower flow rates due to the need to inject into the perched aquifer. SEPTS operations focused on removing water in high priority locations that help control migration of the plume to the southeast. P1PTS operations continue at a lower flow rate, but can be interrupted when the flows to Playa 1 are restricted.

During the long operational history of the SEPTS, much of the treated water has been injected back into the perched zone, as the system was not originally designed to meet the remedial goal of reducing saturated thickness in the perched aquifer. Pantex has focused on beneficial use of the treated water, to the extent possible, since the subsurface irrigation system operation began in May 2005. Water levels are continuing to decline in the areas downgradient of the pump and treat systems, with declines exceeding one ft. per yr. in many wells as depicted in Figure 6.3.

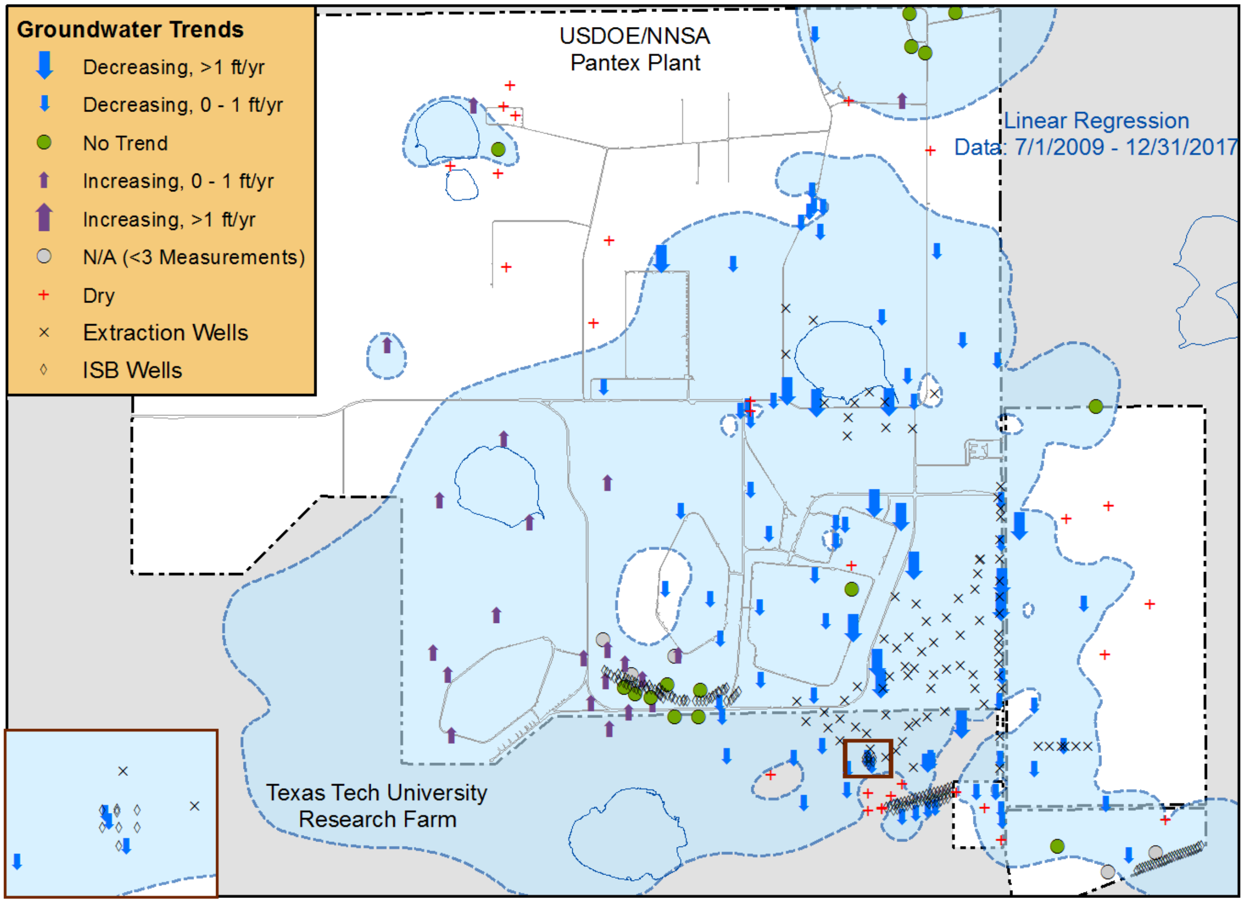
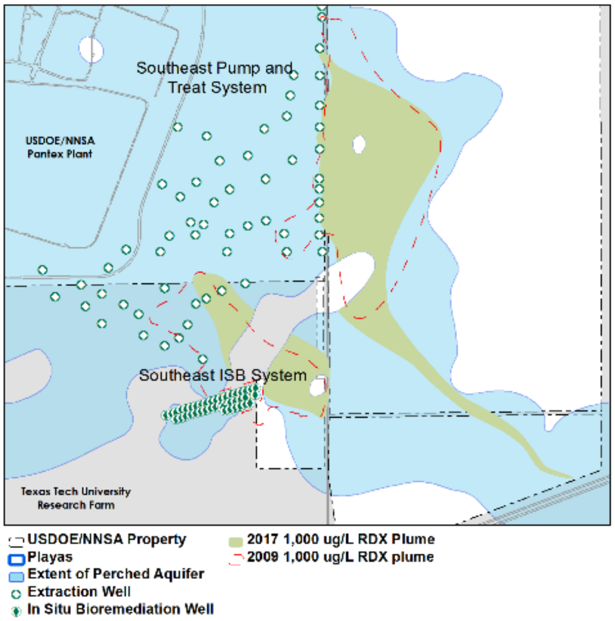
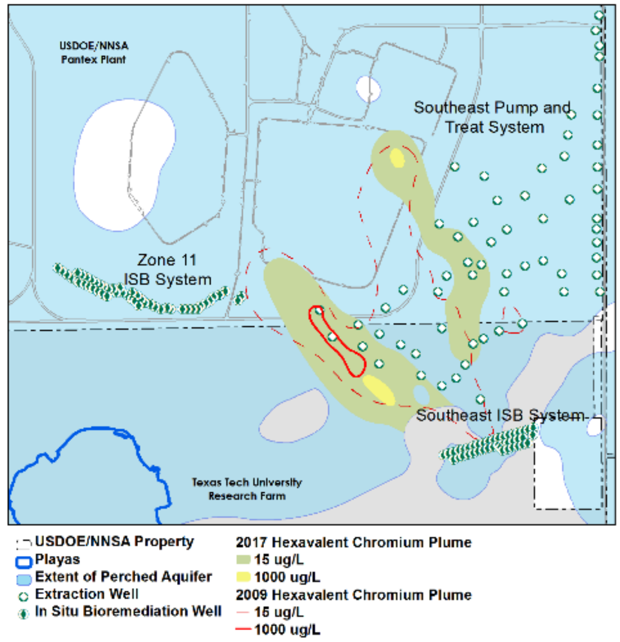



**Figure 6.3 – Water Level Trends in the Perched Aquifer**

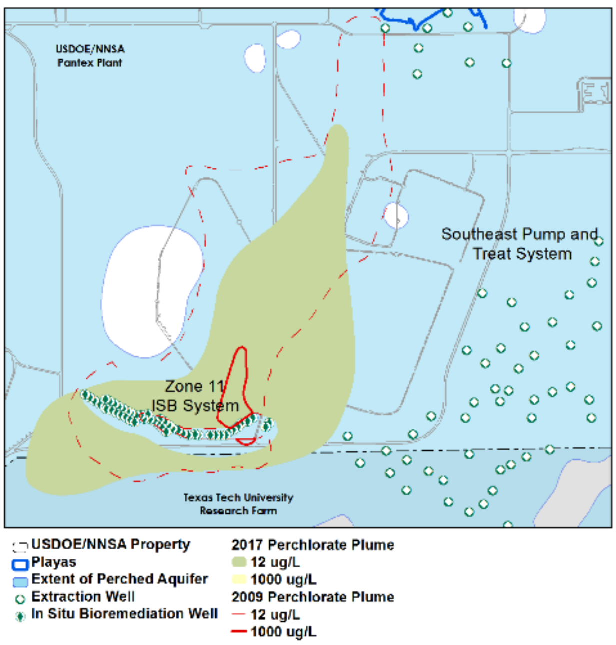
Plume stability is also evaluated to determine if the center of mass is still moving in the perched groundwater. Major perched aquifer COCs (RDX, hexavalent chromium, TCE, and perchlorate) were included in this evaluation. All plumes exhibit slight variations at their boundaries caused by minor variations in concentration over time, additional data from newly constructed or sampled wells, and the low values defining the plume boundaries. In addition, some plume expansion is expected as contaminants move and mix within the groundwater flow system. Because the RDX plume has expanded to the perched extent, the entire plume was not evaluated, but rather the two 1,000 µg/L plume “hot spots” associated with the two source areas (Zone 12 east ditch and Playa 1) were evaluated. As depicted in Figure 6.4, the COC plumes had similar general shapes from 2009 to 2017; however, the eastern portion of the RDX plume has migrated further to the southeast. Movement of the plume in this area appears to be associated with faster groundwater flow paths along channel-type features in the top of the FGZ. Pantex is actively working to determine the downgradient extent of the plume and has already completed a line of injection wells as part of an extension of the Southeast ISB remedy to intercept this plume as it migrates to the southeast.



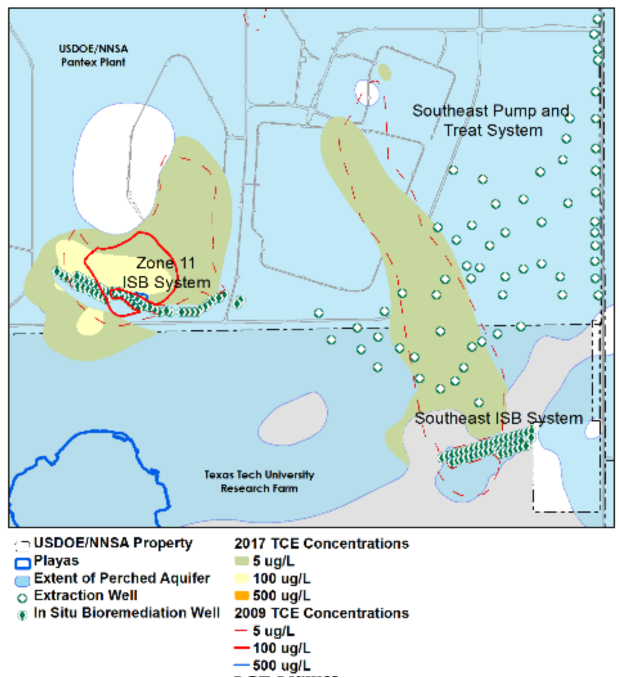

RDX Plumes




Hexavalent Chromium Plume




Perchlorate Plume




TCE Plume

**Figure 6.4 – 2009 - 2017 Plume Movement – Perchlorate, Hexavalent Chromium, RDX, and TCE in the Perched Aquifer**

RDX concentration trends, depicted in Figure 6.5, 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. Similarly, effects of the Southeast ISB on the area to the south are demonstrated by decreasing trends in three wells downgradient of the ISB. As discussed previously, RDX movement is noted to southeast in the direction of the groundwater gradient.

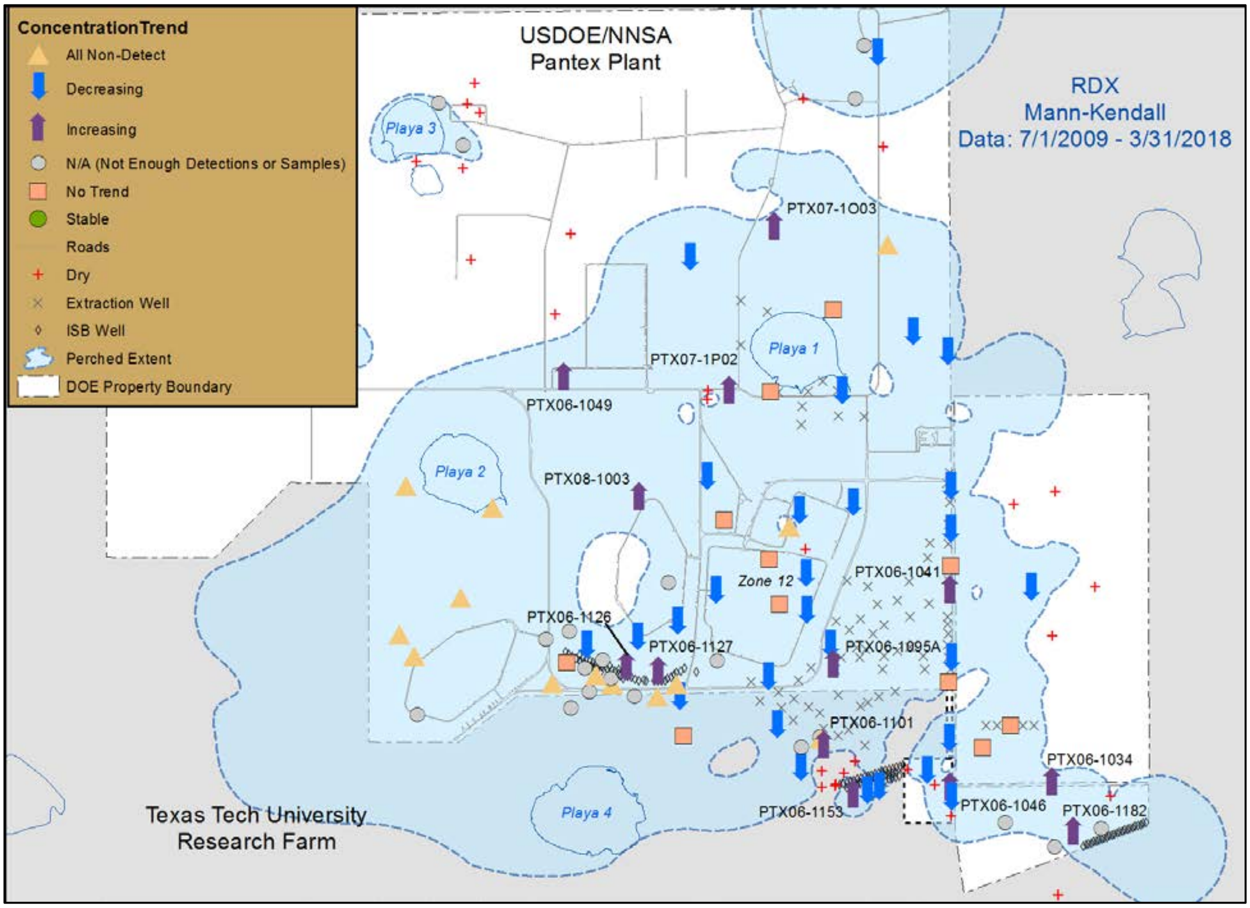



**Figure 6.5 – RDX Concentration Trends in the Perched Aquifer**

Concentration trends for the remaining major COCs (perchlorate, TCE, and hexavalent chromium) are discussed in the 2017 Annual Progress Report. Figure 6.6 shows the annual maximum concentrations of the major COCs observed in the perched aquifer since 2009. Overall declining trends are demonstrated for all of the COCs through 2017. Areas outside the influence of the remedial action systems are also monitored for HE 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 GWPS established in the 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. A new third system was installed in late 2017, but has not yet been injected, so treatment is not discussed here.

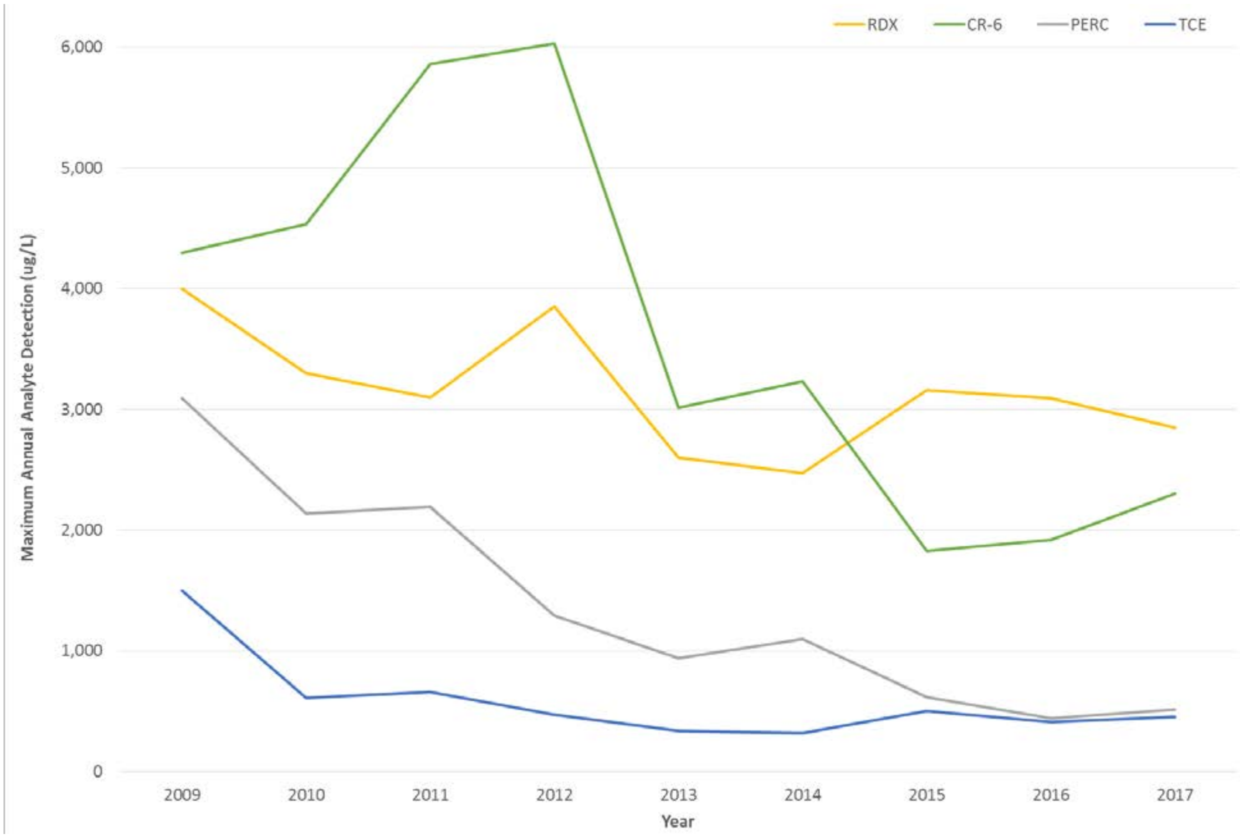



**Figure 6.6 – Annual Maximum Concentration Trends in the Perched Aquifer**

Overall, the Zone 11 and Southeast ISB have been effective in treating the primary COCs: RDX, hexavalent chromium, TCE, and perchlorate. Pantex continues to evaluate areas of the ISBs where an issue has been identified with treatment and has made adjustment to the treatment as needed based on the results of evaluation. Monitoring of conditions within the treatment zone and downgradient indicate that a reducing zone has been established at both 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. In addition, Pantex bioaugmented the west side of the Zone 11 ISB system where incomplete treatment of TCE was caused by the lack of proper bacterial population (*Dehalococcoides sp*.) required for complete dechlorination.

Downgradient monitoring at the Southeast ISB demonstrates that the system has been effective at reducing concentrations of RDX and hexavalent chromium to levels below the GWPS across most of the treatment zone. Pantex will continue to monitor wells in the area to determine groundwater flow patterns, mass flux, and treatment conditions in the western side of the treatment zone where RDX concentrations persist above the GWPS. 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, the future need for injections at the Southeast ISB will be reduced or eliminated.

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

*Dehalococcoides* spp. (DHC) counts indicate that bioaugmentation was successful, reductive dechlorination will only occur at low rates due to the low counts.

## 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 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 2017. Pantex 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* (PANTEXl) 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

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 in the top of the FGZ. Pantex is actively working to determine the downgradient extent of the plume and has already completed a line of injection wells as part of an extension to the Southeast ISB remedy for perched groundwater to intercept this plume as it migrates to the southeast.

### 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. All of the boron and hexavalent chromium detections are below the GWPS. 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 2017.

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 2017. 1,2-Dichloroethane has been variably detected since August 2015, but was not detected above the PQL in 2017. All detections were below the GWPS indicating that the water is still protective of human health.

