Pantex
Plant

2023 Annual Progress Report

Remedial Action Progress

In Support of Hazardous Waste Permit 50284 and
Pantex Plant Interagency Agreement

June 2024

Pantex Plant
FM 2373 and U.S. Highway 60
P.O. Box 30030
Amarillo, TX 79120

Pantex
Plant
Remedial
Action
Systems

Unclassified

CERTIFICATION STATEMENT

2023 Annual Progress Report
Remedial Action Progress
Pantex Plant, June 2024

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

6/19/2024

Jimmy C. Rogers
Senior Director
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Consolidated Nuclear Security, LLC

Date

2023 Annual Progress Report
Remedial Action Progress
in Support of Hazardous Waste Permit #50284
and Pantex Plant Interagency Agreement
for the Pantex Plant, Amarillo, Texas
June 2024

Prepared by:
Consolidated Nuclear Security, LLC
Management and Operating Contractor for the
Pantex Plant and Y-12 National Security Complex
under Contract No. DE-NA0001942
with the U.S. Department of Energy/
National Nuclear Security Administration

In accordance with 30 TAC §335.553 (g), this report has been prepared and sealed by an appropriately qualified licensed professional engineer or licensed professional geoscientist.

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E.0 Executive Summary

The Pantex Plant, located in the Texas Panhandle 17 miles northeast of Amarillo, is implementing a remedial action to remediate perched groundwater and soils. Two types of systems have been installed for the groundwater response action: pump and treat systems in two areas and in-situ bioremediation (ISB) systems in four areas. A soil vapor extraction (SVE) system has also been installed to remediate volatile organic compounds (VOCs) in soils at the Burning Ground area. Other soil remedies (i.e., fencing, soil covers, and ditch liners) and institutional controls are also maintained as part of the soil remedy for Pantex.

Annual Progress Report Outline

- Background Information
- O&M of Remedial Actions
- Groundwater Remedial Action Effectiveness
- Soil Remedial Action Effectiveness
- Conclusions and Recommendations

This annual report satisfies requirements in the Pantex Interagency Agreement (IAG) and Hazardous Waste Permit No. 50284 (HW-50284) to provide information on performance of the remedial action systems and components. The focus of this report is the data and information collected for the soil and groundwater remedies during 2023. Data are evaluated according to criteria outlined in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a); HW-50284; the Interagency Agreement effective February 22, 2008; *Land and Groundwater Use Control Implementation Plan* (Pantex and Sapere, 2010); and various operation and maintenance (O&M) plans for the remediation systems.

E.1 Remedial Actions

Pantex has implemented soil and groundwater remedial actions, which are highlighted here:

Groundwater Remedial Actions

Two pump and treat systems:

- Reduce saturated thickness
- Reduce contaminant mass
- Stabilize Plumes

Four ISB systems:

- Reduce contaminant concentrations as groundwater migrates through the treatment zone

Institutional controls:

- Control perched groundwater use and drilling in contaminated areas

Soil Remedial Actions

Ditch liner and soil covers on landfills:

- Protect future groundwater

Institutional controls:

- Protect workers
- Restrict areas to industrial use

SVE system:

- Clean up soil gas and residual non-aqueous phase liquid (NAPL) in the soil at the Burning Ground

Fencing:

- Prevent traffic and control access

E.2 Operation and Maintenance of Remedial Actions

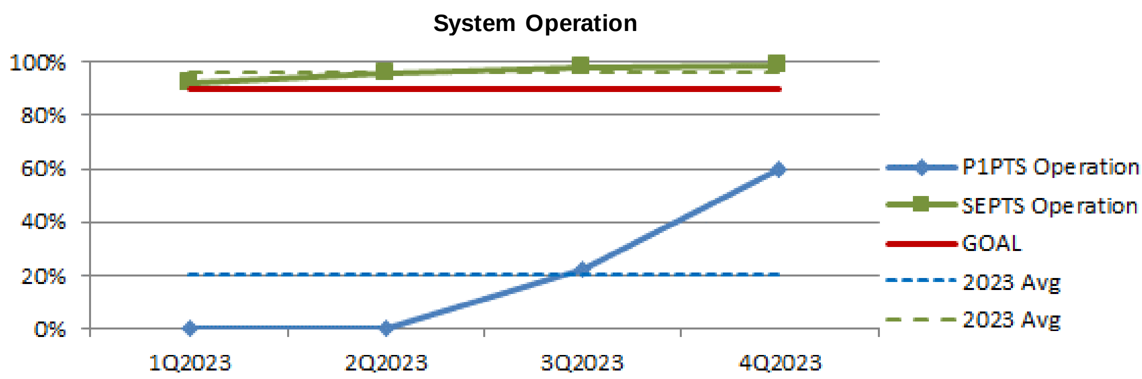
E.2.1 Pump and Treat Systems

Operational goals have been developed to promote mass removal and the continued removal of perched groundwater to reduce the perched aquifer saturated thickness. The first goal of 90% system operation was not applicable at all times during 2023 due to maintenance shutdowns of the systems, shutdown to tie-in the new pivot irrigation system conveyance, and restricted storage capacity of the wastewater treatment facility (WWTF) lagoon. The shutdown for tie-in to the pivot irrigation system conveyance heavily impacted operation of the Playa 1 Pump and Treat System (P1PTS) through August 2023.

During 2023, the average operational rate across 2023 was 21% at the P1PTS and 96% at the SEPTS. Performance of the pump and treat systems for 2023 is depicted in Fig. E-1.

The 90% goal is applicable for the SEPTS during most of 2023, after treatment goals were revised. In accordance with the new goals, P1PTS could not be operated at times due to limited outlets for treated water. SEPTS is fully operated at all times unless there are severely limited treated water outlets. SEPTS provides the primary capture and control of the plumes that are moving to the southeast; therefore, goals have been redefined to ensure this system consistently operates.

The P1PTS was heavily impacted by the shutdown for tie-in to the new pivot irrigation system. The system was tied in by the end of August when the new pivot irrigation system started operating. Although water was still limited to the WWTF through 2023, SEPTS was able to operate fully through most of the year due to the shutdown of P1PTS, and P1PTS was able to operate by sending treated water to the new pivot system once the system was operational.



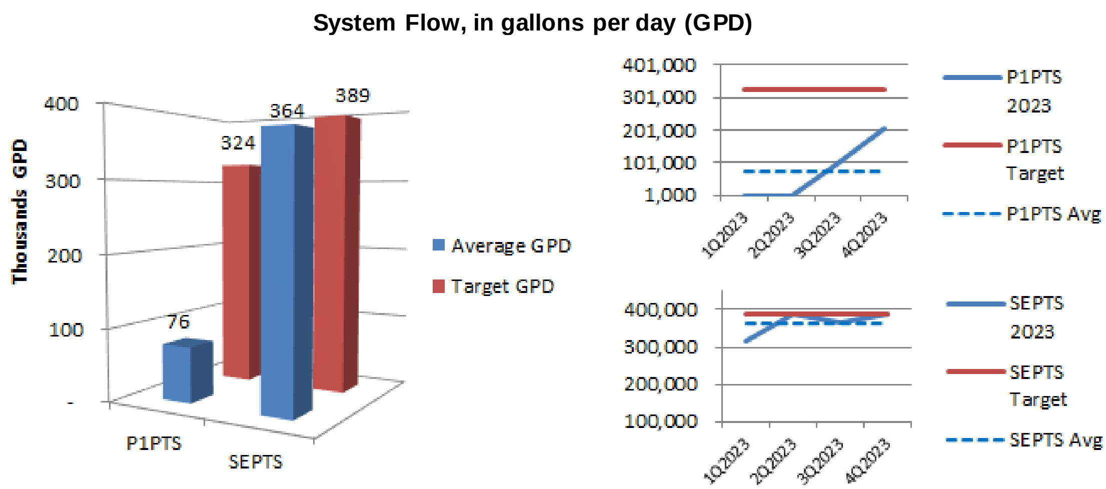
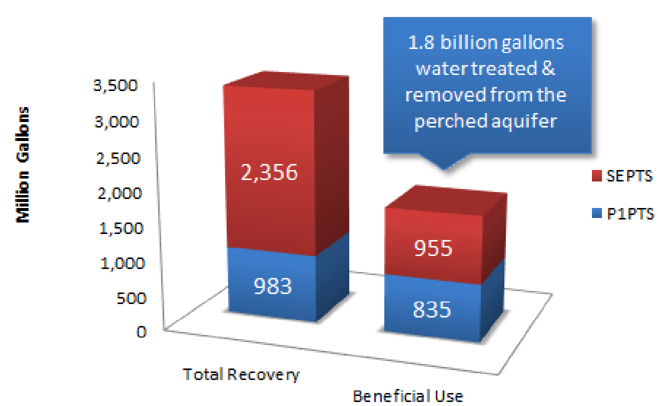


Fig. E-1. Pump and Treat System performance.

P1PTS operation was affected in December 2023 when the pivot irrigation system was shut down due to a break at the wet well. Because WWTF treated water is now routed to Playa 1 due to limited storage capacity resulting from ongoing lagoon repairs, and release to Playa 1 is limited by permit, the P1PTS was shut down.

To better manage treated water, Pantex constructed a new pivot irrigation system east of FM 2373, with the system complete in late August 2023. Additionally, a project was initiated in 2018 to install new injection capabilities near Playa 2, away from the large plumes of contamination in the perched groundwater. That project was completed in February 2022; however, the system was impacted by radio issues that required upgrade and repair. The radio issues were addressed in April 2023, allowing flow to increase at the SEPTS. Together, these two projects provide a long-term solution to treated water management. Pantex may have restricted capacity for treated water at the pivot irrigation system in the winter due to freezing temperatures, but the overall capacity should allow consistent operation of both systems going forward.

In 2023, the systems treated about 160.4 million gallons of impacted perched groundwater. Overall, the systems have operated to treat contamination and reduce saturated thickness. As depicted in Error! Reference source not found., Pantex has treated about 3.3 billion g allons since the startup of the systems, with about 1.8 billion gallons removed and beneficially used. Pantex goals were realigned to ensure continuous operation of SEPTS to capture and control plume migration and reduce saturated thickness. The goals also prioritize beneficial use of water rather than reinjection into the perched groundwater or sending the water to Playa 1. During 2023, only 20.2% of the treated water was beneficially used, 9% was injected back into the perched aquifer, and the rest was sent to Playa 1. Beneficial use of the treated water continued to be heavily impacted by the loss of the subsurface irrigation system operation before August 2023.



In addition to removing impacted water from the perched aquifer, the pump and treat systems remove contaminant mass from groundwater that is extracted from the aquifer. The P1PTS primarily removes the high explosive (HE) hexahydro-1,3,5-trinitro-1,3,5-triazine

(RDX), and the SEPTS primarily removes RDX, perchlorate, and hexavalent chromium, shown as CR(VI) in Fig. E-2 and Fig. E-3. The figures below provide the mass removal for HEs and hexavalent chromium for 2023 as well as totals since startup of the systems.

The SEPTS has been operating longer than the P1PTS, and the greatest concentrations of HEs are found in the SEPTS extraction well field, so mass removal is much higher at that system. During 2023, the SEPTS removed approximately 609 pounds (lbs) of contaminants, and the P1PTS removed approximately 6.5 lbs of contaminants. The systems are also removing per- and poly-fluoroalkyl substances (PFAS). But due to the low concentrations of these contaminants of concern (COCs), only about 1 lb is estimated to be removed per system annually and is not tracked for this reason.

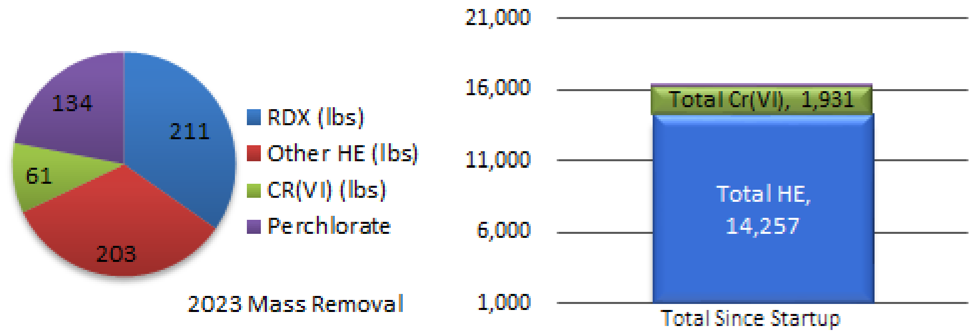


Fig. E-2. SEPTS mass removal.

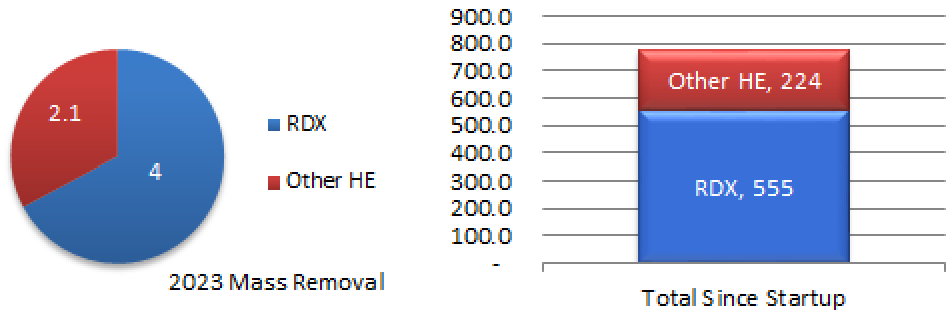


Fig. E-3. P1PTS mass removal.

E.2.2 In Situ Bioremediation Systems

Pantex has four ISB systems installed: Zone 11 ISB, Southeast ISB, Southeast ISB Extension, and Offsite ISB. All but the Southeast ISB were maintained and injected during 2023.

Injection occurred in 70 Zone 11 ISB system wells in 2023, including the newly installed second row wells on the southern side of the system. Pantex continued the use of molasses injection; however, the 26 new 2nd row wells that are more closely spaced were injected with a mixture of Newman Zone® and molasses. The longer-lasting Newman Zone® will not require another injection until 2026.

Results from the treatment zone indicate that conditions between the wells have improved with the use of molasses. The use of molasses has decreased concentrations of trichloroethene (TCE) and perchlorate at the downgradient wells. The downgradient wells are near GWPS, except for two wells that have increasing concentrations. Those wells are downgradient of the new 2nd row of wells, so the downgradient concentrations are expected to decrease with time.

Pantex experienced issues with injection at a portion of the Zone 11 ISB wells; therefore, conditions between those wells was not improving, and response at the downgradient wells was hampered. In 2021, Pantex infilled wells in areas where injection was no longer possible. Injection has occurred in those wells and those areas will continue to be evaluated for improvement. Pantex has also temporarily paused injection in some first row wells to allow recovery of the wells and formation so that the wells can be injected again. This strategy was effective for the PTX06-ISB079 through PTX06-ISB082, as the wells were successfully injected in 2023.

Due to limited water conditions at the Southeast ISB, the system was not injected in 2023. Wells in the treatment zone indicate that HEs and chromium are treated. All but one downgradient monitoring well indicates treatment to the GWPS. PTX06-1153 has not fully responded to changes in injections, indicating only partial treatment of the HEs. Pantex has requested removal of this well from HW-50284, so it may be injected during the next event.

Pantex injected 27 wells with molasses amendment at the Southeast ISB Extension during 2023. Wells in the treatment zone indicate that HEs are treated, but downgradient performance monitoring wells have not yet had time to fully demonstrate treatment. Newly installed extraction wells at the offsite area demonstrate that treated water has arrived in the faster flow paths. The performance monitoring wells are expected to take longer to demonstrate treatment. This system is planned for injection again in 2024.

Pantex injected the Offsite ISB twice during 2023. Thirty-two wells were injected in the spring and 18 wells were injected in the fall. An abbreviated injection was required due to loss of power in portions of the system while infrastructure completion continued, equipment conflicts with other injection events, and the onset of winter conditions. This system is planned for two injections annually through 2036, based on an optimized plan for the offsite remediation. Evaluation of downgradient well data indicates that a treatment zone is being established in areas where multiple injection have occurred and treatment in the heart of the RDX plume has been observed. All HE concentrations are below the GWPS at the downgradient performance monitoring well, indicating the system is preventing further plume growth. The treatment is expected to expand as injections continue at the Offsite ISB.

E.2.3 Soil Remedial Actions

In early 2012, a small-scale catalytic oxidation (CatOx) SVE system was installed at the Burning Ground to address the reduced soil gas plume at the Burning Ground. This small-scale system focuses on treating residual non-aqueous phase liquid (NAPL) and soil gas at soil gas well SVE-S-20.

The system was operated once in 2023 after repairs were completed. Overall operation was approximately 15%. After system repairs, the system operated from September through October before failing again. Fig. E-4 presents the mass removal calculated for the major VOCs contributing to the total VOC composition in 2023, as well as the total mass removed since the SVE system was installed as an interim action in 2002. The system removed about 47 lbs of VOCs during 2023. This system demonstrated significant reductions in influent concentrations beginning in 2020, continuing through 2023. The drop in influent concentrations and removal rates indicate that the NAPL source is near depletion. Pantex prepared a closure report for the system in August 2023, to support removal of the system from HW-50284. The closure report was approved in 2023 and the system was requested for removal from HW-50284.

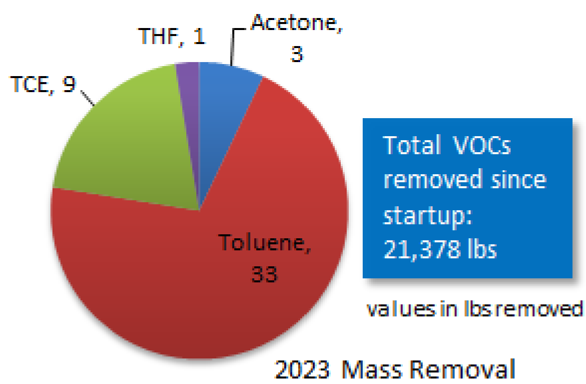


Fig. E-4. Burning Ground SVE mass removal.

In addition to the active soil remediation at the Burning Ground, Pantex maintains institutional controls in accordance with deed restrictions to protect workers and the environment. Pantex provides long-term control of any type of soil disturbance in the solid waste management units (SWMUs) to protect human health and prevent the spread of contaminated soils. Soil covers at the landfills are maintained as issues are identified. Engineered and institutional controls maintenance in 2023 consisted of the following:

- SWMU interference permitting was approved for one new project that required work in a SWMU.
- Pantex completed the control of burrowing animals in specific landfills. Extra soil material was placed in areas where the prairie dogs heavily impacted the cover.
- Extra soil cover was placed on the ash disposal trench at the Burning Ground.
- Extra sand cover was placed on the Closure Turf® at Landfill 1 and 2 for continued protection of the liners.
- Pantex continues to regularly inspect and maintain all soil covers, fences, signs, postings, and ditch liners annually.
- The SWMUs 2 and 5/05 ditch liner indicated continuing issues with sedimentation and a tear in the liner. Pantex contracted for maintenance of the liner, with maintenance complete in May 2023.

Pantex will continue to evaluate the landfills and ditch liner annually and report findings and plans that are developed to address issues. Any problems will be addressed annually through a combination of onsite resources and contracts, based on available funding.

E.3 Groundwater Remedial Action Effectiveness

E.3.1 Plume Stability

Plume stability was evaluated through examination of water level and concentration data. Water levels were used to generate hydrographs and trends for individual wells, maps of water elevations and contours, and water level trends. Concentration data were used to perform concentration trend analysis and were also combined with the water level data to generate plume maps for each COC. The maps and trends together formed the basis for an evaluation of overall plume stability. In addition, a comparison of observed versus expected conditions from the *Long-Term Monitoring System Design Report* (LTM Design Report) (Pantex, 2019a) was conducted as part of the evaluation process.

Overall, calculated concentration and groundwater level trends were consistent with expected conditions defined in the LTM Design Report. Fig. E-5 depicts recent water level trends in the perched aquifer long-term monitoring (LTM) wells.

A total of 46 monitoring wells were expected to have decreasing water level trends, limited water, or dry conditions, as defined in the LTM Design Report. Of these 46 wells, 23 exhibited conditions inconsistent with expected conditions or trends, including 11 wells with recently increasing trends and 12 wells with recent “no trend” conditions. In addition, six wells are exhibiting apparent long-term increasing trends. Most of these wells exhibited recently increasing trends in response to decreased extraction of perched groundwater at P1PTS and release of wastewater to Playa 1. The long-term water level trend is decreasing or not trending for 29 of these wells, and water levels are expected to continue declining.

Four of the remaining wells that have been historically dry or had limited water are now showing fluctuating water levels. The appearance of water in these wells is associated with recharge of stormwater runoff and does not represent the movement of impacted perched groundwater into these areas.

The remaining three wells are located near Playa 1, where reduced extraction of perched groundwater by P1PTS, combined with the release of treated water to the playa, have

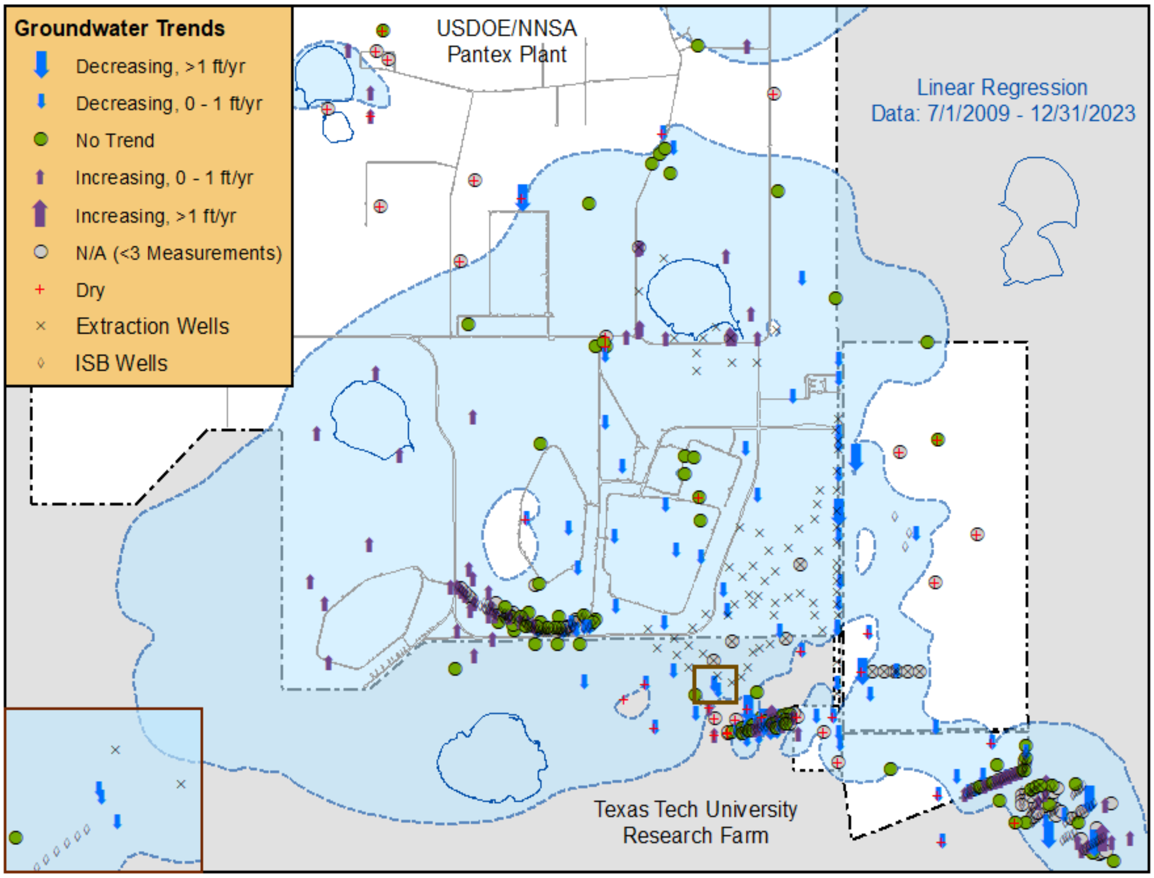


Fig. E-5. Perched Aquifer water level trends.

collectively resulted in short- and long-term increasing trends in these wells. These trends are expected to reverse as long-term operation of the new irrigation system begins.

Of the 117 monitoring wells with expected COC concentration conditions defined in the LTM Design Report, 45 wells did not exhibit trends consistent with expected conditions for the four major COCs (i.e., RDX, hexavalent chromium, TCE, and perchlorate). These trends are anticipated to meet expected conditions as corrective actions continue to operate in the perched aquifer. Fig. E-6 depicts RDX trends since the start of the full remedial action in the perched aquifer LTM wells. Wells in the southeast lobe of the perched aquifer are not yet under the influence of remedial action.

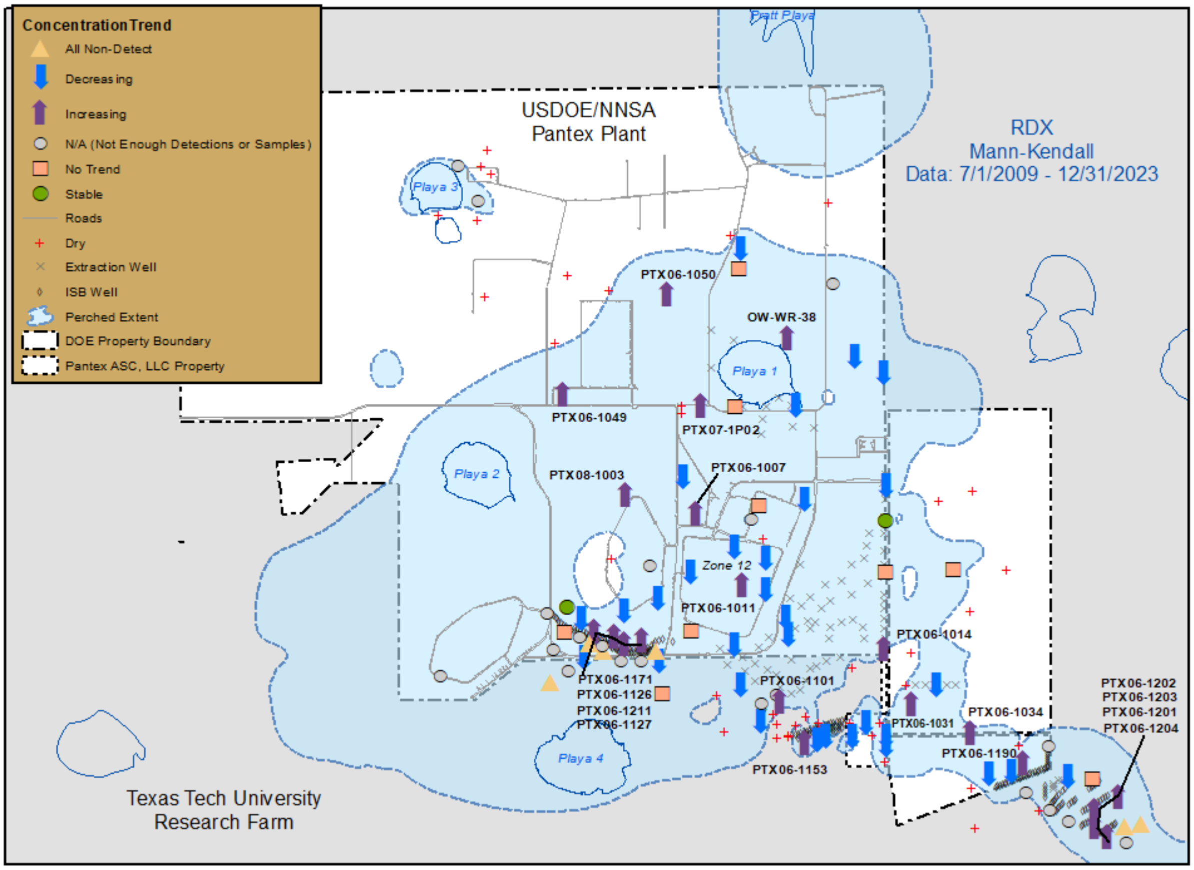


Fig. E-6. RDX trends in the Perched Aquifer.

