Environmental Cleanup and Restoration

Pantex Plant – Amarillo, Texas

PANTEX PROTECTING PEOPLE & THE ENVIRONMENT

What Questions Does This Booklet Address?

1 What are the remedies?

- Remedies for soil include removing chemical vapors from the soil, containing chemicals in soil using covers or liners, and restricting land use and access in contaminated areas.
- Remedies for groundwater include pumping groundwater to the surface and then removing chemicals, enhancing natural biological breakdown of chemicals in groundwater, and restricting groundwater well drilling and pumping.

2 How and why did we choose these remedies?

- The remedies were chosen to manage risks by a combination of reducing chemical concentrations in soil and groundwater, eliminating exposure pathways, and limiting the potential for off-site migration.
- A systematic process was used to identify and evaluate several alternative combinations of remedial actions for managing current and future risks. Each alternative was evaluated by considering multiple criteria, including input from the community. The remedies that best met these criteria were agreed upon by EPA and TCEQ.

3 How do we know the remedies are working?

- The remedies have removed thousands of pounds of chemicals from soil and groundwater.
- Monitoring wells show reduced chemical concentrations in perched groundwater, and many are below groundwater protection standards. Monitoring wells in the Ogallala Aquifer show that all detected chemicals are below the groundwater protection standards.
- Visual inspections ensure that soil covers remain intact, while monitoring data from remediation systems and groundwater monitoring wells allow continual assessment of remedy effectiveness.

4 How are we managing uncertainties and unexpected events that may occur?

- The groundwater monitoring network is designed for early identification of unexpected conditions and assessment of uncertainties in groundwater movement.
- A groundwater contingency plan identifies specific actions to be taken if the monitoring data reveal unexpected conditions.
- Annual and five-year reviews evaluate remedy performance and protectiveness, including analysis of a comprehensive list of chemical constituents in groundwater. The next five-year review is underway, with completion scheduled for September 2018.

5 Where do we go from here?

- Groundwater remediation systems in the southeast perched groundwater plume are currently being expanded, and the larger system is expected to be completed and operational in 2018.
- A study is underway to further evaluate the effectiveness of transitioning to monitored natural attenuation (MNA) as a long-term remedy.

6 How do we ensure long-term stewardship?

- The U.S. Department of Energy (USDOE) is committed to ensuring continued operation and maintenance of ongoing remedial actions and compliance with institutional controls, until such time that these actions and controls are no longer necessary to protect human health and the environment.
- USDOE/NNSA has consistently funded these remedial actions, including contingencies. Funds received for the remedial actions are governed under special controls and cannot be used for any other purpose.

January 2018 Consolidated Nuclear Security, LLC.

Front cover photographs of Pantex site by Monty Schoenhals

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NNSA PRODUCTION OFFICE · UNITED BY A COMMON GOAL

PANTEX

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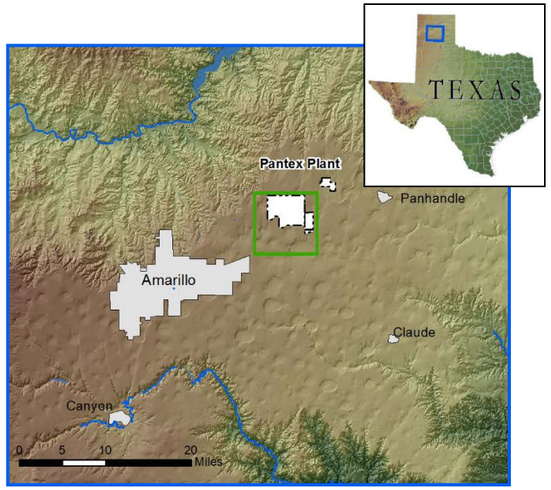
PANTEX PLANT | Y-12 NATIONAL SECURITY COMPLEX

Introduction

The U.S. Department of Energy/National Nuclear Security Administration (USDOE/NNSA) Pantex Plant, located in Carson County in the Texas Panhandle, is an active facility that maintains our nation's nuclear weapons stockpile. Although Pantex Plant is and will remain an active permitted facility, it is currently engaged in a regulatory cleanup process to investigate site conditions and implement environmental cleanup and restoration actions. This process is being conducted in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) under the oversight of the U.S. Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ).

As part of the cleanup process, environmental investigations measured chemical and radionuclide impacts in soil, soil gas, surface water, perched groundwater, and the Ogallala Aquifer. Human health and ecological risk assessments have been conducted to assess potential health risks to onsite workers, Plant neighbors, and animals and plants that may be exposed to affected media as a result of past waste management activities at Pantex Plant. Based on these assessments, contaminants in soil and perched groundwater, if left untreated, could potentially pose a health risk to onsite workers and offsite Plant neighbors. The potential ecological risk to animals and plants is below regulatory levels of concern and is similar to background (i.e., levels that would exist absent any influence from Pantex Plant). While the concentrations in the Ogallala Aquifer beneath the Plant are currently below regulatory standards, contaminants in soil and perched groundwater have the potential for future impact. The constituents in the Ogallala Aquifer must meet the requirements of the Safe Drinking Water Act.



Pantex Plant is located in the Texas Panhandle, 17 miles northeast of Amarillo

A systematic process was used to identify and evaluate several alternative combinations of remedial actions for managing current and future risks. Each alternative was evaluated by considering a number of criteria, including input from the community. The remedies that best met these criteria were selected and are specified in the *Record of Decision for Groundwater, Soil and Associated Media, Pantex Plant* (ROD), which was issued by EPA and USDOE/NNSA with concurrence by TCEQ in September 2008. The selected remedies manage risks using a combination of reducing chemical concentrations in soil and perched groundwater, eliminating exposure pathways using a variety of engineering and institutional controls, and controlling the potential for off-site migration.

Pantex Plant Cleanup Process

Aerial view of Pantex Plant

This Environmental Cleanup and Restoration booklet summarizes the remedial actions currently being undertaken at Pantex Plant, including a brief history of the site investigations, human health and ecological risk assessments, and remedial action selection process. A list of previous reports and other documentation used to create this summary is provided at the end of this booklet. Detailed information from key reports can be found in Pantex Plant Public Reading Room at the Amarillo Downtown Public Library, and at the TCEQ Region 1 office in Amarillo. Some of those reports are also available online at pantex.energy.gov (>Mission >Environment). A map to the library is shown at the end of this document.

CERCLA/RCRA Cleanup Process for Pantex Plant

CERCLA and RCRA provide similar processes for planning and implementing a cleanup program to reduce risk to people and the environment. However, despite the similarities, two significant differences exist between the cleanup processes detailed in CERCLA and RCRA: (1) regulatory authority granted to EPA and TCEQ differs under the two regulations, and (2) the timing of public participation, and the remedy approval process, differ. TCEQ and EPA both approve the remedy selection for chemicals; whereas only EPA approves the remedy selection for radionuclides. Under CERCLA, the remedy selection occurs with the Proposed Plan and the Record of Decision (ROD), which requires public participation in the selection. Under RCRA, the remedy selection is considered for acceptance by TCEQ after completion of the Corrective Measures Study/ Feasibility Study, and final public participation and approval is received when the Compliance Plan Modification is developed. This Plan Modification details the remedy selection, the corrective measure design, and the monitoring network that will be used to evaluate the effectiveness of the remedy.

Pantex History

In 1942, the United States Army constructed the original Pantex Ordnance Plant. The mission of the plant was to load and pack conventional artillery shells and bombs in support of the World War II effort. The Pantex Ordnance Plant was closed the day after the war ended, and the land was leased to Texas Technological College (now Texas Tech University). The federal government re-acquired the land and facilities that made up Pantex Plant in 1951, and it became a key element of the nation's nuclear weapons complex. Portions of the original Pantex Ordnance Facility to the south of Pantex Plant were retained by Texas Tech University for use as an agricultural research farm. Since 1975, Pantex has been the nation's primary assembly, disassembly, retrofit, and life-extension center for our nation's nuclear weapons—the last new nuclear weapon was assembled in 1991. Since then, Pantex has safely dismantled thousands of weapons retired from the stockpile by the military, and has placed the resulting plutonium pits in interim storage.

World War II conventional munitions production line

Community Involvement During the Cleanup Process

The *Environmental Restoration/Long-Term Stewardship Project Community Involvement Plan* was originally developed in 1992. This plan outlines the methods that facilitate two-way communication between the community surrounding Pantex Plant and the NNSA Production Office (NPO) at Pantex, and it serves as a guideline for community involvement in site environmental cleanup activities. The NPO at Pantex uses the community involvement activities outlined in the Plan to ensure that residents are continuously informed and provided opportunities to be involved. The current version of the Community Involvement Plan was updated in 2017, and can be found in the USDOE/NNSA Reading Room or online at pantex.energy.gov.