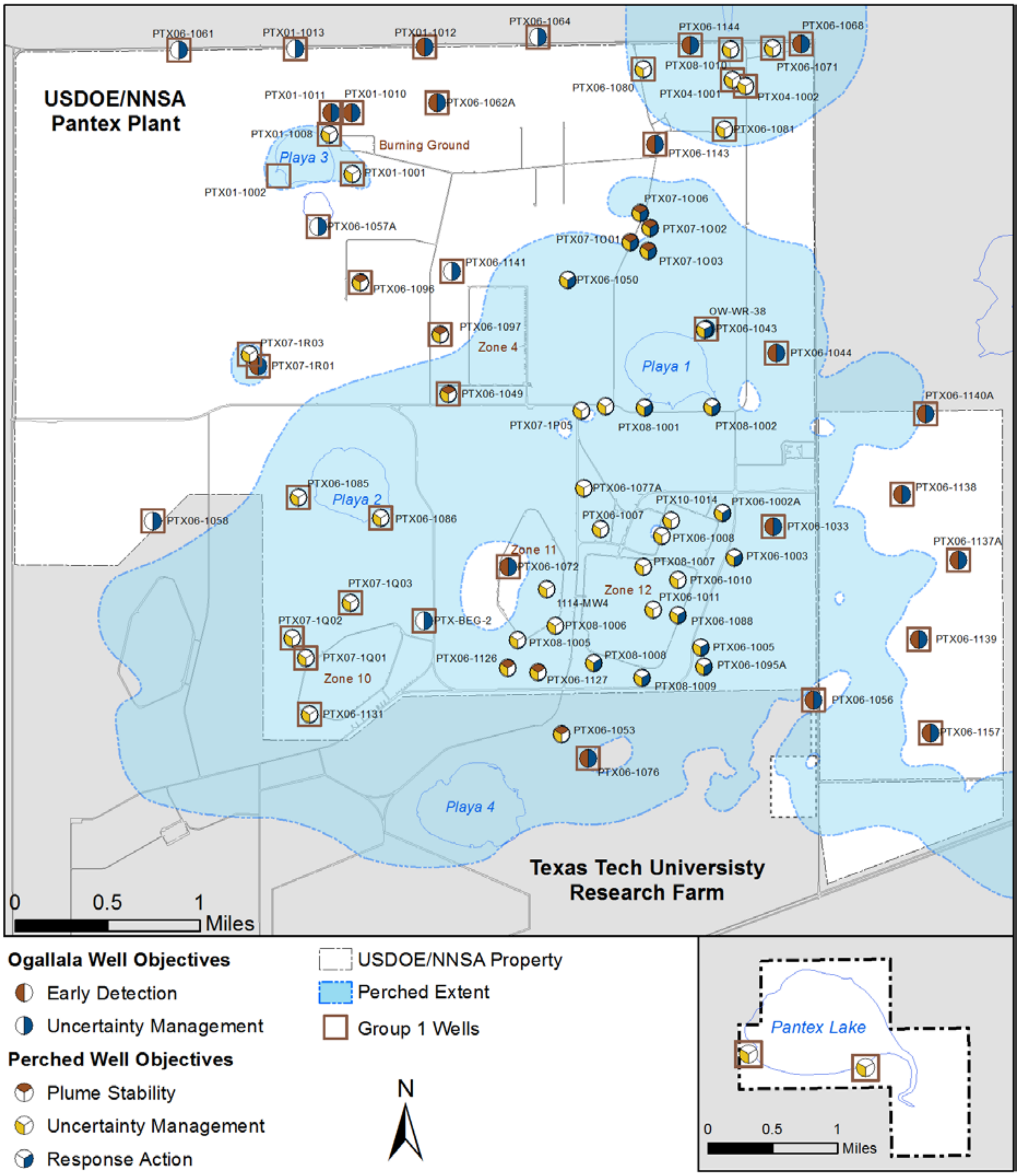



**Figure 6.7 – Uncertainty Management and Early Detection Wells**

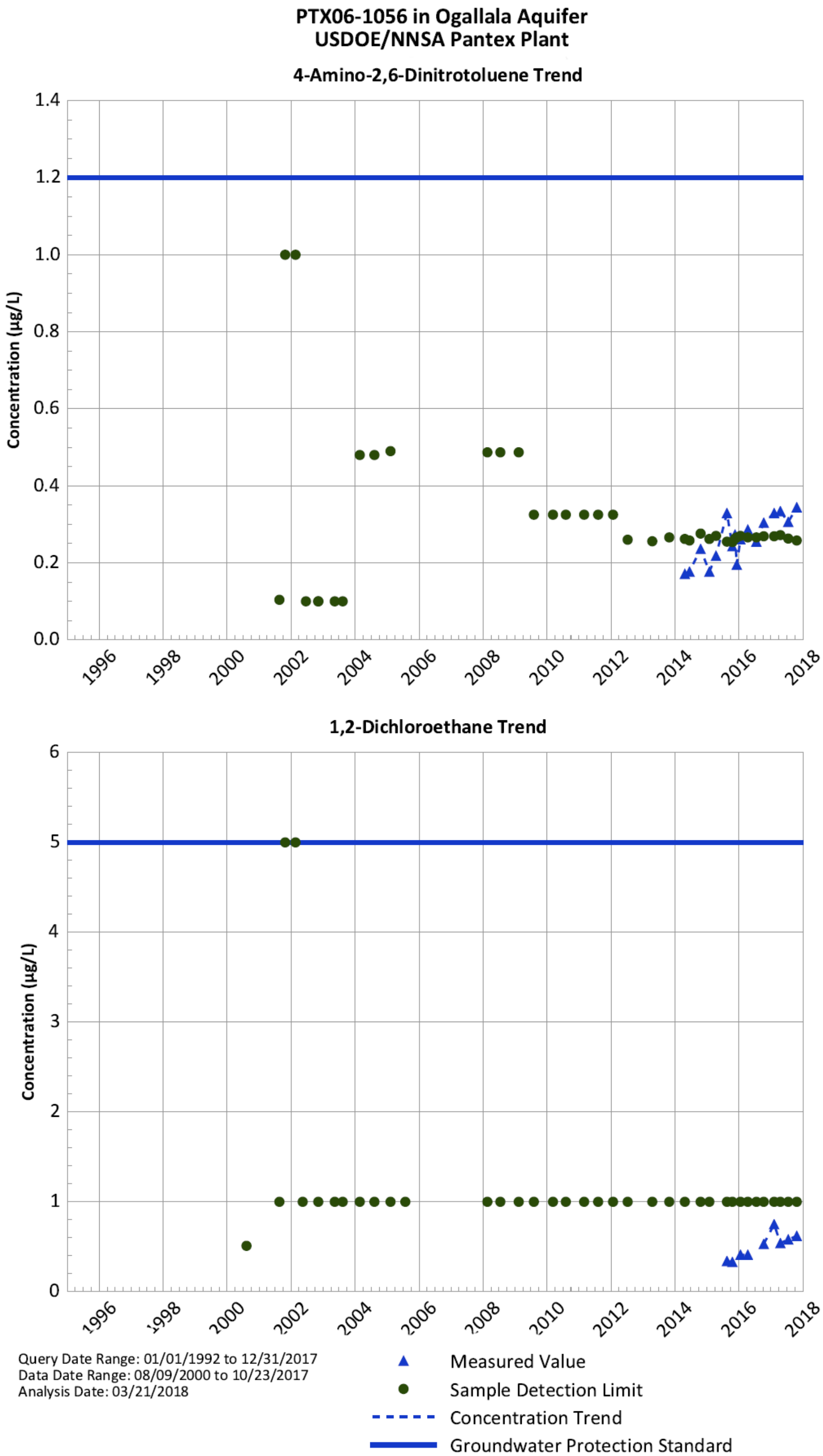



**Figure 6.8 – Summary of Unexpected Conditions in Ogallala Aquifer Well PTX06-1056**

Pantex 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 will continue with quarterly sampling to evaluate trends in these detections. 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 to help determine where natural attenuation is occurring, under what conditions it is occurring, and to eventually determine rates of attenuation for various constituents.

Pantex routinely monitors for breakdown products of the primary COCs. Groundwater conditions that may impact 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 has naturally attenuated over time (Figure 6.9). TNT has been manufactured at Pantex since the 1950s yet is only present in the central portion of the overall southeastern plume – within the SEPTS well field and near Playa 1. Its first breakdown product, 2-amino-4,6-DNT, occurs near the TNT plume and extends slightly beyond. The plume for the final breakdown product, 4-amino-2,6-DNT, extends to the eastern edge of the perched saturation at low concentrations. Only TNT breakdown products are present in perched groundwater beneath Zone 11 and north of Playa 1. Concentrations of the breakdown products are still above GWPS, but most wells with detections 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 is 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 is currently awaiting the results of a project for research of RDX attenuation in the perched groundwater. This research is focused on determining where and what type of degradation is occurring and is being conducted using compound specific isotope analysis and specialized biological analyses to determine what is present.

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

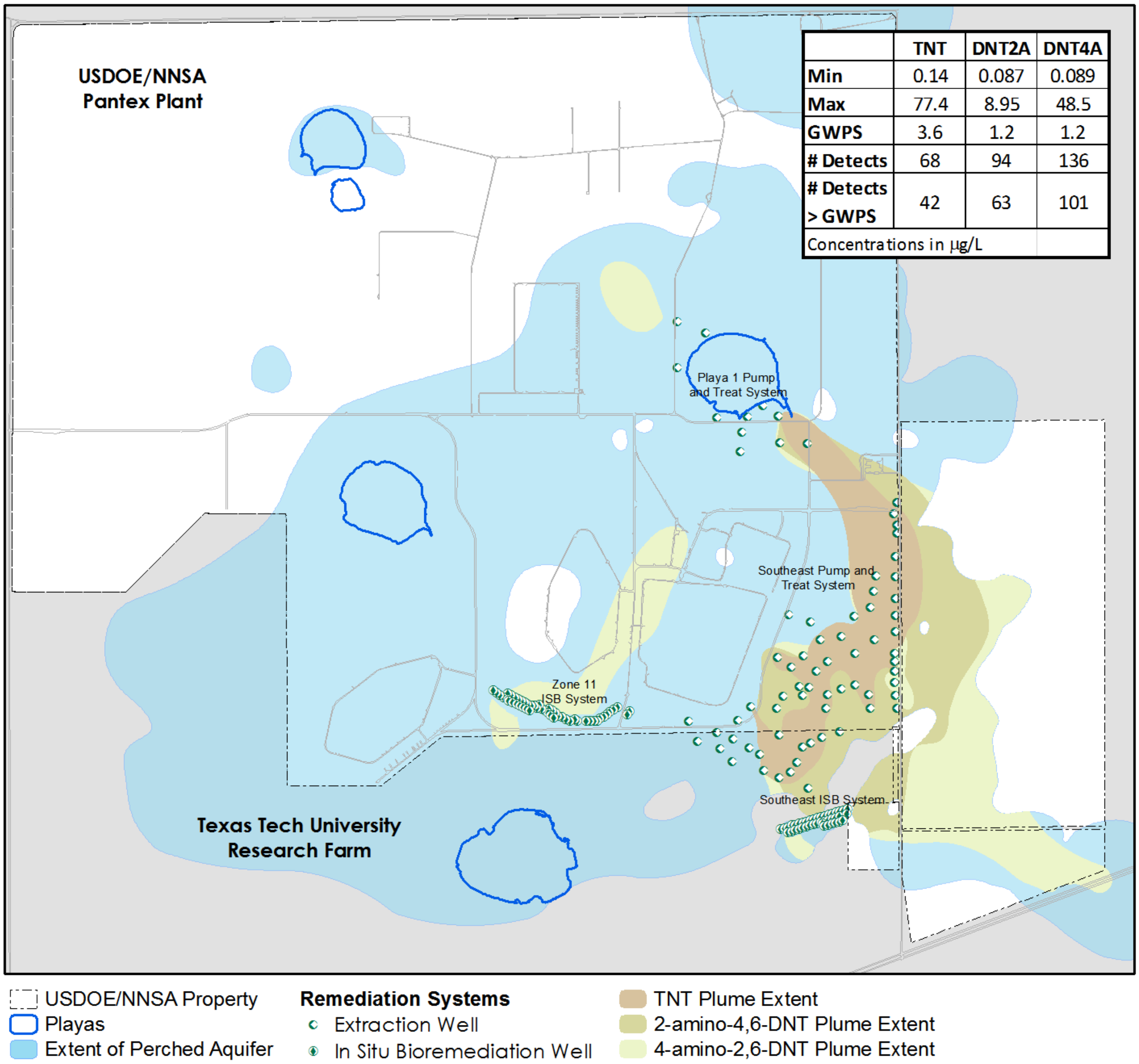
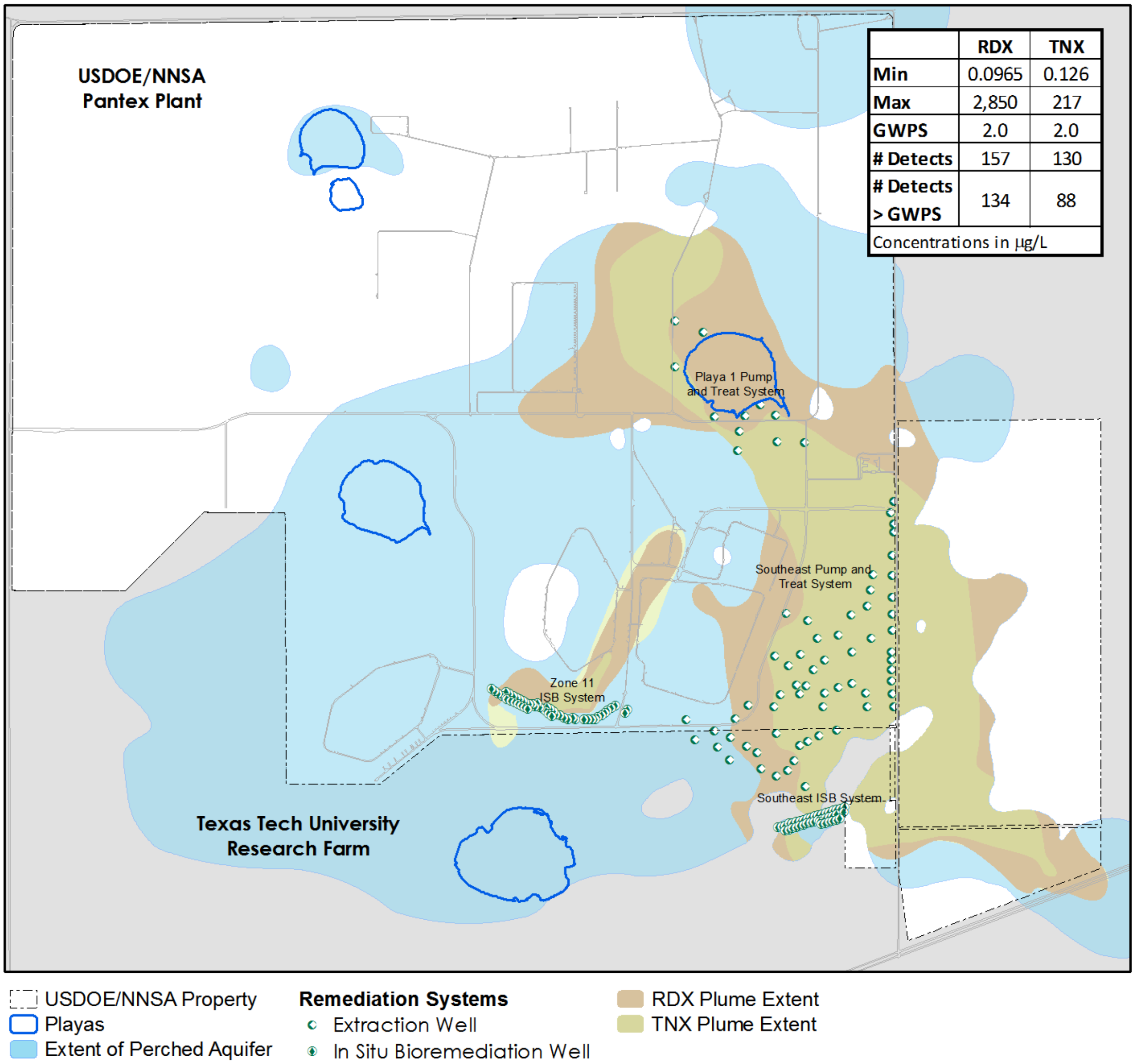



**Figure 6.9 – TNT and Degradation Product Plumes**

## 6.7 Groundwater Monitoring Conclusions

Overall, the groundwater remedial actions continued to be effective in 2017. 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. Perched water levels are declining, 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 indicates that water and contamination have migrated further to the southeast and to offsite property. Pantex has extended the Southeast ISB remedy to that area at the Pantex boundary and plans to continue investigating offsite to determine the nature and extent of contamination and to aid in determining a path to cleanup.




| | RDX | TNX |
|---|---|---|
| Min | 0.0965 | 0.126 |
| Max | 2,850 | 217 |
| GWPS | 2.0 | 2.0 |
| # Detects | 157 | 130 |
| # Detects > GWPS | 134 | 88 |
| Concentrations in µg/L | | |

**Figure 6.10 – RDX and Degradation Product Plumes**

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 has fully implemented the conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d) and will continue quarterly sampling for HEs and VOCs at this well. Pantex 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 has contracted with leading researchers for further study to determine where and what type of natural attenuation is occurring across the RDX plume at the Pantex Plant. If data support quantification of attenuation rates, rates will be calculated to support the evaluation of natural attenuation in areas not under the influence of a remedial action.

# Chapter 7 – Drinking Water

*Results from routine drinking water compliance monitoring in 2017 confirmed that the drinking water system at the Pantex Plant met water quality regulatory requirements. All analytical results for bacteria, chemical compounds, lead & copper, and disinfection by-products were below regulatory limits, and adequate levels of disinfectant were maintained in the distribution system. The Pantex Public Water System continues to be recognized by the TCEQ as a "Superior" supply system.*

## 7.1 The Scope of the Program

The 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 (NTNC-PWS) under the Safe Drinking Water Act (SDWA) regulations. The EPA created this category to identify private systems that continuously supply water to small groups of people (for example, in schools and factories). Water supplied by such systems is consumed daily by the same group of people over long periods of time.

The Plant's drinking water is obtained from the Ogallala Aquifer. The drinking water production wells supply all of the Plant's water needs. Before being transferred to the distribution system, all water is treated to provide disinfection protection throughout the system. In addition, the system provides water to adjacent Texas Tech University-owned property for domestic and agricultural use.

Samples from the drinking water system were collected and analyzed monthly for biological contaminants, annually and triennially for various chemical contaminants as required by the SDWA and its implementing regulations (Title 40 CFR Parts 141 and 143, and Title 30 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 2017.

## 7.3 Water Production and Use

During 2017, the Pantex Plant produced/pumped approximately 133 million gallons (503 million liters) of water from the Ogallala Aquifer. This was an increase of 13 million gallons (49 million liters) compared to water produced in 2016.

Pantex remains committed to reducing the amount of produced water by implementing a water reuse and recycling program. Examples of the water conservation and reuse initiatives include the procurement of more efficient industrial cooling equipment (such as water re-circulating systems) and beneficial reuse of treated wastewater. Typically, Pantex beneficially reuses 100 percent of its treated wastewater to grow crops in the northeast portion of the Plant and continues to investigate other reuse opportunities. In July 2017, Pantex began discharging treated wastewater to an on-site playa lake, due to a system failure associated with the subsurface irrigation system. Surface discharge continued for the remainder of the year. Efforts are underway to restore the beneficial reuse of treated wastewater.

## 7.4 Sampling

Pantex collected routine drinking water samples at 12 locations. Ten locations were sampled for biological indicators and residual disinfectant levels and two locations were monitored for chemical and water quality constituents. The sampling locations are representative of drinking water at the Pantex Plant. The sample locations are listed in Table 7.1. Sample locations are periodically changed to assure adequate Plant coverage.

**Table 7.1 – Drinking Water Sampling Locations, 2017**

| Description | Location |
|---|---|
| **Chemical & Water Quality Monitoring**<br>Building 15-27 (Entry Point to the Distribution System)<br>Building 16-12 (TTHM2 site[1]) | |
| **Biological and Disinfectant Level Monitoring**<br>Building 12-103<br>Building 18-1<br>Building 12-6<br>Building 16-12<br>Building 12-70<br>Building 11-2<br>Building 15-27<br>Building 16-1<br>Building 10-9 | |

## 7.5 Results

In 2017, the TCEQ sampled the water system at Pantex. Results for this drinking water sampling were within regulatory limits for chlorine (disinfectant), and below regulatory limits for disinfection by-products, microbial contaminants, inorganic contaminants, nitrate, pesticides and volatile organic compounds. Table 7.2 shows water quality results from the Pantex water system as measured by the TCEQ.