Generally, 2023's plume shapes are similar to 2009's COC plumes. The greatest differences between the shapes are due to changes in the extent of perched saturation in the extreme southeast lobe of the perched groundwater and HE plumes in that area because of the new information collected from recently drilled wells. Perchlorate has also shifted further to the southeast based on collection of data at more wells and influence of the SEPTS on hydraulic gradients at Zone 11. A shift in the hydraulic gradient eastward in the area between the southern parts of Zones 11 and 12 has allowed perchlorate and TCE to migrate east and southeast toward the SEPTS well field; portions of the perchlorate plume are being actively remediated by the SEPTS at this time. Other changes in plume size and shape were caused by general plume movement downgradient, slight changes in concentrations that define the boundaries of the plumes, newly installed wells, or effects of the pump and treat systems.

Major COC plumes of interest are depicted in Fig. E-7.

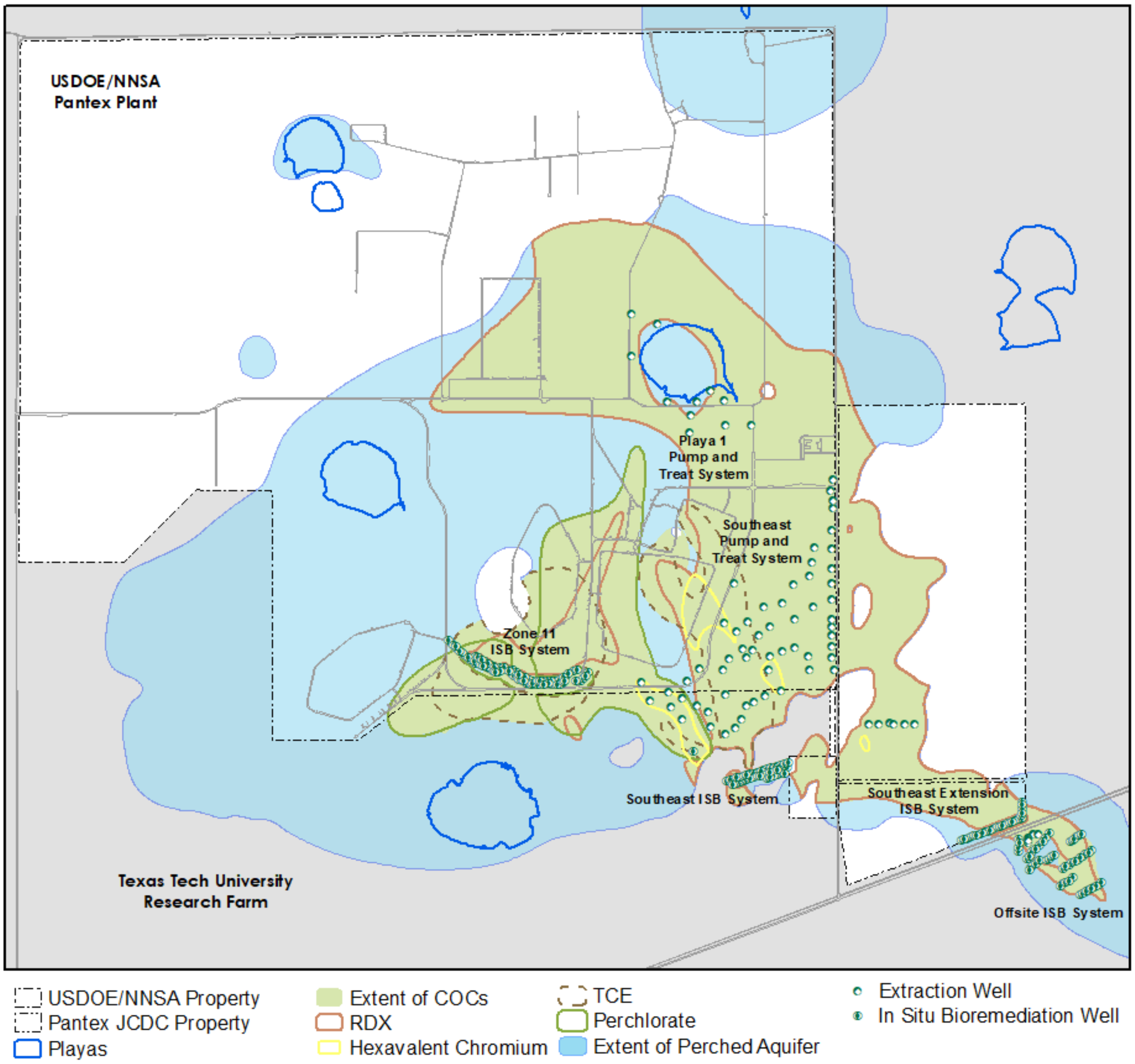


Fig. E-7. Major COC plumes in the Perched Aquifer.

E.3.2 Remedial Action Effectiveness

One goal of the pump and treat systems is to affect plume movement; therefore, a plume stability evaluation can be used to determine the effectiveness of these systems.

The pump and treat systems have continued to be effective in 2023, although their operation was affected by repairs at the WWTF lagoon that limited storage capacity and tie-in to the pivot irrigation system. Prioritized operation of the SEPTS has allowed water and mass to be controlled in critical areas. The SEPTS has altered the groundwater flow direction and gradient at localized areas near the extraction wells in the perched aquifer. When operating, the P1PTS appears to be influencing local water levels and hydraulic gradient in the area near Playa 1. When comparing the 2023 conditions to the LTM Design Report, the majority of expected conditions are being met. Most wells not yet meeting expected conditions are in locations that have not yet been affected by the systems or release of treated water to Playa 1 and P1PTS downtime has impacted water and plume movement near the playa.

The Southeast ISB system data collected in 2023 indicates that it is effectively meeting treatment objectives set in the *Remedial Design/Remedial Action Work Plan* (Pantex, 2009c). Based on geochemical conditions monitored at the treatment zone, the Southeast ISB system has established an adequate reducing zone for the contamination that is present. Two of the closest downgradient monitoring wells for the Southeast ISB (PTX06-1037 and PTX06-1154) demonstrate reductions in RDX, HE degradation products, and hexavalent chromium, resulting in concentrations below the groundwater protection standard (GWPS), with most not detected.

Although PTX06-1153 continues to exhibit RDX concentrations above the GWPS, this well demonstrated signs of partial treatment in 2023, with a decline in RDX and the detection of RDX and breakdown products. However, concentrations remain above the GWPS. Molasses was injected in the treatment zone in 2019 to better distribute amendment. This effort appears to have increased the level of treatment observed at PTX06-1153. As with other locations, water levels at this well continue to decline. Due to declining water levels, the need for future injections will be determined based on data collected at the system.

The Zone 11 ISB system 2023 data indicate that the system has been effective in treating perchlorate and TCE at most downgradient areas. The system has a well-established treatment zone in the original portion of the system where injection has occurred since 2009. Deeper reducing conditions have been established at injection wells within the expansion area, due to increased injection volumes, use of molasses, and repeated injections. The molasses injection has improved conditions between the injection wells across the western side of the Zone 11 ISB; however, some wells have limited ability to accept injection, and those areas will likely continue to demonstrate milder reducing conditions until the wells can be replaced or infilled. Due to this, wells with limited capacity are being paused. Other wells will continue to be injected in the system and evaluation of in-filling additional wells may be necessary in areas where poor performance is observed.

Evaluation of data in the treatment zone wells indicates very mild to strong reducing conditions across the Zone 11 ISB. All wells downgradient of the system have indicated arrival of treated water. Perchlorate was detected above the GWPS in two downgradient in situ performance-monitoring (ISPM) wells in 2023. TCE concentrations are below the GWPS in five of nine ISPM wells, with two of the four wells not at GWPS being close to being below. Pantex has added a second row of wells on the southern side of the ISB to improve treatment of TCE and perchlorate. Improvement of downgradient results are expected within the next 5 years due to injection of the new wells.

The Southeast ISB Extension was first injected in 2019. Treatment zone data, including two TZM wells, indicate strong to mild reducing conditions are present for the treatment of HEs. Downgradient wells demonstrated partial treatment in 2023 supported by increase in total organic carbon (TOC), reduction of RDX concentrations and increase in metals. In response to recommendations in the recent Five-Year Review, Pantex evaluated duration between injection events at the Southeast ISB Extension. Treatment zone results indicate that reducing conditions have been adequate to treat the high explosives and have recommended increasing the injection timeframe to 12 months.

The Offsite ISB was installed in 2020. Phases 1 and 2 of infrastructure to support an injection event were completed in 2021, with first injection of molasses occurring in 2021. The final infrastructure phase and two injection events were completed in 2023. ISB extraction wells at the leading edge of the plume that were sampled in 2023 have indicated arrival of the carbon source and have demonstrated concentrations of HE remains low in wells at the leading edge of the plume. Treatment zone data for the new TZM wells indicates the treatment zone is being established, but portions of the plume are not expected to fully establish treatment until 2025 or later. The downgradient monitoring well for this system demonstrates concentrations below the GWPS, indicating the plume is not expanding.

E.3.3 Uncertainty Management and Early Detection

The uncertainty management wells in the High Plains Aquifer (commonly and hereafter referred to as the Ogallala Aquifer) and perched aquifer have the following purposes:

- Confirm expected conditions identified in the Resource Conservation and Recovery Act (RCRA) Facility Investigations and ensure there are no deviations
- Fill potential data gaps in the investigations
- Fulfill LTM requirements for soil units evaluated in a baseline risk assessment

The purpose of early detection wells is to identify breakthrough of constituents to the Ogallala Aquifer from overlying perched groundwater, if present, or from potential source areas in the unsaturated zone before potential points of exposure are impacted. These wells were proposed in the LTM Design Report to evaluate the effectiveness of the soil and groundwater remedial actions.

Group 1 wells are located where contamination has not been detected or confirmed or in previous plume locations where concentrations have fallen below the GWPS, background, or practical quantitation limit (PQL). These wells were evaluated in 2023 and one Group 1 perched aquifer well had an unexpected condition. PTX01-1001 had a very low detection of a new emerging contaminant, perfluorodecanoic acid (PFDA), a constituent of PFAS. At this time, no further action is required. The data are part of a special sampling request to help develop a work plan to complete a PFAS site investigation.

In 2023, detection of organic constituents occurred in four Ogallala wells. Boron was detected slightly above background in six Ogallala wells. A few miscellaneous metals detections above background occurred in 2023. Those detections were related to variations in background or corrosion of stainless steel screens. The organic detections are summarized below.

One Ogallala Aquifer well, PTX06-1056, had continued detections of 4-amino-2,6-dinitrotoluene (DNT4A), RDX and 1,2-dichloroethane (DCA) above the laboratory PQL, but below the GWPS. Data collected for 1,2-DCA indicate an increasing trend in recent data collected at the well. DNT4A continued to be detected above the GWPS in 2023, indicating possible migration of perched groundwater to the Ogallala Aquifer in the southeast area beneath Texas Tech University property. RDX has also been detected above the PQL, but below the GWPS. The detections in PTX06-1056 do not represent a threat to local water supplies since the well is distant from those sources, and other downgradient Ogallala monitoring wells demonstrate no detections of DNT4A and 1,2-DCA.

In response to the recent detections of DNT4A above the GWPS in PTX06-1056, Pantex installed three new Ogallala monitoring wells in 2023. The new wells were installed in areas identified in earlier plume modeling for being within the flow path of areas at risk of vertical contaminant migration from the perched to the Ogallala Aquifer. Two wells, PTX06-1223 and PTX06-1224, were initially installed in May 2023. The third well, PTX06-1229, was installed in September 2023 as part of continuing efforts to investigate the detections. Preliminary sampling results received in late December 2023 for PTX06-1229 indicated the presence of three high explosive constituents in the Ogallala Aquifer at concentrations above GWPS.

At this time, Pantex is investigating whether the detections are a result of a preferential pathway that was created by an upgradient perched that was drilled too deep. The perched well in question was drilled in 2005, but plugged in October 2010 after indications that it was acting as a preferential pathway to the Ogallala Aquifer. A verification sample was completed at PTX06-1229 in January 2024 that confirmed the high explosive detections above the GWPS. Pantex has requested special funding to implement measures to begin evaluating extent of the detections by installing three additional Ogallala monitor wells in 2024. Further actions will be determined based on future sampling results and in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Groundwater Contingency Plan [Pantex, 2019c]). As noted above for PTX06-1056, drinking water resources are not at risk from these detections due to their distance from this well and downgradient wells in the Ogallala Aquifer do not indicate the presence of any HE compounds.

PTX06-1076 demonstrated a low-level detect of DNT4A, below the PQL and the GWPS. This well has demonstrated sporadic, non-trending detections of DNT4A since 2020. Review of installation logs for PTX06-1076 indicate that the well might not have been sealed properly at the fine-grained zone. Pantex is planning to plug and abandon this well and replace it with a new downgradient well in fiscal year (FY) 2024. In the short-term, Pantex will continue to monitor this well in accordance with the SAP and will continue to follow actions described in the Groundwater Contingency Plan.

Group 2 wells are perched wells near source areas and generally have contamination above the GWPS. The purpose of the Group 2 well annual evaluation is to determine if source strength is declining. The ditches and playas are expected to continue sourcing contaminants to the perched aquifer for 20 years or more but at much lower concentrations than in the past (Pantex, 2006). For many of these wells, concentrations are expected to stabilize, with an eventual long-term decreasing trend below the GWPS.

Nine of the Group 2 wells that have detections of COCs already meet expected conditions. Thirteen wells are showing increasing trends since remedial actions began in 2009 when long-term decreasing trends are expected. Several of these wells are experiencing more recent decreasing trends or the apparent increase is due to use of one-half of the detection limit that is used in trending. Some of those wells' increasing trends are due to changing gradients and/or plume movement away from the source. Pantex will continue to evaluate these trends over time. For many of these wells, concentrations are anticipated to stabilize, with an eventual long-term decreasing trend below the GWPS.

Several other Group 2 wells had metals detections above their site-specific backgrounds but below the GWPS. These detections are likely due to either well-screen corrosion or variation in background.

E.3.3.1 Other Unexpected Conditions

Pantex routinely evaluates laboratory data to determine if data are off-trend, are at an all-time high, or represent a new detection that may require further sampling or evaluation. Through the well-maintenance program, Pantex also inspects wells at least every five years to ensure they are not silting in and to evaluate whether the well remains in contact with the formation. Based on evaluations in 2023, one well was determined to have potential issues with silting, causing problems with the sampling interval. This well is scheduled for well maintenance in 2024. Four other wells were noted to have potential silting issues that will need evaluation for sampling intake and well maintenance. No additional unexpected conditions were noted in 2023.

E.3.3.2 Natural Attenuation

Natural attenuation is the result of processes that naturally lower concentrations of contaminants over time. Data are collected at Pantex to evaluate natural attenuation in the perched aquifer. This is an important process for RDX, the primary risk driver in perched groundwater, because RDX is widespread and extends beyond the reach of the groundwater remediation systems in some areas. Pantex has historically monitored for RDX; 2,4,6-trinitrotoluene (TNT); and TCE degradation products in key areas.

Although Pantex has monitored for breakdown products of TCE for many years, a strong indication of natural attenuation has not been observed in perched groundwater. Based on monitoring results for TNT and its breakdown products, TNT has naturally attenuated over time, with data indicating that the breakdown products are more widespread than TNT.

Perched groundwater sampling results for RDX and its breakdown products indicate that the breakdown products are present throughout most of the RDX plume, with TNX being the most widespread. If complete biodegradation of RDX were occurring, RDX and all breakdown products would be expected to decrease over time.

A Strategic Environmental Research and Development Program (SERDP) study (2014) provided evidence that aerobic degradation is occurring in the Pantex RDX plume but was unable to quantify the rates of attenuation. This study provided new methods for evaluating RDX degradation, including carbon and nitrogen fractionation approaches (compound specific isotope analysis). These approaches, along with the ability to quantify 4-nitro-2,4-diazabutanal (NDAB), an aerobic degradation product, allows Pantex to better evaluate the degradation of RDX.

Pantex subsequently contracted with the leading researcher of the SERDP study, Dr. Mark Fuller with APTIM Corporation, for a project to evaluate lines of evidence for natural attenuation of RDX at the plant. The study included both aerobic and anaerobic degradation, with evidence of both occurring. The predominant attenuation process is aerobic biodegradation by bacterial strains. Biodegradation rates of 0.016 to 0.168 per year were calculated, translating to RDX half-lives of approximately 5 to 50 years.

The project found that the rates of RDX biodegradation are likely limited by the available labile organic carbon in the groundwater. The study found several lines of evidence for natural attenuation of RDX as well as the potential to enhance aerobic biodegradation of RDX by introducing low levels of labile organic carbon. Recommendations were presented for additional treatability studies, bioaugmentation, and additional proteomics analyses of degrading bacterial strains. Results of this study were used in the recent optimization of the Offsite ISB and pump and treat systems.

E.4 Soil Remedial Action Effectiveness

The small-scale SVE system at the Burning Ground is the only active soil remediation system at Pantex. The current CatOx/wet scrubber system has effectively removed the soil NAPL source in the Burning Ground and system closure has been approved.

E.5 Recommendations and Conclusions

Pantex plans to continue currently approved remedial actions. The groundwater remedies are considered protective for the short term since untreated perched groundwater use is controlled to prevent human contact and Ogallala Aquifer data continues to indicate COC concentrations are either non-detect or below the GWPS in areas near onsite and offsite water resources. The systems are also proving to be effective in reaching long-term objectives for cleanup in areas that are under the influence of a remedial action. Pantex has some recommended changes provided below to address areas outside of the influence of the remedial action.

Pantex has one new Ogallala monitor well (PTX06-1229), distant from water resource locations, that demonstrated significant concentration detections of three high explosives above the GWPS. Pantex is following the recommendations in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* and will install three new wells to aid in determining nature and extent for that plume. Further information and recommendations will be provided as data become available.

Soil remedies have also been effective at Pantex; workers and the public are protected from exposure to contaminated soils, and data do not indicate that new contamination is migrating to the underlying groundwater from soil source areas. The SVE system has effectively removed soil gas and residual NAPL in soils at the Burning Ground, thereby mitigating the vertical movement of VOCs to the Ogallala Aquifer.

Based on issues identified in the third FYR and this report, changes are recommended or have already been implemented to enhance the effectiveness of the remedies in some areas and improve monitoring of the overall effectiveness of the actions. Those recommendations are provided in the following sections.

E.5.1 Recommended Changes to the Selected Remedies

Pantex continues to request funding for new systems that were proposed in the 2022 ESD. Pantex will install those systems as funding becomes available. No new recommendations are necessary at this time.

E.5.2 Recommended Changes to the Pump and Treat Systems

Pantex has implemented the new operational goals that prioritize operation of the SEPTS to more effectively capture perched groundwater and contaminant plumes moving to the southeast. Pantex plans to further evaluate priority of pumping at the SEPTS to ensure that plumes and water are efficiently removed. This evaluation was also recommended in the third FYR.

E.5.3 Recommended Changes to the ISB Systems

Pantex continues to evaluate the ISBs and make changes, as appropriate, to address incomplete treatment in certain areas. The third FYR recommended changes to ISB operations in some areas and Pantex is working toward implementing those changes.

E.5.3.1 Southeast ISB

Although Pantex has injected a more soluble carbon (i.e., molasses) to improve the distribution of amendment at the ISB and injected in dry upgradient wells, RDX has declined, but continues to persist above GWPS at PTX06-1153. Pantex has requested the removal of PTX06-1153 as a point of compliance monitoring well from HW-50284 and plans to inject the well after the new permit is issued and as recommended in the third FYR.

E.5.3.2 Southeast ISB Extension

Pantex has evaluated moving to yearly injections at the Southeast ISB Extension. This system is recommended for yearly injections starting in FY 24.

E.5.3.3 Zone 11 ISB

Pantex has installed additional infrastructure to address the hydraulic changes in the system and has in-filled wells where old injection wells will no longer accept amendment injections. Amendment volumes were reviewed for the wells surrounding PTX06-1164 and

PTX06-1169 to determine if extra volume was required during injections. Volumes will be increased in 2024, as needed. Pantex continues to monitor the effect of these changes.

Pantex was unable to install two wells that were planned as part of the second row of wells on the southeastern side of this ISB. Those wells will be installed in FY 24 to address a gap in coverage at the ISB.

E.5.3.4 Offsite ISB

Injections began in 2021 with injections occurring the year following installation of each phase. All phases of installation were complete by the end of 2023 and the system is planned for full operation in FY 24.

No changes to the ISB are recommended at this time.

E.5.4 Recommended Changes to the Monitoring Network

Pantex will implement select recommendations from the MAROS monitoring optimization completed for the third FYR. Those changes will be included in the updated *Long-Term Monitoring System Design* and *Sampling and Analysis Plan* that is scheduled for completion in November 2024.

Due to detections of three high explosives above GWPS at the new Ogallala well PTX06-1229, Pantex will begin drilling wells to evaluate nature and extent of a plume in the Ogallala Aquifer. As recommended in the third FYR, Pantex will develop a work plan to evaluate nature and extent.

Due to low-level detections of high explosives in PTX06-1076 that could be attributed to well construction, Pantex is planning to plug and abandon this well in FY 24, pending receipt of funding. A new well will be drilled approximately 50 ft downgradient of PTX06-1076 so that high explosives and other COCs can continue to be evaluated.

E.5.5 Recommended Changes to Soil Remedies

No changes to the landfill or ditch remedies are recommended.

Pantex prepared a closure plan for the Burning Ground SVE. The system closure was approved by regulatory agencies in 2023. Pantex plans to continue groundwater monitoring at the point of compliance and exposure wells at the Burning Ground to evaluate the long-term effectiveness of this remedial action. Pantex will also include requirements for response to detections in those wells in an updated *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* scheduled for completion in FY 25.

E.5.6 Recommended Changes Based on Regulatory Comments

Pantex received comments from the TCEQ on the supporting documents for the recommended changes to the Pantex Remedial Action (TCEQ, 2022). Pantex has agreed to complete some additional work and track the actions to completion in the annual progress reports, per letter dated February 15, 2023 (USDOE/NNSA, 2023). The following table provides the two items that must be tracked to completion, the recommended timeframe of completion, and the current status of each action.

Table E-1. Status of Actions from Recommended Changes Letter Response, USDOE/NNSA (2023)

Recommended Actions to Complete	Milestone Date	Completion Date	Status
Review/update the well information data table to include updated bottom of fine-grained zone picks from Ogallala wells.	Dec-2026		Pantex is currently preparing to update this table by the end of 2024.
Put in two additional wells at the southeast and southwest perimeter of Zone 11 to better evaluate the Zone 11 plumes.	Dec-2026		Those wells are currently being planned for installation in FY 24, pending receipt of funding.

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amsl	above mean sea level
AOC	area of concern
ASC	Administrative Site Complex
bgs	below ground surface
CatOx	catalytic oxidation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
CFR	Code of Federal Regulations
CMI	Corrective Measures Implementation
COC	contaminant of concern
CP-50284	Compliance Plan 50284
CR(VI)	hexavalent chromium
DCA	dichloroethane
DNT	dinitrotoluene
DNT4A	4-amino-2,6-dinitrotoluene
DNX	hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Difference
EVO	emulsified vegetable oil
FGZ	fine-grained zone
FM	Farm-to-Market Road
FS	Firing Site

ft	feet
ft/ft	feet per foot
FGZ	fine-grained zone
FS-5	Firing Site 5
FY	fiscal year
FYR	five-year review
GAC	granular activated carbon
gpm	gallons per minute
gpd	gallons per day
GPS	Global Positioning System
GWPS	groundwater protection standard
HE	high explosive
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HW-50284	Hazardous Waste Permit No. 50284
IAG	Interagency Agreement
ICM	Interim Corrective Measure
IRAR	Interim Remedial Action Report
ISB	in-situ bioremediation
ISM	interim stabilization measure
ISPM	in situ performance monitoring
lbs	pounds
LOTO	lockout/tagout
LTM	long-term monitoring
LTM Design Report	Long-Term Monitoring System Design Report
Mgal	million gallons
MAROS	Monitoring and Remediation Optimization System
MCL	maximum contaminant level
MDL	method detection limit
MNX	hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine
mV	millivolts
NAPL	non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDAB	4-nitro-2,4-diazabutanal
O&M	operation and maintenance
ORP	oxidation reduction potential
OSTP	Old Sewage Treatment Plant

PRB	permeable reactive barrier
P&A	plugging and abandonment
P1PTS	Playa 1 Pump and Treat System
PCA	1,1,2,2 – tetrachloroethane
PCE	tetrachloroethylene
PCL	protective concentration level
PCR	Perchlorate/Chromium
PFAS	per- and poly-fluoroalkyl substances
PID	photoionization detector
Pantex	Pantex Plant
POC	point of compliance
POE	point of exposure
ppm	parts per million
ppmv	parts per million by volume
PTS	pump and treat system
PQL	practical quantitation limit
PVC	polyvinyl chloride
RA	Remedial Action
RAP	Response Action Plan
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SCADA	supervisory control and data acquisition
scfm	standard cubic feet per minute
SEP/CBP	Solvent Evaporation Pit/Chemical Burn Pit
SEPTS	Southeast Pump and Treat System
SERDP	Strategic Environmental Research and Development Program
SIN	SWMU Interference Notification
SU	standard units
SVE	soil vapor extraction
SVS	supplemental verification site
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
THF	tetrahydrofuran

TLAP	Texas Land Application Permit
TNX	hexahydro-1,3,5-trinitroso-1,3,5-triazine
TNT	2,4,6-trinitrotoluene
TOC	total organic carbon
TRRP	Texas Risk Reduction Program
TTU	Texas Tech University
TZM	treatment zone monitoring
ug/L	micrograms per liter
USDOE/NNSA	United States Department of Energy/National Nuclear Security Administration
UV	ultraviolet
VOC	volatile organic compound
WMG	waste management group
WWTF	Wastewater Treatment Facility

1.0 INTRODUCTION

The Pantex Plant (Pantex), located in the Texas Panhandle approximately 17 miles northeast of Amarillo (see Fig. 1-1), was established in 1942 to build conventional munitions in support of World War II. Pantex was deactivated in 1945 and was sold to Texas Tech University (TTU). In 1951, it was reclaimed for use by the Atomic Energy Commission to build nuclear weapons. Pantex continues with an active mission to support the nuclear weapons stockpile for the United States Department of Energy/National Nuclear Security Administration (USDOE/NNSA).