Community Involvement Program Activities identified in the Community Involvement Plan include annual roundtable meetings and neighbor newsletters. which describe the progress being made in implementing the remedies for soil and groundwater, among other environmental topics. Pantex also communicates important issues to the public through as-needed public meetings, workshops, brochures and fact sheets, community group presentations, pantex.energy.gov, and the news media.

Top: Pantex Quarterly Groundwater Public Meeting
Bottom: Pantex Newsletter and Fact Sheet

Community Involvement in Investigation and Decision Components of the Cleanup Process

The local community actively participated in the Investigation and Decision components of Pantex Plant cleanup process, including a workshop on risk assessment, multiple workshops on fate-and-transport modeling, and a public comment period for the Proposed Plan, which outlined the preferred remedial alternatives. Responses to these comments are included in the Responsiveness Summary incorporated into the 2008 Record of Decision (ROD). The public also participated in a series of meetings and educational workshops on the Long-Term Groundwater Monitoring Network.

★ ***Events in Time*** ● Special Public Meetings

Acronyms:
PICG = Pantex Information Coordinating Group
PPCAB = Pantex Plant Citizens' Advisory Board
ROD = Record of Decision
HHRA = Human Health Risk Assessment

★ ***PICG formed*** (1992)
★ ***PICG dissolved/ PPCAB formed*** (1994)

1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998

Routine Public Meetings:
Quarterly public meetings organized through PICG and PPCAB

● Risk Assessment Meeting with PPCAB (during development of HHRA Work Plan) (1999)
● Meeting to discuss Method for Developing Soil and Groundwater Backgrounds (2001)
● Meeting to present RCRA Facility Investigation/ Radiological Investigation (2003)
● Meeting to present Risk Assessment Results and Conclusions (2006)
● Meeting to present Proposed Plan for public comment (2008)
● Long-Term Monitoring Design Workshop (2008)
● Meeting to open public comment period for Compliance Plan (2009)
★ ***PPCAB dissolved*** (2001)
★ ***ROD Issued*** (2008)
★ ***Compliance Plan Issued*** (2010)

1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010

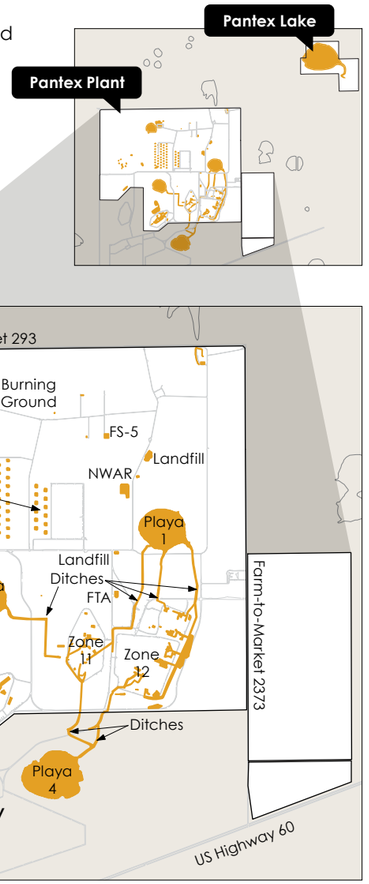
Monthly public meetings
Quarterly public meetings
Semi-annual public meetings




Site Background

Site Description

Pantex Plant is an 11,700-acre facility consisting of a 9,100-acre plant site bounded on the north by Farm-to-Market Road 293, on the east by Farm-to-Market Road 2373, and on the west by Farm-to-Market Road 683; 1,526 acres east of Farm-to-Market Road 2373; and 1,077 acres at Pantex Lake, which is approximately 4 km (2.5 miles) northeast of the main Plant area. Pantex Plant leases approximately 5,900 acres south of the Plant from Texas Tech University for use as a safety and security buffer. The Texas Tech University Research Farm manages the buffer zone for a variety of agricultural uses. Pantex Plant consists of several functional areas, commonly referred to as numbered zones. The locations investigated for cleanup are pictured here, and brief descriptions of the major areas are included.



Zones 10, 11, and 12 are active operational areas. Facilities in these zones were originally built to manufacture conventional bombs during World War II. These zones currently contain both active and inactive areas. Since 1952, facilities in these zones have been reconstructed to serve as assembly/disassembly areas, staging areas, and support areas for other Plant functions.

The Burning Ground is an active operational area. The facility was historically used for the disposal of high explosive waste and contaminated materials. Current use includes thermal treatment of high explosive-contaminated wastes.

Playa 3 is next to the Burning Ground. Playa 3 has not been used for industrial purposes, but it receives stormwater runoff from the Burning Ground. In the past, overflow from the solvent evaporation pit reached Playa 3.

The Fire Training Area (FTA) was used for Pantex Fire Department training exercises; a portion of this area is still used by the Fire Department.

Ditches are located in various areas at Pantex Plant and are associated with the playa drainage basins. Like the playas, these ditches historically received treated and untreated industrial wastewater discharges.

Landfills are inactive units located in multiple areas at Pantex Plant. These landfills were used for general sanitary waste, construction debris, and demolition debris, including asbestos-containing materials and industrial wastes.

Firing Site 5 (FS-5) is an inactive area previously used for research and development testing of high explosives. Explosives were detonated at a surface test pad and in a gravel pit to test the firing of high explosives with parts made of depleted uranium and other metals.

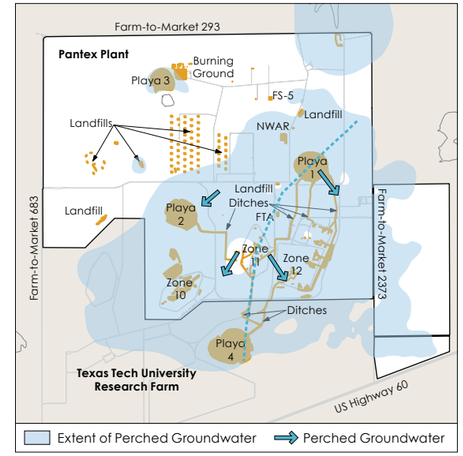
Playas 1, 2, and 4 and Pantex Lake are four of five playas associated with Pantex Plant; Playa 1 and Playa 2 are within the boundaries of Pantex Plant, whereas Pantex Lake is 2.5 miles (4 km) northeast of the Plant boundary. Playa 4 is on Texas Tech property south of Pantex Plant. Historically, these playas received treated and untreated industrial wastewater discharges.

Nuclear Weapons Accident Residue Storage Unit (NWAR) was a storage unit for retrievable radioactive materials. Wastes stored at NWAR included radioactive debris from military aircraft accidents, residue from Pantex Plant Firing Site test shots, and low-level radioactive wastes from Pantex Plant production lines. By 1986, all wastes had been removed, and site decontamination was complete.



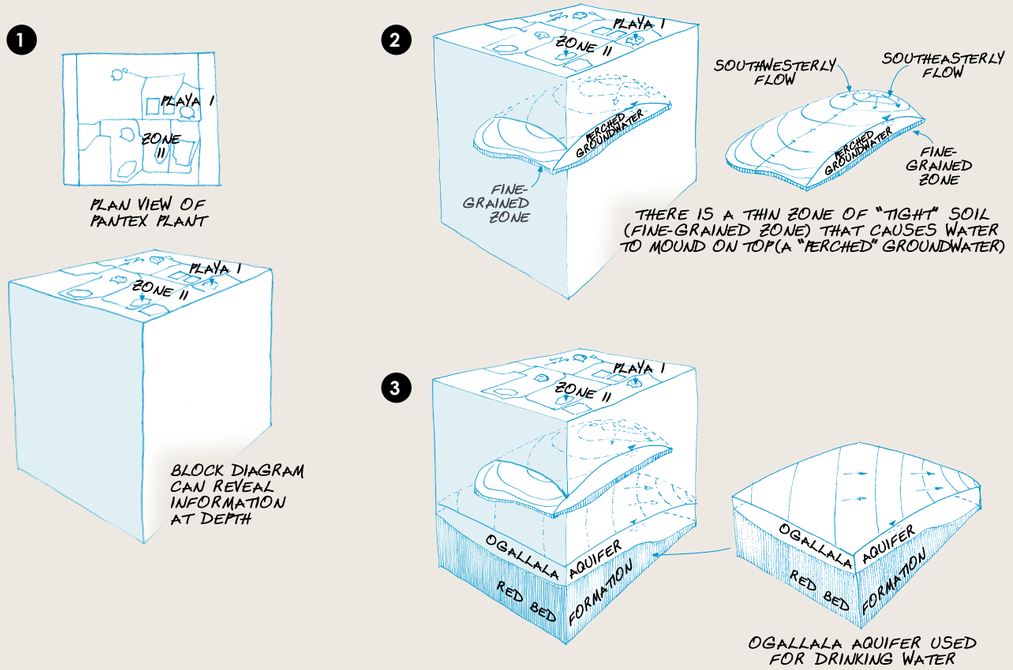

Groundwater at Pantex Plant

Two separate groundwater bodies are present under Pantex Plant at two different depths. The shallow perched groundwater, is created by water pooling on a thin zone of "tight" soil (fine-grained zone) at an average depth of about 276 feet below ground surface. This water body is rather thin (average thickness is about 7 feet), and the horizontal extent is limited. The deeper water body, called the Ogallala Aquifer, is limited in depth by what is referred to as the Red Bed Formation. This formation slopes downward from south to north, so it is present at depths ranging from about 350 to 820 feet below the ground surface. The Ogallala Aquifer is extensive and significantly thicker (up to about 400 feet at the northern property boundary) than the perched groundwater. Vertical flow between the perched groundwater and the Ogallala Aquifer is limited by the presence of the fine-grained zone. Downward movement of perched groundwater through the fine-grained zone to the Ogallala Aquifer varies from area to area. However, downward movement of perched groundwater generally increases toward the south and east near the edge of the perched groundwater.