**Table 7.2 – Water Quality Results**

| CONTAMINANT CATEGORY | ANALYTE | MEASURED VALUE | MAXIMUM CONTAMINANT LEVEL |
|---|---|---|---|
| **DISINFECTANT** | Residual Chlorine | 1.15 mg/L | 4.0 mg/L |
| **TRIHALOMETHANES**<br>(Individual disinfection by-products are not regulated)<br>TTHM2. | Bromodichloromethane | 11.3 µg/L | N/A |
| | Dibromochloromethane | 10.7 µg/L | N/A |
| | Bromoform | 4.10 µg/L | N/A |
| | Chloroform | 8.88 µg/L | N/A |
| **TOTAL TRIHALOMETHANES**<br>(Only Total Trihalomethanes are regulated.) | | **35.0 µg/L** | **80 µg/L** |
| **HALOACETIC ACIDS**<br>(Individual disinfection by-products are not regulated)<br>TTHM2 | BromochloroaceticAcid | 5.00 µg/L | N/A |
| | Dibromoacetic acid | 4.10 µg/L | N/A |
| | Dichloroacetic acid | 4.00 µg/L | N/A |
| | Monobromoacetic acid | 1.10 µg/L | N/A |
| | Monochloroacetic acid | <1.00 µg/L | N/A |
| | Trichloroacetic acid | 1.30 µg/L | N/A |

[1] 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.

| CONTAMINANT CATEGORY | ANALYTE | MEASURED VALUE | MAXIMUM CONTAMINANT LEVEL |
|---|---|---|---|
| **TOTAL HALOACETIC ACIDS** (Only Total Haloacetic Acids are regulated.) | | **10.5 µg/L** | **60 µg/L** |
| **VOLATILE ORGANIC COMPOUNDS** | Vinyl chloride | <0.500 µg/L | 2 µg/L |
| | 1,2-Dibromethane | <0.01 µg/L | 0.05 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 µg/L | 1000 µg/L |
| | 1,1,2-Trichloroethane | <0.500 µg/L | 5 µg/L |
| | Tetrachloroethene | <0.500 µg/L | 5 µg/L |
| | Chlorobenzene | <0.500 µg/L | 100 µg/L |
| **VOLATILE ORGANIC COMPOUNDS** | Ethyl Benzene | <0.500 µg/L | 700 µg/L |
| | m,p-Xylene | <0.500 µg/L | N/A |
| | Styrene | <0.500 µg/L | 100 µg/L |
| | 1,4-Dichlorobenzene | <0.500 µg/L | 75 µg/L |
| | 1,2-Dichlorobenzene | <0.500 µg/L | 600 µg/L |
| | 1,2,4-Trichlorobenzene | <0.500 µg/L | 70 µg/L |
| | o-Xylene (total) | <0.500 µg/L | 10000 µg/L |
| | Dichlorodifluoromethane | <0.500 µg/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 µg/L | N/A |
| | Trichlorofluoromethane | <0.500 µg/L | N/A |
| | Acetone | <5.00 µg/L | N/A |
| | Methyl iodide | <0.500 µg/L | N/A |
| | Carbon disulfide | <0.500 µg/L | N/A |
| | Acrylonitrile | <5.00 µg/L | N/A |
| | tert-Butyl methyl ether (MTBE) | <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 |

| CONTAMINANT CATEGORY | ANALYTE | MEASURED VALUE | MAXIMUM CONTAMINANT LEVEL |
|---|---|---|---|
| | 2-Butanone | <0.500 µg/L | N/A |
| | Bromochloromethane | <0.500 µg/L | N/A |
| | Tetrahydrofuran | <0.500 µg/L | N/A |
| | Chloroform | 1.25 µg/L | N/A |
| | 1,1-Dichloropropene | <0.500 µg/L | N/A |
| **VOLATILE ORGANIC COMPOUNDS** | Methyl methacrylate | <0.500 µg/L | N/A |
| | Dibromomethane | <0.500 µg/L | N/A |
| | Bromodichloromethane | 2.03 µg/L | N/A |
| | cis-1,3-Dichloropropene | <0.500 µg/L | N/A |
| | 4-Methyl-2-pentanone | <0.500 µg/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 | 2.60 µg/L | N/A |
| | 1,1,1,2-Tetrachloroethane | <0.500 µg/L | N/A |
| | o-Xylene | <0.500 µg/L | N/A |
| | Bromoform | 1.45 µg/L | N/A |
| | lsopropylbenzene (Cumene) | <0.500 µg/L | N/A |
| | 1,1,2,2-Tetrachloroethane | <0.500 µg/L | N/A |
| | Bromobenzene | <0.500 µg/L | N/A |
| | 1,2,3-Trichloropropane | <0.500 µg/L | N/A |
| | 1,2,3-Trichloropropane | <0.02 µg/L | N/A |
| | n-Propylbenzene | <0.500 µg/L | N/A |
| | 2-Chlorotoluene | <0.500 µg/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 |
| | 1,2-Dibromo-3-chloropropane | <0.02 µg/L | 0.2 µg/L |
| **VOLATILE ORGANIC COMPOUNDS** | n-Butylbenzene | <0.500 µg/L | N/A |
| | Hexachlorobutadiene | <0.500 µg/L | N/A |
| | Naphthalene | <0.500 µg/L | N/A |
| | 1,2,3-Trichlorobenzene | <0.500 µg/L | N/A |

| CONTAMINANT CATEGORY | ANALYTE | MEASURED VALUE | MAXIMUM CONTAMINANT LEVEL |
|---|---|---|---|
| **INORGANICS** | | | |
| | Cyanide | <0.0200 mg/L | 0.2 mg/L |
| | Nitrate (as N) | 1.42 mg/L | 10 mg/L |
| **SECONDARY WATER STANDARDS** | | | |
| | Chloride | 13.4 mg/L | 300 mg/L |
| | Fluoride | 1.64 mg/L | 2.0 mg/L |
| | Sulfate | 22.2 mg/L | 300 mg/L |
| **WATER QUALITY ANALYSES** | | | |
| | Total Alkalinity ($CaCO_3$) | 225 mg/L | N/A |
| | Specific Conductance | 513 µmho/cm | N/A |
| | Total Dissolved Solids | 281 mg/L | N/A |
| **PESTICIDES** | | | |
| | Aldicarb Sulfoxide | <0.500 µg/L | 4 µg/L |
| | Aldicarb Sulfone | <0.500 µg/L | 2 µg/L |
| | Oxamyl | <1.00 µg/L | 200 µg/L |
| | Aldicarb | <0.500 µg/L | 3 µg/L |
| | Carbofuran | <0.500 µg/L | 40 µg/L |
| | Methomyl | <1.00 µg/L | N/A |
| | 3-Hydroxycarbofuran | <1.00 µg/L | N/A |
| | Propoxur | <1.00 µg/L | N/A |
| | Carbaryl (Sevin) | <1.00 µg/L | N/A |
| | Methiocarb | <1.00 µg/L | N/A |
| **HERBICIDES** | | | |
| | 3,5-Dichlorobenzoic acid | <1.25 µg/L | N/A |
| | Dicamba | <1.25 µg/L | N/A |
| | Dichlorprop | <2.50 µg/L | N/A |
| | Chloramben | <1.25 µg/L | N/A |
| | 2,4,5-T | <0.625 µg/L | N/A |
| | 2,4-DB | <2.50 µg/L | N/A |
| | Bentazon | <2.50 µg/L | N/A |
| | Acifluorfen | <1.25 µg/L | N/A |
| | Dalapon | <1.00 µg/L | 200 µg/L |
| | 2,4-D | <1.00 µg/L | 70 µg/L |
| | Pentachlorophenol | <0.0400 µg/L | 1 µg/L |
| | 2,4,5-TP | <0.200 µg/L | 50 µg/L |
| | Dinoseb | <0.200 µg/L | 7 µg/L |
| | Picloram | <0.100 µg/L | 500 µg/L |

### 7.5.1 Inorganic Contaminants

Monitoring for inorganic contaminants in the PWS is required under the SDWA and the Texas Administrative Code. The state regulates the amount of these contaminants in drinking water to protect public health. Consumption of these contaminants may cause health problems if present in public water supplies in amounts greater than the drinking water standard set by the EPA. All inorganic contaminant results from monitoring conducted in 2017 were below regulatory levels.

### 7.5.2 Biological (Microbial) Monitoring

Water distribution systems contain naturally occurring microorganisms and other organic matter that may 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 (bio-film), or from suspended particulates. Factors that influence bacterial growth include water temperature, flow rate, and chlorination. During 2017, 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. During 2017, no radiological monitoring was conducted.

### 7.5.4 Disinfection By-Products

All drinking water at Pantex is chlorinated prior to entry into the distribution system. Disinfection By-products (DBPs) are produced by the reaction between the disinfectant (chlorine) and organic matter in the water. Reducing the amount of organic matter in the source water before disinfection can help control the quantity of DBPs produced. In addition, limiting the amount of disinfectant introduced in the system reduces the formation of these byproducts. All PWSs where chlorine is used are required to maintain residual levels between 0.2 and 4.0 mg/L (milligrams per liter) 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 MCLs.

### 7.5.5 Water Quality Parameters

Water quality parameter testing was conducted in 2017. These include constituents such as alkalinity and specific conductivity. Typically, detection of these constituents does not indicate that the water is unsafe to drink; rather they may have aesthetic effect 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 2017.

### 7.5.7 Volatile Organic Contaminants

Volatile organic compounds (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, and wax which contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing, and hobby products. All of these products can release organic compounds while being used, and to some degree, when they are stored. Because of the vast number of products on the market that contain VOCs, it is possible that some of these constituents may find their way into drinking water supplies. Concentrations of these constituents in samples collected and analyzed by the TCEQ in 2017 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. Public water systems must control the levels of lead and copper in drinking water by controlling the corrosivity of the water. Pantex is on a triennial monitoring schedule for lead and copper. Lead and copper monitoring was not conducted during 2017.

### 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 public water systems. 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. Pantex did monitor for select contaminants on the CCL during 2017 and results were all non-detectable.

## 7.6 Inspections

The TCEQ monitors the water supply in accordance with the drinking water standards. In September 2017, a TCEQ-contractor collected samples from the Pantex Plant public water supply system. The report generated from that event indicated that Pantex met or exceeded all requirements for operating a Public Water Supply. The TCEQ did not perform a Comprehensive Compliance Inspection of the Pantex Drinking Water system in 2017.

## 7.7 Conclusions

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

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# Chapter 8 – Wastewater

*Pantex operates an on-site wastewater treatment facility. The wastewater treatment system consists of a facultative lagoon and two wastewater storage lagoons. This facility is permitted by the TCEQ to treat and dispose of domestic and industrial wastewater. During 2017, the Pantex Plant discharged more than 60 million gallons of treated wastewater to the on-site playa lake. Pantex beneficially reused more than 91 million gallons of treated wastewater and treated groundwater for agricultural purposes.*

## 8.1 The Scope of the Program

Domestic and industrial wastewaters generated at the Pantex Plant are treated at an on-site wastewater treatment facility (WWTF). Industrial effluents from Plant operations are generally pre-treated and are directed into the WWTF for further treatment. All such effluents are collected in the sanitary sewer, managed in the WWTF, and are either disposed through a permitted outfall to an underground irrigation system or discharged through a permitted outfall to 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 (in previous years)**

The WWTF (Figure 8.2) is a clay-lined, facultative lagoon that covers approximately 1.58 hectares (3.94 acres) and has a capacity of 42 million liters (11 million gallons). Pantex also has two storage lagoons used for storage and retention of treated wastewater. The east lagoon is a storage lagoon with a polyethylene liner with similar dimensions and capacity as the facultative lagoon and can serve as the facultative lagoon should the need arise (Figure 8.3). In addition to the treated domestic and industrial wastewater, this lagoon receives treated groundwater from environmental remediation projects.

**Figure 8.2 – Wastewater Treatment Facility, Facultative Lagoon**

**Figure 8.3 – East Wastewater Storage Lagoon**

The northern storage lagoon is a clay-lined lagoon, which covers approximately 1.05 hectares (2.6 acres) and has a capacity of 25.54 million liters (6.7 million gallons). This lagoon is used only for the storage of treated wastewater (Figure 8.4).

**Figure 8.4 – Wastewater Storage Lagoon**

The treatment process in the facultative lagoon involves a combination of aerobic, anaerobic, and facultative bacteria. At the surface, aerobic bacteria and algae exist in a symbiotic relationship. Oxygen is provided by natural aeration processes, algal photosynthesis, and by solar-powered mechanical aerators. Bacteria use the oxygen for the aerobic degradation of organic matter. Nutrients and carbon dioxide released in the degradation process are used by the algae. Below the surface and above the bottom of the lagoon, treatment and degradation of organic matter is accomplished with facultative bacteria. At the bottom of the facultative lagoon, organic matter is deposited in a sludge layer and is decomposed by anaerobic bacteria. The wastewater treatment process in a facultative lagoon is complex and nearly all treatment is provided by biological activity.

## 8.2 Operational Description and Metrics

The TCEQ is the permitting authority for wastewater discharges. During 2017, Pantex had three authorizations for wastewater disposal. These authorizations require analytical monitoring and periodic reporting to the TCEQ.

Pantex is permitted to dispose of treated wastewater by means of a subsurface irrigation system into agricultural fields for beneficial reuse. This permit is referred to as a Texas Land Application Permit (TLAP), WQ0004397000. This permit was modified and reissued on April 5, 2012, and will expire on December 1, 2020.

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

Finally, Pantex maintains a Texas Water Quality Permit (TWQP) that allows it to discharge treated wastewater to an on-site playa (WQ0002296000). 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 manages and discharges treated effluent in a manner that is beneficial to the environment.

When discharging to the subsurface irrigation system and prior to application in the fields, the treated wastewater passes through a series of filters designed to remove dirt, debris, and particulate matter. After filtration, the water is pumped to a field filter building where it is filtered again. From this point, water is distributed through manifold pipes to individual zones located within four tracts of land that are each approximately 100 acres in size. Fertilizers and maintenance chemicals are injected into the system through chemical tanks at the field filter building (Figure 8.5). This irrigation system consists of hundreds of miles of piping, tubing, and pressure-compensating drip emitters. The irrigation area consists of agricultural land owned by DOE and farmed by 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.


**Figure 8.5 – Agricultural Chemical Injection Tanks**

During 2017, Pantex beneficially applied approximately 91 million gallons of treated wastewater to crops managed by TTU (Figure 8.6). This is a decrease of 144 million gallons compared to operations during 2016. The reason for the reduction in beneficial reuse was major filter leaks in the irrigation system. At the end of 2017, efforts were still underway to restore this system to full operation. Table 8.1 shows the volume of water applied for each irrigation tract.

**Figure 8.6 – Irrigation Tract 101**

**Table 8.1 – Annual Irrigation Summary, 2017**

| **Irrigation Tract** | **Irrigation Area** (acres) | **Volume Applied** (gallons) | **Volume Applied** (acre ft./ac) |
|---|---|---|---|
| 101 | 100.86 | 25,961,242 | 0.79 |
| 201 | 100.5 | 33,229,900 | 1.01 |
| 301 | 98.75 | 22,431,470 | 0.68 |
| 401 | 97.9 | 9,804,952 | 0.30 |

## 8.3 Sampling Locations

Sampling was conducted at the incoming weir of the lagoon system (before treatment) and at the permitted discharge point(s): (a) for the subsurface irrigation system, Outfall 031, and/or (b) for the 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 2017, Pantex discharged approximately 60 million gallons of treated wastewater through Outfall 001A. Water quality results through this outfall is shown in Table 8.2.

TLAP-specific water sampling was routinely conducted at permitted Outfall 031. TLAP-required analyses were reported to the TCEQ in September 2017. A summary of the results from 2017 is shown in Table 8.3. All sample results were within the effluent limitations established in the TLAP. Results from the required soil monitoring in the irrigation application area are provided in Chapter 10 of this report.

**Table 8.2 – Water Quality Results from Outfall 001A, 2017**

| Analyte | Discharge Limits (mg/L) | Minimum Concentration (mg/L) | Maximum Concentration (mg/L) | Average Concentration (mg/L) | Permit Exceedance / Violation | Percent Compliance |
|---|---|---|---|---|---|---|
| Copper | 2.0 | 0.003 | 0.015 | 0.006 | 0/0 | 100 |
| Manganese | 3.0 | 0.006 | 0.011 | 0.008 | 0/0 | 100 |
| Zinc | 6.0 | <0.010 | 0.015 | <0.010 | 0/0 | 100 |
| HMX | Report | <0.001 | <0.001 | <0.001 | 0/0 | 100 |
| RDX | Report | <0.001 | <0.001 | <0.001 | 0/0 | 100 |
| PETN | Report | <0.001 | <0.001 | <0.001 | 0/0 | 100 |
| TNT | Report | 0.0003 | <0.001 | <0.001 | 0/0 | 100 |
| BOD | 30 – 70 | 3.9 | 25.7 | 9.5 | 0/0 | 100 |
| COD | N/A - 150 | 33.5 | 180.0 | 66.1 | 1/1 | 92 |
| TSS | 60 - 90 | 1.8 | 38.8 | 18.1 | 0/0 | 100 |
| Oil/Grease | N/A – 15 | 2.9 | 4.9 | 4.0 | 0/0 | 100 |
| pH[a] | 6.0 Min. 10.0 Max. | 6.4 | 9.0 | 8.1 | 0/0 | 100 |

[a] pH is measured in standard units and not in mg/L.
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.

**Table 8.3 – Water Quality Results from Outfall 031, 2017**

| Analyte | TLAP Limits (mg/L) | Minimum Concentration (mg/L) | Maximum Concentration (mg/L) | Average Concentration (mg/L) | Permit Exceedance/ Violation | Percent Compliance |
|---|---|---|---|---|---|---|
| Copper | 2.0 | 0.008 | 0.047 | 0.020 | 0/0 | 100 |
| Manganese | 3.0 | 0.005 | 0.012 | 0.008 | 0/0 | 100 |
| Zinc | 6.0 | 0.005 | 0.083 | 0.021 | 0/0 | 100 |
| HMX | Report | 0.0003 | 0.0006 | 0.0004 | 0/0 | 100 |
| RDX | Report | <0.001 | <0.001 | <0.001 | 0/0 | 100 |
| PETN | Report | <0.001 | <0.001 | <0.001 | 0/0 | 100 |
| TNT | Report | <0.001 | <0.001 | <0.001 | 0/0 | 100 |
| Ammonia | Report | 0.29 | 1.88 | 0.59 | 0/0 | 100 |
| BOD3 | Report | 5.5 | 95.4 | 29.6 | 0/0 | 100 |
| COD | Report | 19.7 | 106.0 | 49.9 | 0/0 | 100 |
| $NO_2/NO_3$ | Report | 0.13 | 0.84 | 0.30 | 0/0 | 100 |
| Oil/Grease | Report | 1.56 | 1.67 | 1.62 | 0/0 | 100 |
| pH[a] | 6.0 Min. 10.0 Max. | 8.0 | 9.4 | 8.7 | 0/0 | 100 |
| Total Kjeldahl Nitrogen | Report | 1.31 | 6.35 | 3.44 | 0/0 | 100 |

[a] pH is measured in standard units and not in mg/L.
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.

## 8.5 Permit Violations

An unauthorized discharge is defined as either discharge of untreated wastewater, prior to treatment or discharged of treated wastewater to the environment at any location other than through a permitted outfall. During 2017, Pantex experienced three unauthorized discharges. Two of the discharges were treated wastewater associated with the failure of the subsurface irrigation system and the other was caused by a clogged sewer line. In September, Pantex exceeded the effluent limits for chemical oxygen demand (COD). The cause of this exceedance was not determined; however, all values before and after this occurrence were within the normal range. These events were reported to the TCEQ and did not pose any threat to human health or the environment.

## 8.6 Historical Comparisons

Results for ammonia, biochemical oxygen demand (BOD), explosives, metals, and oil and grease were within expected ranges and did not exceed permit limits, when using the subsurface irrigation system. Prior to 2017, discharge to the on-site playa had not occurred in more than 10 years so no historical comparison was made.

## 8.7 Conclusion

The Pantex Plant is the only facility in the DOE-complex that beneficially reuses all of its treated wastewater for agricultural purposes, when the irrigation system is operational. During a period of extreme drought in the region, Pantex not only treats the wastewater, but provides essential water for wildlife and the irrigation of crops while remaining protective of the environment. Since the subsurface irrigation system was installed in 2004, Pantex has beneficially reused more than two billion gallons of treated wastewater.

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# Chapter 9 – Surface Water

*Data from the surface water program during 2017 were consistent with historical data from past monitoring activities, indicating that operations at the Pantex Plant did not adversely impact the surface water environment at Pantex. No significant changes were made to the surface water sampling program during the 2017 calendar year.*

## 9.1 The Scope of the Program

The Pantex Plant is located in a region of relatively flat topography and with a semi-arid climate. Surface water represented by rivers or streams does not exist around the facility site and all surface water drains to isolated playa lakes. Playa lakes are an interesting topographic feature in the Texas Panhandle. They are shallow, ephemeral lakes that have clay-lined basins that fill periodically with surface water runoff (Figure 9.1). 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.

At Pantex, six playas are located on DOE-owned and -leased property. Two of these are on property owned by TTU. Most of the surface drainage on the DOE-owned and -leased lands flows via man-made ditches, natural drainage channels, or by sheet-flow to these on-site playa basins. Playa basins consist of the ephemeral lakes themselves and their surrounding watersheds. Figure 9.2 is a map of the Pantex Plant that shows the locations of the six playas at the facility site with their respective drainage basins (watersheds). Some storm water flows to off-site playas. These areas are at the outer periphery of the site and, for the most part, a considerable distance from most Plant operations.

**Figure 9.1 – Mule Deer Grazing at a Playa Lake at Pantex Plant**

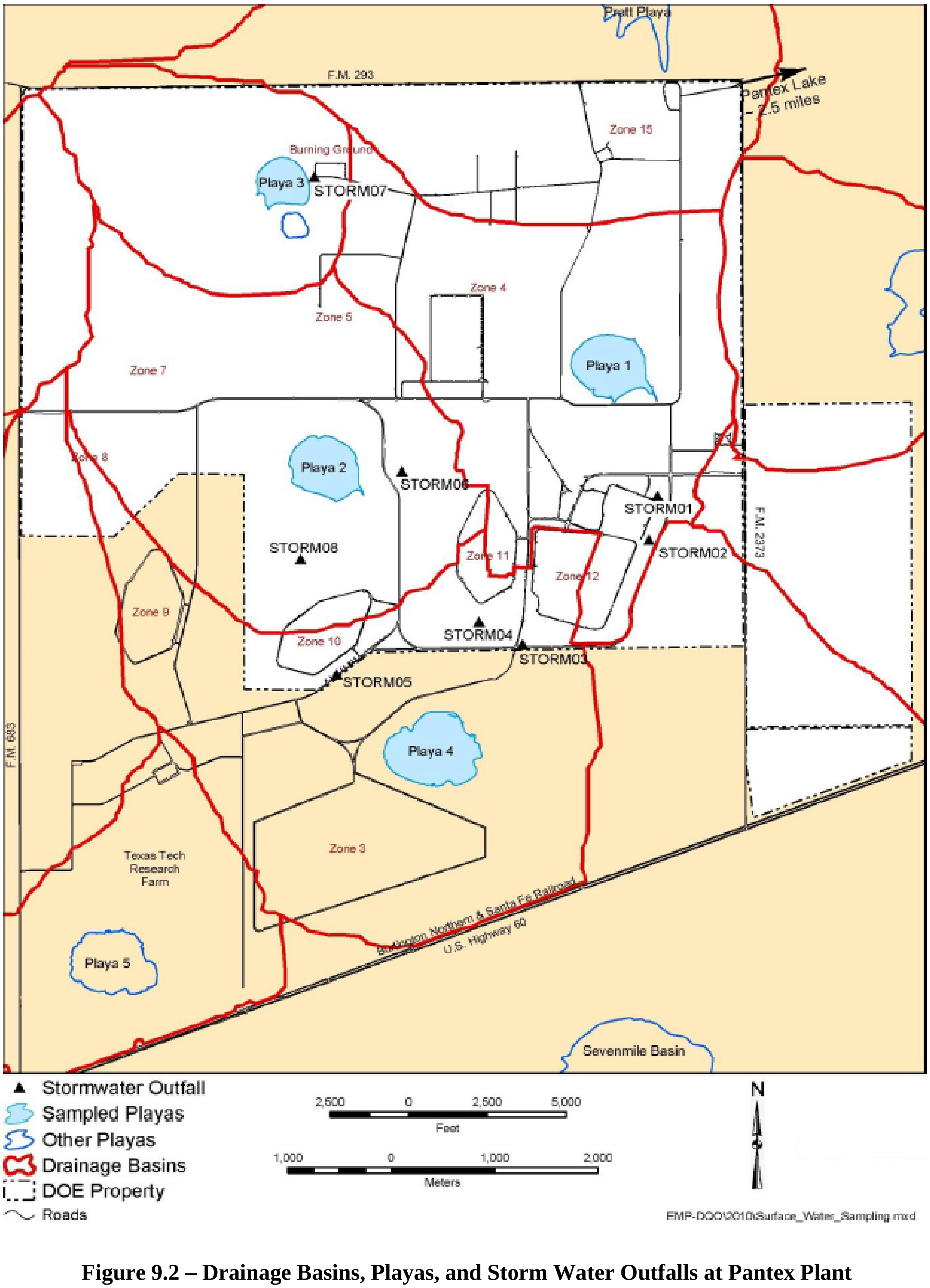


**Figure 9.2 – Drainage Basins, Playas, and Storm Water Outfalls at Pantex Plant**

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

## 9.2 Sampling Locations and Monitoring Results

Surface water sampling occurs as a result of precipitation or discharge events. During 2017 , sampling was conducted in accordance with permits issued by the TCEQ and the Data Quality Objective documents developed by Pantex media scientists. The TCEQ is the permitting authority for storm water discharges for waters in the state of Texas.