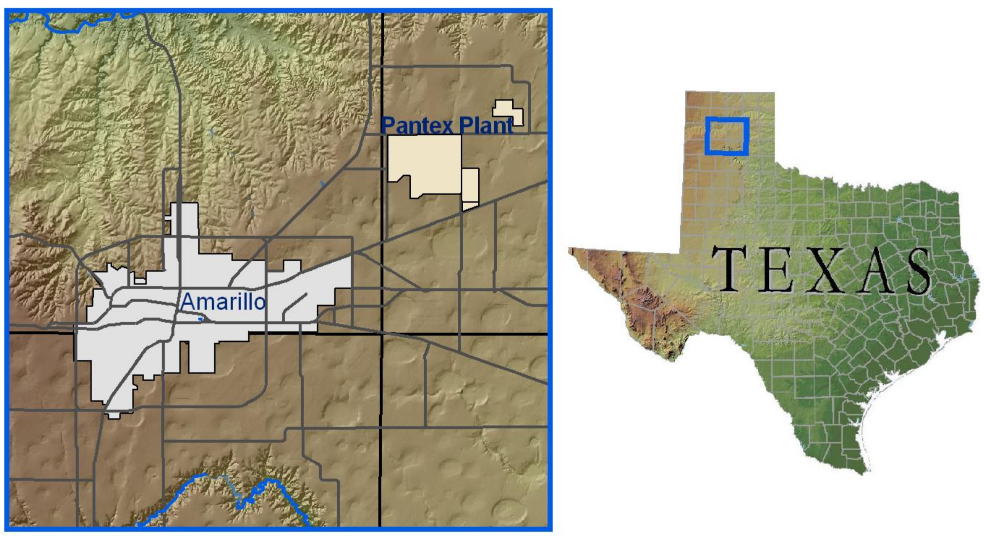

Fig. 1-1. Location of Pantex Plant.

The main plant site encompasses approximately 9,100 acres. Approximately 2,000 acres of the USDOE/NNSA-owned property are used for industrial operations at Pantex, excluding the Burning Ground, Firing Sites, and other outlying areas. The Burning Ground and Firing Sites occupy approximately 489 acres. The remaining USDOE/NNSA-owned land serves safety and security purposes. In 2008, approximately 1,526 acres east of Farm-to-Market Road (FM) 2373 was purchased to provide better access and control of perched groundwater areas included in the Pantex Remedial Action (RA). USDOE/NNSA also owns a detached piece of property called Pantex Lake, approximately 2.5 miles northeast of the main plant. This property, encompassing 1,077 acres, includes the playa lake itself. No industrial operations are conducted at the Pantex Lake property.

Historical waste management practices at Pantex resulted in the release of contaminants through various waste streams. Treated and untreated industrial wastewater released to the ditches and playas resulted in the contamination of perched groundwater beneath Playa 1, portions of Zone 11, Zone 12, TTU property to the south, property east of FM 2373 and offsite property to the southeast. The extent of perched groundwater and major contaminant plumes are depicted in Fig. 1-2.

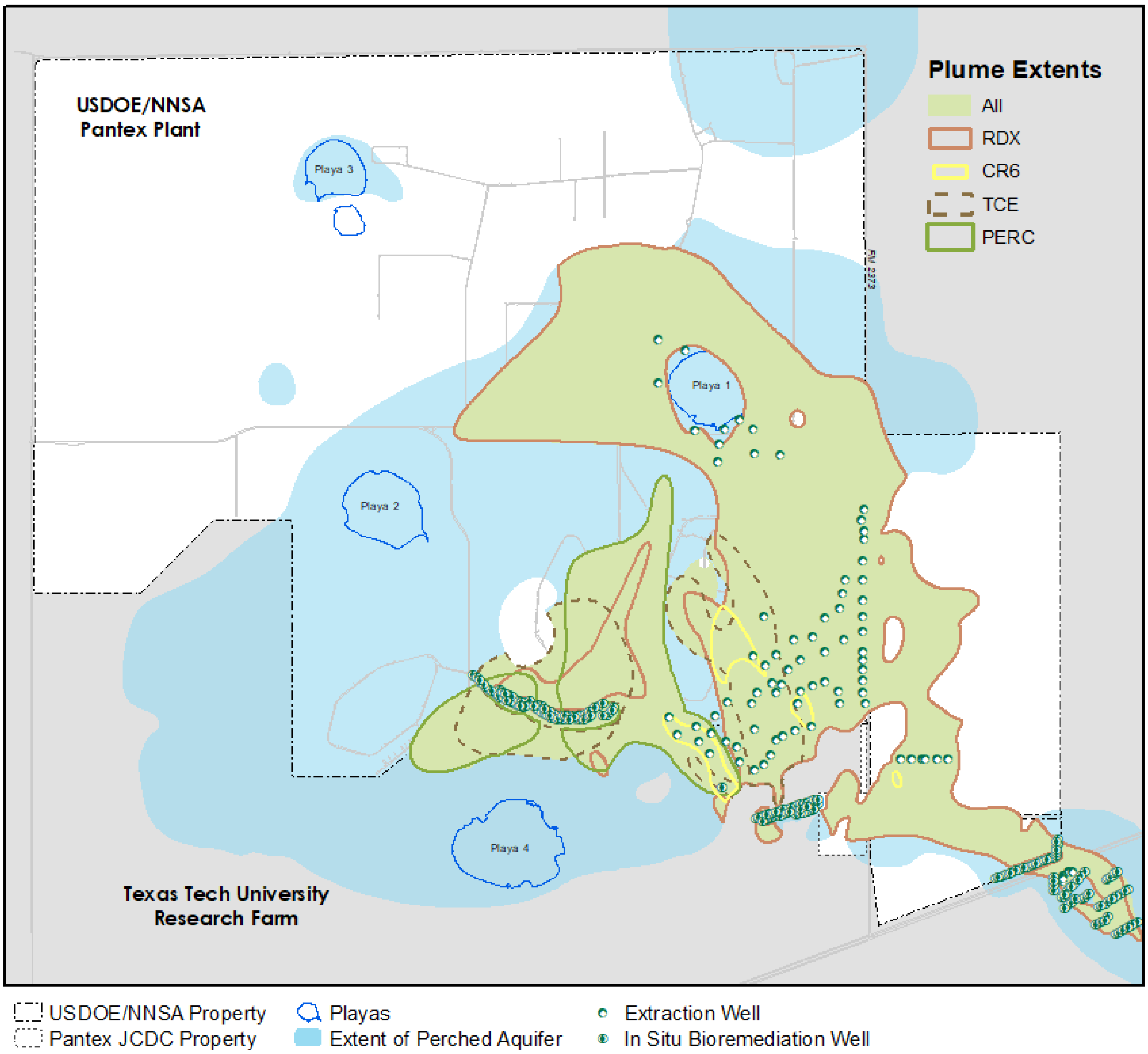

Fig. 1-2. Extent of perched groundwater and contaminant plumes exceeding the Groundwater Protection Standard.

Impacted perched groundwater is not used for residential purposes; however, the perched aquifer overlies the Ogallala Aquifer, a drinking water source for the Texas Panhandle and Pantex. This aquifer system, which is dominated by the Ogallala Formation, includes the Dockum Formation in the vicinity of Pantex.

Historical waste management practices also resulted in the contamination of soil sites at Pantex. Landfills and specific soil sites require institutional controls to ensure continued use of the land for industrial purposes. In addition, some areas require soil covers and ditch liners to be maintained to prevent the infiltration of water and downward migration of contaminants to groundwater. Fencing and signs are also maintained to control worker use and traffic within the soil units.

Pantex has implemented RAs to mitigate perched groundwater contamination and prevent contamination of the deeper drinking water aquifer.

1.1 Regulatory Background

Pantex implemented its RAs in accordance with the *Compliance Plan for Industrial Solid Waste Management Sites* (Compliance Plan [CP-50284]), originally issued on October 21, 2003, and subsequently updated with final RAs on September 16, 2010, under the provisions of Chapter 361 of the Texas Health and Safety Code and Chapter 26 of the Texas Water Code. CP-50284 is a Texas Commission on Environmental Quality (TCEQ) permit that stipulates the requirements for conduct of corrective actions and groundwater monitoring programs according to the Resource Conservation and Recovery Act (RCRA). Pantex's hazardous waste permit (HW-50284) was renewed in 2014, and CP-50284 requirements were incorporated into the permit.

Pantex was listed on the National Priorities List in 1994, requiring investigation and cleanup according to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), in addition to RCRA. Pantex meets the requirements of CERCLA through the Pantex Interagency Agreement (IAG), effective February 22, 2008. Table 1-1 lists the Compliance Plan (shown as CP), hazardous waste permit (shown as HW), and IAG with the date of issuance, modifications, and descriptions of each issue or modification.

Table 1-1. Regulatory Compliance Documents

Document	Date of Issue	Description
CP-50284	10/21/2003	Interim Stabilization Measure Compliance Plan issued to describe interim measures to stabilize groundwater plumes and monitor that action.
Interagency Agreement for the Pantex Superfund Site	2/22/2008	Established an agreement between the Environmental Protection Agency, Texas Commission on Environmental Quality, and the United States Department of Energy for final RAs, the framework for responding to and implementing Comprehensive Environmental Response, Compensation, and Liability Act requirements, and the framework for participation and exchange of information between parties.
Record of Decision	9/25/2008	The Pantex Record of Decision (ROD) presents the "Selected Remedy" for Pantex in accordance with Comprehensive Environmental Response, Compensation, and Liability Act and is synchronized with the Texas Commission on Environmental Quality Compliance Plan provisions.
CP-50284	9/16/2010	Modification issued to remove interim stabilization requirements and incorporate final corrective/remedial actions for Pantex and required monitoring and reporting of those actions.
HW-50284	5/30/2014	Hazardous waste permit renewal with inclusion of the Compliance Plan. Changes include corrective action observation well changes and minor edits. Compliance Plan requirements are included as Provision XI of HW-50284.
Explanation of Significant Difference for the Record of Decision	12/21/2022	Provides an explanation of differences between the following: 1. Several components of the "Selected Remedy" for Pantex and the actual systems constructed, operated, and maintained to achieve RA objectives. 2. The action level in the ROD and protective levels and health advisories established for perchlorate since issuance of the ROD and establishment of the new perchlorate protective level for cleanup of groundwater.

CP-50284, issued in 2003, stipulated the requirements for conducting corrective actions and groundwater monitoring associated with defined interim stabilization measures (ISMs) and provided the operating requirements for ISMs that were in place for Pantex. The final corrective action/remedy has been approved through the *Record of Decision for Groundwater, Soil and Associated Media* (ROD) (Pantex and Sapere Consulting, 2008), and the final remedy was incorporated into CP-50284, effective September 16, 2010. Pantex provided an *Explanation of Significant Difference for Zone 11 ISB, Southeast ISB Extension, Offsite ISB, Southeast Pump & Treat System, and the Action Level for Perchlorate in Perched Groundwater* (ESD) for the ROD, in 2022 (Pantex, 2022a). The changes described in the

ESD were included in the hazardous waste permit renewal application that was provided to the TCEQ in December 2023. The *Long-Term Monitoring System Design Report* (LTM Design Report) (Pantex, 2009a) and the *Sampling and Analysis Plan* (SAP) (Pantex, 2009b) were approved through the Compliance Plan as the basis for monitoring and reporting of the remedies. The 2009 documents were updated in January 2014 and again in 2019 (Pantex, 2019a and 2019b). The 2019 update was approved for use starting January 2020. HW-50284 was renewed in May 2014 and included the Compliance Plan requirements from the September 2010 CP-50284 as Provision XI, with minor changes. HW-50284 will be updated in 2024.

HW-50284, Provision XI requires reporting of information pertaining to the effectiveness of the remedies, treatment of perched groundwater, contaminant data and plumes, and monitoring. Information on operation and maintenance (O&M) of the corrective action systems and components, new construction, the condition and status of the corrective actions/remedies, and recommendations for change is required.

The IAG is a legally binding agreement among the USDOE, Environmental Protection Agency (EPA), and TCEQ to accomplish the cleanup of hazardous substances contamination at and from Pantex, pursuant to CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and Executive Order 12580, as amended by Executive Order 13016. The IAG has the following purposes:

1. Ensure that the environmental impacts associated with past and present activities at Pantex have been analyzed, tested, and thoroughly evaluated, and appropriate RA is taken as necessary to protect the public health, welfare, and the environment.
2. Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions in accordance with CERCLA; the NCP; Superfund policy; RCRA; RCRA policy; and applicable, relevant, and appropriate environmental laws.
3. Facilitate continued cooperation, exchange of information, and participation of USDOE, EPA, and TCEQ in such actions.

The IAG provides requirements for developing schedules, remedial design and remedial action implementation and reporting, record preservation, public participation, budget review, notification requirements, and periodic progress reports. Progress reports are required semi-annually and are combined with the Compliance Plan reports to fulfill the requirements of both RCRA and CERCLA.

Table 1-2 provides a detailed crosswalk of the Compliance Plan and IAG requirements to specific sections of the annual or quarterly report in which the requirements are fulfilled. The requirements are from CP Tables VII and VIII of HW-50284. The specific Articles in the IAG that contain reporting requirements are also listed in the table. Other requirements in the ROD and final documents supporting the design of the RAs were also considered when developing this report.

Table 1-2. Crosswalk of Regulatory Requirements to Quarterly and Annual Progress Reports

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
Hazardous Waste Permit 50284 Requirements from CP Table VII:				
1.	All programs	Annual June 30	Each report shall be certified by a qualified engineer and/or geologist.	See certification page inside front cover of the quarterly and annual progress reports.
2.	Corrective Action	Annual June 30	A table of all modifications and amendments made to this Compliance Plan with their corresponding approval dates by the executive director or the Commission and a brief description of each action;	Section 1.1, Table 1-1.
3.	Corrective Action	Annual June 30	A summary of any activity within an area subject to institutional control.	Section 2.3.2.
4.	Corrective Action	Annual June 30	Tabulation of well casing elevations in accordance with Attachment B;	Section 2.4.2.
5.	Corrective Action	Annual June 30	Certification and well installation diagram for any new well installation or replacement and certification for any well plugging and abandonment;	When applicable, certifications and diagrams are included as an appendix. See "List of Appendices."
6.	Corrective Action	Annual June 30	Recommendation for any changes to the program;	Chapter 5.0 of the annual report. "Recommendations and Conclusions" section of quarterly reports.
7.	Corrective Action	Annual June 30	Any other items requested by the executive director;	Crosswalk of requirements to information contained in report. Section 1.1. Information will be added as requested.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
8.	Corrective Action	Annual June 30	Water table maps shall be prepared from the groundwater data collected pursuant to Provision VII and shall be evaluated by the Permittee with regard to the following parameters: 8.1. Development and maintenance of a cone of depression during operation of the system; 8.2. Direction and gradient of groundwater flow; 8.3. Effectiveness of hydrodynamic control of the contaminated zone during operation; and, 8.4. Estimation of the rate and direction of groundwater contamination migration.	Sections 3.1.5, 3.1.7, and 3.2.
9.	Corrective Action	Annual June 30	The Permittee shall submit a report to each recipient listed in Provision X.C, which includes the information in items 3 through 26 determined since the previously submitted report, if those items are applicable. If both Corrective Action and Compliance Monitoring [Reserved] Programs are authorized, then the June 30th report shall contain information required for both programs.	Reports submitted as required. See items 3 through 26 of this table for location of report information.
10.	Corrective Action	Annual June 30	The Corrective Action System(s) authorized under Provision II in operation during the reporting period and a narrative summary of the evaluations made in accordance with Provisions XI.E, XI.F, and XI.G of this Compliance Plan for the preceding reporting period. The reporting periods shall be annual, January 1 through December 31, for Corrective Action Monitoring, unless an alternative schedule is approved by the Commission. The period for Compliance Monitoring [Reserved] shall be based on the calendar year;	Chapter 2.0 Chapter 3.0 Chapter 4.0 Appendices containing extraction well flow information, data tables, data evaluation tables, expected condition evaluation, contaminant of concern (COC) trending, and hydrographs.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
11.	Corrective Action	Annual June 30	The method(s) utilized for management of recovered/purged groundwater shall be identified in accordance with Provision XIB.8. The Permittee shall maintain this list as part of the facility operating record and make it available for inspection upon request.	Section 2.5 and Appendix C
12.	Corrective Action	Annual June 30	An updated table and map of all monitoring and corrective action system wells. The wells to be sampled shall be those wells proposed in the Compliance Plan Application referenced in Provision XI.A.7. and any changes subsequently approved by the executive director pursuant to Provision XI.B.3. Provide in chronological order, a list of those wells which have been added to, or deleted from, the groundwater monitoring and remediation systems since original issuance of the Compliance Plan. Include the date of the Commission's approval for each entry;	Section 1.6.
13.	Corrective Action	Annual June 30	The results of the chemical analyses, submitted in a tabulated format acceptable to the executive director which clearly indicates each parameter that exceeds the groundwater protection standard (GWPS). Copies of the original laboratory report for chemical analyses showing detection limits and quality control and quality assurance data shall be provided if requested by the executive director;	See "List of Appendices" for data evaluation tables and electronic data. A summary of the point of compliance/point of exposure well detections above GWPS is included in Section 3.5.
14.	Corrective Action	Annual June 30	Tabulation of all water level elevations required in Provision XI.F.3.d.1 depth to water measurements, and total depth of well measurements collected since the data that was submitted in the previous monitoring report;	Section 2.4 and Appendix C. Appendix containing electronic data tables.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
15.	Corrective Action	Annual June 30	Potentiometric surface maps showing the elevation of the water table at the time of sampling, delineation of the radius of influence of the Corrective Action System, and the direction of groundwater flow gradients outside any radius of influence;	Section 3.1.
16.	Corrective Action	Annual June 30	Tabulation of all data evaluation results pursuant to Provision XI.F.4 and status of each well with regard to compliance with the Corrective Action objectives and compliance with the GWPS;	These evaluations are summarized in Section 3.4 and 3.5. See "List of Appendices" for complete electronic data tables and expected conditions evaluation.
17.	Corrective Action	Annual June 30	An updated summary as required by CP Table VIII;	Chapters 1.0 through 4.0.
18.	Corrective Action	Annual June 30	Summary of any changes made to the monitoring/corrective action program and a summary of well inspections, repairs, and any operational difficulties;	Chapters 2.0 and 5.0 and Appendix C.
19.	Corrective Action	Annual June 30	A notation of the presence or absence of NAPLs, both light and dense phases, in each well during each sampling event since the last event covered in the previous monitoring report and tabulation of depth and thickness of NAPLs, if detected;	Section 3.4.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
20.	Corrective Action only	Annual June 30 Quarterly 90 days after end of quarter	Quarterly tabulations of quantities of recovered groundwater and NAPLs, and graphs of monthly recorded flow rates versus time for the Recovery Wells during each reporting period. A narrative summary describing and evaluating the NAPL recovery program shall also be submitted;	Annual Report: a. See Section 2.1 and "List of Appendices" for detailed extraction well flow information. b. See Section 2.3.1 for soil vapor extraction of residual non-aqueous phase liquids (NAPL)s in soils at the Burning Ground. Quarterly Report: a. "Pump and Treat Systems" section and Appendix B.
21.	Corrective Action only	Annual June 30 Quarterly 90 days after end of quarter	Tabulation of the total contaminant mass recovered from each recovery system for each reporting period.	Annual Report: a. Section 2.1. Quarterly Report: a. "Pump and Treat Systems" and "SVE System" sections.
22.	Corrective Action only	Annual June 30	Maps of the contaminated area where GWPSs are exceeded, depicting concentrations of CP Table IIIA constituents and any newly detected CP Table III constituents as isopleth contours or discrete concentrations if isopleth contours cannot be inferred. Areas where concentrations of constituents exceed the GWPS should be clearly delineated. Depict the boundary of the plume management zone (PMZ), if applicable;	Section 3.1.6.
23.	Corrective Action only	Annual June 30	Maps and tables indicating the extent and thickness of the NAPLs both light and dense phases, if detected;	No detected NAPLs in groundwater

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
24.	Corrective Action only	Quarterly 90 days after end of quarter	Corrective Measures Implementation (CMI) Progress Report or Response Action Effectiveness Report or Response Action Completion Report to be submitted as a section of the Compliance Plan report in accordance with Provision XI.H.6, if necessary. The Permittee will include a narrative summary of the status of the approved final corrective measures conducted in accordance with the approved CMI Workplan or Response Action Plan (RAP), and that the requirements of Provision XI.H.7 are being met. The report shall include the following information: a. Information required for Item 20 of this table. b. Information required for Item 21 of this table. c. Trend charts of target COCs and degradation products at downgradient performance monitoring locations for the in-situ bioremediation systems. d. Summary of unexpected conditions, if found, at monitoring wells.	Annual Report: a. See Section 2.1 and "List of Appendices" for detailed extraction well flow information. See Section 2.3.1 for soil vapor extraction of residual NAPLs in soils at the Burning Ground. b. Section 2.1. c. See "List of Appendices" for COC concentration trends. Information is summarized in Section 3.2.3 of this report. d. Section 3.4. Quarterly Report: a. "Pump and Treat Systems" section and Appendix B. b. "Pump and Treat Systems" and "SVE System" sections. c. See Appendix C. d. "Uncertainty Management and Early Detection" section.
25.	Corrective Action only	Annual June 30	The Permittee will include a narrative summary of the status of each Solid Waste Management Unit (SWMU) and/or Area of Concern (AOC) subject to the requirements of Provision XI.H and Interim Corrective Measures (ICMs) Program for a SWMU and/or AOC which documents that the objectives of Provision XI.H.8.b are being achieved. This summary shall be included as a section of the Compliance Plan annual report.	No units at Pantex are subject to the ICM requirements in Provision VIII.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
26.	Corrective Action only	5-Year Review	Conduct five-year review to be consistent with CERCLA §121(c) and the NCP (40 CFR Part 300.430(f)(4)(ii)). The five-year review will be conducted to evaluate the need to adjust corrective actions and associated monitoring.	The third five-year review was started in 2022. The final approved report was completed in September 2023.
Hazardous Waste Permit 50284 CP Table VIII				
A	Corrective Action	Annually	Submit to the Executive Director a schedule summarizing all activities required by the Compliance Plan in the annual progress report. The schedule shall list the starting dates of all routine activities. The Permittee shall include an updated schedule in the annual groundwater monitoring report required by Provision XI.G.3. The schedule shall list the activity or report, the Compliance Plan section which requires the activity or report and the calendar date the activity or report is to be completed or submitted (if this date can be determined).	Section 1.6.4 of the annual report contains a schedule of activities completed since the last annual report, work in progress, and upcoming activities that are scheduled for the next year. The quarterly report provides a listing of activities completed, in progress, or upcoming in the "Schedule Update" section.
IAG Progress Report Requirements:				

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
16.4.	Remedial Action	Quarterly Annual	All results of sampling or other monitoring results obtained during the previous quarter.	The "Uncertainty Management and Early Detection" section of the quarterly report summarizes the quarterly data. Annual Report: a. These data are summarized in Section 3.4 and 3.5. b. See "List of Appendices" for complete electronic data tables and expected conditions evaluation.
16.4	Remedial Action	Annual and Quarterly	Describe the actions which DOE has taken during the previous quarter to implement the requirements of this Agreement.	Section 1.6.4 provides a schedule of activities.
16.4	Remedial Action	Annual	Include a detailed statement of how the requirements and time schedules set out in the attachments to this Agreement are being met, identify any anticipated delays in meeting time schedules, including the reason(s) for each delay and actions taken to prevent or mitigate the delay, and identify any potential problems that may result in a departure from the requirements and time schedules.	Section 1.6.4.

1.2 Remedial Action Background

Pantex has implemented soil and groundwater RAs to mitigate contamination that resulted from historical waste management practices. The remedial actions are described in detail in the ROD, which can be found here: https://pantex.energy.gov/mission/environment/environmental-cleanup-documents. Soil and groundwater RAs are detailed in the following sections.

1.3 Soil Remedial Actions

In accordance with RCRA and CERCLA, Pantex and regulatory agencies identified 254 units at Pantex for further investigation and cleanup. Investigations that identified the nature and extent of contamination at solid waste management units (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 RAs; therefore, no further controls other than deed recordation are necessary for those units. Other units were evaluated in human health and ecological risk assessments to identify units that required further RAs to protect human health and the environment. Fig. 1-3 depicts the location and status of the 254 units.

The 15 units still in active use will be closed in accordance with CERCLA and RCRA permit provisions when they become inactive and are determined to be of no further use as well as when funding is identified for investigation and cleanup of the site. One active facility has been changed to inactive, and Pantex has requested funding to address the site. A detailed summary of actions for the 254 units can be found in the ROD (Pantex and Sapere Consulting, 2008).

Units requiring further RAs were then assessed in a corrective measures study to identify and recommend final RAs. The final RAs that were approved are described in the ROD. A detailed status table of the SWMUs is included in Appendix A of this report.

In late 2023, Pantex identified a new SWMU and reported that to the TCEQ, in accordance with the HW-50284. Building 11-35 AOC has now been included in the application to renew HW-50284 and is included in the SWMU status table in Appendix A. The site will be investigated and closed under the TRRP.