Extent of perched groundwater at Pantex Plant

Site Hydrogeologic Model for Pantex Plant

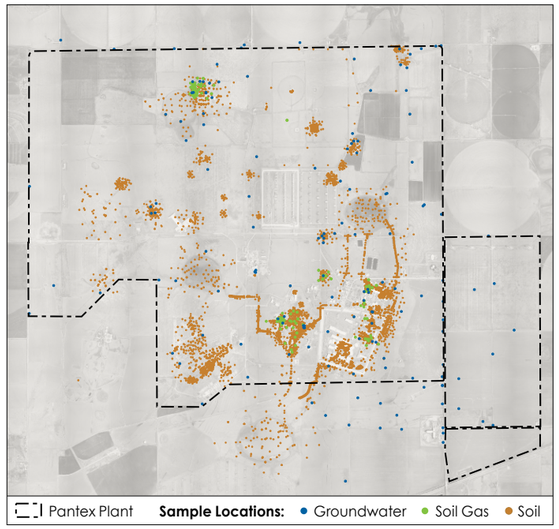





Site Investigation

Soil, soil gas, surface water, and groundwater samples were collected at Pantex Plant as part of multiple remedial investigations conducted at various areas across the site, as well as during the site-wide radiological investigation and groundwater investigation.

At the time when the Proposed Plan was completed in 2008, more than 18,000 soil samples and 500 soil gas samples had been collected. More than 400 groundwater samples had been obtained since 1999 from 31 wells completed in the Ogallala Aquifer, and more than 1,300 perched groundwater samples had been collected from 116 wells. [Note: The number of wells in the Ogallala Aquifer and perched groundwater changes over time as new wells are drilled or existing wells are closed, depending on site conditions and information needs.] The results of these sampling efforts indicated that soil, soil gas, and perched groundwater in different areas of the site had been affected by various contaminants.



Sample locations at the time of the Site Investigations

Excavation of ditch soils in Zone 11

Based on the information collected during the site investigation, interim cleanup activities and early remedial/corrective actions were conducted at Pantex Plant to immediately reduce the threat of exposure to Plant employees and neighbors and to minimize the potential for impacts to the Ogallala Aquifer. These activities included:

- Soil removal
- Landfill covers
- Perched groundwater bioremediation
- Ditch lining
- Soil vapor extraction
- Extraction and treatment of perched groundwater

These early activities occurred before the Corrective Measures Study/Feasibility Study was conducted.

Groundwater Contingency Plan

The *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* was developed to identify contingent actions to be taken in the event that monitoring data reveal deviations from expected remediation technology performance or unexpected conditions in the perched groundwater or Ogallala Aquifer. The process for reviewing groundwater data is shown to the right.

Contingent actions are identified separately for the Playa 1 Pump and Treat System, Southeast Pump and Treat System, Southeast *In-Situ* Bioremediation System, and Zone 11 *In-Situ* Bioremediation System, as well as for the perched groundwater and Ogallala Aquifer.

These actions may include:

- Use of *in situ* treatment to enhance other remedies in specific areas where monitoring and evaluation of results indicates that further remedial action is required.
- Use or expansion of pump-and-treat systems, where feasible, to reduce water levels or meet treatment goals.
- Implementation of interim measures to protect workers or neighbors.

The public will continue to be informed when contingency actions are considered, so feedback can be provided on plans for implementation.

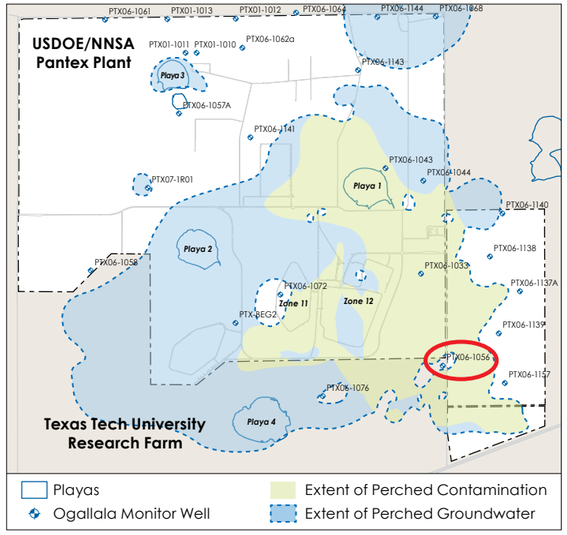



Current Conditions in Groundwater

Contaminants in perched groundwater at Pantex Plant are a result of past industrial wastewater discharges to the ditches and playas and at a wash rack at the Burning Ground. Currently, only one domestic well is completed in a separated perched groundwater to the north of Pantex Plant, where all chemicals remain below regulatory standards. There are no completed domestic wells in the main perched groundwater underlying Pantex Plant.

Contaminants found offsite above regulatory standards (Safe Drinking Water Standards or site-specific RCRA drinking-water standards for residential use, collectively referred to as "groundwater protection standards") in perched groundwater at Pantex Plant are associated with the manufacture of high explosives and include:

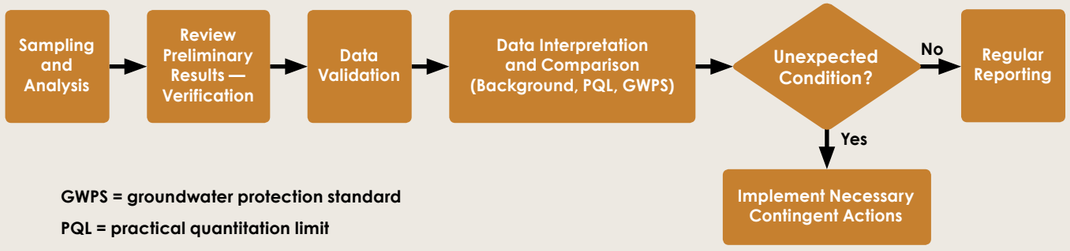
- High explosives, primarily RDX and degradation products, are present near Playa 1 and to the south and southeast.
- TCE (a volatile organic compound) and perchlorate are present south of Zone 11, and hexavalent chromium and perchlorate south of Zone 12.
- Perchlorate and TCE were found in a small, disconnected plume beneath the Burning Ground. The concentrations in this plume were initially above regulatory standards but have since declined to safe levels, at least in part due to early remedial actions implemented during the site investigation.



Radionuclides have not been found in groundwater above regulatory standards.

Isolated detections of chemicals have occurred in the Ogallala Aquifer in recent years. In general, review of the data indicates that there are no trends in the detections, meaning that there are no repeated detections in wells that would indicate the ongoing presence of a chemical plume. The one exception is the repeated detection of a breakdown product of TNT (4-amino-2,6-dinitrotoluene) and a volatile organic compound (1,2-dichloroethane) in a monitoring well immediately south of the southeast corner of Pantex Plant (PTX06-1056). Pantex will continue to monitor the Ogallala Aquifer on a quarterly basis, and implement actions as defined in the Groundwater Contingency Plan.

All detections in the Ogallala Aquifer monitoring wells are below groundwater protection standards.






Current Conditions in Soil

Contaminants in soils at Pantex Plant occur because of past waste management practices that released chemicals to soils.

Several groups of chemicals and some radionuclides have been detected in soils at Pantex Plant. Many of these contaminants are bound to the upper soils because the clay-rich soils present at Pantex Plant and the dry climate conditions, limit leaching or migration to deeper soils or groundwater.