Storm water runoff at the Pantex Plant is sampled in accordance with the TPDES Multi-Sector General Permit (MSGP) TXR050000 for storm water. During 2017, Pantex performed sampling in compliance with the MSGP issued in 2016. Pantex filed for coverage under the MSGP on November 7, 2016. General permits are typically for five years and the most recent MSGP expires in August of 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 the Plant.

The TCEQ has issued a 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 2018. There was one construction project filed under the general permit in effect at Pantex at the end of 2017. 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.

Pantex conducted storm water monitoring during 2017 at designated sampling locations in accordance with permit requirements. Environmental surveillance monitoring was also conducted at the playas as a best management practice. Appendix A lists the 2017 surface water analytes. In addition to routine sampling at four on-site playas, the Pantex Plant has eight storm water outfalls (shown on Figure 9.2). The flow diagram in Figure 9.3 depicts how storm water and treated industrial effluents discharge through the outfalls, and ultimately to the playas or a 400-acre subsurface drip irrigation system on the Pantex site.

During 2017, sampling was conducted at all eight storm water outfalls and all four playas. Based on data from the National Weather Service – Amarillo, located northeast of Amarillo and southwest of the Pantex Plant, rainfall during 2017 was slightly above normal for the year with approximately 67.26 cm (26.48 inches) for the year. The average annual rainfall is typically 50.1 cm (19.71 inches).

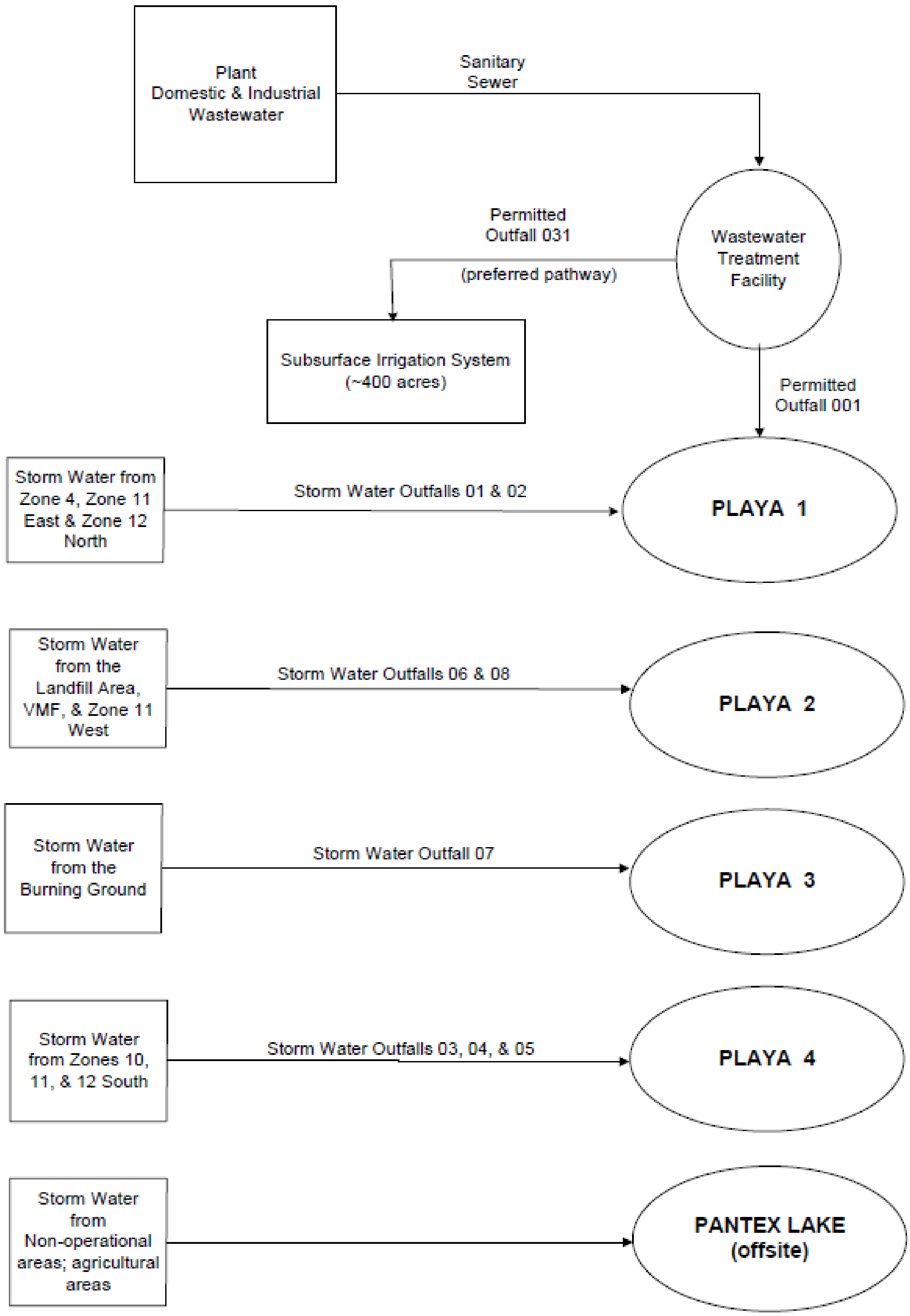


**Figure 9.3 – Pantex Surface Water Schematic, 2017**

Storm water monitoring required by the TPDES MSGP in 2017 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 2017 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 (30 TAC), Chapter 319 and sector-specific analytes required by the MSGP. Metals were compared with IWQPs. Sector-specific analytes are compared to benchmarks listed in the MSGP. Table 9.1 lists the results for metals from the storm water outfalls in 2017 and compares them with the IWQPs.

**Table 9.1 – Annual Storm Water Results (metals), 2017 (mg/L)**

| | Outfall STORM01 | Outfall STORM02 | Outfall STORM03 | Outfall STORM04 | Outfall STORM05 | Outfall STORM06 | Outfall STORM07 | Outfall STORM08 | IWQP |
|---|---|---|---|---|---|---|---|---|---|
| **Arsenic** | 0.004 | <0.010 | <0.010 | <0.010 | <0.010 | 0.009 | 0.004 | <0.010 | **0.3** |
| **Barium** | 0.320 | 0.370 | 0.140 | 0.110 | 0.029 | 0.600 | 0.330 | 0.067 | **4.0** |
| **Cadmium** | 0.0003 | 0.0003 | <0.0005 | <0.0005 | 0.0002 | <0.001 | <0.0005 | <0.0005 | **0.2** |
| **Chromium** | 0.024 | 0.012 | 0.007 | 0.010 | <0.010 | 0.041 | 0.005 | 0.006 | **5.0** |
| **Copper** | 0.018 | 0.009 | 0.004 | 0.006 | 0.011 | 0.039 | 0.010 | 0.003 | **2.0** |
| **Lead** | 0.013 | 0.007 | 0.002 | 0.004 | 0.001 | 0.024 | <0.003 | 0.001 | **1.5** |
| **Manganese** | 0.250 | 0.140 | 0.046 | 0.100 | 0.019 | 0.640 | 0.033 | 0.031 | **3.0** |
| **Mercury** | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | **0.01** |
| **Nickel** | 0.015 | 0.009 | 0.004 | 0.006 | 0.002 | 0.034 | 0.006 | 0.003 | **3.0** |
| **Selenium** | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 0.004 | <0.005 | <0.005 | **0.2** |
| **Silver** | <0.002 | 0.004 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | **0.2** |
| **Zinc** | 0.140 | 0.054 | 0.024 | 0.065 | 0.020 | 0.170 | 0.009 | 0.012 | **6.0** |

IWQP= Inland Water Quality Parameter limits, 30 TAC §319.22
The values above are the maximum concentration from all samples, if more than one sample was collected during the year.

### 9.2.1 Playa 1 Basin

Playa 1 is approximately 32 hectares (79.3 acres) 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 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 2017, playa monitoring was conducted in Playa 1 and both Storm Water Outfalls 01 and 02.

Technicians collected water in Playa 1 during the third quarter of 2017 (Figure 9.4). Metals analyses were all consistent with historic levels found at the playa; all were below the IWQPs. VOCs, and SVOCs were below their respective MDLs. Isotopic radiological analyses for uranium was below the DCGs for ingested water. 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.

**Figure 9.4 – Sampling Technicians at Playa 1**

**Storm Water Outfall 01 – Zone 12 North at BN5A.** BN5A is the Pantex Plant 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 and originates in the operational areas of Zone 12 North. Storm water flows northward from the outfall through the BN5A ditch and on northward, finally discharging into Playa 1.

MSGP-required monitoring at Storm Water Outfall 01 was conducted during the first quarter of 2017. Monitoring included visual monitoring, pH evaluation and metals analysis. 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 metals were below IWQPs in 2017 .

**Storm Water Outfall 02 – Zone 12 East at S. 15th Street**. Flow through this outfall includes storm water discharges from the eastern portions of Zone 12 South, which includes some of the operational areas of the Plant.

Permit-required monitoring at Storm Water Outfall 02 was conducted during the first and third quarters of 2017. Monitoring included visual monitoring, pH evaluation and metals analysis. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP and pH was normal. All metals were below IWQPs in 2017.

### 9.2.2 Playa 2 Basin

Playa 2 is approximately 30 hectares (74 acres) 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 2017, playa monitoring was conducted in Playa 2 and at both Storm Water Outfalls 06 and 08.

Playa 2 was sampled during October 2017 (Figure 9.5). Sampling included metals, VOC's and SVOC's. Metals analyses during the year were all consistent with historic levels found at the playa and all were below the IWQPs. VOCs, and SVOCs were below their respective MDLs. Analysis for the organic compound Benzidine was rejected by the laboratory, due to extremely low spike matrix recovery. Tritium was below the MCL for drinking water. Explosives were below their respective MDLs.

**Figure 9.5 – Technicians Sampling at Playa 2**

**Storm Water Outfall 06 – Vehicle Maintenance Facility (VMF).** This outfall 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 the Plant fleet are also located in this drainage area. The drainage area is primarily a paved lot used for parking and staging vehicles on the south side of the VMF.

Permit-required monitoring at Storm Water Outfall 06 was conducted during the first and second quarters of 2017. Activities included visual monitoring, pH testing, total petroleum hydrocarbons (TPHs) analysis and metals analysis. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP. The pH was above normal level, due to runoff from magnesium chloride sprayed to driveways and parking lots as an ice prevention measure used at Pantex. TPH results were below detection limits for all quarters, indicating that runoff from the VMF staging area and refueling operations is not contributing significant hydrocarbon pollutants to the environment. All metals were below IWQPs in 2017.

**Storm Water Outfall 08 – Landfill.** This outfall receives storm water runoff from an area within the Plant's active landfill. Runoff from active open landfill cells is retained within the cells. Storm water runoff at the 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 the first and third quarters of 2017. Monitoring included visual monitoring, pH evaluation and metals analysis. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP and pH was normal. All metals were below IWQPs in 2017. Sector-specific monitoring is required at this location and includes total suspended solids (TSS) and iron. TSS sampling averaged 174.5 mg/L for the year, which is above the benchmark level of 100 mg/L. Iron averaged 7.35 mg/L for the year, which is above the benchmark level (1.0 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 drainage.

### 9.2.3 Playa 3 Basin

Playa 3, the smallest playa at the Pantex site, is approximately 22 hectares (54 acres) and receives only 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 Burning Ground. In 2017, playa monitoring was conducted in Playa 3 and within the Playa 3 basin at Storm Water Outfall 07.

Playa 3 was sampled in October. Monitoring was for metals, VOCs, SVOCs, explosives, and radionuclides. In January, a co-sampling with TDSHS was conducted for radionuclides only. Metals analyses during the year were all consistent with historic levels found at the playa and all were below the IWQPs. VOCs, and SVOCs were below their respective MDLs. Tritium was below the MCL for drinking water. Isotopic radiological analyses for uranium and plutonium were below the Derived Concentration Standard (DCSs) for ingested water. HMX was detected at 0.0003 mg/L. Explosives have been detected at these levels at Playa 3 in the past. HMX and RDX are legacy contaminants from operations conducted years ago.

**Storm Water Outfall 07 – Burning Ground.** This outfall receives only 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 (Figure 9.6). For this reason, sampling at the outfall can be a challenge.


**Figure 9.6 – Storm Water Outfall 07; Playa 3 in the Background**

Permit-required monitoring at Storm Water Outfall 07 was conducted during the first quarter of 2017. Monitoring included visual monitoring, pH evaluation and metals analysis. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP and pH was normal. All metals were below IWQPs.

### 9.2.4 Playa 4 Basin

Playa 4 is approximately 46 hectares (112.5 acres) and is located on property owned by TTU. The 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 fire water storage tanks or test fire hydrants in sufficient volumes to reach Storm Water Outfall 003. In 2017, playa monitoring was conducted in Playa 4 and within the Playa 4 basin at Storm Water Outfalls 03, 04, and 05.

Playa 4 was sampled during the third quarter. Sample analysis were for metals, VOCs, SVOCs, explosives, and radionuclides. Metals analyses during the year were all consistent with historic levels found at the playa and all were below the IWQPs. VOCs, SVOCs, and explosives were below their respective MDLs. However, thirteen of the SVOC analyses conducted were rejected by the laboratory, due to poor matrix recovery. Isotopic radiological analyses for uranium and plutonium were below the DSCs for ingested water.

**Storm Water Outfall 03 – Zone 12 South**. Surface water monitored at this outfall is primarily storm water runoff from the west half of Zone 12 South. Periodically, water from the Plant's 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 the first and third quarters of 2017. Activities included visual monitoring, pH testing, metals, HE and radiological analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP and the pH was normal. All metals, HE and radionuclides were below IWQPs in 2017.

**Storm Water Outfall 04 – Zone 11 South**. Surface water monitored at this outfall 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 first quarter of 2017. Monitoring included visual monitoring, pH evaluation and metals analysis. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP and pH was normal. All metals were below IWQPs in 2017.

**Storm Water Outfall 05 – Zone 10 South**. Surface water monitored at this outfall is entirely storm water runoff from the southern half of Zone 10 in an area where several contractor laydown yards are located. Some of the laydown yards contained overhead storage tanks for part of the year, with secondary containment, for re-fueling vehicles and heavy equipment. The elevated tanks were subsequently removed or replaced with ground-level double walled above ground storage tanks. Waste staging, primarily scrap metal, is conducted in the area as well as container staging. Drainage in this vicinity is very flat. There are no industrial effluents discharged through this outfall.

Permit-required monitoring at Storm Water Outfall 05 was conducted during the first quarter of 2017. Monitoring included visual monitoring, pH evaluation, and metals analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP and pH was normal. All metals were below IWQPs in 2017.

### 9.2.5 Pantex Lake

Pantex Lake is the largest playa controlled by the DOE and is approximately 136 hectares (337 acres) in size. The playa is located away from the main Plant site, approximately 2.5 miles to the northeast. Playa monitoring at Pantex Lake was discontinued in 2003, as it does not receive any runoff or discharges from the Pantex plant site.

## 9.3 Historical Comparisons

Sampling results from storm water outfalls during 2017 showed no significant changes from the results of prior years. All monitoring results for metals are within the IWQP established by the State of Texas. TPH results are consistent with samples taken in the past. Sampling continues to indicate that storm water discharges at Pantex are of relatively good quality and that current operations at the Plant are not degrading storm water quality.

Playa Lake sample results obtained during 2017 were very similar with past monitoring results. The playa data continues to support the premise that operations at the Pantex Plant are not negatively impacting the water quality of the playas.

## 9.4 Conclusions

Monitoring storm water runoff at the Pantex Plant is performed as required by the TCEQ’s general permits. The playa lakes at Pantex are monitored as a best management practice. Data are often limited due to the semi-arid climate, however, rainfall was slightly above average in 2017 in the Texas Panhandle. Based on the data collected in 2017, surface water monitoring at the Pantex Plant continues to support the premise that continuing Plant operations are having no detrimental impact to the quality of the surface waters at the Plant.

# Chapter 10 – Soils

*Results of permit required soil monitoring are reported in this chapter. Results of soil monitoring conducted at the Pantex Burning Ground in 2017 were within established background comparison values. Results of soil monitoring conducted at the subsurface irrigation site were consistent with previous year's results and indicate operations are having no negative impact to the environment.*

## 10.1 The Scope of the Program

This chapter presents the results of permit required soil sampling at the Pantex Plant during 2017. Surface soil samples were collected at the Pantex Burning Ground and analyzed for metals and explosive in accordance with Provision VI.C of the Pantex Plant Hazardous Waste Permit HW-50284 (Permit HW-50284) (TCEQa). Subsurface soil samples were also collected from four subsurface irrigation tracts and analyzed for various parameters in accordance with Provision V.O of the Pantex Plant TLAP (WQ0004397000) (TCEQb). All samples were analyzed by off-site contract laboratories that meet EPA requirements as discussed in Chapter 13, Quality Assurance. Specific analytes are listed in Appendix A.

## 10.2 Burning Ground Surface Soil Sampling and Analysis

In 2017, 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. During 2017, soil was sampled at five on-site locations, representing three upland and two playa sampling areas associated with the Burning Ground. Samples were collected from a depth of zero to two inches from each associated grid area, and combined to form individual composite samples (Figure 10.1).

### 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% of the background samples for a particular constituent at any location were greater than the MDL, the background value was calculated using a 95% upper tolerance limit with 99.9% coverage.

### 10.2.2 Surface Soil Metals Analysis

Soil samples collected from the Burning Ground and Playa 3 were analyzed for 10 metals (See the "BG Soil" column in Appendix A). With the exception of chromium at sampling location BG-SS-C2, all of the metal concentrations observed in 2017 were below the established permit background concentrations. The initial sampling results indicated a potential statistically significant increase (SSI) for chromium (17.0 mg/kg) at sampling location BG-SS-C2. The established background concentration is 16.23 mg/kg for chromium at BG-SS-C2. The results from confirmation sampling, as provided for in Provision VI.F.1.a of Permit HW-50284 was 13.0 mg/kg. The confirmation sample result was below established background concentration. Sample results are reported in Tables 10.1 through 10.5 in this report.

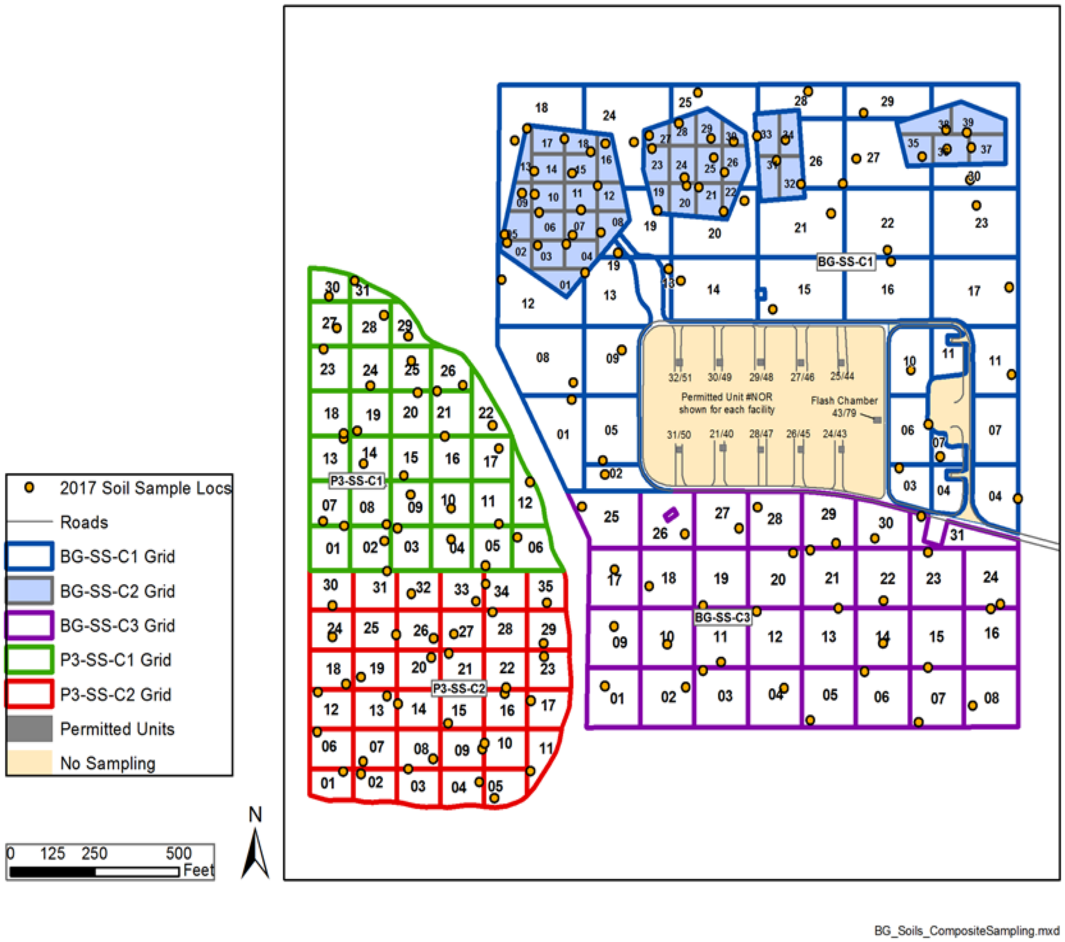


**Figure 10.1 – Burning Ground Multi-Incremental Soil Sampling Locations for 2017**

**Table 10.1 – Calendar Year 2017 Monitoring Results at Location BG-SS-C1 (in mg/kg)**

| Constituent (Code) | 2017 Monitoring Result | Background Comparison Level | 2017 Monitoring Result Exceeds Background? |
|---|---|---|---|
| Silver (Ag) | 1.1 | 8.42 | No |
| Boron (B) | < 47 | 50.0 | No |
| Cadmium (Cd) | 0.54 | 1.0 | No |
| Cobalt (Co) | 7.2 | 17.55 | No |
| Chromium (Cr) | 14 | 19.93 | No |
| Copper (Cu) | 16 | 67.34 | No |
| 2,4-dinitrotoluene (2,4-DNT) | < 0.049 | 0.5 | No |
| 2,6-dinitrotoluene (2,6-DNT) | < 0.049 | 0.5 | No |
| Mercury (Hg) | 0.11 | 0.29 | No |
| Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX) | 47 | 858.24 | No |
| Nickel (Ni) | 15 | 29.76 | No |
| Lead (Pb) | 16 | 54.76 | No |
| Pentaerythritol tetranitrate | < 0.49 | 5.0 | No |

| Constituent (Code) | 2017 Monitoring Result | Background Comparison Level | 2017 Monitoring Result Exceeds Background? |
|---|---|---|---|
| (PETN) | | | |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | < 0.049 | 2.6 | No |
| Triaminonitrobenzene (TATB) | 1.9 | 23.25 | No |
| 1,3,5-trinitrobenzene (TNB135) | < 0.049 | 10.0 | No |
| Trinitrotoluene (TNT) | < 0.049 | 10.0 | No |
| Zinc (Zn) | 61 | 160.58 | No |