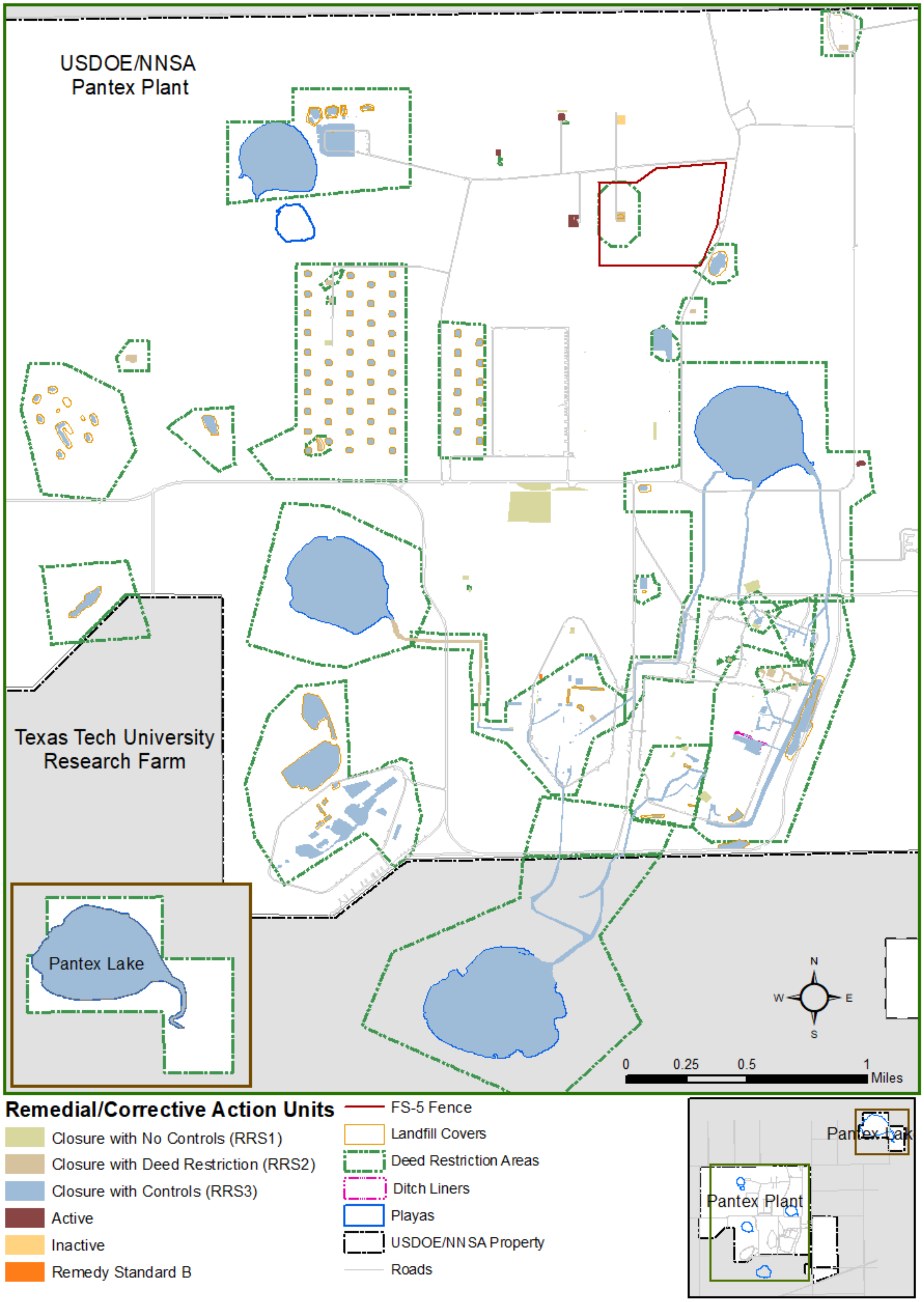

Fig. 1-3. Status of Corrective/Remedial Action units.

Soil RAs focus on the following:

- Cleanup of soil gas and non-aqueous phase liquids (NAPL) in soil at the Burning Ground for future protection of groundwater resources
- Institutional controls to protect workers
- Fencing to prevent traffic and control access to Firing Site 5 (FS-5)

> ***Soil Remedial Actions***
>
> - Ditch Liner
> - Soil Covers on Landfills
> - Institutional Controls
> - Soil Vapor Extraction System
> - Fencing

- Maintenance of soil remedies (i.e., ditch liners and soil covers) for future protection of groundwater resources

In addition to the RAs, Pantex has deed recorded all soil units where contamination was identified. Those areas are restricted to industrial use to ensure future use of the area is in agreement with cleanup assumptions.

1.3.1 BURNING GROUND SOIL VAPOR EXTRACTION SYSTEM

The Burning Ground soil vapor extraction (SVE) system was installed in February 2002 as an interim RA and became the final RA with the issuance of the ROD and HW-50284. The SVE system was installed to remediate volatile organic compounds (VOCs) present in the shallow- and intermediate-depth vadose zone at the Burning Ground, specifically SWMUs 38 and 47.

The system was designed to remediate soil gas in areas beneath the solvent evaporation pit/chemical burn pit (SEP/CBP) and the landfills north of the SEP/CBP. The RCRA Facility Investigations noted that original volatile organic compound (VOC) concentrations at the Burning Ground were as high as 962 parts per million by volume (ppmv) in the shallow zone [i.e., 20 to 90 feet (ft) below ground surface (bgs)], based on wells in place at that time. However, higher concentrations were found in well SVE-S-20 when the SVE system was installed in 2001. Concentrations in the intermediate zone (i.e., 95 to 275 ft bgs) were as high as 1845 ppmv (Stoller, 2002).

The remedial goal was to significantly reduce the mass of VOC contaminants in soil gas, thus mitigating impacts to the underlying groundwater. That goal was achieved in all but a single extraction well, SVE-S-20. Rebound testing conducted in October 2005 indicated that all wells, except SVE-S-20, yielded field-measured VOC concentrations less than 100 ppmv.

A small-scale SVE was installed at the Burning Ground in late 2006 after the large-scale catalytic oxidation (CatOx) and scrubber system became inefficient at continued removal of soil gas and residual NAPL within the soil pore space once the larger area had been remediated. The small-scale system focused on treating residual NAPL and soil gas at SVE-S-20, where soil gas concentrations in the shallow zone continued to remain above 100 parts per million (ppm). The system consisted of a series of activated carbon drums and a smaller blower motor for extraction. The activated carbon system was shut down at the end of January 2012 to install a small-scale CatOx system that has continued to focus on remediating SVE-S-20.

The new system was more cost efficient and effectively treated all detected contaminants of concern (COCs) at the Burning Ground. System construction and installation began in February 2012. System startup and testing began on April 5, 2012, with normal operations commencing on April 19, 2012.

The system was modified in May 2017 to increase air flow through the area surrounding SVE-S-20 and promote increased volatilization and bioremediation of the remaining soil NAPL. Six wells surrounding SVE-S-20 were modified to include aboveground piping that would allow airflow through the wells while the system is operating and pulling air from SVE-S-20 (see Fig. 1-4). Pantex increased influent flow to the SVE by 40% from 32 standard cubic ft per minute (scfm) to approximately 45 scfm, close to the maximum design flow of 50 scfm. To gain baseline information, Pantex also increased monitoring and evaluation of influent air to the SVE system and of the individual wells that were modified. The evaluations, presented in Section 4, helped provide a path to closure of the Burning Ground SVE. Pantex requested closure of the system in the report *Draft Final Burning Ground Soil Vapor Extraction System Closure Report* (Pantex, 2023). The TCEQ and EPA approved the closure report in December and October 2024, respectively. Pantex has requested the removal of the SVE system in the renewal application for HW-50284. Pantex does not plan to operate the system after 2023, although groundwater monitoring will continue for a period of time to evaluate the long-term effectiveness of the removal.

Fig. 1-4. Burning Ground SVE System wells and modifications.

1.3.2 PROTECTIVE COVERS

The RA for landfills included installing and maintaining protective covers for the Former Burning Ground Ash Disposal Trench (SWMUs 14 through 27), the former operational area of FS-5, and 27 landfill units depicted in Fig. 1-3. These protective covers were either placed after landfilling operations ceased or were installed as interim corrective measures (ICMs) under State RCRA Authority to prevent worker contact and the infiltration of water through landfill materials that could lead to migration of contaminants to the underlying aquifer without mitigation.

Construction of all protective covers was completed and approved in 2009. All but two covers are constructed of soil, with the two landfills, Landfill 1 and 2, having Closure Turf installed over the soil cover. Closure Turf was installed at Landfill 1 in 2013 and at Landfill 2 during 2017. Refer to the respective annual reports for the Closure Turf installation information.

1.3.3 Ditch Liners

A total of five ditch sections representing SWMUs 2 and 5-05, with a total length of approximately 832 ft, were lined as an ICM in 2004 to prevent migration of vadose zone soil contamination to the perched groundwater. The ditch liner location is depicted in Fig. 1-3.

The synthetic liner was installed in sections, constructed by welding together smaller sections in the factory using a single-track hot wedge fusion machine. The edges of the liner were anchored into the shoulders of the ditches at least 1-ft deep to control erosion and guard the liner edges against uplift from strong winds. River rock was placed in the bottom of the lined ditches to provide ballast for the liner and protect against uplift. The river rock ballast was replaced by Platipus® anchors in 2011.

Between December 2016 and March 2017, a new 45-millimeter Hypalon® liner was installed over the existing SWMUs 2 and 5-05 ditch liner. Before installing the new liner, sediment, debris, and water were removed from the ditch areas. An anchor trench was excavated around nearly all sides of the liner emplacement and used to secure the new liner around the outer edge of the ditch. A total of 163 Platipus® anchors were installed at approximately 5-ft intervals, typically located at the bottom of the ditch, to further secure the liner in place.

The Platipus® device consists of a flat metal anchor attached to a wire driven two ft vertically into the ground with a pivot set horizontally and a plastic plate tightened to the surface of the liner. At the anchor location, the surface of the liner is then patched to create a water-tight seal. Ten anchors were not installed as planned due to potential interferences with utilities. The Hypalon liner was installed in sections and physically attached and sealed to existing penetrations (e.g., culverts, pipes). The liner was attached to concrete structures including the headwalls and the 12-83 building foundation. Seams were welded and sealed in the field.

1.4 Groundwater Remedial Actions

In accordance with the IAG and HW-50284, Pantex has implemented actions to remediate the contaminated perched groundwater. Two types of active remediation systems (see Fig. 1-5) were installed to address the contamination: pump and treat systems and in-situ bioremediation (ISB) systems. Institutional controls are also part of the final remedy for groundwater.

Groundwater Remedial Actions

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

ISB Systems
- Zone 11 ISB
- Southeast ISB
- Southeast ISB Extension
- Offsite ISB

Institutional Controls

Groundwater RAs focus on the following tasks:

- Clean up perched aquifer to the groundwater protection standard (GWPS).
- Reduce perched water levels to protect the underlying drinking water aquifer (i.e., Ogallala Aquifer) and prevent growth of plumes.
- Implement institutional controls to restrict perched groundwater use without treatment and control drilling into and through the perched aquifer to prevent cross-contamination.

Groundwater deed restrictions have been recorded in the county record for Pantex, TTU property, and three neighboring offsite properties. Two of the offsite restrictions were recently completed in 2021 and 2022 to prevent use of the perched groundwater and restrict drilling into or through the perched groundwater. The original restrictions were provided to TCEQ and EPA in the *Final Pantex Interim Remedial Action Report* (IRAR) (Pantex, 2010a). The two recent deed restrictions were provided to TCEQ and EPA in a comment response letter for the ESD (Pantex, 2022b and 2022c). The two newest restrictions will be removed once remediation is complete at the offsite properties. Fig. 1-5 provides the location of deed restrictions at Pantex, TTU, and offsite properties and also depicts the groundwater remediation systems installed at Pantex.

Two pump and treat systems were installed to address contamination in areas with generally greater than 15 ft of saturation in the perched aquifer. These systems are designed to remove and treat perched groundwater to reduce contaminant mass and the perched aquifer's saturated thickness. Reduction in saturated thickness should significantly reduce the migration of contaminants both vertically and horizontally so that natural breakdown processes can occur over time. Two mobile pump and treat systems were recommended for the future to control plume movement and reduce concentrations offsite and at an area that will continue to contribute high concentrations of hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) to the offsite area in the future. The Offsite Mobile Pump and Treat System has been installed and is planned for operation in 2024. The East Mobile Pump and Treat System wells have been installed. After evaluation of pumping rates in those wells, it has been determined that the new wells will not pump enough to conduct pump and treat operations. Pantex is planning to inject those wells to lower concentrations of RDX that will move to the southeast. The system will be renamed as the East ISB and operations are expected to begin when funding is available for construction of infrastructure (pad and water line for supply water to mix with molasses) and injection operations.

Pantex has installed ISBs to reduce the concentration of contaminants as they migrate through the remediation zone in targeted areas of the groundwater plumes. Currently, Pantex has four ISB systems, but two more are planned for the future to reduce risk to the offsite area to the southeast and to the Ogallala Aquifer that lies beneath the northeast TTU property.

Each of the current remediation systems is detailed in the following sections. Newly planned or installed systems will be included in future reports when they begin operating.

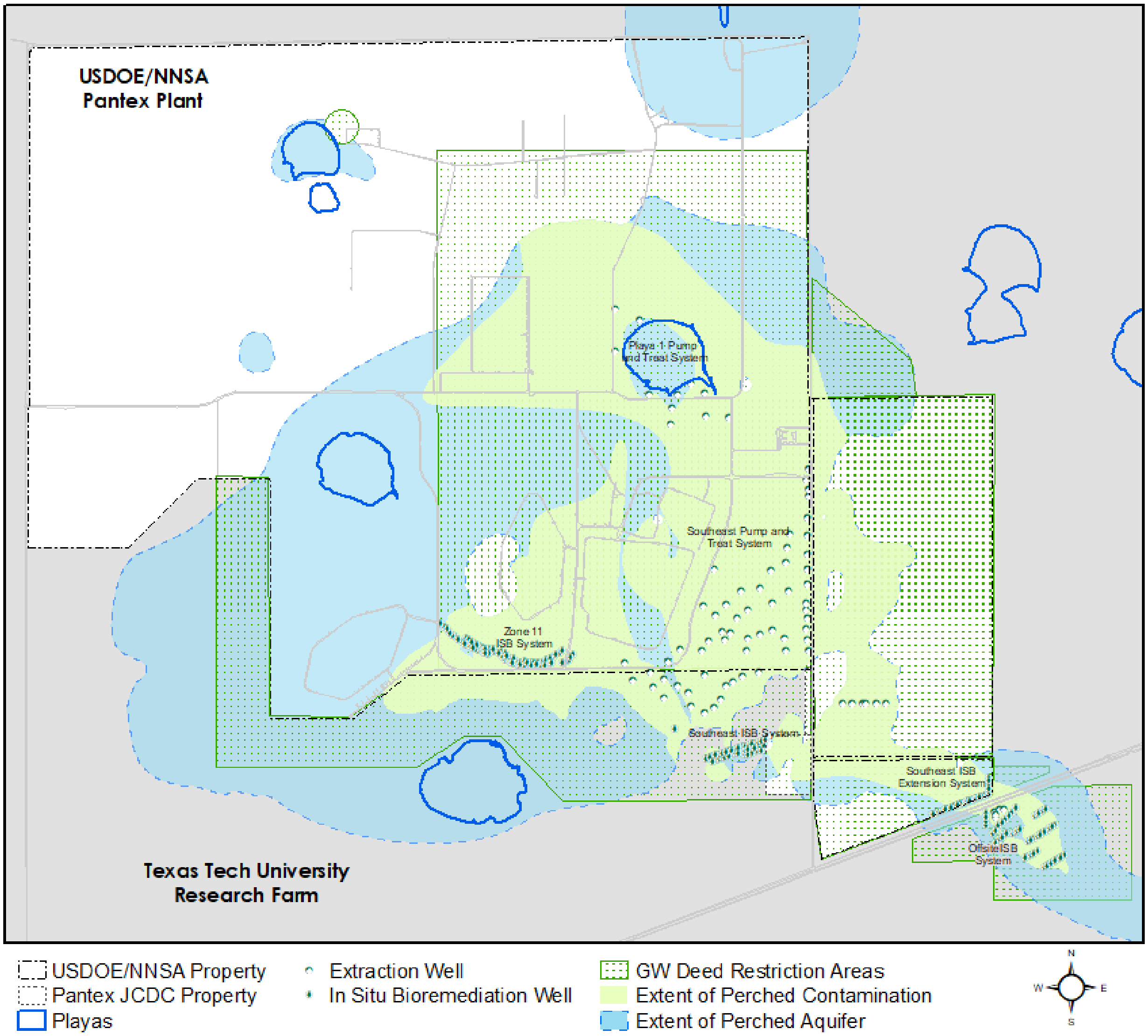

Fig. 1-5. Groundwater Remedial Actions.

1.4.1 Pump and Treat Systems

As part of the RA, Pantex installed two pump and treat systems, the Southeast Pump and Treat System (SEPTS) and the Playa 1 Pump and Treat System (P1PTS), with four injection wells and 76 operating extraction wells that currently treat up to a total of 550 gallons per minute (gpm) of contaminated perched groundwater. The systems address contamination in areas that generally had greater than 15 ft of saturation in the perched aquifer at the time of system installation. These systems were designed to remove and treat groundwater to achieve contaminant mass reduction as well as 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 attenuation processes can occur over time. Operational goals for the two systems, as operated in 2023, are provided in the highlight box. Based on results of the pump and treat optimization (Hydrogeologic [HGL], 2021a), Pantex realigned the pump and treat system (PTS) operational goals in early 2023 to ensure that SEPTS will be prioritized for operation to continue to capture the RDX, perchlorate, and hexavalent chromium plumes. Prioritization of pumping at SEPTS is also planned for realignment to ensure that the plumes are more effectively captured.

PTS Operational Goals

1. Achieve 90% operation time and 90% design capacity flow at both systems when the irrigation systems can receive treated water. Treated water is also managed through injection to the Playa 2 area and ISBs.
2. If well field capacity cannot provide 90% design capacity flow, operate systems at highest flow possible using a combination of irrigation, ISB injection and Playa 2 injection for treated water release. Maintain a minimum of 150 gpm flow at each system.
3. When the irrigation systems limit flow, operation of SEPTS is priority. Maintain 90% operation time and flow at SEPTS or highest flow possible. Operate P1PTS if minimum flow of 150 gpm can be achieved and there are available outlets for water release. All water outlets, including irrigation, ISB injection, Playa 2 injection and injection well near SEPTS will be used. Release to Playa 1 in accordance with permit limits may be used if needed. Operate P1PTS for a few days monthly or quarterly to maintain operability, if the system must be shut down to operate SEPTS at the highest rate possible.

To achieve mass reduction and reduction in saturated thickness, PTSs treat extracted water and remove contaminants before the effluent is sent for beneficial use to the wastewater treatment facility (WWTF) lagoons and subsurface irrigation system or to the new pivot irrigation system completed in August 2023. Pantex also uses the water beneficially for ISB injection and has been approved to use the treated water for various purposes, including dust suppression, firefighting, washing, and make-up water. Pantex installed a bulk water station at the SEPTS that began operating in 2016 to allow beneficial use in accordance with the Texas Land Application Permit (TLAP). While the primary use option is irrigation and ISB injection, the SEPTS retains the capability to inject back into the perched zone as necessary. Currently four wells are used for injection back into the perched aquifer. The wells occur in two areas: Pantex has installed a new injection system near Playa 2, consisting of three injection wells and conveyance to that area, and one well near the SEPTS system. The new system goals prioritize irrigation, ISB injection, and injection into the Playa 2 injection wells to maintain full operation of both pump and treat systems. If irrigation release is limited, injection into the well near the SEPTS is also used. Pantex can use release to Playa 1, in accordance with TCEQ permit requirements. Release to Playa 1 is used only as a last option to ensure continued operation of SEPTS. Playa 1 has been used for release by the WWTF while repairs continued at the subsurface irrigation system and to the WWTF lagoons. Pantex started operating the pivot irrigation system in late 2023, and release to Playa 1 is expected to be discontinued in early 2025 after further evaluation of the WWTF effluent.

The P1PTS began start-up operations in late 2008, and the system became fully operational in January 2009. The SEPTS has been operating since 1995 when it started as a treatability study. It has since been expanded with additional extraction wells and the capacity to treat boron, perchlorate and hexavalent chromium to become part of the final RA for the southeastern portion of the groundwater plumes. A list of the extraction and injection wells and their status is included in Section 1.6.

A new mobile pump and treat system was installed at the Offsite ISB. This system occurs in the northeast corner of the offsite leased property, where five extraction wells have been installed. The purpose of the system is to help pull water from the neighboring property to the west, where there is no active remediation. This will help remediate the adjacent western property in a shorter time frame. This system is planned for operation in 2024, and will be included in the annual report when it starts operating.

1.4.1.1 Playa 1 Pump and Treat System

The P1PTS extracts water from 11 wells near Playa 1 and treats it through a series of granular activated carbon (GAC) beds to reduce high explosives (HEs) below the GWPS established in the ROD and HW-50284. This system focuses on reducing the mound of perched groundwater associated with Playa 1, thereby affecting the movement of the southeast plume by reducing the hydraulic head and achieving mass removal. This system is designed to treat up to 250 gpm.

This system consists of a treatment building and 11 extraction wells that treats small amounts of HEs and volatile organics such as trichloroethene (TCE). Boron is treated using an ion exchange vessel to concentrations below 500 micrograms per liter (ug/L) when the water will be used for irrigation purposes. In 2023, Pantex evaluated perched groundwater at P1PTS for the presence of per- and poly-fluoroalkyl substances (PFAS). PFAS were discovered at low concentrations. All PFAS concentrations are below the current promulgated Texas Risk Reduction Program residential protective concentration limits (PCLs). However, the PFOA and PFOS detected in the P1PTS influent water exceeds the newly promulgated MCLs. The current P1PTS GAC treatment is removing PFAS, along with the high explosives. Since the primary focus of this system is to remove water, only small amounts of COCs are removed during the treatment process as high explosive concentrations have greatly declined in groundwater beneath Playa 1. Fig. 1-6
Fig. 1-12depicts the P1PTS wells and conveyance.

P1PTS beneficially uses all treated water by sending it through the WWTF to the subsurface irrigation system or to the new pivot irrigation system. Because this system cannot inject the treated water back into the perched aquifer, the treatment throughput must be temporarily adjusted or discontinued based on the demands of the WWTF or irrigation system. In 2017, a break occurred at the subsurface irrigation system, so irrigation usage was discontinued until the new pivot irrigation system started operation in late 2023.

Operating under a permit issued by the State of Texas, Pantex can release treated wastewater to Playa 1. Pantex continued to release WWTF and pump and treat effluent to Playa 1 through 2023 while repairs were completed at the onsite irrigation system and WWTF lagoons. Repairs were completed at the subsurface irrigation system, but necessary WWTF lagoon repairs have impacted the ability to release to the subsurface irrigation system. While repairs are ongoing, the WWTF continues to release water to Playa 1, in accordance with the TCEQ permit. Pantex completed installation of a second irrigation system east of FM 2373 to allow beneficial use of water from both pump and treat systems. The new center pivot system construction was complete in August 2023, with testing and operation occurring until a break at the wet well on December 7 required the system to be shut down. Pantex completed repairs in February 2024 and irrigation resumed when freezing temperatures did not affect system use.

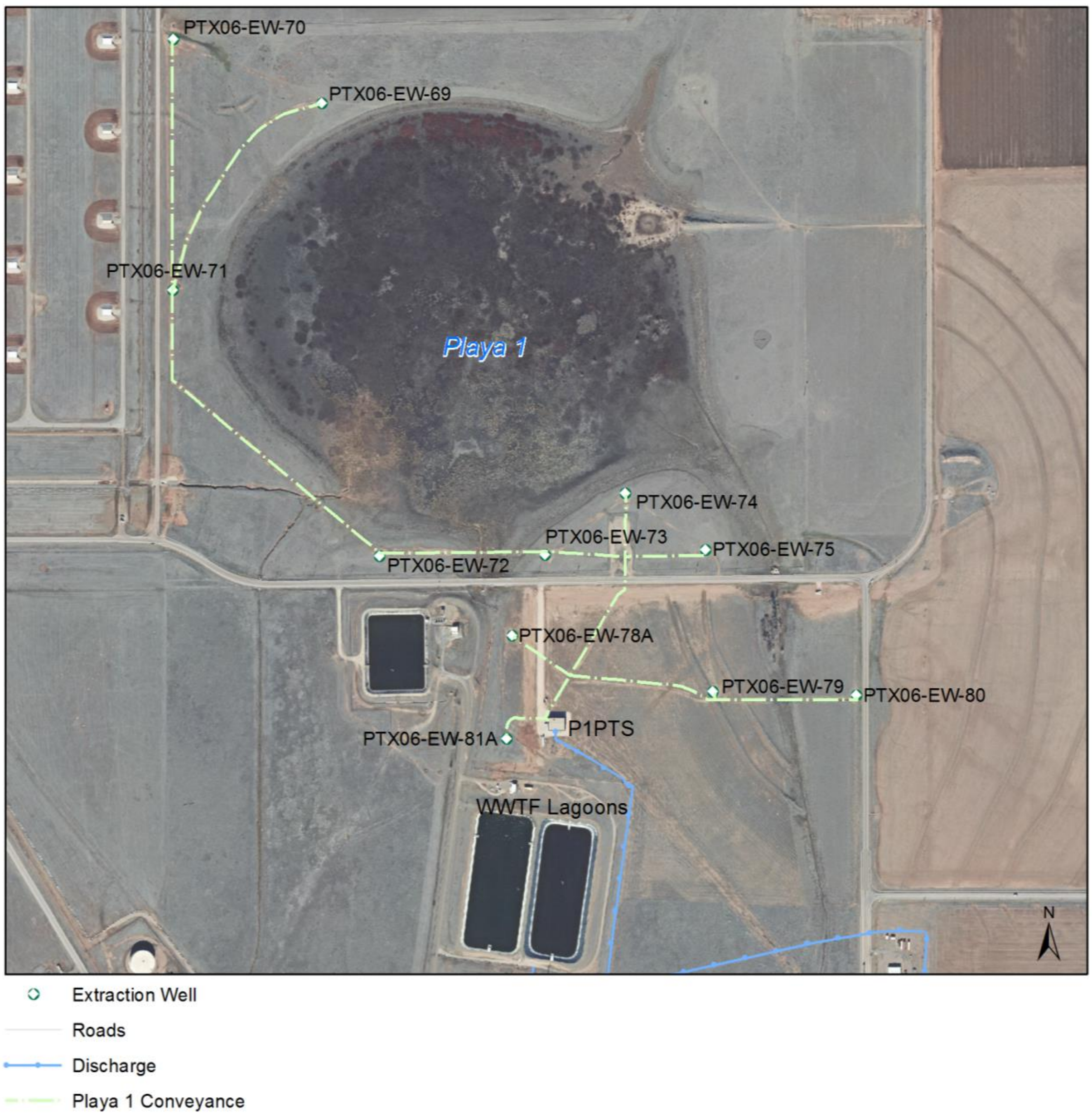

Fig. 1-6. P1PTS wells and conveyance lines.

1.4.1.2 Southeast Pump and Treat System

The SEPTS was originally installed at Pantex in 1995 as part of a treatability study. Since then, the PTS has been expanded to meet the objectives of the environmental restoration project and final remedy established in the ROD and HW-50284.

The SEPTS currently consists of a treatment building, 65 active extraction wells, and four injection wells (see Fig. 1-7). Six new extraction wells were drilled east of FM 2373 to provide additional control of plume movement to the southeast. The wells were tied in to the SEPTS and started operating by May 2019. Currently, only three of those wells remain operational due to the declining water levels in the area.

This system is designed to treat up to 300 gpm. Treatment of the recovered perched groundwater is completed through a series of granular activated carbon (GAC) vessels and ion exchange resin beds to reduce concentrations below the GWPS established in the ROD and HW-50284. Primary contaminants treated by this system include HEs, hexavalent chromium, and perchlorate. There are other minor plumes in the area, including TCE, that are treated by the SEPTS. Boron is treated below 500 ug/L when the water will be used for irrigation purposes. Pantex has designed and installed in 2022, a new resin pre-treatment system for perchlorate.

Pantex started evaluating SEPTS for the possible presence of PFAS in 2023. PFAS was found in the influent to SEPTS and at individual extraction wells. Eleven PFAS compounds were found in the influent to SEPTS. Perfluorooctanoic acid (PFOA) detections were the highest concentrations found, with only 3 of 12 influent concentrations above the Texas Risk Reduction Program (TRRP) protective concentration levels (PCLs). No other influent detections of PFAS exceeded the TRRP PCLS, where PCLs were available. All influent PFOA concentrations are greater than the newly promulgated MCLs. The GAC treatment that was designed to treat high explosives is also removing PFAS from the perched groundwater.