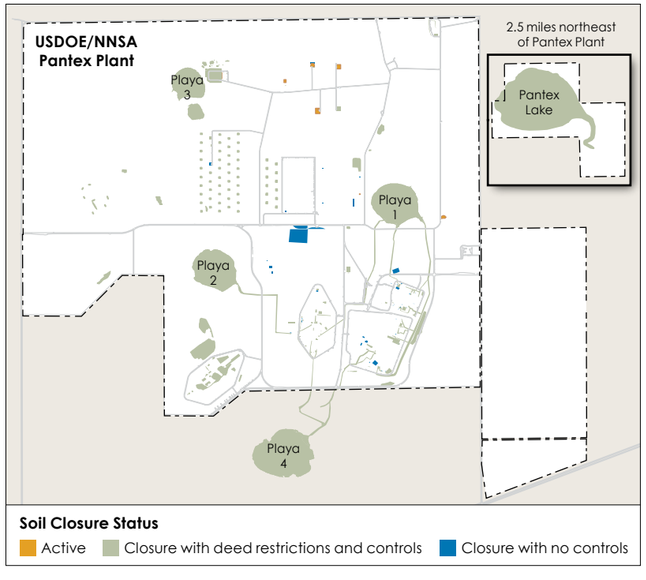
During the investigation, a large portion of the upper soils were cleaned to levels that are safe for a worker who may work full-time in each area. Cover material was added to landfills that needed extra cover for protection of workers or groundwater.

Soil gas plumes were also found in several areas where volatile organic compounds were released. Soil vapor extraction systems were originally placed in Zone 11 and the Burning Ground to address soil gas plumes in those areas. The system in Zone 11 has since been shut down, because interim operation of this system was sufficient to reduce chemicals below levels of concern.

Release Unit Closure Status

Through the RCRA facility assessment, a total of 254 release units were initially identified at Pantex Plant for further investigation and cleanup as warranted. Inactive units were investigated, and some units were closed early, either because no contamination was found, or the early cleanup actions met regulatory standards. The investigations have defined the status of the units as follows:

- 16 units are active facilities—investigation, cleanup, and closure are deferred until the unit is no longer active.
- 46 units were closed administratively—the initial investigation determined that no past releases had occurred at these units.
- 33 units were investigated and closed where levels were at background concentrations (RCRA Reduction Standard 1 [RRS 1]). Closure of these units is considered final.
- 25 units were investigated and closed where levels were below pre-determined regulatory standards (CERCLA preliminary remediation goals or RCRA RRS 2). These sites required deed restrictions and some institutional controls.
- 134 units required a baseline risk assessment (based on CERCLA or RCRA RRS 3 requirements) to determine current and future risks from soil and groundwater. These assessments helped determine what steps were needed to protect people and the environment. The results of the baseline risk assessments are summarized in the next section.

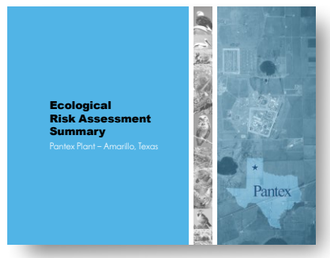


The final status of the 254 Pantex Plant release units is depicted in the map above. The 79 release units depicted in blue were closed with no controls, the 159 release units depicted in green were closed with a deed restriction and controls. The 16 active units are depicted in orange.




Summary of Site Risk

Ecological Risk Assessment



An Ecological Risk Assessment evaluated potential chemical and radiological impacts to plants and wildlife from soils, sediment, and surface water affected by historical operations at Pantex Plant. The key conclusions from the Ecological Risk Assessment were as follows:

- Cleanup actions already completed by the Environmental Projects Department, and improved waste management practices, protect plants and animals at Pantex Plant.
- Results of the ecological risk assessment indicate that animals currently are exposed to chemicals at levels that are below accepted regulatory levels or are similar to background; therefore, further cleanup is not required.
- Future risks due to potential movement of chemicals to the playas are similar to current risk levels, and further cleanup is not required to protect plants and animals in the future.
- Pantex will review the key assumptions of the ecological risk assessment every 5 years, as part of the Long-Term Environmental Stewardship Program, to ensure continued protection of the environment.

Additional details on the methods and results are presented in the *Ecological Risk Assessment Summary* that is available in the Administrative Record File, USDOE/NNSA Reading Room, or online at pantex.energy.gov.

Human Health Risk Assessment

Human Health Risk Assessments evaluated potential radiological and chemical risks to onsite workers and neighbors who live near Pantex Plant, based on how they could be exposed to affected soil, soil gas, or groundwater. The key conclusions from these assessments were as follows:

- There is no current or imminent threat to human health associated with drinking water from the Ogallala Aquifer.
- Potential future risks could occur offsite (to the east and on Texas Tech University property) in the absence of remediation, if a well is placed in the Ogallala Aquifer in that area in the future. These potential future risks are related primarily to predicted movement of RDX, a chemical explosive, that is already present in the perched groundwater because of historical releases to ditches and playas.
- The USDOE/NNSA has designed and is implementing corrective measures to ensure that any potential future impacts to the Ogallala Aquifer are mitigated and exposures prevented. The focus of corrective measures at Pantex Plant will be on the control of RDX in perched groundwater.
- There is no current or imminent threat to human health from chemicals detected in the perched groundwater, because impacted perched groundwater is not used as drinking water.
- Zones 10, 11, and 12; Landfills 1, 2, and 13; Firing Site 5; and the Burning Ground are the only onsite areas in which constituents in soil were identified to be present above target risk levels based on direct exposure of onsite workers. Exposure of onsite workers will be reduced to safe levels through soil management practices. Chemicals in soil do not pose a current or future risk to off-site residents or farmers.
- Long-term monitoring and environmental stewardship will continue at Pantex Plant for the foreseeable future.

Additional details on the methods and results are presented in the *Baseline Human Health Risk Assessment Summary*, available in the Administrative Record File, USDOE/NNSA Reading Room, or online at pantex.energy.gov.

Remedy Selection Process

Based on the results of the Baseline Human Health Risk Assessment, a systematic process was undertaken to identify and evaluate several alternative combinations of remedial actions for managing current and future site risks. This process entailed identifying remedial action objectives, and then evaluating various remedial alternatives to meet these objectives. This remedy selection process resulted in the identification of the preferred alternative.

Remedial Action Objectives

Remedial action (or cleanup) objectives are goals established to protect human health and the environment in accordance with regulatory requirements. The following remedial action objectives were developed by USDOE/NNSA, EPA, and TCEQ for remediation at Pantex Plant.

Soil Cleanup Objectives

- Reduce the direct-contact risk to onsite industrial and construction/excavation workers through removal, treatment, or prevention of contact with contaminants in the soil.
- Reduce potential impact to perched groundwater and the Ogallala Aquifer through source control and stabilization measures in the deeper soils.

Installation of piping and manifold for a soil vapor extraction system at Pantex

Tankers of food grade soybean oil and lactic acid to be injected into the perched groundwater to create an enhanced anaerobic bioremediation zone

Groundwater Cleanup Objectives

- Reduce the risk of exposure to perched groundwater through contact prevention.
- Achieve cleanup standards for all contaminants in perched groundwater at the property boundary and/or areas sensitive to downward migration (areas where the fine-grained zone contains more sand or is thinner, such that water can move through the fine-grained zone over a period of time).
- Prevent growth of contaminant plumes in the perched groundwater.
- Prevent contaminants from exceeding drinking-water standards in the Ogallala Aquifer.

Groundwater cleanup objectives were developed to address two separate groundwater issues: (1) restoration of perched groundwater to drinking-water standards at the property boundary and/or areas sensitive to downward migration, and (2) protection of the Ogallala Aquifer. While the remedial action alternatives address both objectives, protection of the Ogallala Aquifer is the primary goal of implementing remedial actions for groundwater at Pantex Plant.

Achieving Cleanup Objectives

Cleanup objectives for soil and groundwater can be met by a combination of the following:

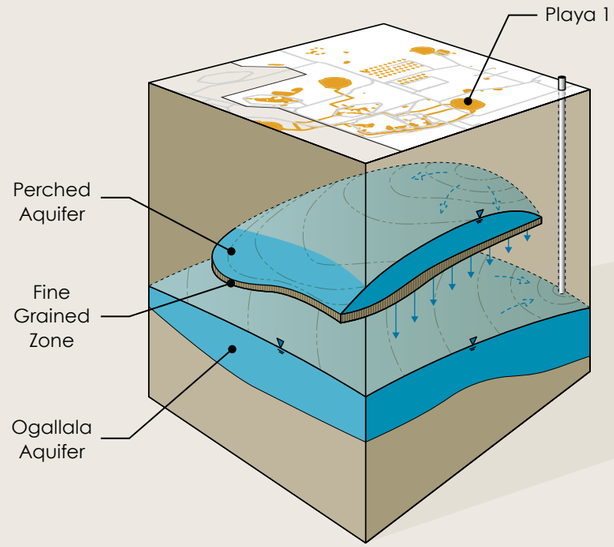
- Reducing the concentrations of contaminants in soil and groundwater to levels at or below cleanup standards
- Reducing the saturated thickness of the perched groundwater to reduce future downward migration of contaminants to the Ogallala Aquifer
- Breaking the exposure pathway to eliminate exposure to the contaminated media.