**Table 10.2 – Calendar Year 2017 Monitoring Results at Location BG-SS-C2 (in mg/kg)**

| Constituent (Code) | 2017 Monitoring Result | Background Comparison Level | 2017 Monitoring Result Exceeds Background? |
|---|---|---|---|
| Silver (Ag) | < 0.95 | 1.0 | No |
| Boron (B) | < 48 | 50.0 | No |
| Cadmium (Cd) | 0.28 | 1.0 | No |
| Cobalt (Co) | 8.4 | 8.77 | No |
| Chromium (Cr) | 13[1] | 16.23 | No |
| Copper (Cu) | 26 | 75.38 | No |
| 2,4-dinitrotoluene (2,4-DNT) | < 0.05 | 0.5 | No |
| 2,6-dinitrotoluene (2,6-DNT) | < 0.05 | 0.5 | No |
| Mercury (Hg) | 0.012 | 0.2 | No |
| Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX) | < 0.05 | 1.0 | No |
| Nickel (Ni) | 17 | 24.53 | No |
| Lead (Pb) | 13 | 77.82 | No |
| Pentaerythritol tetranitrate (PETN) | < 0.5 | 5.0 | No |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | < 0.05 | 1.0 | No |
| Triaminonitrobenzene (TATB) | < 0.05 | 3.0 | No |
| 1,3,5-trinitrobenzene (TNB135) | < 0.05 | 10.0 | No |
| Trinitrotoluene (TNT) | < 0.05 | 10.0 | No |
| Zinc (Zn) | 110 | 317.32 | No |

**Table 10.3 – Calendar Year 2017 Monitoring Results at Location BG-SS-C3 (in mg/kg)**

| Constituent (Code) | 2017 Monitoring Result | Background Comparison Level | 2017 Monitoring Result Exceeds Background? |
|---|---|---|---|
| Silver (Ag) | < 0.9 | 1.0 | No |

[1] Results from confirmation sample. Initial sample results were 17.0 mg/kg.

| Constituent (Code) | 2017 Monitoring Result | Background Comparison Level | 2017 Monitoring Result Exceeds Background? |
|---|---|---|---|
| Boron (B) | < 45 | 50.0 | No |
| Cadmium (Cd) | 0.57 | 1.0 | No |
| Cobalt (Co) | 7.4 | 18.68 | No |
| Chromium (Cr) | 15 | 28.96 | No |
| Copper (Cu) | 27 | 53.84 | No |
| 2,4-dinitrotoluene (2,4-DNT) | < 0.05 | 0.5 | No |
| 2,6-dinitrotoluene (2,6-DNT) | < 0.05 | 0.5 | No |
| Mercury (Hg) | 0.054 | 0.2 | No |
| Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX) | 25 | 367.1 | No |
| Nickel (Ni) | 15 | 30.88 | No |
| Lead (Pb) | 19 | 54.88 | No |
| Pentaerythritol tetranitrate (PETN) | < 0.5 | 5.0 | No |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | 0.51 | 1.8 | No |
| Triaminonitrobenzene (TATB) | 1.2 | 26.86 | No |
| 1,3,5-trinitrobenzene (TNB135) | < 0.05 | 10.0 | No |
| Trinitrotoluene (TNT) | < 0.05 | 10.0 | No |
| Zinc (Zn) | 73 | 168.0 | No |

**Table 10.4 – Calendar Year 2017 Monitoring Results at Location P3-SS-C1 (in mg/kg)**

| Constituent (Code) | 2017 Monitoring Result | Background Comparison Level | 2017 Monitoring Result Exceeds Background? |
|---|---|---|---|
| Silver (Ag) | < 0.95 | 1.0 | No |
| Boron (B) | < 48 | 50.0 | No |
| Cadmium (Cd) | 0.43 | 1.0 | No |
| Cobalt (Co) | 7.3 | 35.78 | No |
| Chromium (Cr) | 15 | 36.35 | No |
| Copper (Cu) | 17 | 44.21 | No |
| 2,4-dinitrotoluene (2,4-DNT) | < 0.049 | 0.5 | No |
| 2,6-dinitrotoluene (2,6-DNT) | < 0.049 | 0.5 | No |
| Mercury (Hg) | 0.021 | 0.2 | No |
| Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX) | < 0.049 | 1.0 | No |
| Nickel (Ni) | 15 | 43.38 | No |
| Lead (Pb) | 16 | 54.13 | No |
| Pentaerythritol tetranitrate (PETN) | < 0.49 | 5.0 | No |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | < 0.049 | 1.0 | No |
| Triaminonitrobenzene (TATB) | < 0.049 | 3.0 | No |
| 1,3,5-trinitrobenzene | < 0.049 | 10.0 | No |

| Constituent (Code) | 2017 Monitoring Result | Background Comparison Level | 2017 Monitoring Result Exceeds Background? |
|---|---|---|---|
| (TNB135) | | | |
| Trinitrotoluene (TNT) | < 0.049 | 10.0 | No |
| Zinc (Zn) | 64 | 129.75 | No |

**Table 10.5 – Calendar Year 2017 Monitoring Results at Location P3-SS-C2 (in mg/kg)**

| Constituent (Code) | 2017 Monitoring Result | Background Comparison Level | 2017 Monitoring Result Exceeds Background? |
|---|---|---|---|
| Silver (Ag) | < 0.92 | 1.0 | No |
| Boron (B) | < 46 | 50.0 | No |
| Cadmium (Cd) | 0.39 | 1.0 | No |
| Cobalt (Co) | 8.9 | 37.21 | No |
| Chromium (Cr) | 16 | 49.34 | No |
| Copper (Cu) | 17 | 43.93 | No |
| 2,4-dinitrotoluene (2,4-DNT) | < 0.05 | 0.5 | No |
| 2,6-dinitrotoluene (2,6-DNT) | < 0.05 | 0.5 | No |
| Mercury (Hg) | 0.019 | 0.2 | No |
| Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX) | < 0.05 | 1.0 | No |
| Nickel (Ni) | 16 | 53.18 | No |
| Lead (Pb) | 16 | 24.41 | No |
| Pentaerythritol tetranitrate (PETN) | < 0.5 | 5.0 | No |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | < 0.05 | 1.0 | No |
| Triaminonitrobenzene (TATB) | < 0.05 | 3.0 | No |
| 1,3,5-trinitrobenzene (TNB135) | < 0.05 | 10.0 | No |
| Trinitrotoluene (TNT) | < 0.05 | 10.0 | No |
| Zinc (Zn) | 63 | 139.91 | No |

### 10.2.3 Surface Soil Explosives Analysis

Soil samples collected from the Burning Ground and Playa 3 were analyzed for eight explosive compounds (Appendix A). All sampling results for explosives in 2017 were below the established permit background concentrations as shown in Tables 10.1 through 10.5.

## 10.3 Subsurface Drip Irrigation System Soil Sampling and Analysis

In 2017, the annual TLAP subsurface drip irrigation system soil samples were collected from four locations, Tract 101, Tract 201, Tract 301, and Tract 401, with each tract representing 100 acres. 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 acres 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 0-12 and 12-24 inches for analysis and reporting (Figure 10.2). These composite samples were analyzed for agricultural parameters, reactivity, two high explosives, and one semi-volatile organic compound (SVOC). See the TLAP Soil column in Appendix A for specific analytes.

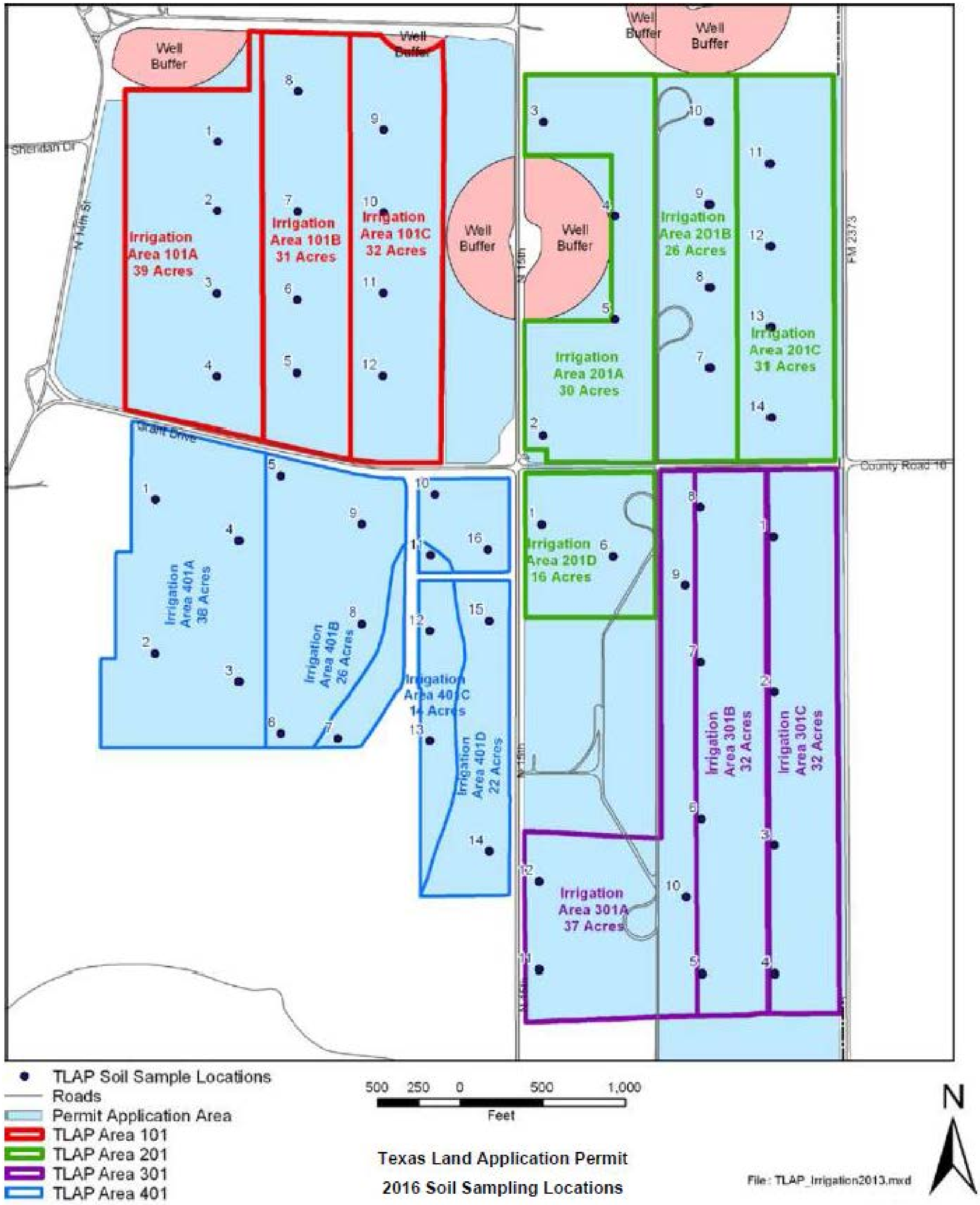


**Figure 10.2 – TLAP Soil Sampling Locations for 2017**

### 10.3.1 Subsurface Drip Irrigation System Soil Sampling Results

The 2017 subsurface soil sampling results for high explosives, reactivity, and the one 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. The TLAP subsurface soil sampling results are reported annually to the TCEQ as report only information, with no comparison values. The agricultural parameters are also used for decision making regarding the addition of nutrient amendments to the agricultural soils.

**Table 10.6 – 2017 TLAP Soil Results from Tract 101**

| Analyte (Agricultural Parameters) | Tract 101A Measured Value | | Tract 101B Measured Value | | Tract 101C Measured Value | | Unit of Measurement |
|---|---|---|---|---|---|---|---|
| | Depth (Inches) | | Depth (Inches) | | Depth (Inches) | | |
| | 12 | 24 | 12 | 24 | 12 | 24 | |
| pH (2:1 ratio soil pH) | 7.7 | 8.3 | 7.8 | 8.3 | 7.8 | | pH Units |
| Total Nitrogen | 937 | 593.4 | 902.4 | 601.9 | 1105 | | mg/kg |
| Nitrate (as Nitrogen) | 7 | 3.4 | 2.4 | 1.9 | 5 | | mg/kg |
| Total Kjeldahl Nitrogen | 930 | 590 | 900 | 600 | 1100 | | mg/kg |
| Ortho Phosphate (Plant-available) | 15 | 5 | 11 | 3 | 23 | | mg/kg |
| Calcium (Plant-available) | 3013 | 6115 | 3390 | 6677 | 3421 | | mg/kg |
| Magnesium (Plant-available) | 689 | 800 | 758 | 888 | 679 | | mg/kg |
| Sodium (Plant-available) | 148 | 175 | 176 | 212 | 144 | | mg/kg |
| Sodium Absorption Ratio (SAR) | 1.6 | 1.8 | 1.8 | 1.9 | 1.6 | | Percent |
| Potassium (Plant-available) | 480 | 500 | 894 | 544 | 573 | | mg/kg |
| Conductivity (Sat Paste ECe) | 0.58 | 0.45 | 0.54 | 0.44 | 0.64 | | µmho/cm |
| Calcium (Water-soluble) | 50 | 40 | 47 | 42 | 61 | | mg/L |
| Magnesium (Water-soluble) | 13 | 7 | 11 | 11 | 14 | | mg/L |
| Sodium (Water-soluble) | 49 | 47 | 53 | 55 | 53 | | mg/L |
| Sulfur (Plant-available) | 13 | 13 | 14 | 13 | 14 | | mg/kg |

**Table 10.7 – 2017 TLAP Soil Results from 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 (Inches) | | Depth (Inches) | | Depth (Inches) | | Depth (Inches) | | |
| | 12 | 24 | 12 | 24 | 12 | 24 | 12 | 24 | |
| pH (2:1 ratio soil pH) | 8 | 8.4 | 8 | 8.3 | 7.7 | 8.3 | 7.8 | 8.3 | pH Units |
| Total Nitrogen | 791.7 | 441.7 | 681.6 | 552 | 881.7 | 582.3 | 872.1 | 611.6 | mg/kg |
| Nitrate (as Nitrogen) | 1.7 | 1.7 | 1.6 | 2 | 1.7 | 2.3 | 2.1 | 1.6 | mg/kg |

| Analyte (Agricultural Parameters) | Tract 201A Measured Value | | Tract 201B Measured Value | | Tract 201C Measured Value | | Tract 201D Measured Value | | Unit of Measurement |
|---|---|---|---|---|---|---|---|---|---|
| | Depth (Inches) | | Depth (Inches) | | Depth (Inches) | | Depth (Inches) | | |
| | 12 | 24 | 12 | 24 | 12 | 24 | 12 | 24 | |
| Total Kjeldahl Nitrogen | 790 | 440 | 680 | 550 | 880 | 580 | 870 | 610 | mg/kg |
| Ortho Phosphate (Plant-available) | 18 | 4 | 12 | 5 | 18 | 4 | 14 | 4 | mg/kg |
| Calcium (Plant-available) | 3809 | 7999 | 4276 | 7918 | 3030 | 6907 | 3447 | 6645 | mg/kg |
| Magnesium (Plant-available) | 822 | 969 | 776 | 953 | 722 | 847 | 760 | 846 | mg/kg |
| Sodium (Plant-available) | 186 | 215 | 178 | 216 | 172 | 205 | 179 | 184 | mg/kg |
| Sodium Absorption Ratio (SAR) | 2.1 | 2.1 | 1.9 | 2 | 1.8 | 2.1 | 1.6 | 1.8 | Percent |
| Potassium (Plant-available) | 503 | 360 | 567 | 381 | 532 | 346 | 411 | 327 | mg/kg |
| Conductivity (Sat Paste ECe) | 0.69 | 0.51 | 0.66 | 0.56 | 0.68 | 0.59 | 0.87 | 0.46 | µmho/cm |
| Calcium (Water-soluble) | 71 | 37 | 53 | 37 | 55 | 42 | 62 | 30 | mg/L |
| Magnesium (Water-soluble) | 20 | 11 | 17 | 14 | 14 | 13 | 17 | 12 | mg/L |
| Sodium (Water-soluble) | 79 | 56 | 62 | 55 | 60 | 62 | 56 | 47 | mg/L |
| Sulfur (Plant-available) | 16 | 15 | 18 | 15 | 14 | 15 | 15 | 13 | mg/kg |

**Table 10.8 – 2017 TLAP Soil Results from Tract 301**

| Analyte (Agricultural Parameters) | Tract 301A Measured Value | | Tract 301B Measured Value | | Tract 301C Measured Value | | Unit of Measurement |
|---|---|---|---|---|---|---|---|
| | Depth (Inches) | | Depth (Inches) | | Depth (Inches) | | |
| | 12 | 24 | 12 | 24 | 12 | 24 | |
| pH (2:1 ratio soil pH) | 7.6 | 8.3 | 7.9 | 8.2 | 7.9 | 8.2 | pH Units |
| Total Nitrogen | 952.6 | 571.3 | 902.2 | 731.6 | 902.4 | 681.8 | mg/kg |
| Nitrate (as Nitrogen) | 2.6 | 1.3 | 2.2 | 1.6 | 2.4 | 1.8 | mg/kg |
| Total Kjeldahl Nitrogen | 950 | 570 | 900 | 730 | 900 | 680 | mg/kg |
| Ortho Phosphate (Plant-available) | 25 | 5 | 12 | 5 | 15 | 5 | mg/kg |
| Calcium (Plant-available) | 2743 | 6038 | 3664 | 6611 | 3983 | 6024 | mg/kg |
| Magnesium (Plant-available) | 774 | 884 | 813 | 888 | 953 | 1014 | mg/kg |

| Analyte (Agricultural Parameters) | Tract 301A Measured Value | | Tract 301B Measured Value | | Tract 301C Measured Value | | Unit of Measurement |
|---|---|---|---|---|---|---|---|
| | Depth (Inches) | | Depth (Inches) | | Depth (Inches) | | |
| | 12 | 24 | 12 | 24 | 12 | 24 | |
| Sodium (Plant-available) | 177 | 203 | 183 | 196 | 158 | 194 | mg/kg |
| Sodium Absorption Ratio (SAR) | 0.50 | 2.3 | 2.4 | 2 | 1.6 | 1.9 | Percent |
| Potassium (Plant-available) | 542 | 269 | 454 | 541 | 460 | 407 | mg/kg |
| Conductivity (Sat Paste ECe) | 0.54 | 0.56 | 0.71 | 0.50 | 0.56 | 0.51 | µmho/cm |
| Calcium (Water-soluble) | 2 | 41 | 61 | 41 | 53 | 43 | mg/L |
| Magnesium (Water-soluble) | 0 | 12 | 15 | 9 | 15 | 12 | mg/L |
| Sodium (Water-soluble) | 3 | 64 | 81 | 56 | 50 | 54 | mg/L |
| Sulfur (Plant-available) | 13 | 14 | 16 | 17 | 17 | 15 | mg/kg |

**Table 10.9 – 2017 TLAP Soil Results from 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 (Inches) | | Depth (Inches) | | Depth (Inches) | | Depth (Inches) | | |
| | 12 | 24 | 12 | 24 | 12 | 24 | 12 | 24 | |
| pH (2:1 ratio soil pH) | 7.7 | 8.3 | 7.8 | 8.4 | 8 | 8.1 | 7.9 | 8.3 | pH Units |
| Total Nitrogen | 812 | 531.5 | 961. | 571.5 | 811.7 | 601.8 | 871.9 | 541.7 | mg/kg |
| Nitrate (as Nitrogen) | 2 | 1.5 | 1.5 | 1.5 | 1.7 | 1.8 | 1.9 | 1.7 | mg/kg |
| Total Kjeldahl Nitrogen | 810 | 530 | 960 | 570 | 810 | 600 | 870 | 540 | mg/kg |
| Ortho Phosphate (Plant-available) | 12 | 5 | 11 | 3 | 26 | 11 | 8 | 5 | mg/kg |
| Calcium (Plant-available) | 2572 | 6389 | 3852 | 8825 | 4138 | 5002 | 3804 | 7390 | mg/kg |
| Magnesium (Plant-available) | 701 | 863 | 610 | 771 | 537 | 719 | 798 | 930 | mg/kg |
| Sodium (Plant-available) | 132 | 167 | 102 | 131 | 106 | 139 | 140 | 149 | mg/kg |
| Sodium Absorption Ratio (SAR) | 1.5 | 1.7 | 1.1 | 1.3 | 1.1 | 1.3 | 1.3 | 1.3 | Percent |
| Potassium (Plant-available) | 468 | 368 | 386 | 292 | 564 | 398 | 443 | 387 | mg/kg |
| Conductivity (Sat Paste ECe) | 0.49 | 0.57 | 0.56 | 0.54 | 0.68 | 0.77 | 0.56 | 0.52 | µmho/cm |
| Calcium (Water-soluble) | 34 | 43 | 56 | 57 | 78 | 76 | 53 | 48 | mg/L |
| Magnesium (Water-soluble) | 14 | 13 | 13 | 12 | 15 | 15 | 13 | 12 | mg/L |

| Analyte (Agricultural Parameters) | Tract 401A Measured Value | | Tract 401B Measured Value | | Tract 401C Measured Value | | Tract 401D Measured Value | | Unit of Measurement |
|---|---|---|---|---|---|---|---|---|---|
| | Depth (Inches) | | Depth (Inches) | | Depth (Inches) | | Depth (Inches) | | |
| | 12 | 24 | 12 | 24 | 12 | 24 | 12 | 24 | |
| Sodium (Water-soluble) | 41 | 51 | 35 | 40 | 42 | 48 | 41 | 40 | mg/L |
| Sulfur (Plant-available) | 12 | 13 | 16 | 13 | 17 | 20 | 16 | 16 | mg/kg |

## 10.4 Conclusions

On-site Burning Ground surface soil monitoring results for 2017 were within the concentration ranges of the established background levels. Results of soil monitoring conducted at the subsurface irrigation for 2017 were consistent with previous year's results and indicate operations are having no negative impact to the environment.