The objective of the SEPTS is to remove and treat contaminated perched groundwater for industrial and/or irrigation use. While this system can inject treated water back into the perched zone, the intent is to permanently remove perched groundwater to gradually reduce the saturated thickness in this zone. This effort will achieve the following two important objectives:

- Gradual reduction of the volume of perched groundwater and contamination moving downgradient toward the extent of the perched aquifer.

- A reduction in the head (i.e., driving force) for vertical migration of perched groundwater into the fine-grained zone (FGZ) and to the drinking water aquifer.

To meet these objectives, operational goals were established for this system, as presented in the highlight box in Section 1.4.1. Goals are prioritized for system operation and will be met as conditions allow. Based on observed extensions of the RDX plume and optimization modeling conducted for the PTSs, Pantex revised the operational goals in early 2023. Based on optimization modeling and observations of plume movement, it is clear that operation of the SEPTS is necessary to control the RDX plume and reduce future risk due to movement of the plume to the southeast; therefore, the goals emphasize the operation of SEPTS when water outlets are limited for the pump and treat systems. Pantex started operating the two pump and treat systems under the new goals, once approved by the TCEQ in a letter dated April 13, 2023.

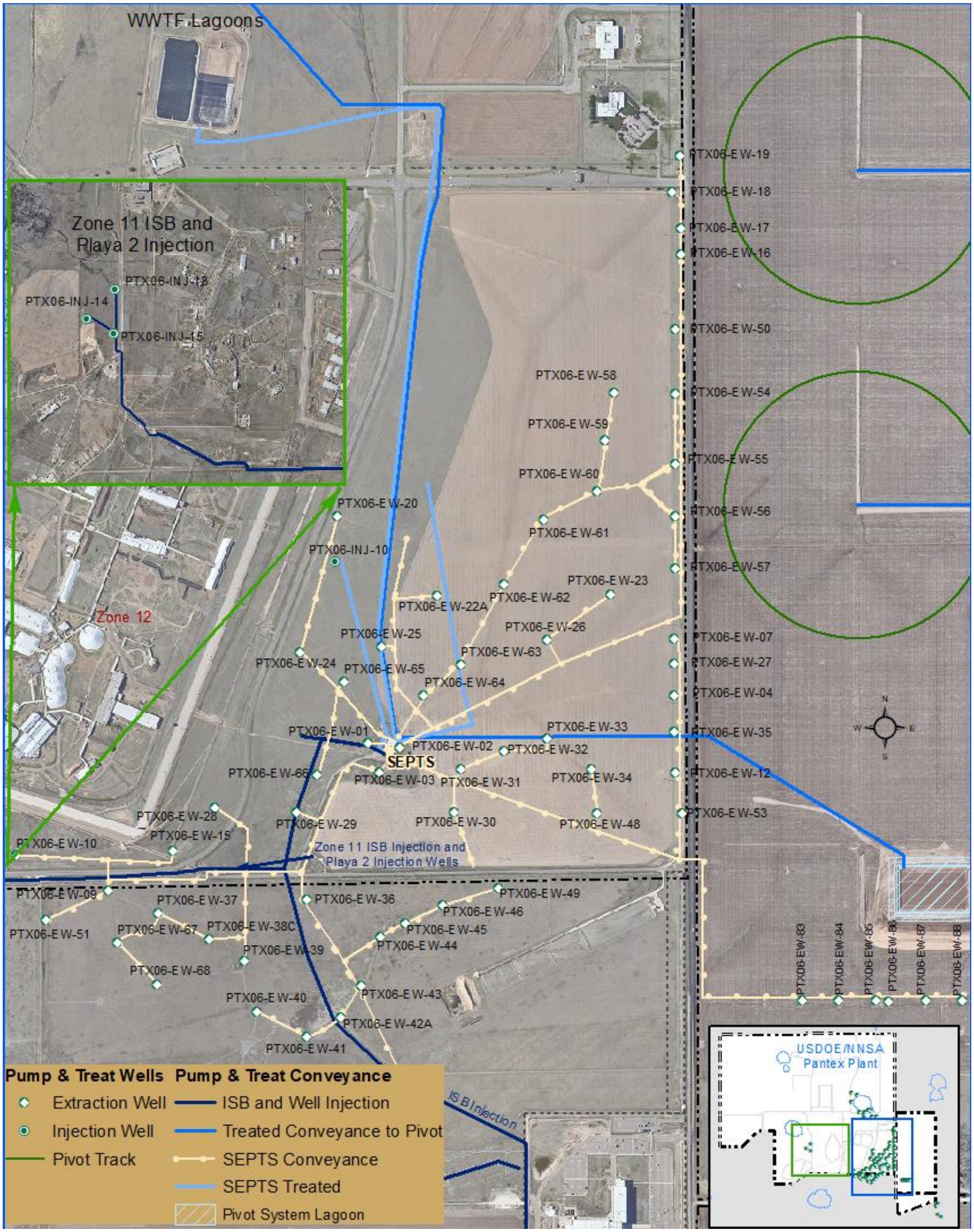

Fig. 1-7. SEPTS wells and conveyance lines.

1.4.2 In Situ Bioremediation Systems

Pantex has installed and operates four ISB systems as part of the final RA for groundwater. One operating system is on the southeast side of the Plant on TTU property, another along the southeast property boundary east of FM 2373, one is offsite to the southeast, and the final one is south of Zone 11.

In 2023, the operating ISB systems consisted of 198 active ISB injection wells, 28 ISB extraction wells (REC-named wells in figures), 14 treatment zone monitoring (TZM) wells, and 19 in-situ performance-monitoring (ISPM) wells. New wells were drilled in 2023 at the Offsite ISB System, including 21 ISB wells, 16 ISB extraction wells and 2 TZM wells. The new wells have not yet been operated due to continuing installation of injection infrastructure during 2023; however, the new wells will be operated in 2024. This installation represents the final planned phase of installation for the Offsite ISB.

A new pilot well for a planned Perchlorate/Chromium ISB (PCR ISB) was also installed to evaluate the plume in that area. The PCR ISB is planned for installation in 2024, pending availability of funding. The PCR ISB will be detailed in future reports, once the system is fully installed.

Pantex has converted three previously installed wells that were originally installed to be used for a mobile pump and treat system. However, the wells could only pump approximately 2 gpm each; rendering them unusable for the pump and treat system. The wells were intended to be converted to ISB injection once water was difficult to extract; therefore, Pantex is converting the wells to injection and will begin injecting once budget is identified to build infrastructure for injection. Pantex plans to install a pad and water conveyance line from the pivot irrigation inlet to the pad so that injections can be performed. Once the system is completely installed, the new East ISB will be detailed in future reports.

The objective of the ISB systems is to establish an anaerobic biodegradation treatment zone capable of reducing COC concentrations to the GWPS by injecting the necessary amendments and nutrients to stimulate resident bacteria. The bacteria first consume oxygen and then, in turn, consume other electron acceptors, creating reducing geochemical conditions. Under reducing conditions, biotic and abiotic treatment mechanisms are carried out to remove contaminant mass from groundwater. Regular injections of amendment are essential to maintaining the health of the treatment zone.

1.4.2.1 Zone 11 ISB

The Zone 11 ISB System is on Pantex property, south of Zone 11 (see Fig. 1-8). The system, as operated in 2023, consists of 89 active injection wells, 7 TZM wells, and 9 downgradient ISPM wells installed in a zone of saturated thickness of approximately 15 to 20 ft.

The system, originally consisting of 23 wells and 3 downgradient performance monitoring wells, was installed by March 2009. An additional nine wells were installed in September 2009 to better treat the perchlorate plume on the eastern side and the TCE plume on the western side of the ISB.

Pantex expanded the system in late 2014 to include an additional 20 injection wells (i.e., 18 new injection wells and 2 previously installed pump test wells), 3 new downgradient ISPM wells, and 3 TZM wells that will not receive injection. One TZM well was previously installed as a pump test well, and two additional TZM wells were also installed in the original system on the TCE (i.e., western) side. The TZM wells have replaced monitoring of a portion of the injection wells in the areas they are installed.

To evaluate the movement of treated water to the south of the system, Pantex also designated three established downgradient monitoring wells as ISPM wells to evaluate the movement of treated water to the south of the system. In late 2019, Pantex extended the system again with six new injection wells to the northwest. The expansion wells were installed to fully encompass the TCE and perchlorate plume that extended northwest of the original system.

In 2021, a second row of wells, consisting of 26 ISB injection wells, was added across the southern side of the ISB to address the higher concentrations of TCE that are now moving to the southeast. Those wells were spaced at approximately 50 ft to allow for use of emulsified soybean oil, which does not distribute as widely as a more soluble carbon. Five wells were infilled on the western side of the ISB due to the loss of injection capacity at nearby wells. Additionally, two TZM wells were added to the southern expanded area. One upgradient monitoring well was added to evaluate the incoming TCE plume. To avoid confusion, the well installed as a replacement for PTX06-ISB075 was renamed as PTX06-1230 and will serve as a TZM well until the original PTX06-ISB075 fails.

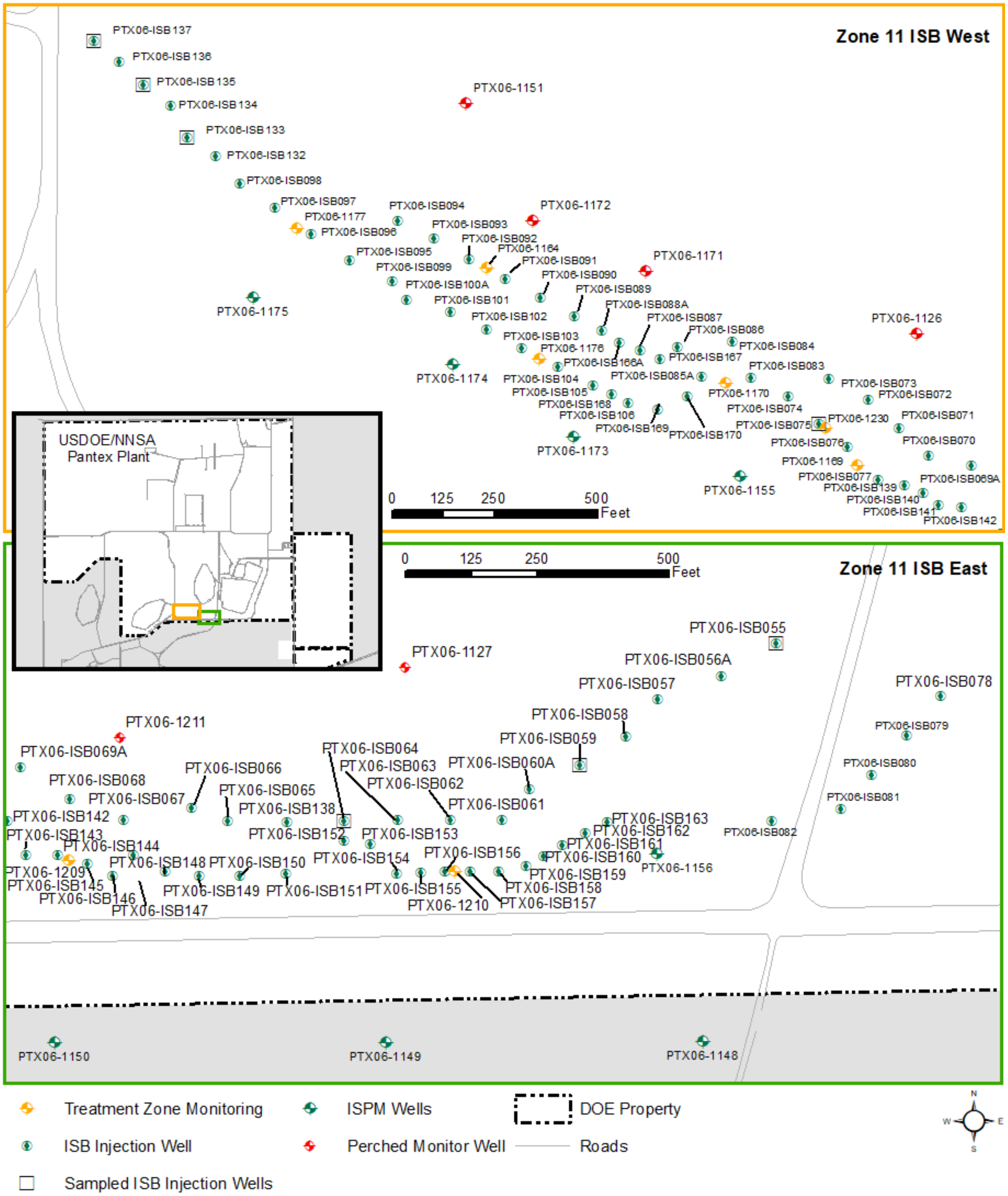

Fig. 1-8. Zone 11 ISB treatment zone and performance monitoring wells.

Installed injection wells were drilled in a line perpendicular to the hydraulic gradient so water flowing through this zone will be treated before it reaches the area beneath TTU property near Playa 4. This system treats primarily TCE and perchlorate, although minor plumes of HEs are also present. Based on the rate of perched groundwater flow and estimated amendment longevity of the Newman Zone® soybean oil, injections were estimated to be necessary approximately every 12 to 36 months. Pantex has been scheduling rehabilitation and injection activities every 36 months at wells that receive the soybean oil based on data collected in the original treatment zone.

To improve amendment distribution at more widely spaced wells, Pantex recently moved to use of a more soluble amendment, molasses, for injection. However, molasses will require more frequent injections and thus has been scheduled for reinjection about every 12 months following the 2019 injection.

Fifteen injection events have been completed for this system. Table 1-3 provides the list of injection events and dates of completion.

Table 1-3. Zone 11 ISB Injection Events

Injection Event	Completion Date
1	June 2009
2	November 2009
3	September 2010
4	October 2011
5	September 2012
6	July 2013
7	July 2014
8	November 2015
9	August 2016
10	October 2018
11	January 2020
12	January 2021
13	November 2021
14	September 2022
15	December 2023

The *In Situ Bioremediation Corrective Measures Construction Zone 11 South Implementation Report* (Aquifer Solutions, 2009a) documents the implementation of the Zone 11 ISB System. That report was included with the IRAR (Pantex, 2010a). The installation of the nine new wells is documented in the *Well Installation Implementation Report Perched Aquifer Injection Wells for the In Situ Bioremediation System* (Stoller, 2009) included in the *2009 Annual Progress Report* (Pantex, 2010b).

Pantex expanded the Zone 11 ISB in 2014, and the design report for the equipment pad, road, and water supply was included in the *2014 Annual Progress Report* (Pantex, 2015). The well design followed the original design document for the Zone 11 ISB (Aquifer Solutions, 2008). Well installations are documented in the *Well Drilling Implementation Report* (Trihydro, 2014), which is also included in the *2014 Annual Progress Report*. The *Bioaugmentation Implementation Plan* (Trihydro, 2015) provides the detailed plan for injection of *Dehalococcoides sp*.

The 2019 well installations follow the design of the original well installation. The 2021 expansion was developed based on the original design, although spacing was varied depending on the type of injection expected at the wells. Well construction details for newly installed wells were provided in the annual report for the year that the wells were drilled.

1.4.2.2 Southeast ISB

Installed in 2007 as an early action, the Southeast ISB System is on TTU property south of Pantex and consists of 42 injection wells within the treatment zone and 5 ISPM wells (see Fig. 1-9). The injection wells were drilled in a line perpendicular to the hydraulic gradient so the water flowing through the treatment zone will be treated before reaching the area beneath TTU property where the FGZ becomes less resistant to vertical migration. The system is designed to treat HEs and hexavalent chromium.

Based on the rate of perched groundwater flow and estimated longevity of the Newman Zone® soybean oil, injections were originally estimated to be necessary about every 12 to 24 months. However, recent injections at this ISB are now informed by data and the presence of water in the system.

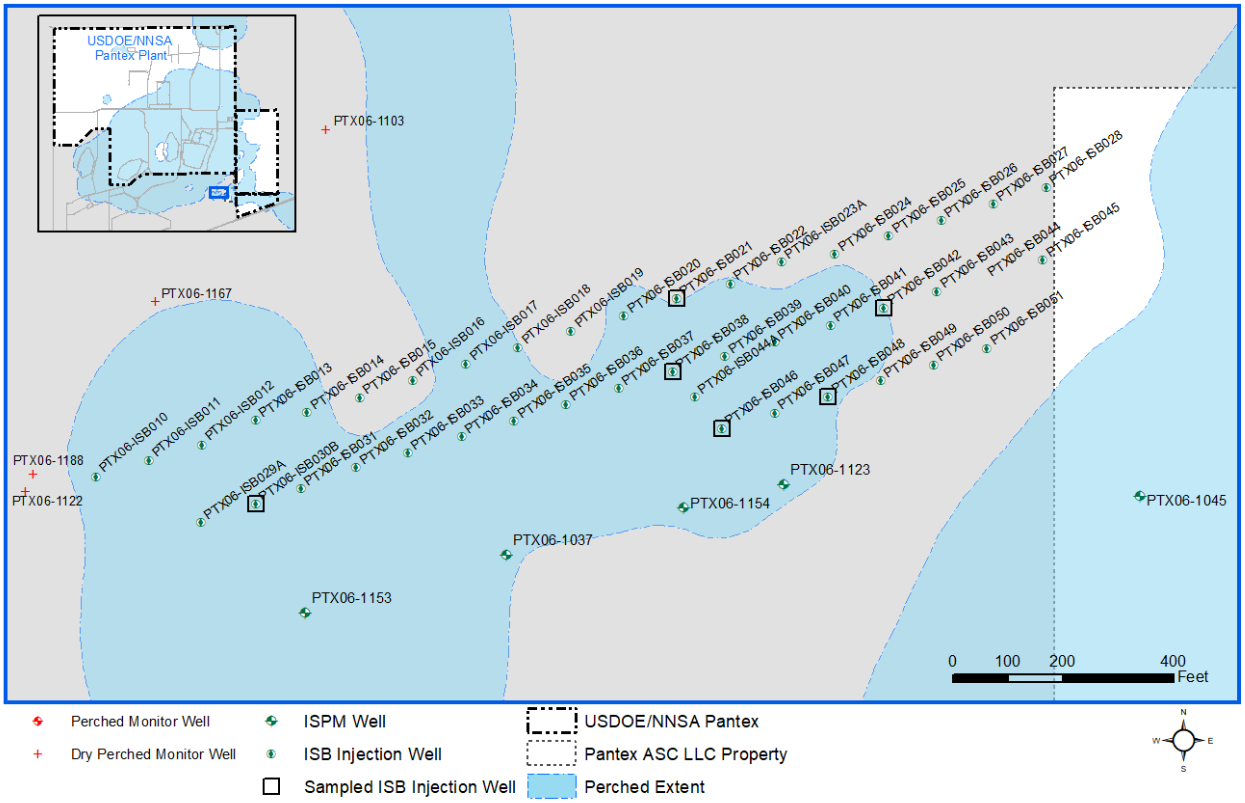

Fig. 1-9. Southeast ISB treatment zone and performance monitoring wells.

In 2019, Pantex moved to injection of molasses in this system to achieve wider distribution of amendment. With the change in substrate, another injection was completed in 2022. However, due to continued water level decline, injections are expected to cease in upcoming years. Current injections are limited to approximately 50% of the system due to increased dry areas within the system. Eight injection events have been completed for the Southeast ISB, as shown in Table 1-4.

Table 1-4. Southeast ISB Injection Events

Injection Event	Completion Date
1	March 2008
2	April 2010
3	May 2012
4	September 2013
5	April 2015
6	October 2016
7	January 2020
8	May 2022

The *Revised Implementation Report, Southeast Plume In Situ Bioremediation Corrective Measures Design and Construction* (Aquifer Solutions, 2009b) documents the design and construction of the Southeast ISB. That report was included in the IRAR (Pantex, 2010a).

1.4.2.3 Southeast ISB Extension

Pantex installed a new system in 2017 to address another area of contamination in the southeast perched groundwater. The new system is an extension of the original ISB remedy for the southeast perched groundwater plume, as provided in the ROD.

The system consists of 31 ISB injection wells, 2 TZM wells, and 2 ISPM wells. The system was originally installed in 2017 with 24 new injection wells and one monitoring well that was converted for use as an injection well. The system was expanded northward with four new ISB injection wells in 2020 and further expanded in 2021 with two new ISB injection wells and two new TZM wells. Further expansion to the north is anticipated in the future, due to observed and modeled expansion of the plume to the east.

The system was positioned to treat high explosive (HE) contaminants, particularly RDX, that are moving to offsite landowner property. Due to the new extraction wells' upgradient removal of water, water levels are anticipated to decline in this system over time, and future injections will be unnecessary or limited. Fig. 1-10 depicts the Southeast ISB Extension.

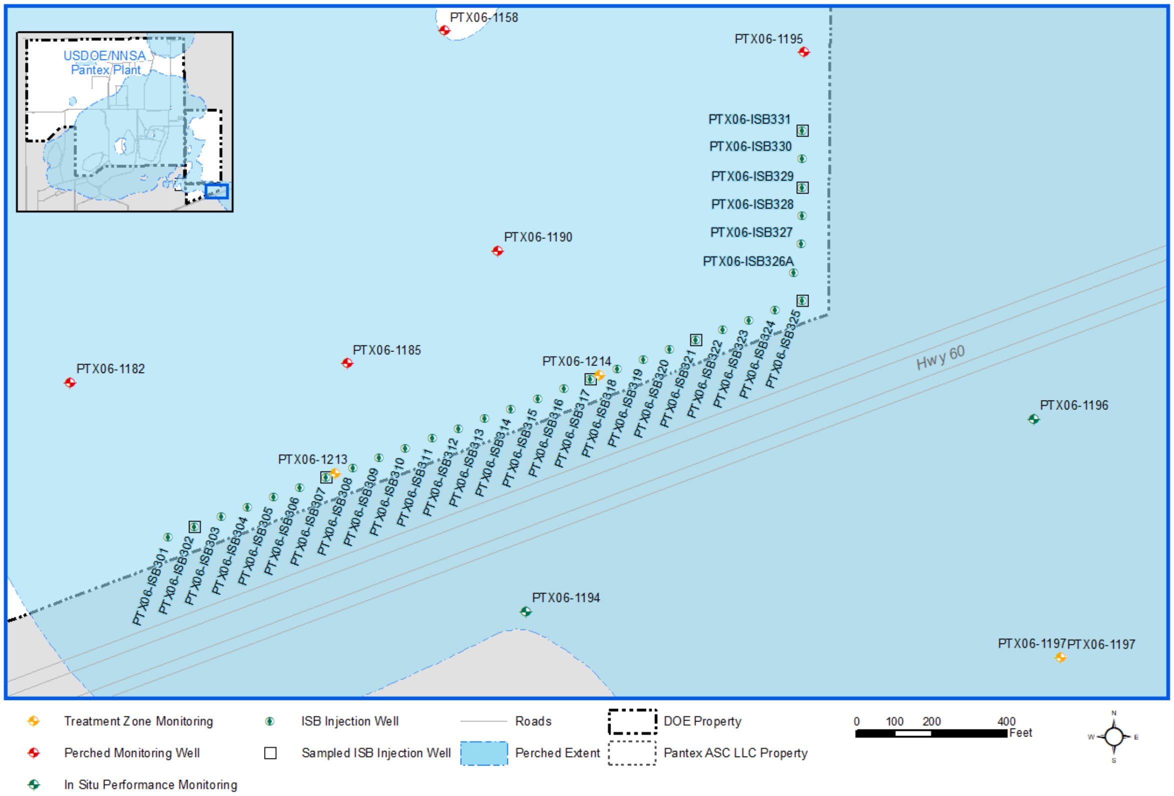

Fig. 1-10. Southeast ISB Extension treatment zone and performance monitoring wells.

Based on the rate of perched groundwater flow and estimated amendment longevity of molasses, injections are estimated to be necessary about every 12 months. As depicted in Table 1-5, seven injection events have been completed at this system.

This system was installed using a similar design to the Southeast ISB. Wells were more closely spaced at 75 ft to ensure better distribution of amendment. The implementation of this system was documented in the *2018 Annual Progress Report* (Pantex, 2019d) as part of the implementation report for drilling. Wells drilled in the future will be added to the Well Certifications and Completion Diagrams appendix in each year's annual progress report.

Table 1-5. Southeast ISB Extension Injection Events

Injection Event	Completion Date
1	February 2019
2	September 2019
3	August 2020
4	May 2021
5	December 2021
6	September 2022
7	October 2023

1.4.2.4 Offsite ISB

To address HE contamination that moved beneath a neighboring property, Pantex began installing an offsite ISB system in 2020 with installation complete in 2023. Pantex has reserved a few wells that would not currently be within the plume of HE contamination. Those wells will only be installed if needed to mitigate HEs due to plume growth. This ISB is located to the southeast of Pantex-owned property, south of Highway 60, and currently consists of 56 ISB injection wells and 44 active ISB extraction wells (REC-named wells), and 6 TZM wells, as depicted in Fig. 1-11. One ISPM well (PTX06-1191) was converted to injection late in 2022 to treat a neighboring property where a small portion of the plume occurs.

The first phase of system installation in 2020 focused on beginning treatment at the leading edge and in the heart of the plume near the property's northern boundary. Three new ISB injection wells were installed on the neighboring property in 2021 and were injected in 2022, in addition to the converted ISPM well. The system was expanded in 2022 with 19 ISB wells, 17 ISB extraction wells and 3 TZM wells and is planned for injection in 2023 (wells depicted as inactive in Fig. 1-11). The final planned phased system installation was completed in 2023 and included ISB injection, ISB extraction, pump and treat injection, and TZM wells. The new ISB wells installed in 2023 are planned for injection starting in 2024.

All water used in the injection process must be withdrawn from beneath the offsite property, so downgradient ISB extraction wells were installed. Downgradient removal also assists in pulling the amendment towards the removal wells, providing an expanded zone for COC treatment.