Cleanup standards for soil and groundwater were determined using information about the expected use of the land (industrial use at Pantex Plant), the highest beneficial use of the groundwater (drinking water in the surrounding area), and associated potential receptors (Pantex workers and surrounding neighbors).

Protecting the Ogallala Aquifer

The Ogallala Aquifer is the primary source of drinking and irrigation water in the region and for Pantex Plant. The actions implemented to treat contaminants in perched groundwater also serve to protect the Ogallala Aquifer as a drinking-water source.

Monitoring of groundwater in the Ogallala Aquifer is required to verify that remedial actions for perched groundwater are effective at protecting the Ogallala Aquifer as a source of drinking water. Pantex currently monitors the aquifer by regularly collecting samples from an extensive well network. The monitoring results are reviewed at least quarterly as part of the reporting requirements for RCRA and CERCLA, and the effectiveness of the remedial actions chosen for the Record of Decision are also reviewed every 5 years to ensure that the remedial action objectives are being achieved.



The long-term groundwater monitoring program also includes a contingency plan to define the process for determining and implementing future response actions for the Ogallala Aquifer, in the event that contaminants in perched groundwater reach the Ogallala Aquifer (see Groundwater Contingency Plan side bar on p. 8). These response actions would be implemented to protect human health and address any confirmed impacts to the Ogallala Aquifer, should they occur.

Irrigation is the primary use of water from the Ogollala Aquifer in Texas (photo from USGS)

Criteria for Evaluating Remedial Alternatives

Remedial action alternatives were evaluated against three general types of criteria, consistent with CERCLA and RCRA requirements.

Threshold Criteria

The following criteria must be met for an alternative to be considered as a preferred alternative:

- Overall Protection of Human Health and the Environment
- Compliance with Applicable or Relevant and Appropriate Requirements

Balancing Criteria

The following criteria are the primary factors taken into account when comparing the alternatives:

- Long-Term Reliability and Effectiveness
- Reduction of Toxicity, Mobility, or Volume of Waste
- Short-Term Effectiveness
- Implementability
- Cost

Modifying Criteria

The following criteria involve consideration of State and public concerns that may modify the alternatives proposed for the site:

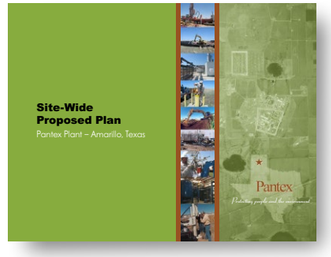
- Public Acceptance
- Regulatory Acceptance

Threshold Criteria and Balancing Criteria were evaluated in the Corrective Measures/ Feasibility Study (see CERCLA/RCRA Cleanup Process sidebar on page 3). The Modifying Criteria were evaluated after the public comment period.

SAMPLE COMPARATIVE ALTERNATIVES ANALYSIS

The alternative evaluations for each release unit was summarized in a table. Each table lists all alternatives evaluated, identified if the alternative satisfied the threshold criteria, provided an evaluation of how well the alternative satisfied each of the balancing criteria, and showed the net present cost of implementing the alternative.

List of Alternatives	Threshold Criteria		Balancing Criteria						
							Cost		
	Protective of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, or Volume of Waste	Short-Term Effectiveness	Implementability	Capital	Total O&M	Total Cost
Alternative 1: No Action			Relative Ranking Scale Least Effective … Most Effective				None		
Alternative 2	✓	✓					$	$$	$$$
Alternative 3	✓	✓					$$	$$	$$$$
Alternative 4	✓	✓					$$	$$$$	$$$$$$

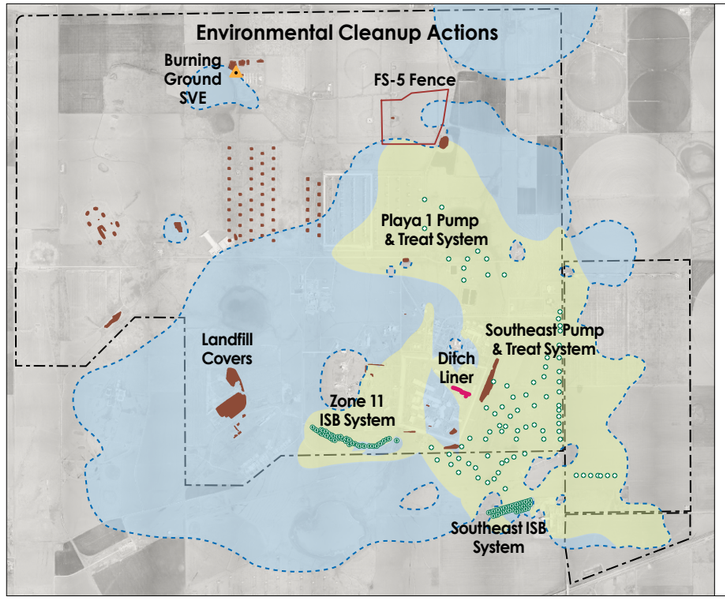


Additional details on the Remedial Action Objectives and the methods and results of the remedial action alternatives evaluation are presented in the *Site-Wide Proposed Plan* available in the Administrative Record File, USDOE/NNSA Reading Room, or online at pantex.energy.gov.

The chosen remedies were documented in the Record of Decision and Compliance Plan.

Remedial Actions

Pantex has implemented several types of actions to clean up and restore perched groundwater and soils. Collectively referred to as "remedial actions," those at Pantex Plant have reached a stage of long-term stewardship and environmental restoration. That is, the remedies have been installed and are now being operated, maintained, and monitored to achieve remedial action objectives. The remedial actions will restore land and groundwater to environmentally healthy conditions.



Groundwater Remedies:

2 Pump and 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:

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

Pantex Plant
Extent of Perched Groundwater
Extent of Perched Contamination

The current, active remedial action for perched groundwater at Pantex Plant involves the operation of two types of cleanup technologies: (1) groundwater extraction and treatment (pump and treat) in two areas, and (2) enhanced biological breakdown (*in situ* bioremediation, or ISB) of contamination in two areas. A summary of how these technologies work is provided below. In addition, groundwater remedial actions have also included a network of wells to monitor the long-term performance of the remedy and the natural degradation of contamination in groundwater (monitored natural attenuation, or MNA).

The current, active remedial action for soils at the site uses a technology called soil vapor extraction (SVE) to remove volatile organic compounds (VOCs) from soils at the Burning Ground area. The remedial actions for soil have also included soil removal, containment of non-hazardous waste in landfills with maintained clean-soil covers, fencing to control access and use of areas with contaminated soil, and liners in two drainage ditches to block leaching of soil contamination into groundwater.

The remedial actions for groundwater and soil also incorporate "institutional controls." Institutional controls are non-engineered tools, such as administrative and/or legal controls, that minimize the potential for human exposure to contaminants by limiting land or resource access and use. Examples of institutional controls include land and natural resource access and use restrictions, groundwater drilling and well restrictions, deed restrictions, deed notices, property purchase, and education.

Perched Groundwater Cleanup Considerations

The perched groundwater beneath Pantex Plant is not a continuous aquifer like the Ogallala Aquifer, so cleaning up the perched groundwater presents some challenges. To address these challenges, Pantex created an Innovative Technologies Remediation Demonstration (ITRD) Project Group that evaluated possible technologies for use in the final remedy for the perched groundwater. This group guided laboratory and field-scale pilot studies to determine the most reliable technologies that can reduce or stabilize contamination to meet cleanup requirements.

Selecting and designing the best cleanup technologies for each of the two areas of perched groundwater contamination (Southeast plume and Zone 11 plume) included careful consideration of the following features of perched groundwater at the site:

- The perched groundwater becomes very thin near the outer edges of the aquifer (to the east and south of Pantex Plant). This prevents the use of pump-and-treat technologies in these areas.
- Perched groundwater has some thicker saturated zones (more than 15 feet) that allow treatment using pump-and-treat technologies. However, not all of the perched groundwater is thick enough to effectively pump and treat.
- The perched groundwater zone is deep (about 260 feet below ground surface), and some areas of the fine-grained zone are thin, making it difficult and unsafe to implement some technologies, such as horizontal drilling.
- Mounded water beneath Playa 1 continues to push perched groundwater away from the playa and toward offsite areas.
- *In situ* treatments (treatment within subsurface groundwater) are costly to implement, and not all such technologies work efficiently under the chemical and geologic conditions found in the perched groundwater beneath Pantex Plant. The ITRD Project evaluated several *in situ* treatment technologies.
- The plume of contaminated perched groundwater associated with Zone 11 is much smaller than the Southeast plume and contains fewer contaminants.
- The Zone 11 plume contains some contaminants that are not found in the Southeast plume, so not all treatment options are applicable in both areas.