# Chapter 11 – Fauna

*Radionuclide concentrations in faunal samples (black-tailed prairie dogs and cottontail rabbits) were compared to historical values and values observed in samples from control locations. Comparisons indicated no detrimental impacts from Plant operations in 2017.*

## 11.1 The Scope of the Program

Faunal surveillance is complementary to air, flora, 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.

## 11.2 Radiological Surveillance in Fauna

Radionuclide surveillance of fauna at Pantex was scheduled semi-annually at nine on-site locations and one control location. They were the Burning Ground, Firing Site 4 (FS-4), Zone 4, Zone 12 South, northwest of Building 12-36, west of Zone 4, Playa 2, Playa 3, Zone 8, and a control site, Buffalo Lake National Wildlife Refuge (BLNWR) near Umbarger, Texas (Randall County). BLNWR was chosen as the control site because populations there are far enough from the Pantex Plant (66 km/41 mi) to be unaffected by Plant operations, and more so than on private lands, affords a dependable availability of prairie dogs, cottontails, and property access. Like in the previous year, prairie dogs were only available west of Zone 4, in Zone 8, near Playa 2, and at BLNWR in 2017. Cottontails were secured from Zone 4, Zone 12 South and BLNWR.

Sample animals are live-trapped, euthanized, and shipped to the analytical lab. Whole-body composites are prepared for determination of tritium, uranium$^{233/234}$ ($^{233/234}U$), and uranium$^{238}$ ($^{238}U$) levels. These analytes are associated with Pantex activities, but are also naturally occurring in Pantex soils.

Analytical results of the 2017 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). Fifteen prairie dogs and six cottontails were sampled during 2017. Results for prairie dogs and cottontails were similar to or less than historic data. Results for prairie dogs were all below minimal detection activity (MDA), as were most of the cottontails (94.4%).

## 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 and indicated no detrimental impacts from Plant operations in 2017.

**Table 11.1 – Tritium, $^{233/234}$U, and $^{238}$U in Prairie Dogs in 2017, 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) | 4 (4) | 0.281 ± 0.690 | 0.130 ± 0.631 | 0.205 ± 0.064 | 10 | 0.012 ± 0.279 |
| Zone 8 | 4 (4) | 0.604 ± 0.410 | -0.243 ± 0.638 | 0.169 ± 0.350 | 14 | 0.017 ± 0.065 |
| Playa 2 | 4 (4) | 0.587 ± 0.414 | -0.281 ± 0.639 | 0.127 ± 0.360 | 14 | 0.055 ± 0.136 |
| Burning Ground | -- | -- | -- | -- | 11 | 0.152 ± 0.300 |
| Playa 3 | -- | -- | -- | -- | 14 | 0.019 ± 0.070 |
| FS-4 | -- | -- | -- | -- | 8 | 0.313 ± 0.321 |
| 12-36 | -- | -- | -- | -- | 10 | -0.065 ± 0.365 |
| Buffalo Lake[f] | 3 (3) | 0.227 ± 0.377 | -0.315 ± 0.640 | 0.022 ± 0.294 | 14 | 0.015 ± 0.055 |
| **$^{233/234}$Uranium** | | | | | | |
| Zone 4 (W) | 4 (4) | 0.016 ± 0.011 | 0.006 ± 0.007 | 0.013 ± 0.005 | 10 | 0.018 ± 0.011 |
| Zone 8 | 4 (4) | 0.020 ± 0.011 | 0.008 ± 0.008 | 0.014 ± 0.005 | 11 | 0.012 ± 0.019 |
| Playa 2 | 4 (4) | 0.029± 0.013 | 0.012 ± 0.010 | 0.019 ± 0.007 | 11 | 0.013 ± 0.022 |
| Burning Ground | -- | -- | -- | -- | 9 | 0.018 ±0.040 |
| Playa 3 | -- | -- | -- | -- | 11 | 0.020 ±0.022 |
| FS-4 | -- | -- | -- | -- | 8 | 0.017 ± 0.018 |
| 12-36 | -- | -- | -- | -- | 10 | 0.021 ± 0.025 |
| Buffalo Lake | 3 (3) | 0.023 ± 0.010 | 0.008 ± 0.009 | 0.018 ± 0.009 | 11 | 0.017 ± 0.025 |
| **$^{238}$Uranium** | | | | | | |
| Zone 4 (W) | 4 (4) | 0.011 ± 0.010 | 0.003 ± 0.010 | 0.006 ± 0.004 | 10 | 0.012 ± 0.008 |
| Zone 8 | 4 (4) | 0.017 ± 0.009 | 0.008 ± 0.008 | 0.013 ± 0.005 | 11 | 0.010 ± 0.021 |
| Playa 2 | 4 (4) | 0.016 ± 0.008 | 0.006 ± 0.007 | 0.011± 0.005 | 11 | 0.009 ± 0.009 |
| Burning Ground | -- | -- | -- | -- | 9 | 0.013 ± 0.026 |
| Playa 3 | -- | -- | -- | -- | 11 | 0.011 ± 0.015 |
| FS-4 | -- | -- | -- | -- | 8 | 0.012 ± 0.015 |
| 12-36 | -- | -- | -- | -- | 10 | 0.009 ± 0.006 |
| Buffalo Lake | 3 (3) | 0.020 ± 0.009 | 0.007 ± 0.009 | 0.011 ± 0.008 | 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 is the “error.”
b Standard deviation. (see definition in glossary.)
c Historical data period for Zone 4 (W), FS-4 and 12-36 is 2007-2010 due to these being newer sampling areas.
d Prairie dogs unavailable.
e Negative values indicate results below the (statistically determined) background level for the counting system used at the analytical laboratory.
f Control site.

**Table 11.2 – Tritium, $^{233/234}U$, and $^{238}U$ in Cottontail Rabbits in 2017 in pCi/g Dry Weight**

| Location | No. of Samples (# ≤ MDA) | Maximum[a] | Minimum[a] | Mean ± Std.[b] | No. of Samples 2007-2010[c] | 2007-2010 Mean ± Std. |
|---|---|---|---|---|---|---|
| **Tritium** | | | | | | |
| Zone 4 | 2 (2) | -0.161 ± 0.652 | -0.232 ± 0.651 | -0.197 ± 0.050 | 12 | 0.087 ± 0.274 |
| Zone 12 South | 2 (2) | 0.171 ± 0.606 | -0.435 ± 0.633 | -0.132 ± 0.429 | 13 | 0.346 ± 0.397 |
| Buffalo Lake[d] | 2 (2) | 0.338 ± 0.660 | 0.059 ± 0.352 | 0.198 ± 0.197 | 10 | 0.175 ± 0.260 |
| **$^{233/234}$Uranium** | | | | | | |
| Zone 4 | 2 (2) | 0.014 ± 0.009 | 0.006 ± 0.009 | 0.010 ± 0.006 | 12 | 0.014 ± 0.013 |
| Zone 12 South | 2 (2) | 0.009 ± 0.007 | 0.008 ± 0.007 | 0.009 ± 0.001 | 13 | 0.012 ± 0.008 |
| Buffalo Lake | 2 (2) | 0.019 ± 0.009 | 0.009 ± 0.011 | 0.014 ± 0.007 | 10 | 0.042 ± 0.031 |
| **$^{238}$Uranium** | | | | | | |
| Zone 4 | 2 (2) | 0.006 ± 0.006 | 0.005 ± 0.006 | 0.006 ± 0.001 | 12 | 0.009 ± 0.011 |
| Zone 12 South | 2 (2) | 0.007 ± 0.007 | 0.006 ± 0.006 | 0.006 ± 0.001 | 13 | 0.005 ± 0.005 |
| Buffalo Lake | 2 (1) | 0.021 ± 0.009 | 0.012 ± 0.008 | 0.016 ± 0.006 | 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. (See definition in Glossary.)
[c] Sampling of rabbits began in 2007; thus historical data is based on these years.
[d] Control location.

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# Chapter 12 – Flora

*Radionuclide concentrations in vegetation samples, which included both native vegetation and crops from on-site and off-site locations, were compared to historical values and values observed in samples from control locations. These comparisons indicated no adverse impacts from Plant operations in 2017.*

## 12.1 The Scope of the Program

Flora surveillance is complementary to air, fauna, and surface water monitoring in assessing potential short- and long-term effects of operations at the Pantex Plant on the environment. Radionuclide analyses were performed on both native vegetation and crops. Native vegetation species on the southern High Plains consist primarily of prairie grasses and forbs. Crops are defined as any agricultural product harvested or gathered for animal or human food, including garden produce, forage, or fiber. 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 monitors potential impacts from current 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 8 kilometers (5 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 the Pantex Plant, ease of access, lack of industrial activity, and the presence of typical Southern High Plains vegetation.

Sampling locations are approximately 10-meter diameter circles 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$^{233/234}$ ($^{233/234}U$) and uranium$^{238}$ ($^{238}U$). Analytical data were corrected for moisture content and reported in pCi/g dry weight. The on-site and off-site data were compared to those from the control locations and six-year mean values, where possible, to identify and interpret differences. Although the DOE limits the dose to terrestrial plants to one rad/day (see Chapter 4), there are currently no limiting concentrations for tritium or uranium in vegetation.

### 12.2.1 Native Vegetation

Native vegetation samples, primarily consisting of stem and leaves from grasses and forbs were collected from one control, 11 on-site, and nine off-site locations. Samples were collected during the growing season, no more frequently than once per month in 2017. The presence of adequate vegetation for sampling in 2017 was not difficult due to normal conditions during the growing season.

Tritium results from 100 percent of on-site and off-site sample locations were at or below MDA levels. The mean results of tritium analyses at on-site and off-site locations were similar to the results at the control location OV-VS-20 (Figure 12.2) and the historical mean (calendar years 1997-2002).

Results from sampling events during the year starting in early May yielded similar or lower values for tritium than any of the results from the control location during the year and were also less than the historical mean results from the control location.

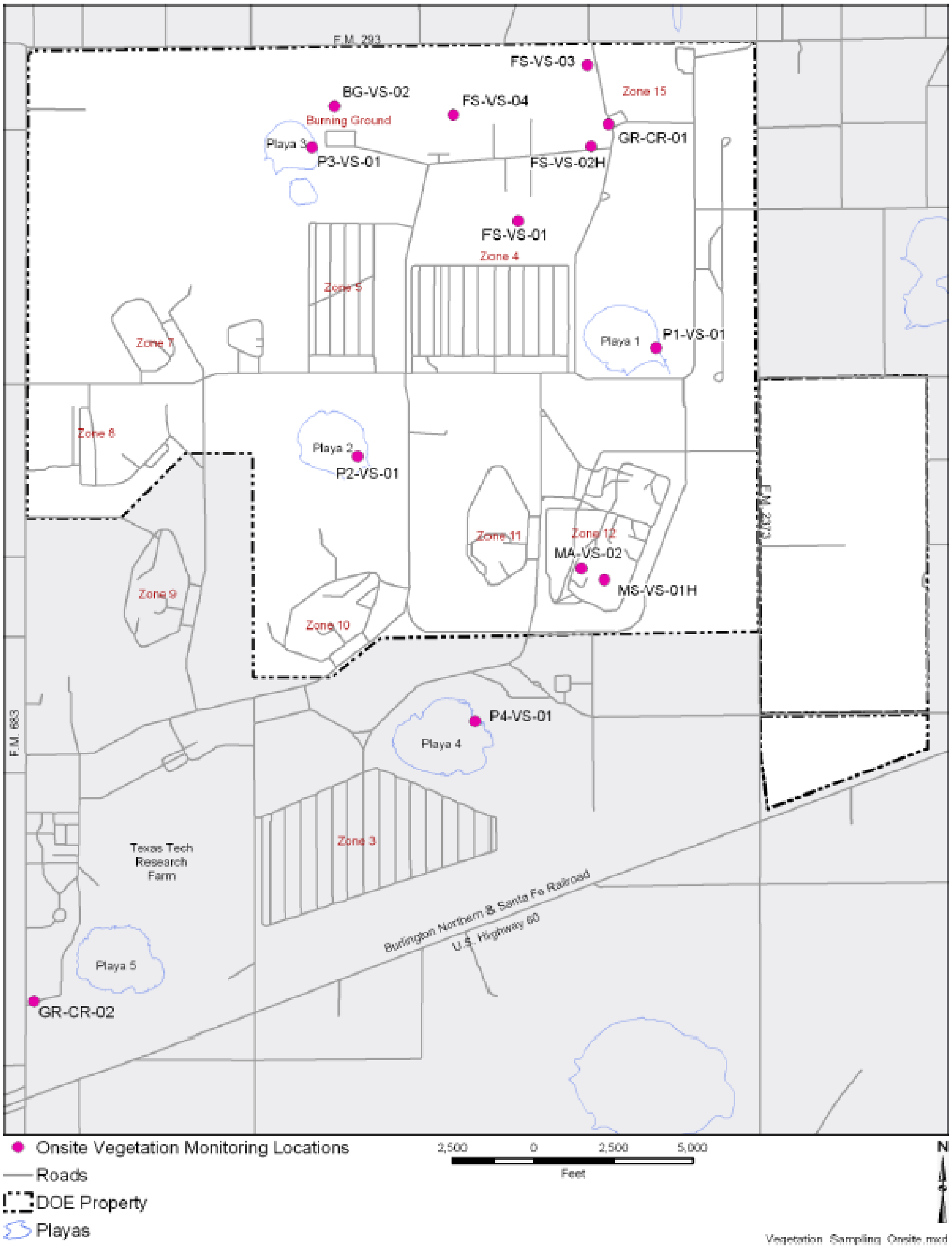


**Figure 12.1 – On-site Vegetation Monitoring Locations**

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.

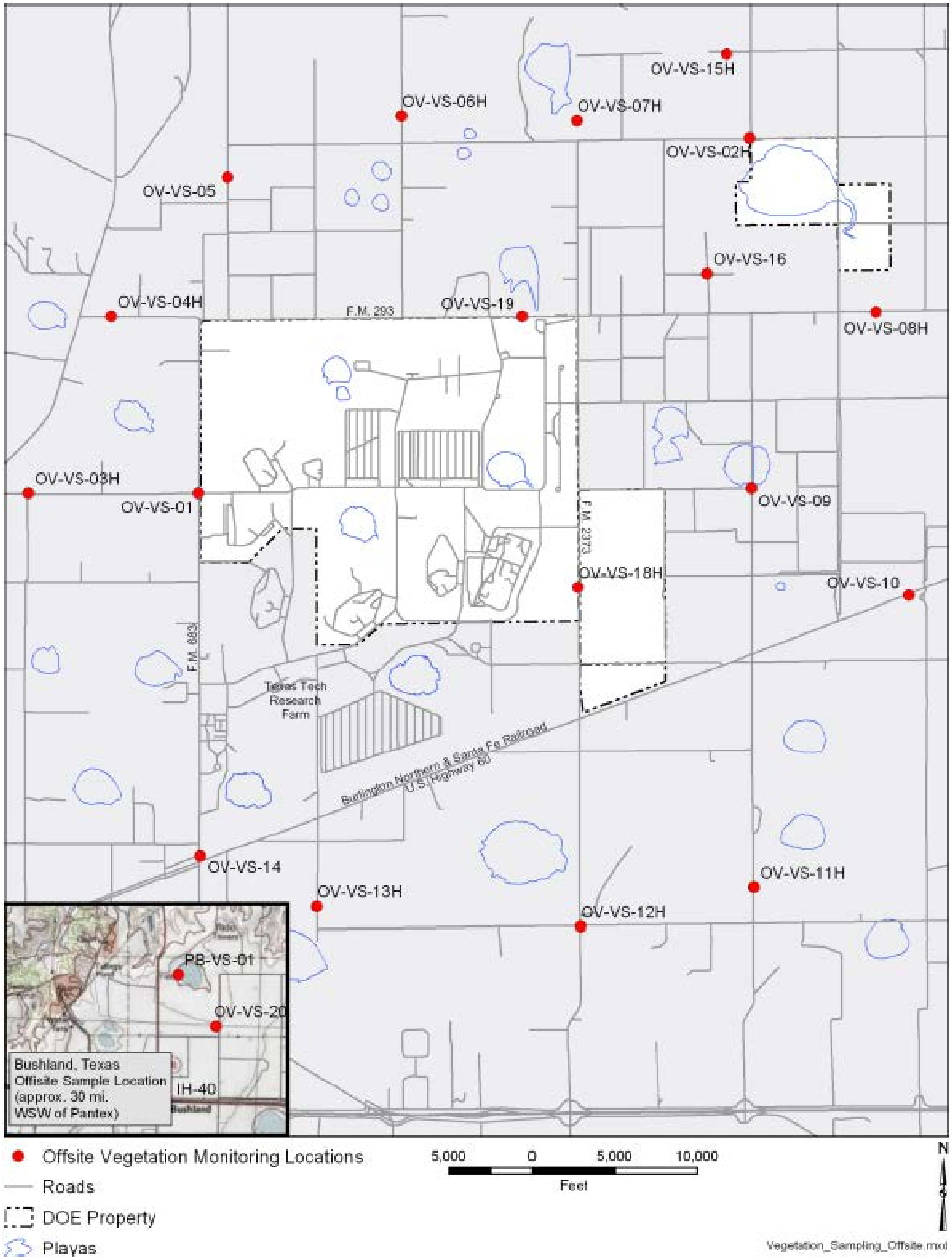


**Figure 12.2 – Off-site Vegetation Monitoring Locations**

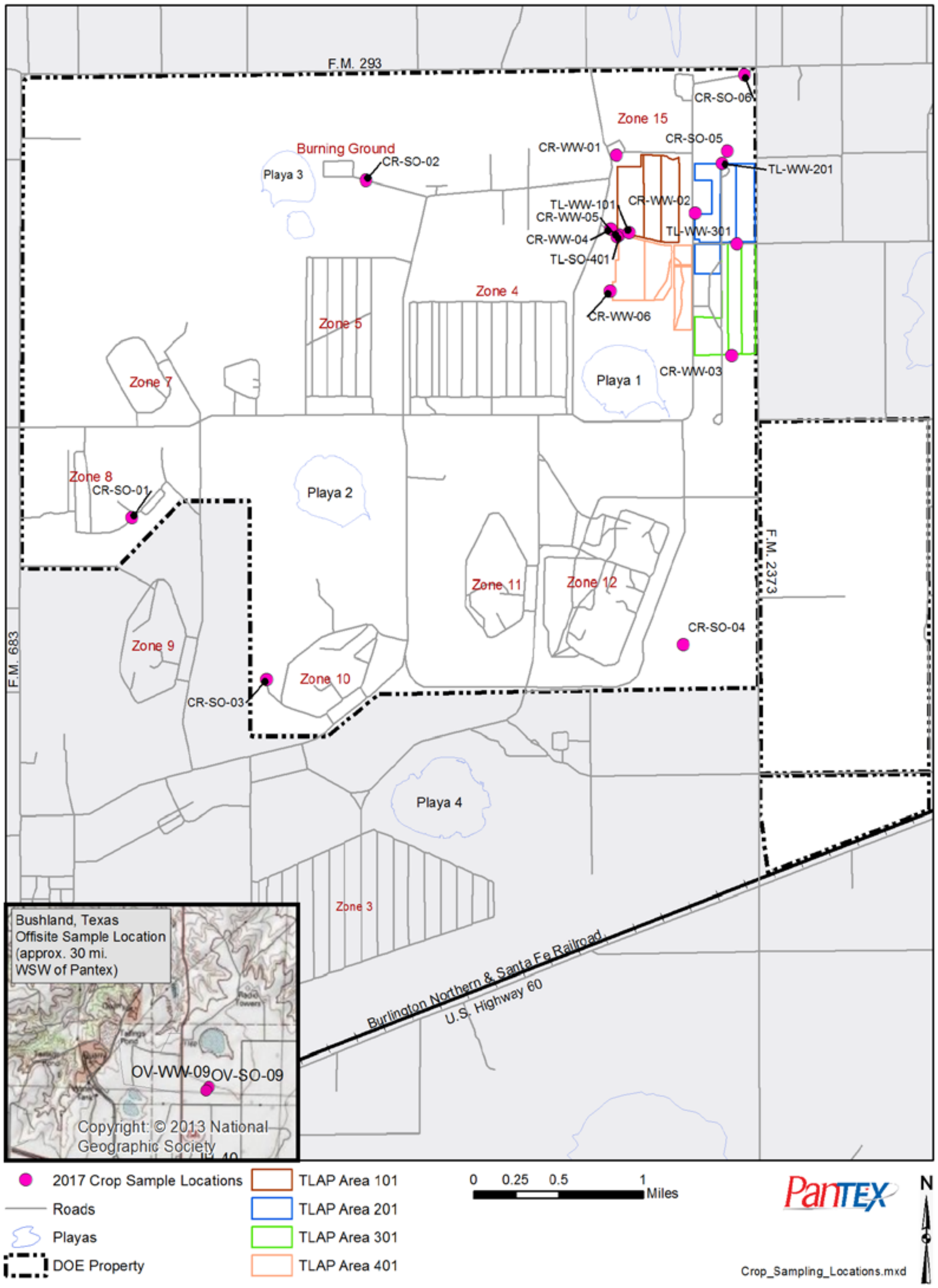


**Figure 12.3 – Crop Monitoring Locations for 2017**

The percentage of vegetation samples at or below the MDA level for $^{233/234}U$ and $^{238}U$ in all vegetation were 45 and 82 percent, respectively. The percentage for $^{238}U$ is higher than most years. 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 elevated, not all-time highs, and were comparable to the control location and historical data (Table 12.1). Results for all on-site and off-site locations were consistent with those found in previous years. Concentration of $^{233/234}U$ and $^{238}U$ in native vegetation indicates that no uptake of $^{233/234}U$ and $^{238}U$ into vascular plants has occurred.