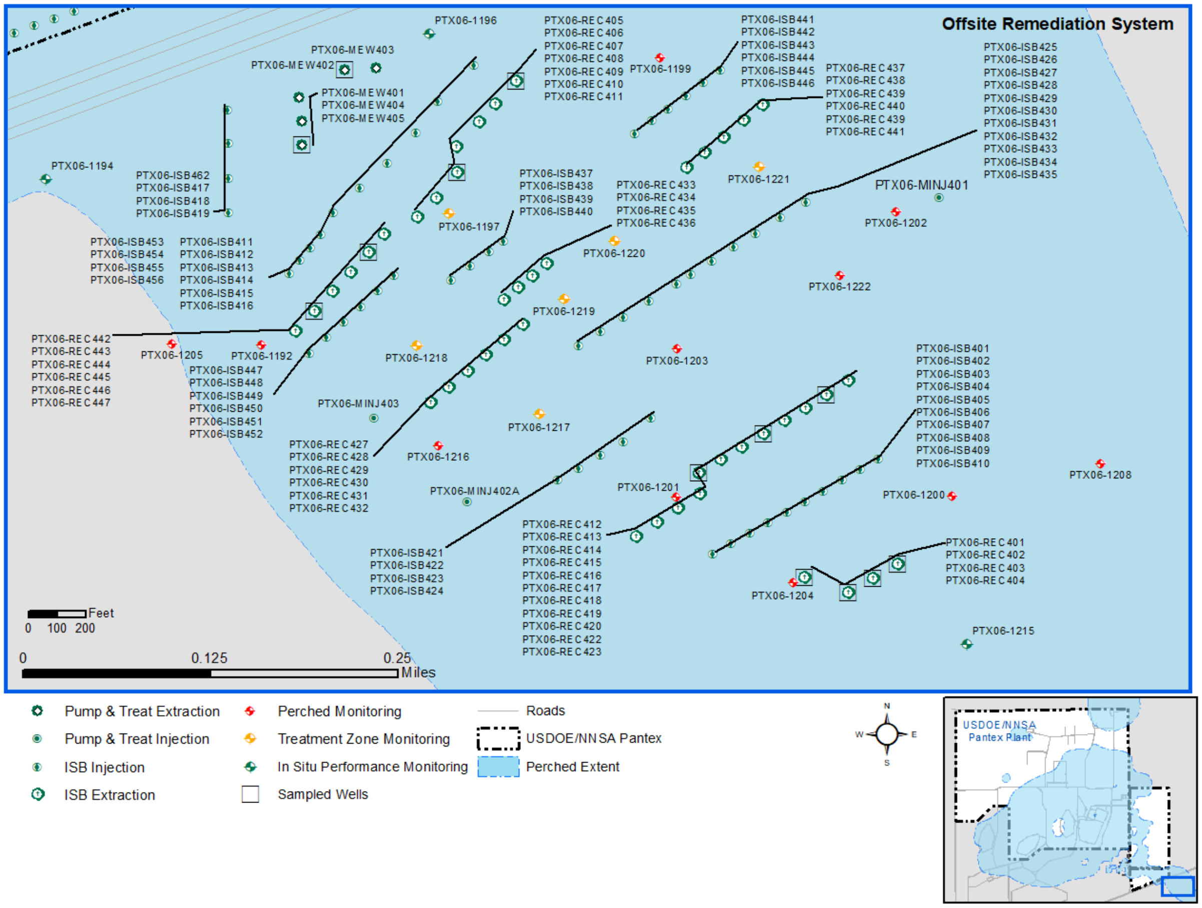

Fig. 1-11. Offsite ISB treatment zone and performance monitoring wells.

Based on the use of molasses, injections are planned every six months at differing parts of the system. Injection plans will follow the schedule that was designed using fate and transport and optimization modeling. No injections occurred in 2020 and early 2021 due to required planning, setting up of new contracts, and development of necessary infrastructure for injection. However, injection began in June 2021 and five injection events have been completed at the system. Injection events for this system are provided in Table 1-6.

Table 1-6. Offsite ISB Injection Events

Injection Event	Completion Date
1	October 2021
2	August 2022
3	November 2022
4	August 2023
5	December 2023

Designed to complete cleanup within 25 years at the offsite property, the system was developed using the updated perched groundwater fate and transport model (HGL, 2021b). The final placement of wells was driven by the data collected from new system wells installed in 2020, with modeling used to determine optimum placement and timing of injections to achieve cleanup. That modeling effort has guided the plans for final placement of system wells in 2022 and 2023 as well as the future injection timing for the system wells. Based on the optimization modeling, all or portions of the injection wells are injected twice per year.

1.5 Report Purpose and Objectives

This report satisfies requirements in the IAG and HW-50284 to provide information on the remedial system performance and components. The focus of this report is on the data and information collected for the soil and groundwater remedies during the previous year, and the objective is to provide a more detailed account of the remedies than the quarterly reports.

The only active soil remedy is the Burning Ground SVE system, and this report provides information on its operation, mass removal, and effluent readings. This report also provides information on the inspection and maintenance of the ditch liner, soil covers, and fencing that are part of the RA. In addition, information on site control in accordance with institutional controls and deed restrictions is provided.

Groundwater Remedial Action Evaluation Criteria

- Plume Stability
- Remedial Action Effectiveness
- Uncertainty Management
- Early Detection
- Natural Attenuation of COCs

This progress report also provides information on the O&M of groundwater remediation systems and components. Data are evaluated according to criteria outlined in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a). Those criteria are included in the highlight box on the left and are detailed in the appropriate sections of this report.

This report is organized to present detailed information in a summary form in the main report along with appropriate supporting detail in the appendices to provide an understanding of the conclusions. The appendices include detailed information such as statistical trending of concentrations and water levels at each well, electronic analytical and field-collected data, pump and treat flow data, well maintenance activities, SWMU status, contractor operational reports for the ISB, certification and well construction diagrams for new wells, implementation reports, and well-drilling reports, as applicable.

1.6 Long-Term Monitoring of Remedial Actions

Pantex has developed a long-term monitoring (LTM) network to evaluate the effectiveness of the RAs, ensure that objectives from the ROD are achieved, and confirm expected future conditions within the perched and Ogallala aquifers. The LTM design and evaluation criteria are provided in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a). The final system design was incorporated into the Compliance Plan portion of the hazardous waste permit when it was issued. The design was further detailed in the Compliance Plan portion of the hazardous waste permit to designate specific wells as point of exposure (POE) and point of compliance (POC) wells where the GWPS is required to be met.

Pantex also monitors extraction wells in the PTS to supplement data used to map plumes and to evaluate plume changes in the systems. ISB and TZM wells are used to monitor the health of the ISB treatment zones, and downgradient ISPM wells are used to monitor the effectiveness of the ISB RAs. Most ISPM wells also serve as POC wells in HW-50284. The SVE is primarily monitored at the influent and effluent of the system; however, Pantex has sampled individual soil gas wells as needed.

All of the LTM and remedial system wells are detailed in the following sections, along with the dates of drilling or inclusion in the hazardous waste permit, as applicable.

1.6.1 Perched Aquifer LTM Network

The final perched aquifer LTM network is divided into four areas defined by indicator COC monitoring lists for wells in each area. At the end of 2023, the network consisted of the 136 perched wells. The well assets were sampled or managed according to the following criteria:

- Twenty-six wells are monitored for continued dry or limited water conditions.
- Ninety wells are sampled for indicator COCs and other applicable analytes including natural attenuation products, corrosion indicators, and general water quality indicators.

- Twenty wells are monitored as ISPM wells for the ISB systems and previous pilot study system. The ISPM wells are monitored for COCs, degradation products, and ISB treatment zone parameters.
- All 135 perched LTM wells and 38 additional wells not included in the LTM network have water levels measured semi-annually.
- Sixty-four wells are sampled semi-annually, 36 wells are sampled annually, and 10 wells are sampled every five years.
- Thirty-four of the sampled wells, including 24 of the annually and semi-annually sampled wells, are sampled every five years using a modified groundwater list in Title 40 of the Code of Federal Regulation (40 CFR), Part 264, *Protection of Environment*, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix IX, to satisfy uncertainty management requirements. The modified Appendix XI monitoring list is included in HW-50284 as CP Table III. The next five-year sampling is scheduled for 2026.
- Pantex has designated 20 of the perched wells as POC wells where the GWPS must be met for all COCs. The 20 wells were updated with the application to renew HW-50284. Those wells are depicted in Fig. 1-12.
- Four indicator areas were defined for the perched groundwater. COCs to be monitored are defined for each of those areas.
- One new monitor well was added to the offsite area during 2023.

Table 1-7 lists all wells in the perched LTM network and HW-50284, their LTM objective, indicator monitoring area, Compliance Plan objective (POC or POE well), date of inclusion or removal from HW-50284, and coordinates. The wells are listed in chronological order according to the date of inclusion in HW-50284, in accordance with HW-50284's CP Table VII requirements. Fig. 1-12 depicts the current active LTM wells listed in Table 1-7.

Table 1-7. Perched LTM Network and Compliance Plan Wells

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX-BEG3		Y	N	6/9/2003	9/16/2010	P&A			3773380.09	643702.32
PTX01-1008	Burning Ground	Y	Y	6/9/2003		Active	UM	POC	3770782.89	629942.97
PTX01-1001	Burning Ground	Y	Y	6/9/2003		Active	UM	POC	3769641.90	630592.95
PTX01-1002	Burning Ground	Y	Y	6/9/2003	1/4/2017	P&A			3769596.99	628496.92
PTX06-1012	ISPM Zone 11	Y	Y	6/9/2003		Active	PS, RAE		3755068.80	634640.91
PTX04-1002	Miscellaneous	Y	Y	6/9/2003		Active	UM		3772165.27	641818.01
PTX06-1080	Miscellaneous	Y	Y	6/9/2003	2/11/2020	Active			3772643.95	638901.00
PTX06-1081	Miscellaneous	Y	Y	6/9/2003	2/11/2020	Active			3770912.33	641222.41
PTX08-1010	Miscellaneous	Y	Y	6/9/2003		Active	UM		3773206.74	641401.47
PTX06-1048A	North	Y	Y	6/9/2003		Active	PS, RAE		3766957.63	642103.43
PTX06-1015	Southeast	Y	Y	6/9/2003		Active	RAE		3753617.00	643765.00
PTX06-1023	Southeast	Y	Y	6/9/2003		Active	RAE	POC	3764603.10	642773.84
PTX06-1030	Southeast	Y	Y	6/9/2003		Dry	RAE		3755008.03	644670.42
PTX06-1034	Southeast	Y	Y	6/9/2003		Active	RAE	POC	3752434.98	646555.62
PTX06-1036	Southeast	Y	Y	6/9/2003		Dry	PS		3752455.56	638615.43
PTX06-1038	Southeast	Y	Y	6/9/2003		Active	RAE		3760426.35	643802.04
PTX06-1040	Southeast	Y	Y	6/9/2003		Active	RAE		3758262.93	643811.23
PTX06-1042	Southeast	Y	Y	6/9/2003		Active	RAE	POC	3755779.88	643812.20
PTX06-1046	Southeast	Y	Y	6/9/2003		Active	RAE	POC	3752292.55	643802.63
PTX06-1052	Southeast	Y	Y	6/9/2003		Active	RAE	POC	3753957.66	639100.91
PTX06-1069	Southeast	Y	Y	6/9/2003		Active	PS		3762879.60	646317.00
PTX06-1053	Southeast, Zone 11	Y	Y	6/9/2003		Active	PS, UM		3753672.06	636576.74
PTX08-1008	Southeast, Zone 11	Y	Y	6/9/2003		Active	UM, RAE		3755695.51	637485.10
PTX06-1035	Zone 11	Y	Y	6/9/2003		Active	PS		3755092.64	633027.45
PTX10-1014	Southeast, Zone 11	N	Y	8/26/2010		Active	UM		3759769.72	639701.73
PTX01-1004	Burning Ground	N	Y	9/16/2010		Dry	PS		3770768.71	630729.82

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX01-1009	Burning Ground	N	Y	9/16/2010		Dry	PS		3769018.50	630594.67
PTX06-1037	ISPM Southeast	N	Y	9/16/2010		Active	RAE		3752194.06	641549.25
PTX06-1045	ISPM Southeast	N	Y	9/16/2010		Active	RAE	POC	3752300.00	642697.65
PTX06-1118	ISPM Southeast	N	Y	9/16/2010	2/11/2020	Active			3752736.07	641644.92
PTX06-1123	ISPM Southeast	N	Y	9/16/2010		Active	RAE		3752319.94	642051.96
PTX06-1153	ISPM Southeast	N	Y	9/16/2010		Active	RAE	POC	3752089.44	641184.13
PTX06-1154	ISPM Southeast	N	Y	9/16/2010		Active	RAE	POC	3752278.90	641870.52
PTX06-1155	ISPM Zone 11	N	Y	9/16/2010		Active	RAE	POC	3755215.62	634603.74
PTX06-1156	ISPM Zone 11	N	Y	9/16/2010		Active	RAE	POC	3755076.47	636378.92
PTX04-1001	Miscellaneous	N	Y	9/16/2010	2/11/2020	Active			3772334.66	641458.10
PTX06-1049	Miscellaneous	N	Y	9/16/2010		Active	PS		3763376.96	633343.53
PTX06-1055	Miscellaneous	N	Y	9/16/2010	2/11/2020	Active			3767254.87	633521.90
PTX06-1071	Miscellaneous	N	Y	9/16/2010		Active	UM		3773219.43	642601.46
PTX06-1082	Miscellaneous	N	Y	9/16/2010		Active	UM		3780321.59	653856.27
PTX06-1083	Miscellaneous	N	Y	9/16/2010		Active	UM		3779777.76	658643.46
PTX06-1085	Miscellaneous	N	Y	9/16/2010		Active	UM		3760418.31	629059.82
PTX06-1086	Miscellaneous	N	Y	9/16/2010		Active	UM		3759843.32	631411.81
PTX06-1096A	Miscellaneous	N	Y	9/16/2010	2/11/2020	Active			3766548.35	630823.57
PTX06-1097	Miscellaneous	N	Y	9/16/2010		Dry	PS		3765068.63	633104.35
PTX06-1131	Miscellaneous	N	Y	9/16/2010		Active	UM		3754232.91	629371.68
PTX07-1Q01	Miscellaneous	N	Y	9/16/2010		Active	UM		3755836.12	629274.83
PTX07-1Q02	Miscellaneous	N	Y	9/16/2010		Active	UM		3756408.66	628876.97
PTX07-1Q03	Miscellaneous	N	Y	9/16/2010	2/11/2020	Active			3757408.87	630542.61
PTX07-1R03	Miscellaneous	N	Y	9/16/2010		Active	UM		3764501.80	627664.39
OW-WR-38	North	N	Y	9/16/2010		Active	UM, RAE		3765214.16	640649.01
PTX06-1050	North	N	Y	9/16/2010		Active	UM, RAE	POC	3766622.06	636746.04
PTX06-1136	North	N	Y	9/16/2010		Dry	PS		3766771.76	634860.83

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX07-1O01	North	N	Y	9/16/2010		Active	PS, UM, RAE		3767695.22	638532.53
PTX07-1O02	North	N	Y	9/16/2010		Active	PS, UM, RAE	POC	3768117.46	639106.56
PTX07-1O03	North	N	Y	9/16/2010		Active	PS, UM, RAE		3767462.56	639046.64
PTX07-1O06	North	N	Y	9/16/2010	2/11/2020	Active			3768536.81	638814.40
PTX06-1002A	Southeast	N	Y	9/16/2010		Active	UM, RAE		3759984.00	641161.56
PTX06-1003	Southeast	N	Y	9/16/2010	2/11/2020	Active			3758711.05	641498.93
PTX06-1005	Southeast	N	Y	9/16/2010		Active	UM, RAE		3756139.87	640545.44
PTX06-1010	Southeast	N	Y	9/16/2010		Active	UM		3758067.00	639886.62
PTX06-1013	Southeast	N	Y	9/16/2010		Active	RAE		3764075.09	643710.38
PTX06-1014	Southeast	Y	Y	9/16/2010		Active	RAE		3755125.71	643758.88
PTX06-1031	Southeast	Y	Y	9/16/2010		Active	RAE		3753348.03	644674.92
PTX06-1039A	Southeast	N	Y	9/16/2010		Active	RAE		3759272.56	643807.47
PTX06-1041	Southeast	N	Y	9/16/2010		Active	RAE		3757622.78	643803.61
PTX06-1047A	Southeast	N	Y	9/16/2010		Active	RAE		3752004.39	643817.46
PTX06-1051	Southeast	N	Y	9/16/2010		Dry	PS		3752279.10	640332.91
PTX06-1088	Southeast	N	Y	9/16/2010		Active	UM, RAE		3757059.42	639902.10
PTX06-1089	Southeast	N	Y	9/16/2010		Dry	PS		3760258.95	646637.32
PTX06-1090	Southeast	N	Y	9/16/2010		Dry	PS		3757684.39	647727.51
PTX06-1091	Southeast	N	Y	9/16/2010		Dry	PS		3756363.40	646554.01
PTX06-1093	Southeast	N	Y	9/16/2010		Dry	PS		3759922.32	645529.01
PTX06-1094	Southeast	N	Y	9/16/2010	2/11/2020	Active			3751494.55	643813.77
PTX06-1095A	Southeast	N	Y	9/16/2010		Active	UM, RAE		3755598.65	640634.87
PTX06-1098	Southeast	N	Y	9/16/2010		Active	RAE		3753628.43	640266.14
PTX06-1100	Southeast	N	Y	9/16/2010	2/11/2020	Active			3753579.52	640285.97
PTX06-1101	Southeast	N	Y	9/16/2010		Active	RAE		3753437.09	640383.57
PTX06-1102	Southeast	N	Y	9/16/2010		Dry	RAE		3754532.94	642751.09

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX06-1103	Southeast	N	Y	9/16/2010		Dry	RAE	POC	3752963.37	641222.64
PTX06-1119	Southeast	N	Y	9/16/2010	2/11/2020	Active			3752739.01	642646.10
PTX06-1120	Southeast	N	Y	9/16/2010		Active	PS		3752735.03	643152.43
PTX06-1121	Southeast	N	Y	9/16/2010		Dry	PS		3752750.09	643645.57
PTX06-1122	Southeast	N	Y	9/16/2010		Dry	PS		3752308.74	640677.35
PTX06-1124	Southeast	N	Y	9/16/2010	2/11/2020	Active			3752327.45	642877.91
PTX06-1125	Southeast	N	Y	9/16/2010		Dry	PS		3752331.14	643377.53
PTX06-1130	Southeast	N	Y	9/16/2010		Active	RAE	POC	3759745.02	644270.36
PTX06-1133A	Southeast	N	Y	9/16/2010		Active	PS		3751315.73	645287.37
PTX06-1135	Southeast	N	Y	9/16/2010		Dry	PS		3753631.93	638343.76
PTX06-1146	Southeast	N	Y	9/16/2010		Active	PS	POC	3757691.87	645978.91
PTX06-1147	Southeast	N	Y	9/16/2010		Active	PS		3753953.21	645431.85
PTX08-1002	Southeast	N	Y	9/16/2010		Active	UM, RAE		3763003.22	640859.00
PTX08-1009	Southeast	N	Y	9/16/2010		Active	UM, RAE		3755275.01	638866.95
PTX06-1008	Southeast, Zone 11	N	Y	9/16/2010		Active	UM		3759325.25	639441.93
PTX06-1011	Southeast, Zone 11	N	Y	9/16/2010		Active	UM		3757219.75	639178.93
PTX08-1007	Southeast, Zone 11	N	Y	9/16/2010		Active	UM		3758440.46	638900.04
1114-MW4	Zone 11	N	Y	9/16/2010		Active	UM		3757809.40	636151.93
PTX06-1006	Zone 11	N	Y	9/16/2010		Active	PS		3757599.75	637450.19
PTX06-1007	Zone 11	N	Y	9/16/2010		Active	UM		3759513.00	637679.37
PTX06-1073A	Zone 11	N	Y	9/16/2010		Dry	PS		3758072.00	634963.34
PTX06-1077A	Zone 11	N	Y	9/16/2010		Active	UM		3760689.50	637201.80
PTX06-1126	Zone 11	N	Y	9/16/2010		Active	PS	POC	3755562.85	635034.72
PTX06-1127	Zone 11	N	Y	9/16/2010		Active	PS	POC	3755432.03	635901.90
PTX06-1134	Zone 11	N	Y	9/16/2010		Active	PS		3754409.17	633520.06
PTX06-1148	Zone 11	N	Y	9/16/2010		Active	PS, RAE		3754719.67	636467.02
PTX06-1149	Zone 11	N	Y	9/16/2010		Active	PS		3754717.64	635864.13
PTX06-1150	Zone 11	N	Y	9/16/2010		Active	PS, RAE		3754718.24	635233.98

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX06-1151	Zone 11	N	Y	9/16/2010		Active	PS		3756123.62	633935.95
PTX07-1P02	Zone 11	N	Y	9/16/2010		Active	UM	POC	3763019.08	637817.70
PTX07-1P05	Zone 11	N	Y	9/16/2010		Active	UM		3762886.83	637136.13
PTX08-1001	Zone 11	N	Y	9/16/2010		Active	UM, RAE		3762976.26	638941.45
PTX08-1003	Zone 11	N	Y	9/16/2010		Active	PS		3760136.56	635385.36
PTX08-1005	Zone 11	N	Y	9/16/2010		Active	UM		3756346.19	635316.66
PTX08-1006	Zone 11	N	Y	9/16/2010		Active	UM		3756761.86	636400.41
PTX06-1167	Southeast	N	Y	7/28/2013		Dry	RAE		3752653.00	640913.72
PTX06-1158	Zone 11	N	Y	5/30/2014		Dry	PS		3752025.93	648137.99
PTX06-1159	Zone 11	N	Y	5/30/2014		Active	PS, RAE		3754843.46	634015.04
PTX06-1160	Zone 11	N	Y	5/30/2014		Active	PS		3756274.13	632835.73
PTX06-1166	Southeast	N	Y	5/30/2014		Active	PS		3752799.74	639750.35
PTX06-1173	Zone 11	N	Y	11/17/2015		Active	RAE		3755312.40	634197.62
PTX06-1174	Zone 11	N	Y	11/17/2015		Active	RAE		3755489.15	633904.63
PTX06-1175	Zone 11	N	Y	11/17/2015		Active	RAE		3755651.06	633416.97
PTX06-1182	Southeast	N	Y	7/11/2016		Active	PS		3751088.49	647140.17
PTX06-1183	Southeast	N	Y	7/11/2016		Active	PS		3753350.43	639765.77
PTX06-1184	Southeast	N	Y	5/4/2017		Dry	PS		3750638.25	646625.06
PTX06-1185	Southeast	N	Y	5/6/2017		Active	PS		3751139.83	647878.41
PTX06-1188	Southeast	N	Y	5/22/2017		Dry	PS		3752340.04	640691.28
PTX06-1189	Southeast	N	Y	5/19/2017		Dry	PS		3752711.44	640322.51
PTX06-1190	Southeast	N	Y	11/20/2017		Active	PS		3751439.52	648281.31
PTX06-1191	Southeast	N	Y	1/22/2018		Active	RAE		3750720.88	648996.85
PTX06-1192	Southeast	N	Y	1/19/2018		Active	PS		3749893.14	649119.32
PTX06-1193	Southeast	N	Y	1/24/2018		Dry	PS		3749346.75	646719.13
PTX06-1194	Southeast	N	Y	1/27/2018		Active	RAE		3750477.77	648355.41
PTX06-1195	Southeast	N	Y	1/30/2018		Active	PS		3751968.74	649096.79
PTX06-1196	Southeast	N	Y	7/20/2018		Active	RAE		3750989.94	649710.26

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX06-1197	Southeast	N	Y	7/17/2018		Active	PS		3750355.29	649782.14
PTX06-1199	Southeast	N	Y	7/11/2018		Active	PS		3750905.45	650525.52
PX06-1200	Southeast	N	Y	01/07/19		Active	PS		3749356.32	651557.89
PX06-1201	Southeast	N	Y	01/10/19		Active	PS		3749355.48	650585.15
PX06-1202	Southeast	N	Y	01/12/19		Active	PS		3750361.84	651358.99
PX06-1203	Southeast	N	Y	01/25/19		Active	PS		3749879.41	650588.31
PX06-1204	Southeast	N	Y	01/29/19		Active	PS		3749051.98	650997.75
PX06-1205	Southeast	N	Y	01/23/19		Dry	PS		3749894.03	648801.56
PX06-1207	Zone 11	N	Y	1/21/2020		Active	PS		3754046.00	632911.00
PTX06-1171	Zone 11	N	Y	2/11/2020		Active	PS		3755715.08	634373.95
PTX06-1180	Zone 11	N	Y	2/11/2020		Active	PS		3756487.93	633474.07
PTX06-1208	Southeast	N	Y	4/26/2020		Active	PS		3749472.60	652081.58
PTX06-1211	Zone 11	N	Y	8/22/2021		Active	PS		3755297.21	635358.50
PTX06-1212	Southeast	N	Y	8/29/2021		Dry	PS		3753016.03	640166.01
PTX06-1215	Southeast	N	Y	4/24/2022		Active	PS		3748834.66	651607.49
PTX06-1216	Southeast	N	Y	6/24/2022		Active	PS		3749537.50	649743.32
PTX06-1222	Southeast	N	Y	8/22/2023		Active	RAE		3750136.29	651163.21

P&A – plugged and abandoned POC – point of compliance POE – point of exposure
PS – plume stability RAE – remedial action effectiveness UM – uncertainty management

Wells with no designation in the POC/POE column are considered observation wells. These wells are not listed in HW-50284, CP Table V, so the corresponding date of HW-50284 approval or removal date corresponds to either the date of inclusion in a Compliance Plan modification, approval letter date for the corresponding progress report where the recommendation was made to include or remove the well in the monitoring network, approval date of the LTM System Design Report, or the date the well was drilled. Typically, wells are included in the annual report the year they are drilled.

[1]ISM – interim stabilization monitoring (from CP-50284 issued 10/21/2003) – most of these wells were retained in the Corrective Action Compliance Plan issued in 2010.

[2]LTM –long-term monitoring from CP-50284 issued 9/16/2010, which included the final corrective actions and long-term monitoring for the actions. CP-50284 is now included as Provision XI in HW-50284.

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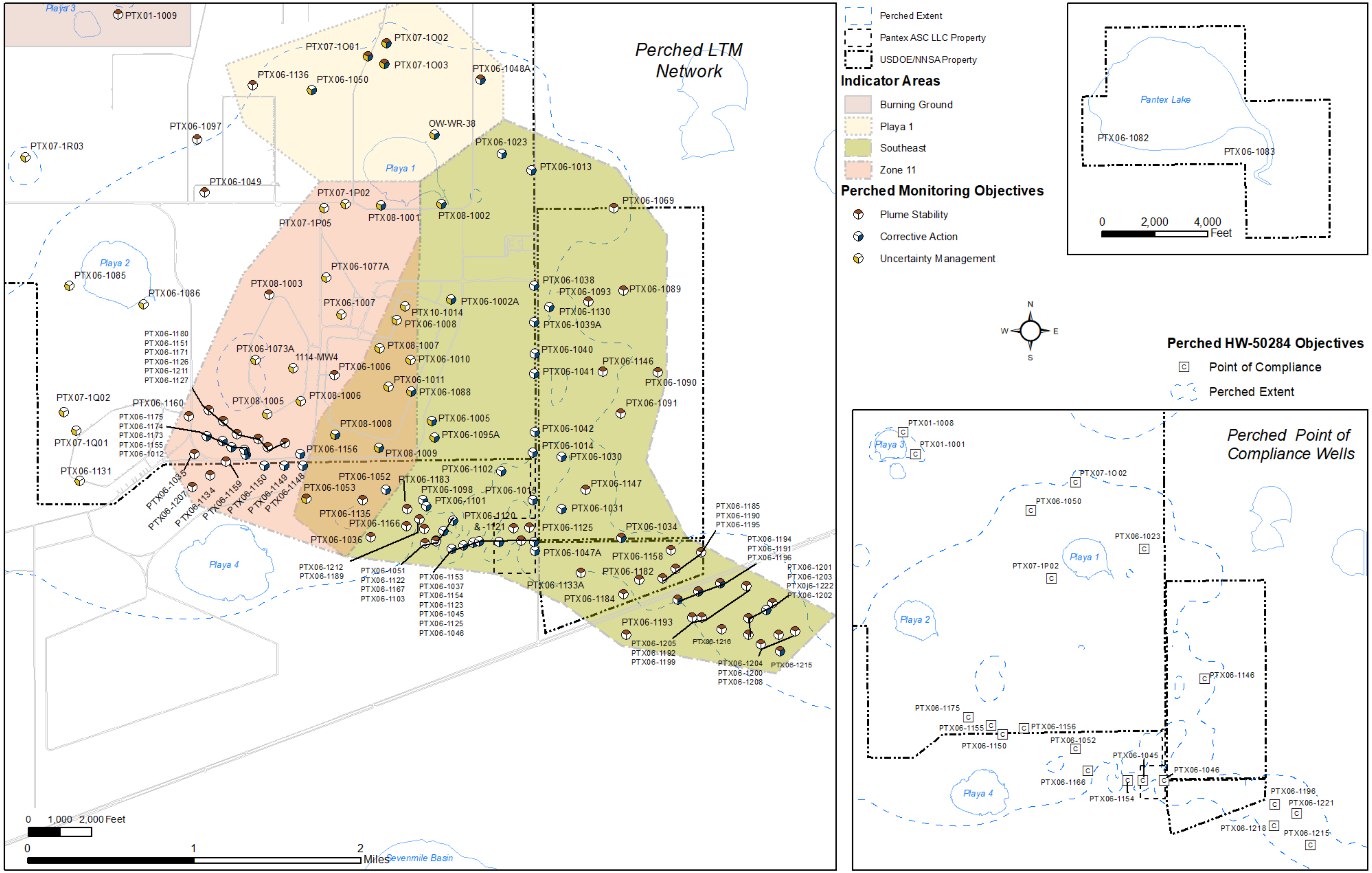

Fig. 1-12. Perched LTM network and HW-50284 CP Table V wells.