Wildflowers at Playa 1



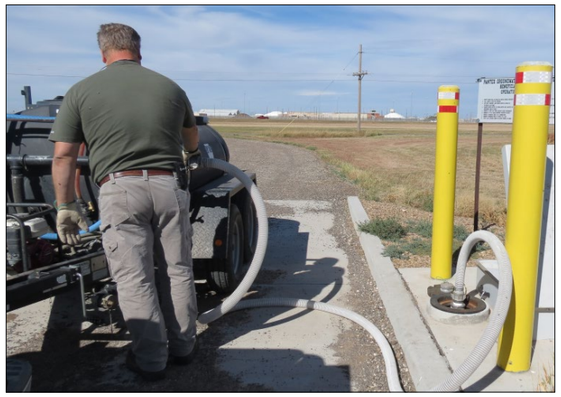

Remedial Actions for Perched Groundwater

As mentioned previously, two technologies are being operated at Pantex Plant as part of the remedial actions to clean up perched groundwater: (1) groundwater extraction and treatment (pump and treat) in two areas, and (2) enhanced biological breakdown (*in situ* bioremediation, or ISB) of contamination in two areas.

Pump-and-Treat Systems

Pump and treat, as its name implies, consists of extracting affected groundwater from the perched zone by pumping through a well and then treating it with a system designed to remove or reduce the contaminants to levels that are protective of human health and the environment. Two pump-and-treat systems are in operation at Pantex Plant: the Southeast Pump and Treat System (SEPTS) and the Playa 1 Pump and Treat System (P1PTS). The SEPTS addresses the southeastern portion of the perched groundwater plume. It has been operating since 1995, and has been expanded over the years by adding more extraction wells and the capacity to treat boron and hexavalent chromium. The SEPTS also has the capability to inject the treated water back into the perched aquifer when beneficial use of treated water is not possible. The P1PTS was installed more recently and became fully operational in January 2009.

Granular Activated Carbon Tanks and Sediment Filters at SEPTS



Bulk Water Station at SEPTS

Pantex pump-and-treat systems are designed to extract water and remove contaminant mass from the water before the effluent is beneficially used by the wastewater treatment facility (WWTF) and irrigation system for general Pantex Plant needs, or for amendment injections at the *in situ* bioremediation (ISB) systems (discussed below). The systems treat the water by passing it through a series of granular activated carbon tanks to remove organic contaminants, including high explosives and solvents. Metals such as hexavalent chromium and boron are removed by passing the water through tanks that contain small beads that attract these metals (ion exchange resin beds). The treatment systems reduce contaminants in the extracted water to concentrations that are safe for residential use (the most stringent regulatory standards), before the water is sent for non-residential beneficial uses. Operational priorities for pump-and-treat systems emphasize achieving beneficial use of the treated water.

The pump-and-treat systems are also designed to remove water from the perched aquifer, reducing the total volume of perched groundwater and the thickness of the perched groundwater zone. This reduction in groundwater zone thickness reduces migration of contaminants both vertically and horizontally, so that natural breakdown processes can occur over time. Reducing migration provides protection for the underlying Ogallala Aquifer.




In Situ Enhanced Anaerobic Bioremediation

In Situ Enhanced Anaerobic Bioremediation (ISB) is a remediation process that enhances the natural environment, so that microbes that live in the groundwater will use the contaminants as a source of food and energy, turning the contaminants into common gases such as methane, hydrogen, and carbon dioxide. Microbes are very small organisms, such as bacteria. Proper nutrients and conditions must be present for microbes to grow, multiply, and degrade more contaminants. To maintain the enhanced microbial environment, amendments (nutrients and other chemicals) are injected through wells into the groundwater to create a "treatment zone" of stimulated growth and activity of contaminant-metabolizing bacteria (microbes) living in the groundwater.

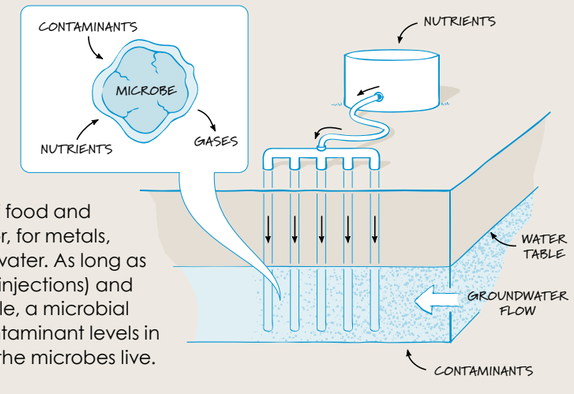
Bioremediation can occur "aerobically," which relies on the presence of oxygen for the microbe to use, or "anaerobically," which takes place in the absence of oxygen and uses something other than oxygen (for example, nitrate, iron, manganese, sulfate) to foster microbial degradation of contaminants. ISB in the perched groundwater at Pantex Plant is anaerobic, which can be used when the contaminants are highly chlorinated compounds, munitions, perchlorate, and hexavalent chromium. In anaerobic bioremediation, the microbes may metabolize the contaminant in a respiratory process. Note that metals, such as chromium, cannot be destroyed through bioremediation. Rather, microbes support the reduction of hexavalent chromium to trivalent chromium, lowering its ability to be dissolved in water and causing it to precipitate out of the groundwater.

Injecting amendment into perched groundwater to create a permeable treatment zone

The groundwater remedial action at Pantex Plant includes two ISB systems (Zone 11 ISB and Southeast ISB) that consist of 94 injection wells used to inject amendments for enhancing growth of microbes and 13 downgradient monitoring wells used to monitor the effectiveness of the treatment zone. The amendments injected include soybean oil and lactic acid. The Southeast ISB was installed in the southeast area of the plume on Texas Tech University property. The Zone 11 ISB was installed to intercept contaminants moving toward the Texas Tech property to the south and to address multiple contaminants that are treatable with ISB technology. The primary contaminants being degraded by the Zone 11 ISB are trichloroethylene (TCE) and perchlorate. The primary contaminants being degraded by the Southeast ISB are RDX and hexavalent chromium. It is expected to take several years of treatment to restore perched groundwater as the contaminant plumes move through the ISB treatment zones.

How Does it Work?

***In Situ* Enhanced Bioremediation (ISB)** involves injecting amendments and nutrients into the groundwater to create a zone of stimulated growth and activity of bacteria (microbes) living in the groundwater. Indigenous microbes or added microbes are identified that use contaminants as a source of food and energy, converting them into common gases or, for metals, into a form that precipitates out of the groundwater. As long as optimal subsurface conditions (maintained by injections) and a food source (the contamination) are available, a microbial community can be sustained that reduces contaminant levels in groundwater passing through the zone where the microbes live.






Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is the reliance on natural processes to reduce (attenuate) levels of contaminants. Natural attenuation processes include a variety of physical, chemical, and biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, and/or concentration of contaminants.

Research is being conducted to determine the type of attenuation that is occurring naturally in groundwater at Pantex Plant, as well as its rate and spatial variability. It is expected that, in areas outside the influence of the pump-and-treat and ISB systems, natural attenuation will continue to reduce levels of contamination and keep them below levels of concern. Long-term monitoring will continue to ensure that MNA is achieving groundwater protection standards.

Long-Term Groundwater Monitoring

A long-term monitoring (LTM) network was developed to evaluate the effectiveness of the remedial actions, and Pantex Plant made the transition to the LTM in July 2009. The LTM is used to (1) ensure that the remedial system is effectively stabilizing plumes and meeting remedial action objectives, (2) detect any new chemicals of concern that may be released from source areas or discovered in the Ogallala Aquifer, and (3) evaluate the presence and amount of natural attenuation that may be occurring in the groundwater plumes. The monitoring information is evaluated and reported in annual and quarterly progress reports, which can be found at pantex.energy.gov.

Sampling technician measuring depth to water

GROUNDWATER REMEDY

Southeast Perched Groundwater

- Continue extraction of perched groundwater in the Southeast area and at Playa 1 to remove contaminants (pump and treat), and to stabilize plume migration.
- Discontinue, to the extent possible, injection of treated water back into the perched zone.
- Continue enhanced *in situ* anaerobic bioremediation to establish permeable treatment zones in the perched groundwater south of Pantex Plant, to prevent downward movement of contaminants to the Ogallala Aquifer.
- Implement institutional controls to prohibit extraction and use of untreated groundwater.
- Monitor the natural attenuation occurring in areas where engineered treatment technologies are more difficult and costly to implement, and where contaminants are not expected to migrate to the Ogallala Aquifer for long periods of time, allowing time for natural attenuation to reduce contamination.
- Monitor the perched groundwater and Ogallala Aquifer to verify plume stability, effectiveness of the treatments, and natural attenuation processes.