**Table 12.1 – Native Vegetation Comparison of $^{233/234}U$ and $^{238}U$ – July 2017 and the Control Location**

| Sampling Location | $^{233/234}U$ pCi/g | $^{233/234}U$ Mean + 1 St. Dev. | $^{238}U$ pCi/g | $^{238}U$ Mean + 1 St. Dev. |
|---|---|---|---|---|
| OV-VS-01 | 0.31±0.05 | 0.120±0.165 | 0.06±0.02 | 0.029±0.025 |
| OV-VS-16 | 0.10±0.02 | 0.051±0.044 | 0.04±0.01 | 0.020±0.018 |
| OV-VS-20 (control) | 0.03±0.02 | 0.023±0.010 | 0.01±0.01 | 0.012±0.002 |

### 12.2.2 Crops

Crop surveillance enables evaluation of potential impacts from Plant operations on humans and livestock. Samples consisting of stems and leaves of dryland and irrigated winter wheat and irrigated grain sorghum were collected on-site and at the Bushland, Texas control locations.

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 property and one on the southwest side of the TTU property (Figure 12.1).

Six dryland and three irrigated winter wheat samples, along with a duplicate from on-site, were collected in April 2017, and one control sample was collected from the control site (Bushland, Texas). The majority of on-site winter wheat sampling locations were located on the east and north side of the Plant and on the TLAP area, with dryland grain sorghum sampling locations, south and east of the Burning Ground, and on the TLAP area (Figure 12.3). Six dryland and one irrigated grain sorghum samples, a control sample and duplicate from on-site were collected in July 2017. Fruits and leaves from garden plants were sampled in August 2017.

All crop and garden samples were analyzed for tritium, $^{233/234}U$ and $^{238}U$. All crop and garden produce analyses in 2017 with the exception of one (GR-CR-01) were at or below the MDA level for tritium, $^{233/234}U$, and $^{238}U$ and were comparable to the off-site control location (Table 12.2). Results for all crop and garden results were consistent with those found in previous years. Concentration of $^{233/234}U$ and $^{238}U$ in crop and garden vegetation indicates no uptake of $^{233/234}U$ and $^{238}U$ into vascular plants has occurred.

**Table 12.2 – Garden Produce Comparison of $^{233/234}U$ and $^{238}U$ – August 2017 and the Control Location**

| Sampling Location | $^{233/234}U$ pCi/g | $^{233/234}U$ Mean + 1 St. Dev. | $^{238}U$ pCi/g | $^{238}U$ Mean + 1 St. Dev. |
|---|---|---|---|---|
| GR-CR-01 | 0.15±0.03 | 0.083±0.060 | 0.09±0.02 | 0.043±0.044 |
| GR-CR-02 (control) | 0.050±0.02 | 0.039±0.015 | 0.02±0.01 | 0.021±0.023 |

## 12.3 Conclusions

Radionuclide concentrations in flora samples were comparable to values observed in samples from control locations or historical data and indicate no detrimental impacts from Plant operations in 2017.

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# Chapter 13 – Quality Assurance

*Pantex, because of its unique mission and service to our country, 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 maintain an unparalleled QA and quality control (QC) program that meets our need for high reliability. Of the 24,159 individual analytical results obtained during 2017, 99.54 percent were useable for making environmental decisions.*

## 13.1 The Scope of the Program

The 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 CERCLA ROD, TCEQ-issued environmental permits, DOE Order 414.1D Quality Assurance (DOEg), and ISO-2004 Environmental Management Systems – Requirements with Guidance for Use, 2004 (ISO, 2004). During 2017, the QA/QC program enhanced the reliability of data acquired for environmental monitoring, which includes air, soil, groundwater, surface water, flora, and fauna programs.

The ultimate goal of the Pantex environmental monitoring QA/QC program is to consistently generate reliable, high quality environmental monitoring data. One measure of success for this QA/QC program is the amount of useable environmental data based on technical acceptance criteria for chemical and radiochemical measurements. By providing consistently useable data, Pantex fosters a high degree of confidence for regulatory compliance and protection of human health and the environment with stakeholders. This approach also allowed Pantex 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 scientist or subject matter expert defined data collection requirements based on program needs and used guidance such as EPA QA/G4 Guidance for Data Quality Objective Process (EPAa), 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 includes sample location, sampling frequency, analytical method, and data acceptance criteria. During 2017, 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 relies on a robust quality system described in the Pantex Plant Environmental Monitoring Program Management and Quality Plan, QPLAN-0010 (PANTEXd). 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.

**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, documentation for laboratory procedures, such as run logs, data reduction, standard operating procedures (SOPs), condition and calibration of analytical instruments, and sample disposal.

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.

**Annual Review of all Operations**

An annual review of the sampling operations, administrative functions, and quality systems is conducted by Pantex 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.

**Recordkeeping**

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

### 13.3.1 Quality Plan Requirements for Subcontract Laboratories

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

Each subcontract laboratory must be qualified by Pantex prior to receiving samples for analysis. The prequalification process includes a review of the technical proposal submitted by the prospective laboratory, successful analysis of Performance Evaluation (PE) samples, and a systems audit performed by DOECAP, 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 performed by DOECAP. Their purpose is to ensure that all existing subcontract laboratories are qualified to provide high quality analytical laboratory services.

A Data Package Assessment is conducted annually at subcontract laboratories. In this type of assessment, random analytical deliverables are selected, and all the supporting documentation such as calibration records, method detection limits, and QA/QC reports are reviewed. The 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 (PANTEXm).

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 the 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.

Nonconformance reports are submitted by the laboratory if unacceptable PE results are reported. PE sample requirements may be waived for any analysis in which a suitable PE sample is not available. Sample shipments to a subcontract laboratory may be suspended if it is determined that the laboratory is not capable of meeting the analytical, quality assurance, and deliverable requirements of the SOW.

## 13.4 Laboratory Quality Assurance

During 2017, the Pantex Laboratory Quality Assurance Program (LQAP) continued to provide qualified laboratory auditors to participate in DOECAP. The primary function of DOECAP is to evaluate laboratory quality assurance systems and verify that they are effective. Pantex supports this resource-sharing approach to laboratory quality assurance.

During 2017, all Pantex requirements for the subcontract laboratories were met. All of the subcontract laboratories had the proper certifications for analyzing environmental samples from Pantex. They performed the necessary internal audits, and participated in the appropriate PE programs. Annual DOECAP audits were also conducted. 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 were:

- 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 quality control 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 contaminated the actual sample or the lab blank contained parameters of interest above a control limit, the associated sample results may be rejected.
- Other. This category includes, but is not limited to, the following:
    - Broken Chain-of-Custody (COC). There was a failure to maintain proper custody of samples, as documented on COC forms and laboratory sample log-in records.
    - Instrument Failure. Either the instrument failed to attain minimum method performance specifications or the instrument or a piece of equipment was not functioning.
    - Preservation Requirements. The requirements, as identified by the EPA or a specific method, were not met and/or properly documented.
    - Incorrect Test Method. The analysis was not performed according to a method contractually required by Pantex.
    - Incorrect or Inadequate Detection or Reporting Limit. The laboratory is required to attain specific levels of sensitivity when reporting target analytes, unless matrix effects prevent adequate detection and quantitation of the compound of interest.

The Pantex media scientist was alerted to any limitations in the use of the data, based on the DQO requirements. Of the 24,159 individual results obtained in 2017 from all laboratory analyses, 99.54 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 0.46 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 2017, Pantex 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 36 and 37, for all participating subcontract laboratories used by Pantex in 2017 (GEL and TestAmerica) are presented in Figure 13.2. Both subcontract laboratories had acceptable MAPEP results in 2017.

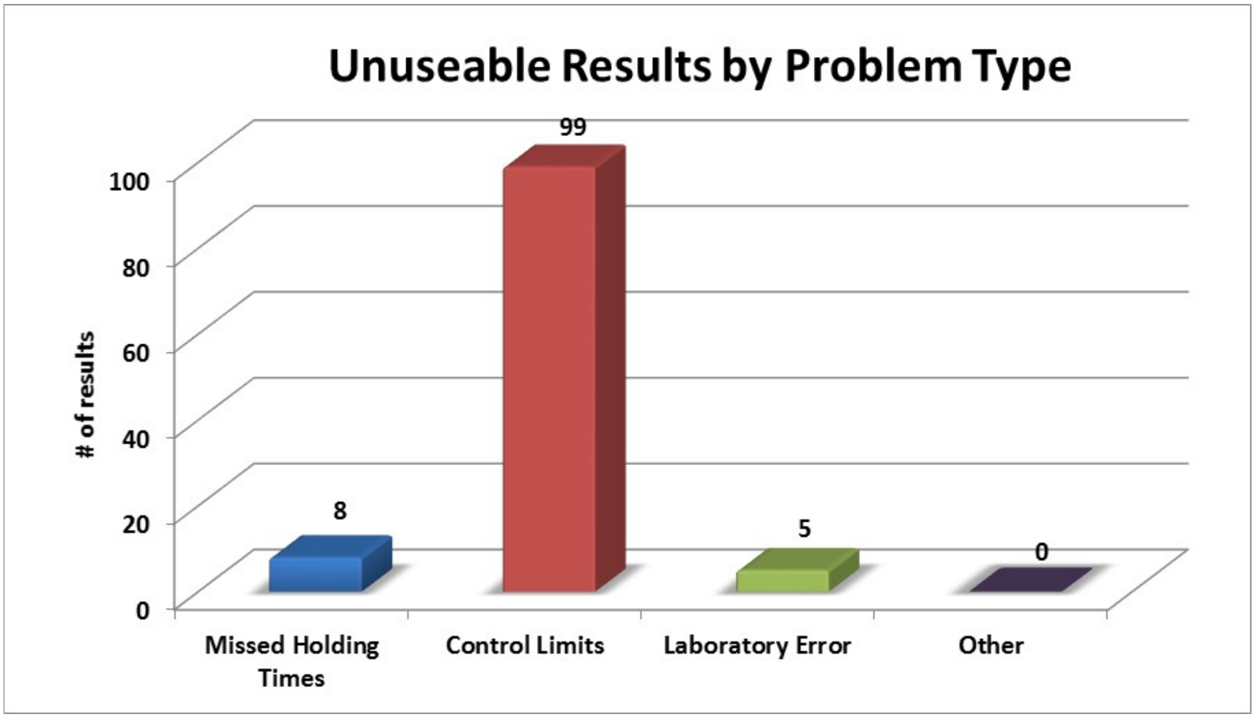


**Figure 13.1 – 2017 Data Rejection Summary**

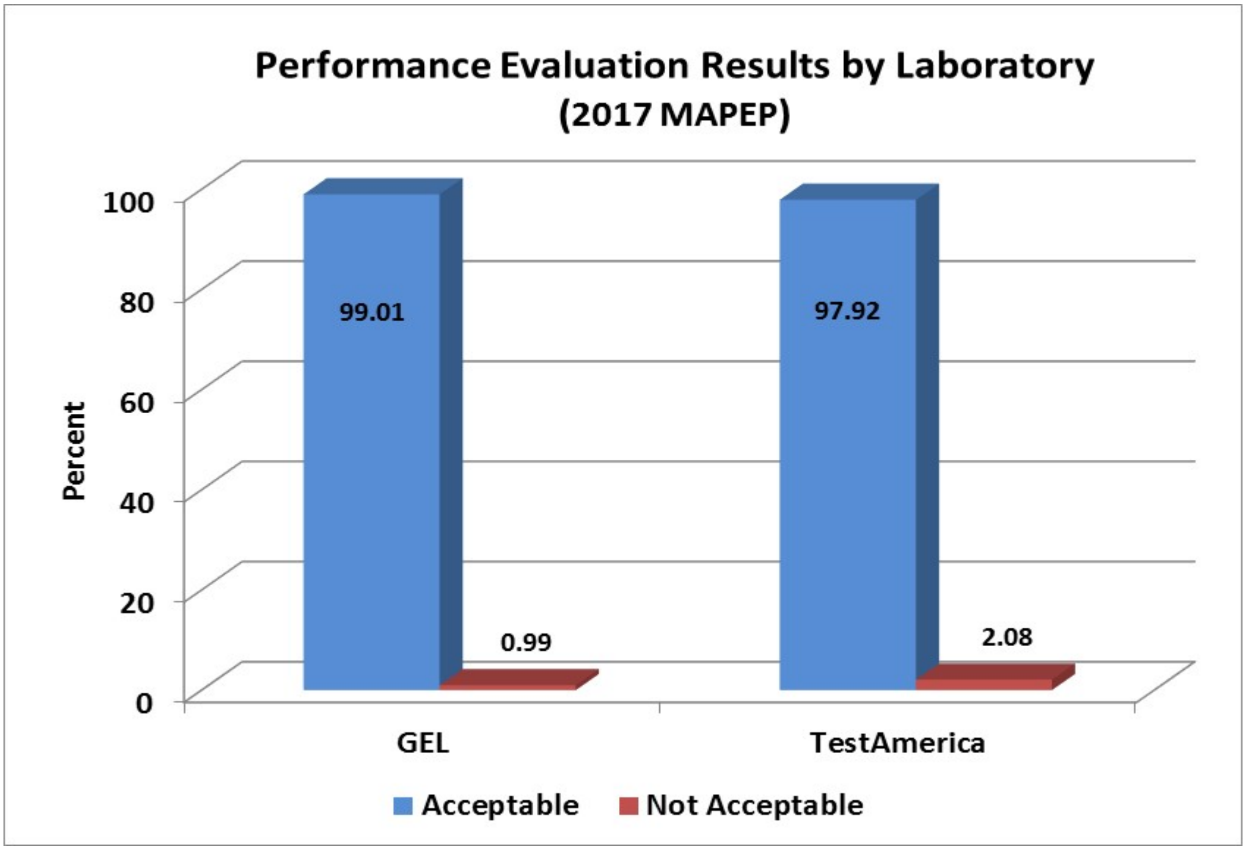


**Figure 13.2 – 2017 MAPEP Results**

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.

## 13.5 Field Operations Quality Assurance

Quality assurance 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 2017, Pantex continued to collect and analyze field duplicate and replicate samples. A true field duplicate sample set consists of a thoroughly homogenized sample collected from one desired location. The sample is split into two discrete samples and may even be labeled as representing two separate sampling locations. When the laboratory is not informed that the two samples are 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

$\sigma 95S$ = sample uncertainty (95 percent)

$\sigma 95R$ = 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 2017, the average RER value for vegetation data was 0.459 with an associated standard deviation of 0.351. The 2017 vegetation sample RER analysis indicated that field replicate sample precision accurately reflects the actual sample value. Figure 13.3 summarizes the RER data.

### 13.5.2 Blanks and Rinsates

During 2017, 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 detects found in sample values. The detects found were used to flag associated sample detects as "U" (undetected).

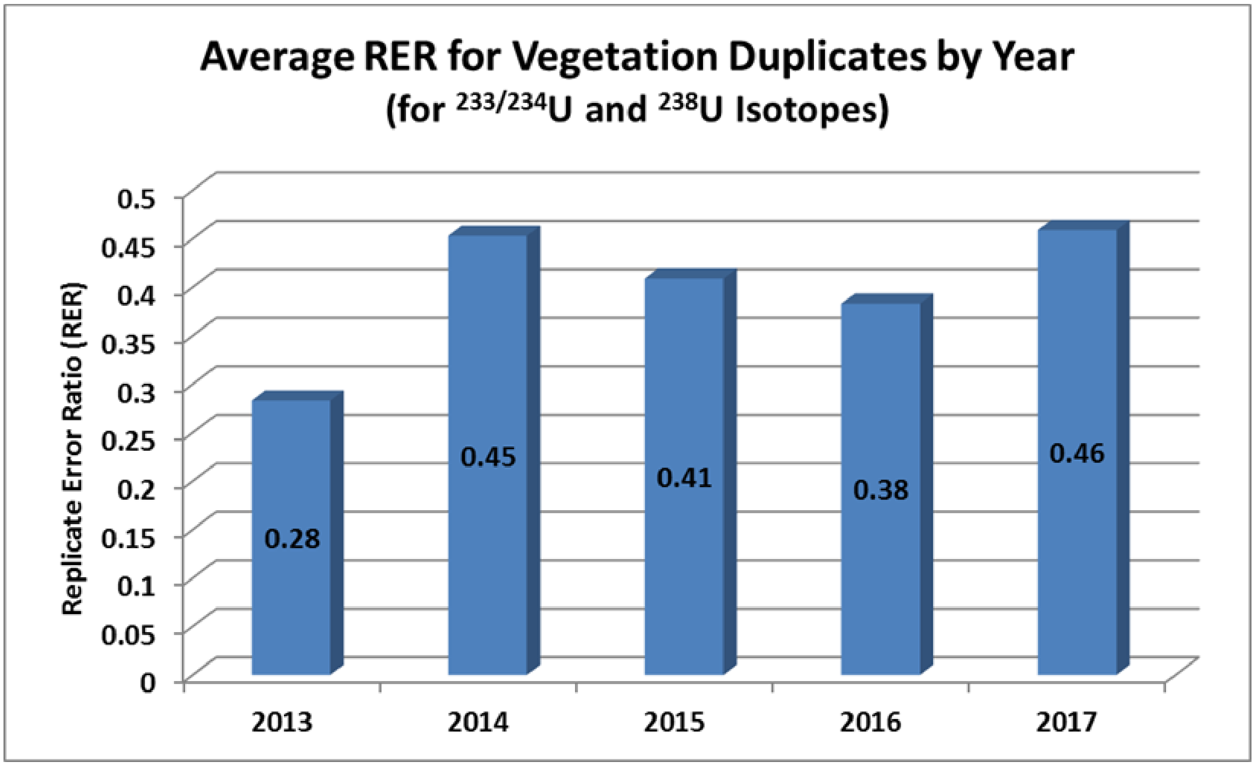


**Figure 13.3 – Five Year Average Replicate Error Ratio for Vegetation Duplicates**

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 trichloroethene and tetrachloroethylene were detected in trip blanks in 2017. These compounds are indicative of common laboratory solvents. The frequency of detection was 0.35 percent.

## 13.6 On-site Analytical Laboratories

A limited number of samples were analyzed on-site during 2017, using approved EPA or standard industry methods. On-site analyses included the following:

- Pantex Materials and Analytical Services Laboratory performed analysis of samples for alkalinity, nitrate, and hexavalent chromium.

The on-site laboratories followed an internal quality control 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 2017, the 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, quality control/assurance practices, and refinement of data quality objectives, 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 quality control 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 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 meeting all site and stakeholder requirements for quality and reliability.