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1.6.2 Ogallala Aquifer LTM Network

The final Ogallala Aquifer LTM network consists of the 27 LTM wells and 3 additional monitoring wells along the southern boundary that are monitored annually to evaluate the quality of groundwater upgradient of the Plant. The LTM well assets are monitored and managed as follows:

- All 27 LTM wells are monitored for indicator COCs and water levels.
- Nineteen wells are sampled semiannually and eight are sampled annually.
- Seven wells are sampled at multiple levels every five years. The baseline multi-level sampling was conducted after the wells were installed. All other multi-level sampling events are conducted for five-year reviews (FYRs). The next FYR sampling event is scheduled for 2026. Two wells, PTX06-1137A and PTX06-1139, were installed with two sampling intervals; however, water levels dropped below the first interval so they are now only sampled at the deepest sampling interval.
- Seven wells are sampled every five years using a modified groundwater list in 40 CFR 246, *Protection of Environment*, “Source Separation for Materials Recovery Guidelines,” Appendix IX, to satisfy uncertainty management requirements.
- Two Ogallala wells are designated at POC wells in HW-50284. The GWPS must be met at these locations, if a plume should develop in that area.
- Eight Ogallala wells are designated as POE wells in HW-50284. The GWPS must not be exceeded at these locations.
- Two indicator areas were defined for the Ogallala wells, and indicator COC monitoring lists were developed for each of those areas.
- Three new Ogallala wells were installed in 2023 to evaluate detections in the PTX06-1056 well.

Table 1-8 lists all wells in the LTM network and HW-50284, with the corresponding LTM objective, indicator monitoring area, Compliance Plan objectives (POE and POC wells), date of inclusion or removal from HW-50284, and coordinates. Fig. 1-13 depicts current active monitoring wells listed in Table 1-8 as well as the additional three wells monitored along the southern boundary. The figure also depicts the designated POC and POE wells in the Ogallala network. The wells are listed in chronological order according to their date of inclusion in HW-50284, in accordance with CP Table VII requirements.

Table 1-8. Ogallala Aquifer LTM and Compliance Plan Wells

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date[3]	Current Status	LTM Objectives	POC/ POE	Multi-Level Well	Easting	Northing
PTX01-1010	Northwest	Y	Y	6/9/2003		Active	ED, UM	POC		630576.88	3771397.26
PTX01-1011	Northwest	Y	Y	6/9/2003		Active	ED, UM			629986.45	3771397.29
PTX01-1012	Northwest	Y	Y	6/9/2003		Active	ED, UM	POE		632664.21	3773264.13
PTX01-1013	Northwest	Y	Y	6/9/2003		Active	UM	POE		628976.89	3773218.25
PTX06-1033	Southeast/Northwest	Y	Y	6/9/2003	11/15/2017	P&A	ED, UM			642614.48	3759581.41
PTX06-1044	Southeast/Northwest	Y	Y	6/9/2003		Active	ED, UM			642706.18	3764538.54
PTX06-1054		N	N	6/9/2003	8/11/2004	P&A				641522.72	3752221.24
PTX06-1056	Southeast	Y	Y	6/9/2003		Active	ED, UM	POC		643767.03	3754642.87
PTX06-1057A	Northwest	Y	Y	6/9/2003		Active	UM			629630.04	3768142.23
PTX06-1058	Northwest	Y	Y	6/9/2003		Active	UM			624894.00	3759747.11
PTX06-1059[4]		Y	N	6/9/2003	9/16/2010	Active				628129.98	3760459.31
PTX06-1061	Northwest	Y	Y	6/9/2003		Active	UM			625651.61	3773186.59
PTX06-1062A	Northwest	Y	Y	6/9/2003		Active	ED, UM			633017.18	3771685.22
PTX06-1063A[5]		Y	N	6/9/2003	9/16/2010	Unknown				639265.11	3775502.62
PTX06-1064	Northwest	Y	Y	6/9/2003		Active	UM	POE		635900.45	3773557.90
PTX06-1065		Y	N	6/9/2003	9/16/2010	P&A				633197.45	3775896.50
PTX06-1066		Y	N	6/9/2003	9/16/2010	P&A				632838.71	3773430.45
PTX06-1067		Y	N	6/9/2003	9/16/2010	P&A				622714.85	3773696.89
PTX06-1068	Northwest	Y	Y	6/9/2003		Active	ED, UM	POE		643403.70	3773360.30
PTX06-1074		Y	N	6/9/2003	9/16/2010	P&A				620994.02	3765626.52
PTX06-1075[4]		Y	N	6/9/2003	9/16/2010	Active				630512.54	3753624.01
PTX06-1076	Southeast/Northwest	Y	Y	6/9/2003		Active	ED, UM			637327.32	3752978.41
PTX-BEG2	Northwest	Y	Y	6/9/2003	1/31/2018	P&A	UM			632652.49	3756906.56
PTX06-1157	Southeast	N	Y	2/10/2010		Active	ED, UM		Y	647100.00	3753700.00
PTX06-1043	Southeast/Northwest	N	Y	9/16/2010		Active	ED, UM			640711.00	3765225.21
PTX06-1072	Northwest	N	Y	9/16/2010		Active	ED, UM			635047.45	3758434.63

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date[3]	Current Status	LTM Objectives	POC/ POE	Multi-Level Well	Easting	Northing
PTX06-1137A	Southeast	N	Y	9/16/2010		Active	ED, UM			647900.89	3758635.67
PTX06-1138	Southeast	N	Y	9/16/2010		Active	ED, UM	POE	Y	646285.31	3760503.82
PTX06-1139	Southeast	N	Y	9/16/2010		Active	ED, UM	POE	Y	646768.73	3756376.08
PTX06-1140	Southeast	N	Y	9/16/2010		Active	ED, UM		Y	646959.38	3762807.67
PTX06-1141	Northwest	N	Y	9/16/2010		Active	UM		Y	633445.44	3766872.94
PTX06-1143	Northwest	N	Y	9/16/2010		Active	ED, UM	POE	Y	639244.72	3770496.78
PTX06-1144	Northwest	N	Y	9/16/2010		Active	ED, UM	POE	Y	640252.98	3773320.45
PTX07-1R01	Northwest	N	Y	9/16/2010		Active	ED, UM			627914.28	3764159.91
PTX06-1032	Southeast	N	Y		2/10/2010	P&A	ED, UM			646004.29	3752640.94
PTX06-1060[4]		N	N			Active				620969.93	3758599.72
PTX06-1223	Southeast	N	Y	5/2/2023		Active	ED, UM			642669.67	3753673.34
PTX06-1224	Southeast	N	Y	4/19/2023		Active	ED, UM		Y	644065.72	3754118.10
PTX06-1229	Southeast	N	Y	9/17/2023		Active	ED, UM		Y	642725.64	3754642.57

P&A – plugged and abandoned POC – point of compliance POE – point of exposure

ED – early detection RAE – remedial action effectiveness UM – uncertainty management

[1]ISM – interim stabilization monitoring (from CP-50284 issued 10/21/2003) – most of these wells were retained in the Corrective Action Compliance Plan issued in 2010.

[2]LTM –long-term monitoring from CP-50284 issued 9/16/2010, which included the final corrective actions and long-term monitoring for the actions. CP-50284 is now included as Provision XI in HW-50284.

[3]The CP removal date corresponds to the date of a Compliance Plan/hazardous waste permit change or an approval letter date.

[4]These wells are retained for monitoring water upgradient to Pantex Plant but are not considered as LTM wells.

[5]This well was located on offsite property. Well ownership has been transferred to the landowner.

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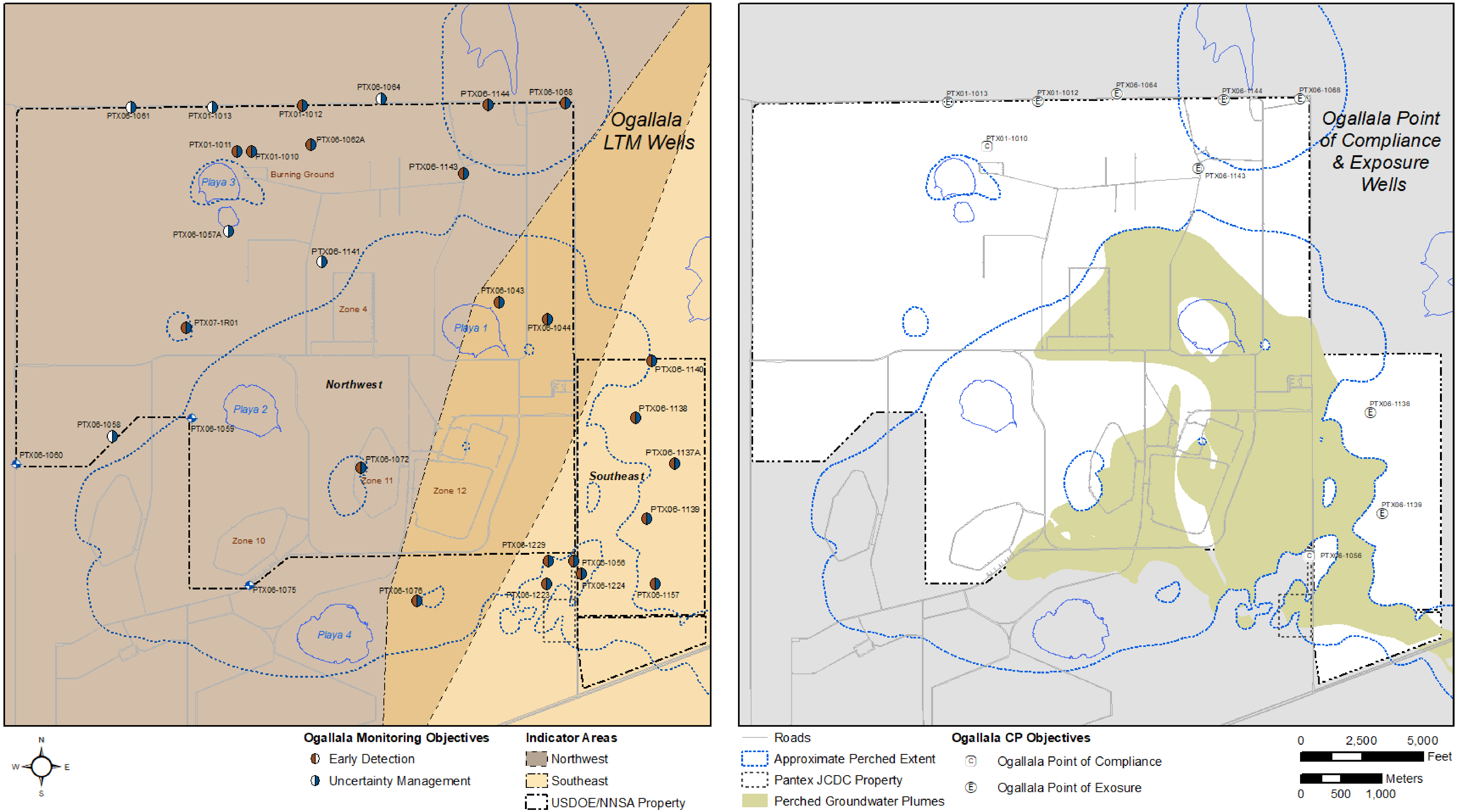

Fig. 1-13. Ogallala Aquifer LTM network and HW-50284 CP Table V wells.

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1.6.3 Remedial Action Wells

Two groundwater remedial actions (pump and treat and ISB) and one soil remedial action (SVE) are being performed at Pantex. Wells have been installed for two PTSs, four ISB systems, and an SVE system.

Table 1-9 and Table 1-10 detail all installed wells for the PTSs and for the ISB systems, respectively, as well as their current status, date of plugging and abandonment, and coordinates. Table 1-11 details all installed wells for the SVE system, their current status, plugging and abandonment dates, well depths, and coordinates. Figures depicting the active well systems follow each table.

The remedial action wells are used for remediation, but some wells are also monitored to provide information for the remedial action. TZM wells are installed to monitor conditions inside the treatment zone at ISB systems and are used exclusively for monitoring rather than for remediation. The RA system monitoring consists of the following:

- Fifteen active ISB wells are used to monitor treatment zone conditions in the four established ISB systems.
- Eight TZM wells are used to monitor treatment zone conditions in the Zone 11 ISB, two TZM wells at the Southeast ISB Extension, and four TZM wells at the Offsite ISB.
- Ten ISB extraction (named REC) wells at the Offsite ISB are monitored for carbon and reducing conditions.
- All available pump and treat extraction wells (i.e., pumping at time of sampling) are generally monitored annually during the summer. These data are used to support the plume mapping.
- Nine wells in the SEPTS are monitored semiannually and three wells are monitored annually to evaluate the movement of perchlorate into those wells.
- The SVE system influent and effluent is monitored to evaluate RA effectiveness and path to closure and to provide information for the air quality monitoring report for the TCEQ. Individual wells are monitored as needed.

The following changes to the RA systems occurred during 2023:

- Twenty new ISB injection wells were added to the Offsite ISB.
- One new pilot well for the perchlorate/chromium ISB was installed. This well will be tested to determine final placement of wells for that system.

- Sixteen new ISB extraction wells were added to the Offsite ISB.
- Two new TZM wells were added to the Offsite ISB.
- Two new Offsite pump and treat injection wells were added. A mobile pump was constructed in 2023 to be used at the property during warm months, with the water being used for amendment injections or injection at downgradient wells. The Offsite Mobile PTS is scheduled to begin operating in 2024 and will be included in that corresponding annual progress report.
- The PTX06-ISB075 replacement well was renamed as PTX06-1230 and will be used as a treatment zone monitoring well until the orginal PTX06-ISB075 well fails.

Table 1-9. Pump and Treat System Wells

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
Southeast Pump and Treat System					
PTX06-EW-01	9/13/1995	Active		641278.87	3756038.24
PTX06-EW-02	8/30/1995	Active		641528.4	3756005.28
PTX06-EW-03	9/8/1995	Active		641366.55	3755801.72
PTX06-EW-04	8/23/1996	Active		643755.08	3756426.14
PTX06-EW-05	8/23/1996	P&A	12/30/2011	643358.11	3755061.32
PTX06-EW-06[1]	9/15/1996	Converted to PTX06-1206		641510.19	3753404.52
PTX06-EW-07	8/26/1996	Active		643751.83	3756882.87
PTX06-EW-08A[1]	10/2/1996	Converted to PTX06-1102		642751.09	3754532.94
PTX06-EW-09	9/28/1996	Active		639170.49	3754843.18
PTX06-EW-10	8/17/1996	Active		638430.01	3755126.91
PTX06-EW-11	9/18/1996	P&A	12/28/2011	643761.85	3754217.08
PTX06-EW-12	8/26/1996	Active		643756.48	3755796.66
PTX06-EW-13[1]	9/13/1996	Converted to PTX06-1108	11/19/2014	643764.04	3754617.19
PTX06-EW-14	9/24/1996	P&A	12/28/2011	643767.08	3753367.23
PTX06-EW-15	8/19/1996	Active		639694.26	3755163.6
PTX06-EW-16	9/8/1998	Active		643801.7	3759993.02
PTX06-EW-17	9/11/1998	Active		643801.02	3760200.19
PTX06-EW-18	9/14/1998	Active		643731.32	3760496.47
PTX06-EW-19	9/18/1998	Active		643797.5	3760790.28
PTX06-EW-20	2/23/2000	Active		641025.56	3757877.46
PTX06-EW-21	8/1/1999	Inactive		641586.01	3757701.14
PTX06-EW-22A	8/26/1999	Active		641838.18	3757228.36
PTX06-EW-23A	9/26/1999	Active		643234.37	3757243.67
PTX06-EW-24	9/12/1999	Active		640724.28	3756777.19
PTX06-EW-25	8/9/1999	Active		641383.9	3756817.82
PTX06-EW-26	9/24/1999	Active		642723.35	3756878.53
PTX06-EW-27	8/13/1999	Active		643750.35	3756680.87
PTX06-EW-28	6/20/1999	Active		640036.65	3755513.98
PTX06-EW-29	7/28/1999	Active		640696.41	3755476.57
PTX06-EW-30	9/1/1999	Active		641973.98	3755476.99
PTX06-EW-31	8/30/1999	Active		642024.65	3755827.25
PTX06-EW-32	8/28/1999	Active		642374.99	3755975.61
PTX06-EW-33	8/25/1999	Active		642726.52	3756075.79
PTX06-EW-34	8/18/1999	Active		643080.1	3755826.59
PTX06-EW-35	8/14/1999	Active		643750.86	3756128.69
PTX06-EW-36	9/24/1999	Active		640775.89	3754778.09
PTX06-EW-37	1/25/2000	Active		639573.03	3754667.07
PTX06-EW-38C	4/6/2000	Active		639987.21	3754454.74
PTX06-EW-39	9/29/1999	Active		640275.11	3754278.61
PTX06-EW-40	3/28/2000	Active		640372.77	3753865.67
PTX06-EW-41	3/15/2000	Active		640775.16	3753666.41
PTX06-EW-42A	3/10/2000	Active		641052.06	3753818.72

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
PTX06-EW-43	9/15/1999	Active		641223.53	3754077.05
PTX06-EW-44	3/9/2000	Active		641376.89	3754474.61
PTX06-EW-45	9/23/1999	Active		641575.19	3754577.81
PTX06-EW-46	3/12/2000	Active		641876.25	3754724.89
PTX06-EW-47[1]	9/11/1999	Converted to PTX06-1168		642128.78	3755035.31
PTX06-EW-48	9/12/1999	Active		643124.45	3755475.11
PTX06-EW-49	2/28/2000	Active		642325.53	3754868.53
PTX06-EW-50	9/1/2005	Active		643762.45	3759386.42
PTX06-EW-51	9/9/2005	Active		638670.18	3754606.95
PTX06-EW-52[1]	9/15/2005	Converted to PTX06-1103	10/28/2010	641248.7	3752987.68
PTX06-EW-53	5/14/2001	Active		643813.98	3755471.87
PTX06-EW-54	2/21/2007	Active		643766.44	3758870.74
PTX06-EW-55	2/22/2007	Active		643763.99	3758298.96
PTX06-EW-56	2/24/2007	Active		643763.8	3757875.83
PTX06-EW-57	2/25/2007	Active		643766.32	3757453.43
PTX06-EW-58	2/12/2007	Active		643262.82	3758881.53
PTX06-EW-59	2/8/2007	Active		643197.17	3758490.03
PTX06-EW-60	2/1/2007	Active		643131.98	3758083.47
PTX06-EW-61	1/30/2007	Active		642700.95	3757847.08
PTX06-EW-62	1/28/2007	Active		642379.35	3757323.3
PTX06-EW-63	1/27/2007	Active		642028.64	3756678.15
PTX06-EW-64	1/25/2007	Active		641727.44	3756431.79
PTX06-EW-65	1/17/2007	Active		641081.67	3756535.05
PTX06-EW-66	1/11/2007	Active		640868.51	3755784.1
PTX06-EW-67	3/6/2007	Active		639249.6	3754428.77
PTX06-EW-68	3/6/2007	Active		639566.17	3754095.17
PTX06-EW-82	07/26/2016	Active		644481.36	3753953.55
PTX06-EW-83	07/24/2016	Active		644782.02	3753953.69
PTX06-EW-84	07/21/2016	Active		645082.73	3753954.16
PTX06-EW-85	09/14/2015	Active		645382.52	3753959.20
PTX06-EW-86	09/13/2015	Active		645482.05	3753946.07
PTX06-EW-87	08/03/2016	Active		645782.09	3753953.71
PTX06-EW-88	09/12/2016	Active		646083.18	3753954.30
PTX06-INJ-1	1/12/1993	P&A	9/24/2004	641043	3757545
PTX06-INJ-2	9/8/1996	P&A	11/23/2011	641155.36	3758791.57
PTX06-INJ-3	2/10/2000	P&A	10/25/2004	643226.15	3756469.63
PTX06-INJ-4	2/26/2000	P&A	3/26/2008	640126.87	3755016.27
PTX06-INJ-5	2/10/2000	P&A	10/25/2004	641482	3755164.77
PTX06-INJ-6	2/26/2000	P&A	10/26/2004	642521.57	3755369.02
PTX06-INJ-7	3/7/2000	P&A	10/27/2004	640774.75	3754319.02
PTX06-INJ-8	2/27/2000	P&A	3/25/2008	640419.84	3756164.91
PTX06-INJ-9	2/17/2000	P&A	10/26/2004	642024.8	3756518.86
PTX06-INJ-10	9/12/2004	Active		641005.96	3757505.73
PTX06-INJ-11	8/28/2004	Inactive		641752.09	3758137.05
PTX06-INJ-12A	1/24/2008	P&A	5/24/2017	640737.15	3756104.67
PTX06-INJ-13	2/14/2020	Active		632833.86	3758925.67

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
PTX06-INJ-14	2/18/2020	Active		632209.79	3758255.51
PTX06-INJ-15	2/21/2020	Active		632812.71	3757937.70
Playa 1 Pump and Treat System					
PTX06-EW-69	7/22/2007	Active		638869.86	3765146.41
PTX06-EW-70	8/11/2006	Active		638141.28	3765454.51
PTX06-EW-71	7/24/2007	Active		638139.57	3764250.42
PTX06-EW-72	8/20/2007	Active		639152.16	3762973.95
PTX06-EW-73	8/10/2007	Active		639962.23	3762980.08
PTX06-EW-74	8/18/2007	Active		640354.99	3763274.66
PTX06-EW-75	8/19/2006	Active		640751.11	3763004.67
PTX06-EW-76[1]	7/13/2007	Converted to PTX06-1128		641330.75	3763667.42
PTX06-EW-77[1]	8/6/2007	Converted to PTX06-1129		641330.75	3763667.42
PTX06-EW-78A	8/23/2007	Active		639800.79	3762590.92
PTX06-EW-79	8/18/2007	Active		640784.57	3762323.44
PTX06-EW-80	8/14/2007	Active		641490.31	3762305.03
PTX06-EW-81A[2]	9/21/2013	Active		639773.41	3762095.77
Offsite Mobile Pump and Treat System[3]					
PTX06-MEW401	8/10/2020	Inactive		649249.28	3750765.90
PTX06-MEW402	9/13/2020	Inactive		649411.98	3750861.97
PTX06-MEW403	9/17/2020	Inactive		649523.62	3750870.15
PTX06-MEW404	10/10/2021	Inactive		649260.39	3750681.12
PTX06-MEW405	10/8/2021	Inactive		649260.94	3750597.10
PTX06-MINJ401	9/12/2022	Inactive		651112.69	3749713.17
PTX06-MINJ402A	8/26/2023	Inactive		649844.32	3749339.38
PTX06-MINJ403	8/29/2023	Inactive		649514.67	3749634.99

P&A = plugging and abandonment
[1]Due to low well yield and need for monitoring data, the extraction well was converted to a monitoring well rather than being plugged and abandoned.
[2]Pantex completed connection to the system in June 2016, with the well becoming operational by November 2016.
[3]A portion of system components have been installed, but the system will not operate until 2024. The system will be added to Sections 1.4, 2, and 3 in 2023.

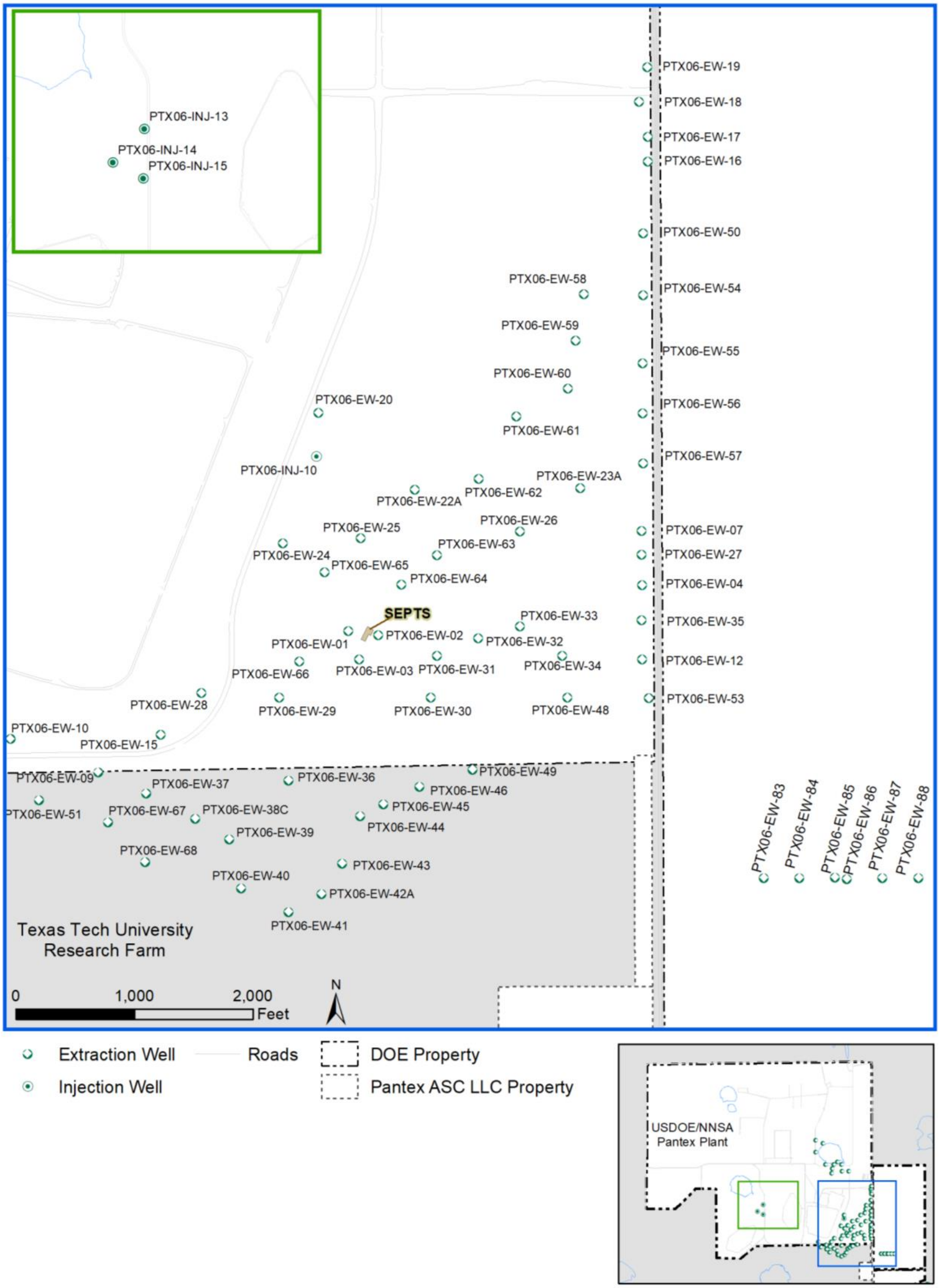

Fig. 1-14. SEPTS wells.