Zone 11 Perched Groundwater

- Implement the *in situ* bioremediation treament to reduce contaminants in perched groundwater to levels that are safe for human health and the environment.
- Use institutional controls to restrict groundwater extraction and use.
- Monitor the natural attenuation of contaminants after *in situ* treatment of the most highly contaminated portion of the plume has ended. Slower movement of perched groundwater to the Ogallala Aquifer near Zone 11 allows more time for natural breakdown to occur.
- Monitor the perched groundwater and Ogallala Aquifer to verify the effectiveness of the treatment and natural attenuation processes.




Remedial Actions for Soils

The current active remedial action for soils at Pantex Plant uses a technology called soil vapor extraction (SVE) to remove volatile organic compounds (VOCs) from soils at the Burning Ground area, along with containment of non-hazardous waste in landfills with maintained clean-soil covers, fencing to restrict access to contaminated soils at Firing Site 5, and liners in two drainage ditches to block leaching of soil contamination into groundwater.

Burning Ground Soil Vapor Extraction

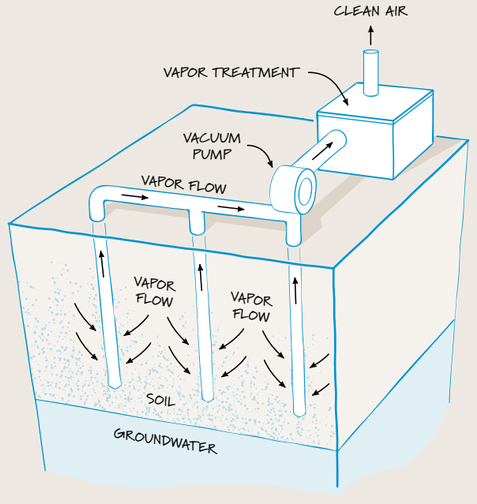
Soil vapor extraction (SVE) is a process that physically removes volatile contaminants from subsurface soil by using a vacuum to move air through the soil. The moving air strips volatile contamination from the soil as vapor and carries the vapor through vacuum extraction wells to a treatment system that burns (oxidizes) the contamination. Based on successful experience with SVE at many sites, EPA has designated SVE as a preferred remedy (called "presumptive remedy") for Superfund sites with VOCs in soil.

SVE System at Burning Ground

An SVE system was installed and has been operating at the Burning Ground since February 2002. After a large-scale system completed remediation of a large area at the Burning Ground, a small-scale system using activated carbon to remove contaminants in the extracted vapor was installed in late 2006. The activated carbon system was replaced in 2012 by the current system, which uses a small-scale catalytic oxidizer and wet scrubber to remove contaminants from the extracted vapor. This system continues to focus on treating contamination at a single well where soil gas concentrations remain high.

How Does it Work?

In soil vapor extraction (SVE), moving air strips volatile contamination from the soil as vapor and carries the vapor through vacuum extraction wells to a treatment system that removes the contamination.



Landfill Containment

Containment is achieved by placing a cover over designated materials to prevent human contact and to reduce leaching of chemicals from the contained materials by properly channeling the drainage of rain water. Containment is the EPA's presumptive remedy for municipal and industrial waste landfills at Superfund sites. Landfills, found in many areas across Pantex Plant, include construction debris (from demolition of buildings) as well as sanitary and industrial waste from the former Pantex Ordnance Plant and from Pantex Plant. A cover has been installed on each landfill, consistent with EPA's presumptive remedy for landfills. Removal of contaminated soil hotspots was also conducted at some landfills. Pantex regularly inspects and maintains soil covers on landfills to prevent infiltration of water into the landfill contents, and migration of contaminants to groundwater.

Vegetative cover on Landfill 1

Ditch Liner in Zone 12

Drainage Ditch Liners

Liners have been placed onto the land surface in two drainage ditches at Pantex Plant that received effluent from the former high explosive processing facility and released to the Zone 12 main ditch. Contaminants in the soil in these ditches pose a direct-contact risk to onsite industrial and construction/excavation workers and have the potential to leach into perched groundwater. High-density plastic liners have been installed in these two ditches to prevent worker contact and leaching. In addition, Pantex requires prior authorization for any activities that may involve disturbing or drilling of areas with soil covers or liners.

Firing Site 5

Pantex completed an interim corrective action at Firing Site 5 that included excavation and offsite disposal of nearly 1,800 cubic yards of contaminated soil, decontamination and demolition of the facilities, and backfilling the area inside the berm with clean soil. This work removed the contaminated soil that represented the majority of the risk at Firing Site 5, and the remaining contaminated soil is distributed across the entire area of the former firing site. The remedial action includes a vegetative cover to minimize windblown dust dispersion, to protect workers and offsite residents. Access to the firing sites, including Firing Site 5, is highly restricted. The remedial action also includes fencing to prevent unauthorized access to the area. Workers are present only during mowing that is conducted to control fire risk. Again, Pantex requires prior authorization for any activities that may involve disturbing or drilling of areas with soil covers.

SOIL REMEDY

Burning Ground Soil Vapor Extraction

- Soil vapor extraction (SVE)
- Institutional controls to limit deep drilling in these areas.

Pantex Plant Landfills

- Containment, soil covers, vegetation (grass).
- Inspection and maintenance of covers to ensure effective water drainage away from the landfill.
- Institutional controls to limit worker activity and excavation in the landfill and to help protect the long-term integrity of the landfill covers.

SWMUs 2 and 5-05 Drainage Ditches

- Installation and maintenance of plastic ditch liners to reduce worker risk and limit infiltration of rainwater and leaching of contaminants in soil to the perched groundwater.
- Institutional controls to limit worker activity and future use of the ditches for stormwater only.

Firing Site 5

- Soil removal and facility decontamination and demolition.
- Fencing and institutional controls to prevent unauthorized access, limit worker activity (such as excavation), and maintain or prevent disturbance of vegetative cover.

Disturbance of release units prohibited without authorization

Remediation Accomplishments

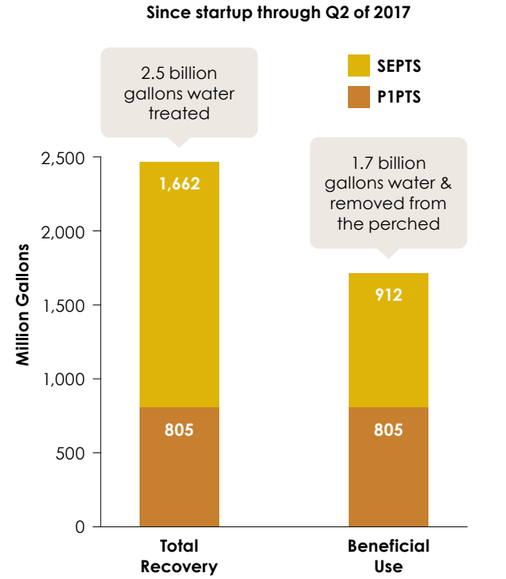
Pantex has made significant progress toward environmental remediation and restoration of the site. An important remediation accomplishment is the removal of substantial amounts of contamination from soil and groundwater. As a result, sources of contaminants in perched groundwater are being reduced, concentrations are reaching groundwater protection standards, and the Ogallala Aquifer is being protected.

The pump-and-treat systems at Pantex Plant have treated an average of 230 million gallons of water and removed an average of 1,000 pounds of contaminants per year since the start of the remedial action. As of 2017, Pantex has treated 2.5 billion gallons of affected perched groundwater, removing about 14,000 pounds of contaminants. Pantex has beneficially used about 71% of the treated water since 1995. The saturated thickness of the perched groundwater is declining by about 1 foot or more per year in the areas influenced by the pump-and-treat systems.

Preparing for injection of amendment to create a permeable treatment zone in perched groundwater.

The Burning Ground SVE system began operation in 2002 as a large-scale catalytic oxidizer (CatOX) system. Due to a large reduction in VOC concentrations, a small CatOX system has been operating at the Burning Ground SVE system since April 2012. Through Q2 of 2017, the SVE system has removed 19,147 pounds of VOCs from soil since it was brought online.

Areas of Pantex Plant that have soil covers have been restored to a natural vegetative state using native grasses and flowers. A synthetic landfill cover, ClosureTurf™, has been installed on Landfills 1 and 2.



The Southeast ISB system has reduced high explosives and hexavalent chromium concentrations to levels below groundwater protection standards at all but one downgradient monitoring well. The Zone 11 ISB system has reduced perchlorate and TCE concentrations to levels near or below groundwater protection standards at most wells.

ClosureTurf™ installation

Next Steps

Long-Term Stewardship and Continued Community Involvement

Pantex will continue to operate, maintain, and monitor the groundwater and soil remedies at the site for the foreseeable future as part of its long-term monitoring and environmental stewardship at Pantex Plant. As any important issues arise, Pantex continues to notify the public through mailings, public meetings, public workshops, poster sessions, community group presentations, the Pantex website, and the news media. Neighbor Newsletters will be published at least annually to provide the local community with general information and news from the Plant, as well as progress of the remedial actions. Annual public meetings will also be held to provide an opportunity for the public to be informed and involved in the remedial actions. As the project nears decision-making points for cleanup, closure, and long-term environmental stewardship, Pantex will continue to employ innovative methods for communicating and developing strong community involvement and support.