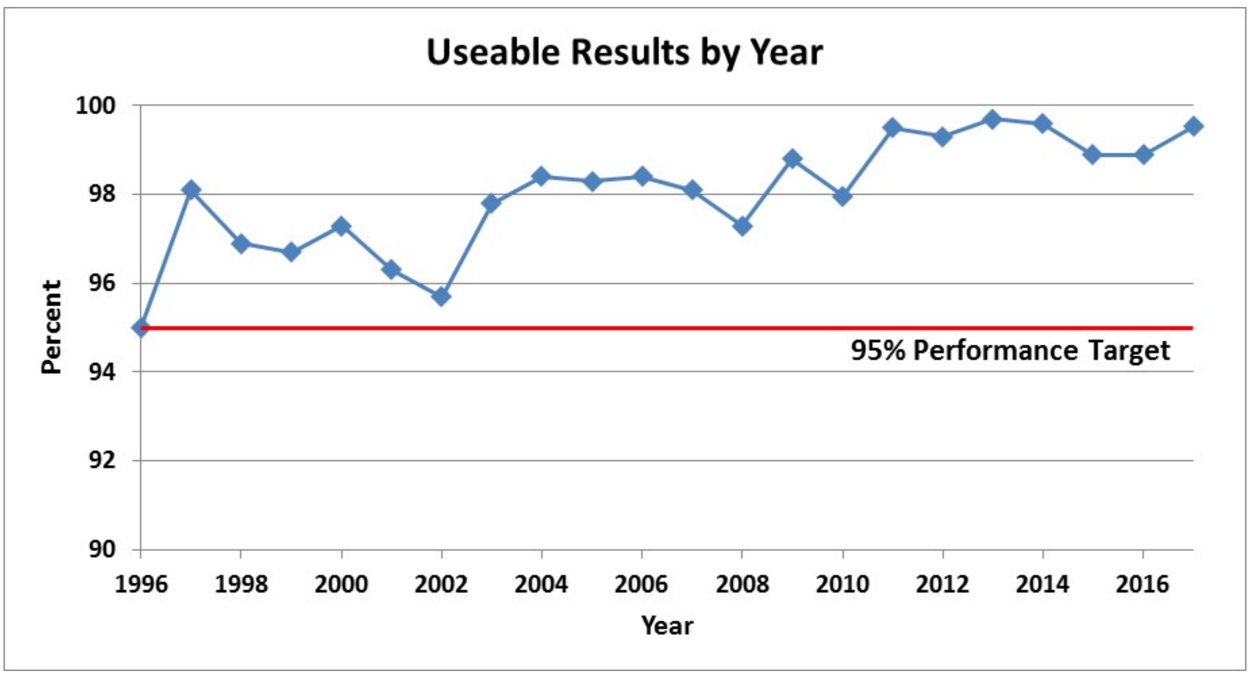


**Figure 13.4 – History of Useable Results Data**

## Appendix A – Analytes Monitored in 2017

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

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Calcium | 7440-70-2 | - | + | - | - | - | - | + [i] | - | - |
| Chromium | 7440-47-3 | - | + | + | + | - | + | - | - | - |
| Chromium (hexavalent) | 18540-29-9 | - | + | - | - | - | - | - | - | - |
| Cobalt | 7440-48-4 | - | - | - | + | - | + | - | - | - |
| Copper | 7440-50-8 | - | - | + | + | + | + | + [i] | - | - |
| Iron | 7439-89-6 | - | + | + | + | - | - | + [i] | - | - |
| 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 | - | - | + | + | - | + | - | - | - |
| Sodium | 7440-23-5 | - | - | + | - | - | - | + [i] | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 | - | + | - | + | + | + | - | - | - |
| Nitrobenzene | 98-95-3 | - | - | - | + | - | - | + | - | - |

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

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Atrazine | 1912-24-9 | - | - | + | - | - | - | - | - | - |
| Bromacil | 314-40-9 | - | - | + | - | - | - | - | - | - |
| Chlordane | 57-74-9 | - | - | + | - | - | - | - | - | - |
| Dieldrin | 60-57-1 | - | - | + | - | - | - | - | - | - |
| Endrin | 72-20-8 | - | - | + | - | - | - | - | - | - |
| Heptachlor | 76-44-8 | - | - | + | - | - | - | - | - | - |
| Heptachlor epoxide | 1024-57-3 | - | - | + | - | - | - | - | - | - |
| Lindane (gamma-BHC) | 58-89-9 | - | - | + | - | - | - | - | - | - |
| Methoxychlor | 72-43-5 | - | - | + | - | - | - | - | - | - |
| Methyl n,n-dimethyl-n-{(methlycarbamoyl)oxy}-1 | 23135-22-0 | - | - | + | - | - | - | - | - | - |
| s-Methyl-n-((Methylcarb amoyl)-oxy)-thioacetimidate | 16752-77-5 | - | - | + | - | - | - | - | - | - |
| Metribuzin | 21087-64-9 | - | - | + | - | - | - | - | - | - |
| Prometon | 1610-18-0 | - | - | + | - | - | - | - | - | - |
| Propachlor | 1918-16-7 | - | - | + | - | - | - | - | - | - |
| Sevin (carbaryl) | 63-25-2 | - | - | - | - | - | - | - | - | - |
| Simazine | 122-34-9 | - | - | + | - | - | - | - | - | - |
| **Herbicides** | | | | | | | | | | |
| 2,4-D | 94-75-7 | - | - | - | - | - | - | - | - | - |
| **Miscellaneous** | | | | | | | | | | |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | T-005 | - | + | - | - | - | - | - | - | - |
| Ammonia (as N) | 7664-41-7 | - | + | - | - | + | - | - | - | - |
| Biochemical oxygen demand | 10-26-3 | - | - | - | - | + | - | - | - | - |
| Bromide | 24959-67-9 | - | + | - | - | - | - | - | - | - |
| Chemical oxygen demand | C-004 | - | - | - | - | + | - | - | - | - |
| Chlorate | 14866-68-3 | - | - | - | - | - | - | - | - | - |
| Chloride | 16887-00-6 | - | + | - | - | - | - | - | - | - |
| Chlorine residual | 7782-50-5 | - | - | + | - | - | - | - | - | - |
| Color | M-002 | - | - | - | - | - | - | - | - | - |
| Corrosivity | 10-37-7 | - | - | - | - | - | - | - | - | - |
| Cyanide, free | 10-71-9 | - | - | - | - | - | - | - | - | - |
| Cyanide, total | 57-12-5 | - | - | - | - | | - | - | - | - |
| Dissolved Organic Carbon | 11-59-6 | - | + | - | - | - | - | - | - | - |
| Dissolved Oxygen | NA | - | + | - | - | - | - | - | - | - |
| Electrical Conductivity-Paste | NA | - | - | - | - | - | - | +[i] | - | - |
| Fluoride | 7782-41-4 | - | + | - | - | - | - | - | - | - |
| Foaming agents (surfactants) | NA | - | - | - | - | - | - | - | - | - |
| Ignitability | NA | - | - | - | - | - | - | + | - | - |
| Nitrate (as N) | 14797-55-8 | - | + | + | - | - | - | + | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrate/nitrite (as N) | 1-005 | - | - | - | - | + | - | - | - | - |
| Nitrite (as N) | 14797-65-0 | - | - | | - | - | - | - | - | - |
| Oil and grease | 10-30-0 | - | - | - | - | + | - | - | - | - |
| Ortho Phosphate | 14265-44-2 | - | - | - | - | - | - | + [i] | - | - |
| Oxidation – Reduction Potential | | | + | - | - | - | | | | |
| Perchlorate | 14797-73-0 | - | + | - | - | - | - | - | - | - |
| pH | 10-29-7 | - | + | + | + | + | - | - | - | - |
| pH (1:1 ratio soil pH) | NA | - | - | - | - | - | - | + [i] | - | - |
| pH (2:1 ratio soil pH) | NA | - | - | - | - | - | - | + [i] | - | - |
| Phosphorus, Total (As P) | 7723-14-0 | - | + | - | - | - | - | - | - | - |
| Reactivity | NA | - | - | - | - | - | - | + | - | - |
| Sodium Adsorption Ratio | NA | - | - | - | - | - | - | + [i] | - | - |
| Specific conductance | 10-34-4 | - | - | - | - | - | - | - | - | - |
| Sulfate | 14808-79-8 | - | + | - | - | - | - | - | - | - |
| Sulfide | 18496-25-8 | - | + | - | - | - | - | - | - | - |
| Sulfur | NA | - | - | - | - | - | - | + [i] | - | - |
| Temperature | NA | - | + | + | + | + | - | - | - | - |
| Total dissolved solids | 10-33-3 | - | + | - | - | - | - | - | - | - |
| Total hardness (as $CaCO_3$) | 11-02-9 | - | - | + | - | - | - | - | - | - |
| Total Kjeldahl Nitrogen | NA | - | - | - | - | - | - | + [i] | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Nitrogen | NA | - | + | - | - | - | - | + [i] | - | - |
| Total organic carbon | C-012 | - | + | - | - | - | - | - | - | - |
| Total petroleum hydrocarbons | 10-90-2 | - | - | - | + | - | - | - | - | - |
| Turbidity | G-019 | - | + | - | - | - | - | - | - | - |
| **Volatile Organics** | | | | | | | | | | |
| 1,1,1,2-tetrachloroethane | 630-20-6 | - | - | + | + | - | - | - | - | - |
| 1,1,2,2-tetrachloroethane | 79-34-5 | - | - | + | + | - | - | - | - | - |
| 1,1,1-trichloroethane | 71-55-6 | - | - | + | + | - | - | - | - | - |
| 1,1,2-trichloroethane | 79-00-5 | - | - | + | + | - | - | - | - | - |
| 1,2,3-tricholorobenzene | 87-61-6 | - | - | + | - | - | - | - | - | - |
| 1,2,3-trichloropropane | 96-18-4 | - | - | + | + | - | - | - | - | - |
| 1,2,4-trimethylbenzene | 95-63-6 | - | - | + | - | - | - | - | - | - |
| 1,3,5-trimethylbenzene | 108-67-8 | - | - | + | - | - | - | - | - | - |
| 1,1-dichloroethane | 75-34-3 | - | - | + | + | - | - | - | - | - |
| 1,1-dichloroethene | 75-35-4 | - | - | + | + | - | - | - | - | - |
| 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 | - | - | + | + | - | - | - | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| 1,2-dichloroethane | 107-06-2 | - | + | + | + | - | - | - | - | - |
| 1,2-dichloroethene | 156-60-5 | - | - | - | + | - | - | - | - | - |
| *cis*-1,2-dichloroethene | 156-59-2 | - | + | + | + | - | - | - | - | - |
| *trans*-1,2-dichloroethene | | - | + | + | + | - | - | - | - | - |
| 1,2-dichloropropane | 78-87-5 | - | - | + | + | - | - | - | - | - |
| 1,3-dichlorobenzene | 541-73-1 | - | - | + | + | - | - | - | - | - |
| 1,3-dichloropropane | 142-28-9 | - | - | + | - | - | - | - | - | - |
| *cis*-1,3-dichloropropene | 10061-01-5 | - | - | + | + | - | - | - | - | - |
| *trans*-1,3-dichloropropene | 10061-02-6 | - | - | + | + | - | - | - | - | - |
| *trans*-1,4-dichloro-2-butene | 110-57-6 | - | - | - | + | - | - | - | - | - |
| 1,4-dichlorobenzene | 106-46-7 | - | - | + | + | - | - | - | - | - |
| 2,2-dichloropropane | 594-20-7 | - | - | + | - | - | - | - | - | - |
| 2-butanone (methyl ethyl ketone) | 78-93-3 | - | - | + | + | - | - | - | - | - |
| 2-chloro-1,3-butadiene | 126-99-8 | - | - | - | + | - | - | - | - | - |
| 2-chlorotoluene | 95-49-8 | - | - | + | - | - | - | - | - | - |
| 2-hexanone | 591-78-6 | - | - | + | + | - | - | - | - | - |
| 4-chlorotoluene | 106-43-4 | - | - | + | - | - | - | - | - | - |
| 4-isopropyltoluene | 99-87-6 | - | - | + | - | - | - | - | - | - |
| Acetone | 67-64-1 | - | + | + | + | - | - | - | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Acetonitrile | 75-05-8 | - | - | - | + | - | - | - | - | - |
| Acetylene | 74-86-2 | - | - | - | - | - | - | - | - | - |
| Acrolein | 107-02-8 | - | - | - | + | - | - | - | - | - |
| Acrylonitrile | 107-13-1 | - | - | + | + | - | - | - | - | - |
| Allyl Chloride | 107-05-1 | - | - | - | + | - | - | - | - | - |
| Benzene | 71-43-2 | - | - | + | + | - | - | - | - | - |
| Bromobenzene | 108-86-1 | - | - | + | - | - | - | - | - | - |
| Bromochloromethane | 74-97-5 | - | - | + | - | - | - | - | - | - |
| Bromodichloromethane | 75-27-4 | - | - | + | + | - | - | - | - | - |
| Bromoform | 75-25-2 | - | - | + | + | - | - | - | - | - |
| Bromomethane | 74-83-9 | - | - | + | + | - | - | - | - | - |
| sec-Butylbenzene | 135-98-8 | - | - | + | - | - | - | - | - | - |
| tert-Butylbenzene | 98-06-6 | - | - | + | - | - | - | - | - | - |
| Carbon disulfide | 75-15-0 | - | - | + | + | - | - | - | - | - |
| Carbon tetrachloride | 56-23-5 | - | - | + | + | - | - | - | - | - |
| Chlorobenzene | 108-90-7 | - | - | + | + | - | - | - | - | - |
| Chloroethane | 75-00-3 | - | - | + | + | - | - | - | - | - |
| Chloroform | 67-66-3 | - | + | + | + | - | - | - | - | - |
| Chloromethane | 74-87-3 | - | - | + | + | - | - | - | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Dibromochloromethane | 124-48-1 | - | - | + | + | - | - | - | - | - |
| Dibromomethane | 74-95-3 | - | - | + | + | - | - | - | - | - |
| Dichlorodifluoromethane | 75-71-8 | - | - | + | + | - | - | - | - | - |
| Ethylbenzene | 100-41-4 | - | - | + | + | - | - | - | - | - |
| Ethyl methacrylate | 97-63-2 | - | - | + | + | - | - | - | - | - |
| Freon 113 | 76-13-1 | - | - | - | + | - | - | - | - | - |
| Iodomethane | 74-88-4 | - | - | - | + | - | - | - | - | - |
| Isobutyl alcohol | 78-83-1 | - | - | - | + | - | - | - | - | - |
| Isopropylbenzene | 98-82-8 | - | - | + | - | - | - | - | - | - |
| Methylacrylonitrile | 126-98-7 | - | - | - | + | - | - | - | - | - |
| Methylene chloride | 75-09-2 | - | - | + | + | - | - | - | - | - |
| Methyl isobutyl ketone | 108-10-1 | - | - | - | + | - | - | - | - | - |
| Methyl methacrylate | 80-62-6 | - | - | + | + | - | - | - | - | - |
| n-Butylbenzene | 104-51-8 | - | - | + | - | - | - | - | - | - |
| n-Propylbenzene | 103-65-1 | - | - | + | - | - | - | - | - | - |
| Pentachloroethane | 76-01-7 | - | - | - | + | - | - | - | - | - |
| Propionitrile | 107-12-0 | - | - | - | + | - | - | - | - | - |
| Styrene | 100-42-5 | - | - | + | + | - | - | - | - | - |
| tert-Butyl methyl ether | 1634-04-4 | - | - | + | - | - | - | - | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Tetrachloroethylene | 127-18-4 | - | + | + | + | - | - | | - | - |
| Tetrahydrofuran | 109-99-9 | - | - | + | - | - | - | - | - | - |
| Toluene | 108-88-3 | - | - | + | + | - | - | - | - | - |
| Trichloroethene (Trichloroethylene) | 79-01-6 | - | + | + | + | - | - | - | - | - |
| Trichlorofluoromethane | 75-69-4 | - | + | + | + | - | - | - | - | - |
| Vinyl acetate | 108-05-4 | - | - | + | + | - | - | - | - | - |
| Vinyl chloride | 75-01-4 | - | + | + | + | - | - | - | - | - |
| Xylene, m | 108-38-3 | - | - | + | + | - | - | - | - | - |
| Xylene, o | 95-47-6 | - | - | + | + | - | - | - | - | - |
| Xylene, p | 106-42-3 | - | - | + | + | - | - | - | - | - |
| Xylenes, Total | 1330-20-7 | - | - | + | + | - | - | - | - | - |
| **Semi Volatile Organic Compounds** | | | | | | | | | | |
| 1,2,4,5-tetrachlorobenzene | 95-94-3 | - | - | - | + | - | - | - | - | - |
| 1,2,4-trichlorobenzene | 120-82-1 | - | - | + | + | - | - | - | - | - |
| 1,2-diphenylhydrazine | 122-66-7 | - | - | - | + | - | - | - | - | - |
| 1,4-dioxane | 123-91-1 | - | + | - | - | - | - | - | - | - |
| 1,4-naphthoquinone | 130-15-4 | - | - | - | - | - | - | - | - | - |
| 2,3,4,6-tetrachlorophenol | 58-90-2 | - | - | - | + | - | - | - | - | - |
| 2,4,5-trichlorophenol | 95-95-4 | - | - | - | + | - | - | - | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| 2,4,6-trichlorophenol | 88-06-2 | - | - | - | + | - | - | - | - | - |
| 2,4-dichlorophenol | 120-83-2 | - | - | - | + | - | - | - | - | - |
| 2,4-dimethylphenol | 105-67-9 | - | - | - | + | - | - | - | - | - |
| 2,4-dinitrophenol | 51-28-5 | - | - | - | + | - | - | - | - | - |
| 2-chloronaphthalene | 91-58-7 | - | - | - | + | - | - | - | - | - |
| 2-chlorophenol | 95-57-8 | - | - | - | + | - | - | - | - | - |
| 2-methylnaphthalene | 91-57-6 | - | - | - | + | - | - | - | - | - |
| 2-methylphenol (o-Cresol) | 795-48-7 | - | - | - | + | - | - | - | - | - |
| 4,6-dinitro-2-methylphenol | 534-52-1 | - | - | - | + | - | - | - | - | - |
| 4-chloroaniline | 106-47-8 | - | - | - | + | - | - | - | - | - |
| 4-chlorophenyl phenyl ether | 7005-72-3 | - | - | - | + | - | - | - | - | - |
| 4-methylphenol (p-Cresol) | 106-44-5 | - | - | - | + | - | - | - | - | - |
| Acenaphthene | 83-32-9 | - | - | - | + | - | - | - | - | - |
| Acenaphthylene | 208-96-8 | - | - | - | + | - | - | - | - | - |
| Acetophenone | 98-86-2 | - | - | - | + | - | - | - | - | - |
| Anthracene | 120-12-7 | - | - | - | + | - | - | - | - | - |
| Benzidine | 92-87-5 | - | - | - | + | - | - | - | - | - |
| Benzo[*a*]anthracene | 56-55-3 | - | - | - | + | - | - | - | - | - |
| Benzo[*a*]pyrene | 50-32-8 | - | - | + | + | - | - | - | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| 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) phthalate | 117-81-7 | - | - | + | + | - | - | - | - | - |
| 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 | - | - | - | + | - | - | - | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Di-n-octyl phthalate | 117-84-0 | - | - | - | + | - | - | - | - | - |
| Diphenylamine | 122-39-4 | - | - | - | + | - | - | - | - | - |
| Fluoranthene | 206-44-0 | - | - | - | + | - | - | - | - | - |
| Fluorene | 86-73-7 | - | - | - | + | - | - | - | - | - |
| Hexachlorobenzene | 118-74-1 | - | - | + | - | - | - | - | - | - |
| Hexachlorobutadiene | 87-68-3 | - | - | + | + | - | - | - | - | - |
| Hexachlorocyclopentadiene | 77-47-4 | - | - | + | - | - | - | - | - | - |
| Hexachloroethane | 67-72-1 | - | - | - | + | - | - | - | - | - |
| Indeno(1,2,3-c,d)pyrene | 193-39-5 | - | - | - | + | - | - | - | - | - |
| Isophorone | 78-59-1 | - | - | - | + | - | - | - | - | - |
| Monobromoacetic acid | 79-08-3 | - | - | + | - | - | - | - | - | - |
| Monochloroacetic acid | 79-11-8 | - | - | + | - | - | - | - | - | - |
| 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 | - | - | - | - | - | - | - | - | - |

| Analyte | CAS Number | Air | GW[a] | DW[b] | SW[c] | IW[d] | BG[e] Soil | TLAP Soil[f] | Veg.[g] | Fauna |
|---|---|---|---|---|---|---|---|---|---|---|
| Parathion, methyl | 298-00-0 | - | - | - | - | - | - | - | - | - |
| Pentachlorophenol | 87-86-5 | - | - | - | + | - | - | + | - | - |
| Phenanthrene | 85-01-8 | - | - | - | + | - | - | - | - | - |
| Phenol | 108-95-2 | - | - | - | + | - | - | - | - | - |
| Pronamide | 23950-58-5 | - | - | - | + | - | - | - | - | - |
| Pyrene | 129-00-0 | - | - | - | + | - | - | - | - | - |
| Pyridine | 110-86-1 | - | - | - | - | - | - | - | - | - |
| Trichloroacetic acid | 76-03-9 | - | - | + | - | - | - | - | - | - |
| **Biological** | | | | | | | | | | |
| Complete blood count | NA | - | - | - | - | - | - | - | - | + |
| Histopathology | NA | - | - | - | - | - | - | - | - | + |
| Necropsy | NA | - | - | - | - | - | - | - | - | + |
| Total coliform bacteria | 10-46-8 | - | - | + | - | - | - | - | - | - |
| *Escherichia coli* | NA | - | - | + | - | - | - | - | - | - |
| Eastern encephalitis | NA | - | - | - | - | - | - | - | - | + |
| Western encephalitis | NA | - | - | - | - | - | - | - | - | + |
| Hanta virus | NA | - | - | - | - | - | - | - | - | + |
| Plague bacteria | NA | - | - | - | - | - | - | - | - | + |
| Pseudorabies | NA | - | - | - | - | - | - | - | - | + |

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

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

[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
+ = Sampled for
- = Not sampled
NA = Not available

# Appendix B – Birds Identified at Pantex

| Common Name | *Scientific Name* |
|---|---|
| Cattle egret | *Bubulcus ibis* |
| Great blue heron | *Ardea herodias* |
| Sandhill crane | *Grus canadensis* |
| Canada goose | *Branta canadensis* |
| Mallard | *Anas platyrhynchos* |
| Green-winged teal | *Anas crecca* |
| Northern shoveler | *Anas clypeata* |
| Blue-winged teal | *Anas discors* |
| Bufflehead | *Bucephala albeola* |
| American coot | *Fulica americana* |
| American avocet | *Recurvirostra americana* |
| Black-necked stilt | *Himantopus mexicanus* |
| Killdeer | *Charadrius vociferus* |
| Wilson’s phalarope | *Phalaropus tricolo* |
| American kestrel | *Falco sparverius* |
| 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* |
| American bald eagle | *Haliaeetus leucocephalus* |
| Sharp-shinned hawk | *Accipiter striatus* |

| **Common Name** | ***Scientific Name*** |
|---|---|
| Cooper's hawk | *Accipiter cooperii* |
| Northern bobwhite | *Colinus virginianus* |
| Scaled quail | *Callipepla squamatta* |
| Ring-necked pheasant | *Phasianus colchicus* |
| Mourning dove | *Zenaida macroura* |
| Eurasian collared dove | *Streptopelia decaocto* |
| Barn owl | *Tyto alba* |
| Short-eared owl | *Asio flammeus* |
| Great-horned owl | *Bubo virginianus* |
| Burrowing owl | *Athene cunicularia hypugea* |
| Common nighthawk | *Chordeiles minor* |
| Red-headed woodpecker | *Melanerpes erythrocephalus* |
| Eastern kingbird | *Tyrannus tyrannus* |
| Western kingbird | *Tyrannus verticalis* |
| Horned lark | *Eremophila alpestris* |
| Tree swallow | *Tachycineta bicolor* |
| Barn swallow | *Hirundo rustica* |
| Cliff swallow | *Hirundo pyrrhonota* |
| Chihuahuan raven | *Corvus cryptoleucus* |
| American robin | *Turdus migratorius* |
| Loggerhead shrike | *Lanius ludovicianus* |
| Northern mockingbird | *Mimus polyglottos* |
| Curve-billed thrasher | *Toxostoma curvirostre* |
| European starling | *Sturnus vulgaris* |
| White-crowned sparrow | *Zonotrichia leucophrys* |
| Bobolink | *Dolichonyx oryzivorus* |
| Western meadowlark | *Sturnella neglecta* |

| **Common Name** | ***Scientific Name*** |
|---|---|
| Yellow-headed blackbird | *Xanthocephalus xanthocephalus* |
| Brown-headed cowbird | *Agelaius phoeniceus* |
| Great-tailed grackle | *Quiscalus mexicanus* |
| House sparrow | *Passer domesticus* |

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# Appendix C – References

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# Appendix D – Helpful Information

## 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 $10^9$m |
| Mega | M | $10^6$ | 1 megameter (Mm) = 1 x $10^6$m |
| Kilo | k | $10^3$ | 1 kilometer (km) = 1 x $10^3$m |
| 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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Pantex Plant, Amarillo, Texas