As discussed previously, a long-term groundwater monitoring system was designed in conjunction with the TCEQ and EPA. Pantex continuously monitors groundwater for:

- **Plume stability** – Pantex evaluates the plumes to determine whether they are stabilizing and responding to treatment or continuing to spread.
- **Remedial action effectiveness** – Pantex evaluates the concentrations in the immediate vicinity and downgradient of the treatment system to determine whether the systems are effectively treating or removing contaminants as expected. Pantex also evaluates whether water levels are declining as expected, to prevent the movement of contaminated groundwater to areas that could allow migration to the Ogallala Aquifer.
- **Uncertainty management in groundwater and at the source areas** – Pantex evaluates data to determine whether the source areas are being depleted of contaminants as expected, and to confirm that no new contamination has moved into the perched groundwater.
- **Early detection in the Ogallala Aquifer** – Pantex evaluates Ogallala wells at points where break-through could occur upgradient of water sources.
- **Natural attenuation of contaminants** – This process is monitored at Pantex to help determine where natural attenuation is occurring and under what conditions, and to possibly determine a rate of attenuation. In areas that are difficult to treat, natural attenuation is evaluated to determine whether it is a viable remedial option.

November 2017 Public Meeting

Pantex is also subject to reviews every five years of the status and progress of remedial actions. The second Five Year Review was started in 2017, with a final report scheduled for September 2018. These reviews evaluate whether:

- Remedial actions are performing as designed
- Data used to select the remedial actions are still valid
- Remedial actions are currently protective and will remain protective of human health and the environment.

Recent Remedial Action Improvements

Through continuous evaluation of the clean-up operations, Pantex recently determined that certain areas of affected perched groundwater were not responding to the clean-up systems that are in place. Pantex took several steps to determine where problems were occurring, by drilling new wells in 2016 and 2017. The new wells revealed an area of water that ranges from 2–14 feet in thickness, to the southeast near Highway 60, that was previously believed to be dry. Evaluation of sampling data also revealed that the water contains high explosives, indicating that the affected perched groundwater has moved to the southeast. As a result, Pantex has begun preparing for further drilling and extension of the Southeast ISB System into this area. Additionally, the Southeast Pump and Treat System is being expanded to another area east of FM 2373 to capture the water that continues to move to the southeast.

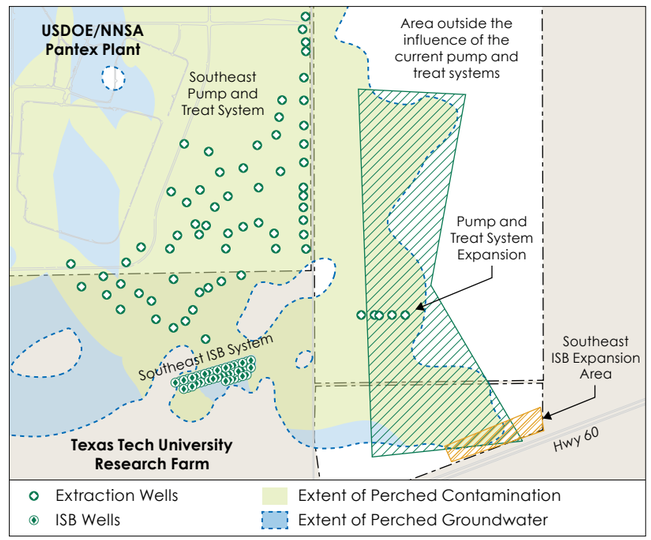
How Are Uncertainties About The Remedial Actions Managed?

The extensive and comprehensive environmental investigations and modeling done at Pantex Plant have provided a confident basis for designing an effective set of remedial actions. However, as with any prediction of future environmental processes, uncertainties remain that need to be managed to ensure that cleanup and restoration goals are achieved. Pantex manages these uncertainties through the long-term groundwater monitoring system and proactive contingency actions. There are wells in the long-term groundwater monitoring system that are located specifically to detect changes that indicate unexpected conditions and provide data to reduce uncertainty about predicted source and plume behavior and remedy performance.

For example, the predictions of potential future impacts to the Ogallala Aquifer were evaluated under baseline conditions, but these predictions have some uncertainty, in that they did not consider the potential effects of the perched groundwater pump-and-treat system or naturally occurring degradation rates. Pantex Plant has adopted a proactive strategy to address these uncertainties by locating long-term groundwater monitoring wells where they will detect potential changes in conditions that may lead to impacts to the Ogallala Aquifer, and take contingency actions to eliminate the source and mechanisms of these potential impacts before they occur.

This approach to uncertainty management resulted in the recent expansion of the remedial action for the southeast perched groundwater. Over time, long-term monitoring data will reduce uncertainty to a level at which there will no longer be a potential for that uncertainty to significantly affect the achievement of remediation goals. Until then, careful monitoring and proactive contingency actions will ensure remedial action effectiveness and protection of human health, the environment, and the Ogallala Aquifer.

Studies are under way to evaluate improvements to the remedial actions. For example, Pantex is evaluating options for additional beneficial uses of treated water from pump-and-treat systems, which would further reduce the amount of water recharging the perched aquifer. Pantex is also undertaking a study to evaluate the effectiveness of transitioning to MNA as a long-term remedy for RDX in the perched groundwater. Based on monitoring data for the Zone 11 ISB System, Pantex is optimizing the frequency of injection in the original portion of the system, as well as the expanded portion to the northwest. Finally, Pantex will be addressing erosion observed at Landfill 3, to maintain the integrity of the soil cover. These types of activities will continue into the future, as necessary, to ensure that the ongoing remedial actions remain protective of human health and the environment.



Groundwater Remediation System Expansion

Access to Supporting Materials

USDOE/NNSA encourages community involvement to ensure that the preferred remedial action alternatives for soil and groundwater contaminants at Pantex Plant incorporate community needs and protect human health and the environment.

Documents and reports used to develop this Environmental Cleanup and Restoration booklet can be found in the Pantex Administrative Record:

USDOE/NNSA Pantex Plant
Highway 60 and F.M. 2373, Amarillo, TX 79120

Phone: (806) 477-3800

Hours: *By appointment*
Monday – Thursday
8:00 am – 4:00 pm

USDOE/NNSA maintains a reading room at the Amarillo Downtown Public Library that allows the public easy access to unclassified documents concerning Pantex and other DOE facilities. Copies of final reports related to the environmental restoration program are available in the reading room. Some documents are also available on the internet at pantex.energy.gov (> Mission > Environment).

Amarillo Downtown Public Library
413 SE. 4th Avenue, Amarillo, TX 79101

Phone: (806) 378-3054

Hours: Mon – Thur 9:00 am – 9:00 pm
Fri – Sat 9:00 am – 6:00 pm
Sun 2:00 pm – 6:00 pm

The following key documents were used to put together this Environmental Cleanup and Restoration booklet:

- Baseline Human Health Risk Assessment Summary (2007)
- Ecological Risk Assessment Summary (2007)
- Site-Wide Proposed Plan (2008)
- Annual Progress Report – Remedial Action Progress (2016)
- Annual Site Environmental Report – Pantex Plant (2016)
- Pantex Plant Environmental Restoration/Long-Term Stewardship Project Community Involvement Plan (2017)
- Environmental Fact Sheets (2017):
  - Groundwater Monitoring
  - *In Situ* Groundwater Bioremediation Systems
  - Extension of Southeast *In Situ* Groundwater Bioremediation System
  - Perched Groundwater Pump and Treat Systems

For additional details regarding the ongoing environmental cleanup and restoration efforts at Pantex Plant, please visit pantex.energy.gov (>Mission > Environment) to view the most recent editions of the following reports:

- Remedial Action Progress Reports:
  - Quarterly
  - Annual
  - 5-year Review
- Site Environmental Reports
- Public Meeting Slides
- Public Newsletters

Pantex Mission Statement

Pantex Plant, a United States Department of Energy/National Nuclear Security Administration (USDOE/NNSA) facility, has a long-term mission to maintain the safety, security, and reliability of the nation's nuclear weapons stockpile. All work at Pantex is carried out under those overarching priorities: the security of weapons and information, the safety and health of workers and the public, and the protection of the environment.

Consolidated Nuclear Security, LLC (CNS), the management and operating contractor at Pantex, maintains, builds, and retires nuclear weapons in support of our nation's nuclear deterrent. The Environmental Projects Department (EPD) is responsible for the investigation and cleanup of the corrective action units at Pantex Plant. The mission of the EPD is protecting people and the environment through responsible leadership, responsive cleanup actions, and innovative technology.

Additional information can be found at pantex.energy.gov

ACKNOWLEDGEMENTS

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