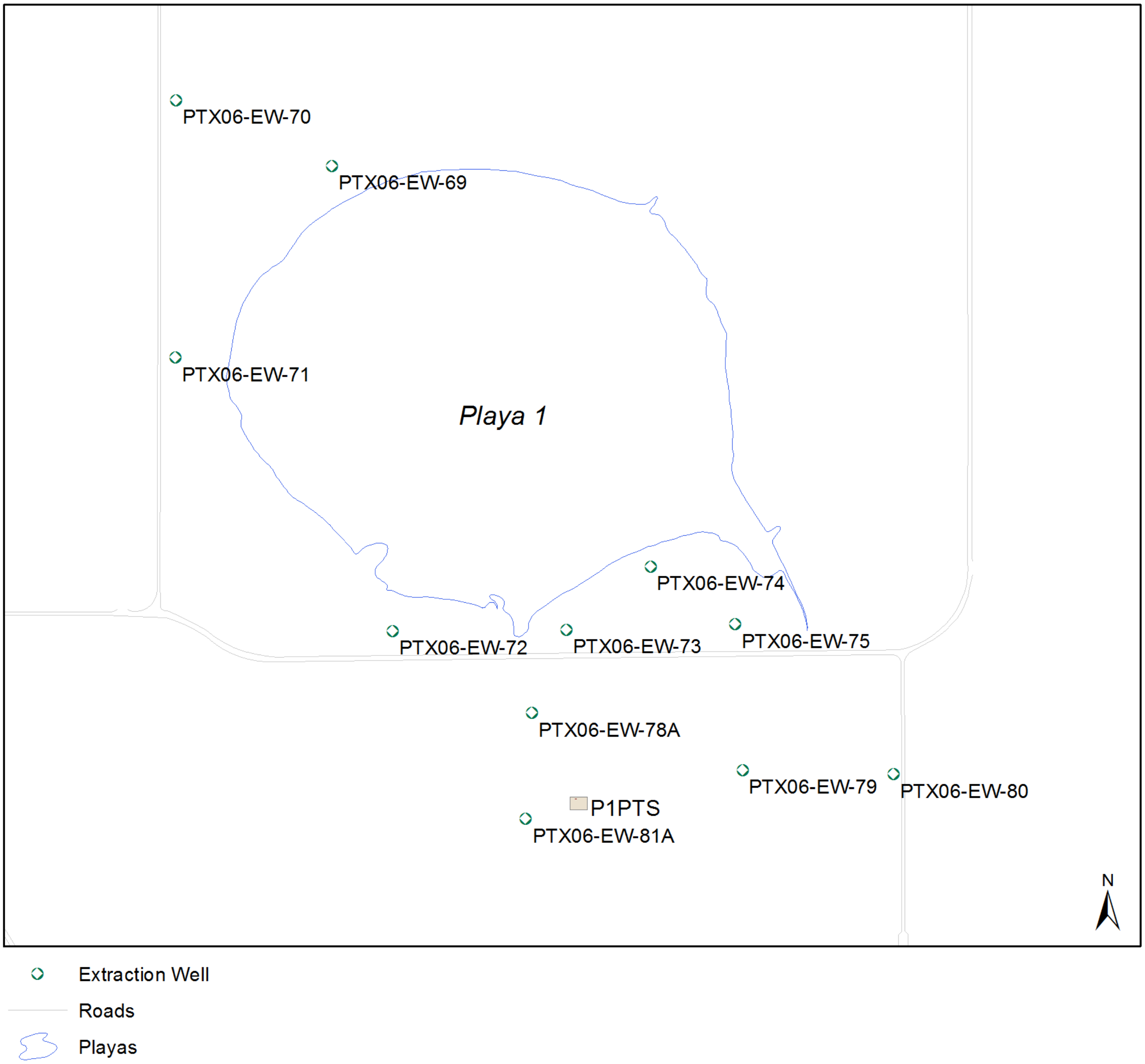

Fig. 1-15. P1PTS wells.

Table 1-10. ISB System Wells

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
Southeast ISB System						
PTX06-ISB010	10/4/2007	Active			640805.43	3752335.36
PTX06-ISB011	8/6/2007	Active			640901.34	3752364.37
PTX06-ISB012	10/3/2007	Active			640997.33	3752392.85
PTX06-ISB013	10/2/2007	Active	6/17/2011		641094.48	3752437.36
PTX06-ISB014	10/1/2007	Active			641188.34	3752451.45
PTX06-ISB015	10/1/2007	Active			641282.85	3752478.49
PTX06-ISB016	8/4/2007	Active			641379.46	3752509.22
PTX06-ISB017	10/4/2007	Active			641476.26	3752538.73
PTX06-ISB018	9/18/2007	Active			641570.69	3752567.95
PTX06-ISB019	9/19/2007	Active			641666.28	3752597.62
PTX06-ISB020	9/24/2007	Active			641762.34	3752625.80
PTX06-ISB021	9/24/2007	Active			641857.77	3752657.45
PTX06-ISB022	10/1/2007	Active			641955.44	3752684.48
PTX06-ISB023A	10/22/2007	Active			642048.63	3752724.53
PTX06-ISB024	7/18/2007	Active			642144.65	3752737.70
PTX06-ISB025	9/14/2007	Active			642241.84	3752770.49
PTX06-ISB026	9/13/2007	Active			642336.93	3752798.27
PTX06-ISB027	8/22/2007	Active			642431.36	3752828.68
PTX06-ISB028	8/20/2007	Active			642527.37	3752858.27
PTX06-ISB029A	9/27/2007	Active			640994.88	3752253.46
PTX06-ISB030B	9/17/2007	Active			641094.72	3752286.25
PTX06-ISB031	7/11/2007	Active			641176.52	3752313.22
PTX06-ISB032	8/15/2007	Active			641277.51	3752351.41
PTX06-ISB033	8/16/2007	Active			641370.09	3752378.35
PTX06-ISB034	9/9/2007	Active			641467.88	3752407.71
PTX06-ISB035	9/7/2007	Active			641563.65	3752435.15
PTX06-ISB036	9/6/2007	Active			641657.73	3752465.76
PTX06-ISB037	9/11/2007	Active			641753.03	3752494.63
PTX06-ISB038	8/14/2007	Active			641850.23	3752524.17
PTX06-ISB039	9/26/2007	Active			641945.73	3752552.70
PTX06-ISB040	8/31/2007	Active			642035.47	3752578.67
PTX06-ISB041	8/29/2007	Active			642136.52	3752608.90
PTX06-ISB042	8/25/2007	Active			642233.39	3752640.96
PTX06-ISB043	10/24/2007	Active			642329.34	3752670.29
PTX06-ISB044	8/3/2007	P&A		7/27/2011	642425.15	3752698.59
PTX06-ISB044A	6/12/2011	Active			641891.24	3752479.24
PTX06-ISB045	8/24/2007	Active			642521.05	3752726.81
PTX06-ISB046	10/24/2007	Active			641939.34	3752422.69
PTX06-ISB047	10/10/2007	Active			642035.50	3752450.45
PTX06-ISB048	10/24/2007	Active			642131.84	3752479.89
PTX06-ISB049	10/24/2007	Active			642227.63	3752509.10
PTX06-ISB050	10/24/2007	Active			642323.05	3752537.46
PTX06-ISB051	10/19/2007	Active			642419.78	3752567.70

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
			Zone 11 ISB System			
PTX06-ISB055	3/4/2009	Active			636606.08	3755477.40
PTX06-ISB056A	3/3/2009	Active			636503.22	3755414.42
PTX06-ISB057	2/27/2009	Active	6/15/2011		636381.76	3755371.18
PTX06-ISB058	2/26/2009	Active			636320.75	3755299.58
PTX06-ISB059	2/25/2009	Active			636234.22	3755246.12
PTX06-ISB060A	2/24/2009	Active			636136.74	3755200.44
PTX06-ISB061	2/23/2009	Active			636085.48	3755140.80
PTX06-ISB062	2/20/2009	Active			635986.17	3755141.57
PTX06-ISB063	2/19/2009	Active			635886.33	3755141.05
PTX06-ISB064	2/18/2009	Active			635785.77	3755140.34
PTX06-ISB065	2/17/2009	Active			635563.31	3755140.57
PTX06-ISB066	2/17/2009	Active	9/21/2012		635495.33	3755164.83
PTX06-ISB067	2/13/2009	Active			635364.80	3755140.76
PTX06-ISB068	2/12/2009	Active			635263.93	3755181.61
PTX06-ISB069A	2/11/2009	Active			635170.02	3755241.04
PTX06-ISB070	2/10/2009	Active			635064.71	3755266.05
PTX06-ISB071	11/25/2008	Active			634991.20	3755334.12
PTX06-ISB072	11/20/2008	Active			634917.45	3755401.42
PTX06-ISB073	11/19/2008	Active	9/29/2011		634821.31	3755453.71
PTX06-ISB074	11/18/2008	Active			634722.57	3755411.00
PTX06-ISB075	11/17/2008	Active	9/28/2012		634813.17	3755333.92
PTX06-ISB076A	11/26/2008	Active			634867.07	3755287.08
PTX06-ISB077	11/13/2008	Active			634942.76	3755207.57
PTX06-ISB078	9/18/2009	Active			636919.77	3755377.85
PTX06-ISB079	9/18/2009	Inactive			636854.05	3755302.76
PTX06-ISB080	9/18/2009	Inactive			636787.42	3755227.38
PTX06-ISB081	8/26/2009	Inactive			636729.13	3755162.74
PTX06-ISB082	8/26/2009	Inactive			636597.92	3755139.36
PTX06-ISB083	9/8/2009	Active			634632.29	3755455.37
PTX06-ISB084	9/8/2009	Active			634585.86	3755544.14
PTX06-ISB085A	9/17/2009	Active			634511.57	3755458.25
PTX06-ISB086	9/8/2009	Active			634452.91	3755531.59
PTX06-ISB087	07/24/2014	Active			634360.64	3755523.08
PTX06-ISB088A	09/23/2014	Active			634266.60	3755570.13
PTX06-ISB089	07/12/2014	Active			634200.34	3755606.47
PTX06-ISB090	07/10/2014	Active			634117.26	3755650.38
PTX06-ISB091	09/09/2012	Active			634032.91	3755697.13
PTX06-ISB092	09/11/2012	Active			633944.35	3755745.69
PTX06-ISB093	07/16/2014	Active			633857.23	3755794.35
PTX06-ISB094	07/07/2014	Active			633769.25	3755838.98
PTX06-ISB095	07/24/2014	Active			633652.63	3755742.68
PTX06-ISB096	06/22/2014	Active			633559.57	3755807.06
PTX06-ISB097	08/27/2014	Active			633470.54	3755870.31
PTX06-ISB098	08/19/2014	Active			633384.06	3755929.79
PTX06-ISB099	08/11/2014	Active			633757.56	3755690.13
PTX06-ISB100A	09/16/2014	Active			633791.28	3755646.03
PTX06-ISB101	08/07/2014	Active			633899.71	3755616.85
PTX06-ISB102	07/31/2014	Active			633985.55	3755572.69

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
PTX06-ISB103	09/02/2014	Active			634073.50	3755527.39
PTX06-ISB104	08/19/2014	Active			634160.38	3755482.36
PTX06-ISB105	08/06/2014	Active			634245.60	3755438.20
PTX06-ISB106	07/29/2014	Active			634332.49	3755393.36
PTX06-ISB132	12/15/2019	Active			633327.01	3755997.20
PTX06-ISB133	12/18/2019	Active			633258.03	3756042.56
PTX06-ISB134	12/21/2019	Active			633217.07	3756119.70
PTX06-ISB135	1/11/2020	Active			633150.44	3756170.97
PTX06-ISB136	1/8/2020	Active			633089.99	3756225.42
PTX06-ISB137	12/14/2019	Active			633029.65	3756277.60
PTX06-ISB138	8/8/2021	Active			635675.44	3755137.30
PTX06-ISB139	4/24/2021	Active			635005.52	3755195.02
PTX06-ISB140	4/27/2021	Active			635051.38	3755174.17
PTX06-ISB141	5/6/2021	Active			635088.36	3755145.85
PTX06-ISB142	5/7/2021	Active			635143.73	3755139.11
PTX06-ISB143	5/9/2021	Active			635180.87	3755074.58
PTX06-ISB144	5/11/2021	Active			635241.47	3755075.28
PTX06-ISB145	6/4/2021	Active			635296.63	3755057.95
PTX06-ISB146	5/25/2021	Active			635344.98	3755036.21
PTX06-ISB147	6/6/2021	Active			635384.38	3755074.70
PTX06-ISB148	6/8/2021	Active			635445.64	3755043.39
PTX06-ISB149	6/10/2021	Active			635508.91	3755035.46
PTX06-ISB150	6/12/2021	Active			635585.74	3755034.55
PTX06-ISB151	6/22/2021	Active			635675.13	3755038.51
PTX06-ISB152	8/5/2021	Active			635784.45	3755102.76
PTX06-ISB153	7/28/2021	Active			635835.66	3755095.93
PTX06-ISB154	6/25/2021	Active			635885.73	3755039.76
PTX06-ISB155	6/27/2021	Active			635930.84	3755041.30
PTX06-ISB156	7/8/2021	Active			635976.40	3755042.87
PTX06-ISB157	7/11/2021	Active			636025.19	3755042.94
PTX06-ISB158	7/13/2021	Active			636078.85	3755043.82
PTX06-ISB159	7/25/2021	Active			636131.78	3755054.73
PTX06-ISB160	12/4/2021	Active			636164.03	3755072.21
PTX06-ISB161	12/2/2021	Active			636200.30	3755094.74
PTX06-ISB162	11/23/2021	Active			636243.20	3755117.70
PTX06-ISB163	11/21/2021	Active			636285.73	3755137.92
PTX06-ISB166A	10/28/2021	Active			634311.35	3755540.15
PTX06-ISB167	11/7/2021	Active			634408.63	3755500.04
PTX06-ISB168	11/5/2021	Active			634291.60	3755416.38
PTX06-ISB169	11/10/2021	Active			634403.01	3755377.62
PTX06-ISB170	11/18/2021	Active			634476.21	3755411.44
PTX06-1164[2]	9/10/2012	Active			633987.48	3755722.37
PTX06-1169[2]	8/11/2014	Active			634889.61	3755241.66
PTX06-1170[2]	8/9/2014	Active			634569.69	3755442.71
PTX06-1176[2]	8/27/2014	Active			634114.06	3755500.53
PTX06-1177[2]	8/23/2014	Active			633524.62	3755818.55
PTX06-1209[2]	8/20/2021	Active			635261.07	3755063.54
PTX06-1210[2]	8/24/2021	Active			635995.51	3755042.86
PTX06-1230[2]	9/28/2012	Active			634813.167	3755333.918

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
			Southeast ISB Extension[1]			
PTX06-ISB301	04/22/2017	Active			647400.94	3750677.17
PTX06-ISB302	12/13/2017	Active			647471.65	3750705.36
PTX06-ISB303	12/04/2017	Active			647541.96	3750731.23
PTX06-ISB304	12/02/2017	Active			647612.02	3750757.59
PTX06-ISB305	12/15/2017	Active			647682.57	3750783.88
PTX06-ISB306	12/13/2017	Active			647753.08	3750810.07
PTX06-ISB307	11/03/2017	Active			647823.09	3750836.66
PTX06-ISB308	11/07/2017	Active			647894.07	3750862.53
PTX06-ISB309	11/03/2017	Active			647964.07	3750888.51
PTX06-ISB310	11/05/2017	Active			648034.69	3750914.87
PTX06-ISB311	11/14/2017	Active			648105.30	3750940.93
PTX06-ISB312	11/15/2017	Active			648175.64	3750967.12
PTX06-ISB313	11/17/2017	Active			648245.97	3750993.50
PTX06-ISB314	11/30/2017	Active			648316.24	3751019.54
PTX06-ISB315	11/08/2017	Active			648386.52	3751045.71
PTX06-ISB316	11/06/2017	Active			648457.75	3751072.09
PTX06-ISB317	11/04/2017	Active			648527.50	3751098.16
PTX06-ISB318	12/03/2017	Active			648597.96	3751124.55
PTX06-ISB319	12/01/2017	Active			648668.62	3751150.76
PTX06-ISB320	11/17/2017	Active			648738.78	3751176.87
PTX06-ISB321	11/29/2017	Active			648809.07	3751203.15
PTX06-ISB322	10/24/2017	Active			648879.71	3751229.17
PTX06-ISB323	11/15/2017	Active			648950.08	3751255.41
PTX06-ISB324	11/14/2017	Active			649020.47	3751282.05
PTX06-ISB325	11/01/2017	Active			649090.64	3751308.18
PTX06-ISB326A	10/7/2020	Active			649069.98	3751382.33
PTX06-ISB327	10/15/2020	Active			649090.60	3751459.62
PTX06-ISB328	10/18/2020	Active			649090.73	3751534.22
PTX06-ISB329	10/20/2020	Active			649091.36	3751609.51
PTX06-ISB330	9/26/2021	Active			649090.85	3751684.95
PTX06-ISB331	9/30/2021	Active			649092.70	3751760.79
PTX06-1213[2]	9/22/2021	Active			647847.08	3750845.56
PTX06-1214[2]	9/24/2021	Active			648550.59	3751106.97
			Offsite ISB			
PTX06-ISB401	6/11/2020	Active			650711.91	3749151.58
PTX06-ISB401	6/15/2020	Active			650776.49	3749189.00
PTX06-ISB402	5/28/2020	Active			650841.82	3749226.42
PTX06-ISB403	5/18/2020	Active			650906.57	3749264.00
PTX06-ISB404	6/2/2020	Active			650972.52	3749300.97
PTX06-ISB405	5/13/2020	Active			651036.29	3749338.63
PTX06-ISB406	5/19/2020	Active			651101.78	3749376.17
PTX06-ISB407	5/14/2020	Active			651167.09	3749413.87
PTX06-ISB408	6/3/2020	Active			651231.74	3749451.28
PTX06-ISB409	5/16/2020	Active			651296.89	3749487.69
PTX06-ISB410	8/21/2020	Active			649369.83	3750358.61
PTX06-ISB411	8/23/2020	Active			649464.65	3750447.35
PTX06-ISB412	6/17/2020	Active			649562.18	3750534.62
PTX06-ISB413	6/26/2020	Active			649662.66	3750642.84

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
PTX06-ISB414	8/25/2020	Active			649740.82	3750753.45
PTX06-ISB415	8/27/2020	Active			649866.95	3750879.41
PTX06-ISB416	6/11/2020	Active			650711.91	3749151.58
PTX06-ISB417	9/14/2021	Active			649002.830	3750605.840
PTX06-ISB418	9/12/2021	Active			649000.080	3750479.950
PTX06-ISB419	9/9/2021	Active			648999.920	3750358.330
PTX06-REC401A	5/2/2020	Active			651032.67	3749068.08
PTX06-REC402	6/15/2020	Active			651188.55	3749013.99
PTX06-REC403	5/31/2020	Active			651274.87	3749064.42
PTX06-REC404	6/13/2020	Active			651363.17	3749115.24
PTX06-REC405	9/10/2020	Active			649666.01	3750342.12
PTX06-REC406	8/31/2020	Active			649732.34	3750408.10
PTX06-REC407	7/25/2020	Active			649808.08	3750498.69
PTX06-REC408	7/28/2020	Active			649805.35	3750592.25
PTX06-REC409	8/6/2020	Active			649883.64	3750677.72
PTX06-REC410	8/8/2020	Active			649942.73	3750742.93
PTX06-REC411	8/10/2020	Active			650016.35	3750822.87
PTX06-ISB425	8/7/2022	Active			650237.10	3749889.05
PTX06-ISB426	8/4/2022	Active			650315.00	3749940.31
PTX06-ISB427	8/2/2022	Active			650394.60	3749988.93
PTX06-ISB428	7/7/2022	Active			650485.88	3750047.56
PTX06-ISB429	6/29/2022	Active			650582.37	3750108.23
PTX06-ISB430	6/27/2022	Active			650635.79	3750141.61
PTX06-ISB431	8/18/2022	Active			650708.72	3750189.11
PTX06-ISB432	8/8/2022	Active			650787.00	3750238.86
PTX06-ISB437	6/29/2022	Active			649787.61	3750120.41
PTX06-ISB438	7/7/2022	Active			649855.36	3750171.10
PTX06-ISB439	7/9/2022	Active			649921.41	3750221.31
PTX06-ISB440	7/12/2022	Active			649972.93	3750258.98
PTX06-ISB453	7/13/2022	Active			649215.32	3750145.23
PTX06-ISB454	7/20/2022	Active			649253.94	3750191.39
PTX06-ISB455	7/23/2022	Active			649291.57	3750235.65
PTX06-ISB456	7/24/2022	Active			649328.78	3750281.30
PTX06-ISB501	8/31/2022	Inactive			645402.44	3758144.97
PTX06-ISB502	8/25/2022	Inactive			645791.43	3757732.13
PTX06-ISB503	8/28/2022	Inactive			645698.75	3757351.47
PTX06-REC416	7/25/2022	Active			650662.78	3749438.56
PTX06-REC417	8/26/2022	Active			650738.08	3749484.59
PTX06-REC418	8/18/2022	Active			650812.65	3749529.58
PTX06-REC419	8/5/2022	Active			650889.91	3749576.75
PTX06-REC420	8/10/2022	Active			650963.40	3749623.60
PTX06-REC421	8/8/2022	Active			651037.35	3749667.44
PTX06-REC422	8/2/2022	Active			651112.69	3749713.17
PTX06-REC433	6/19/2022	Active			649972.75	3750051.20
PTX06-REC434	6/21/2022	Active			650022.61	3750092.70
PTX06-REC435	7/11/2022	Active			650072.32	3750134.99
PTX06-REC436	7/20/2022	Active			650123.62	3750176.26
PTX06-REC442	5/9/2022	Active			649237.73	3749938.28
PTX06-REC443	5/18/2022	Active			649302.46	3750009.54

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
PTX06-REC444	5/22/2022	Active			649367.39	3750079.82
PTX06-REC445	6/1/2022	Active			649432.37	3750148.34
PTX06-REC446	6/5/2022	Active			649496.71	3750217.21
PTX06-REC447	6/7/2022	Active			649549.37	3750280.47
PTX06-1218[2]	5/4/2022	Active			649667.96	3749890.07
PTX06-1219[2]	6/26/2022	Active			650185.72	3750054.28
PTX06-1221[2]	4/27/2022	Active			650875.74	3750521.45
PTX06-ISB420	8/4/2023	Inactive			650162.60	3749414.18
PTX06-ISB421	8/6/2023	Inactive			650236.94	3749456.45
PTX06-ISB422	8/8/2023	Inactive			650315.41	3749501.38
PTX06-ISB423	8/24/2023	Inactive			650394.76	3749548.27
PTX06-ISB424	8/29/2023	Inactive			650493.88	3749634.53
PTX06-ISB433	8/19/2023	Inactive			650864.32	3750286.73
PTX06-ISB434	8/18/2023	Inactive			650951.71	3750341.34
PTX06-ISB435	8/9/2023	Inactive			651040.07	3750397.41
PTX06-ISB441	8/7/2023	Inactive			650437.34	3750638.45
PTX06-ISB442	8/4/2023	Inactive			650497.81	3750684.05
PTX06-ISB443	8/5/2023	Inactive			650553.74	3750724.76
PTX06-ISB444	8/1/2023	Inactive			650619.07	3750772.62
PTX06-ISB445	7/26/2023	Inactive			650677.26	3750818.52
PTX06-ISB446	7/24/2023	Inactive			650737.83	3750863.50
PTX06-ISB447	8/26/2023	Inactive			649286.70	3749862.88
PTX06-ISB448	8/24/2023	Inactive			649347.71	3749917.94
PTX06-ISB449	8/22/2023	Inactive			649407.57	3749973.28
PTX06-ISB450	8/20/2023	Inactive			649467.66	3750028.13
PTX06-ISB451	8/18/2023	Inactive			649528.05	3750083.49
PTX06-ISB452	8/10/2023	Inactive			649586.87	3750138.63
PTX06-REC412	4/6/2023	Inactive			650437.73	3749213.32
PTX06-REC413	4/12/2023	Inactive			650512.91	3749262.62
PTX06-REC414	5/21/2023	Inactive			650587.71	3749313.76
PTX06-REC415	6/23/2023	Inactive			650662.99	3749363.57
PTX06-REC423	4/5/2023	Inactive			651187.96	3749762.93
PTX06-REC427	5/18/2023	Inactive			649712.76	3749688.43
PTX06-REC428	5/31/2023	Inactive			649777.58	3749742.50
PTX06-REC429	6/13/2023	Inactive			649843.53	3749798.74
PTX06-REC430	6/25/2023	Inactive			649907.33	3749854.10
PTX06-REC431	7/20/2023	Inactive			649973.39	3749909.97
PTX06-REC432	7/10/2023	Inactive			650037.95	3749964.07
PTX06-REC437	7/11/2023	Inactive			650617.99	3750517.92
PTX06-REC438	7/19/2023	Inactive			650681.26	3750569.55
PTX06-REC439	7/9/2023	Inactive			650749.77	3750626.27
PTX06-REC440	6/28/2023	Inactive			650818.95	3750684.18
PTX06-REC441	6/20/2023	Inactive			650887.46	3750738.62
PTX06-1217[2]	8/2/2023	Inactive			650101.19	3749645.37
PTX06-1220[2]	8/20/2023	Inactive			650367.11	3750258.95

[1]Pantex renumbered the wells in this system in 2020 for ease of system identification.

[2]TZM wells used for monitoring the treatment zone.

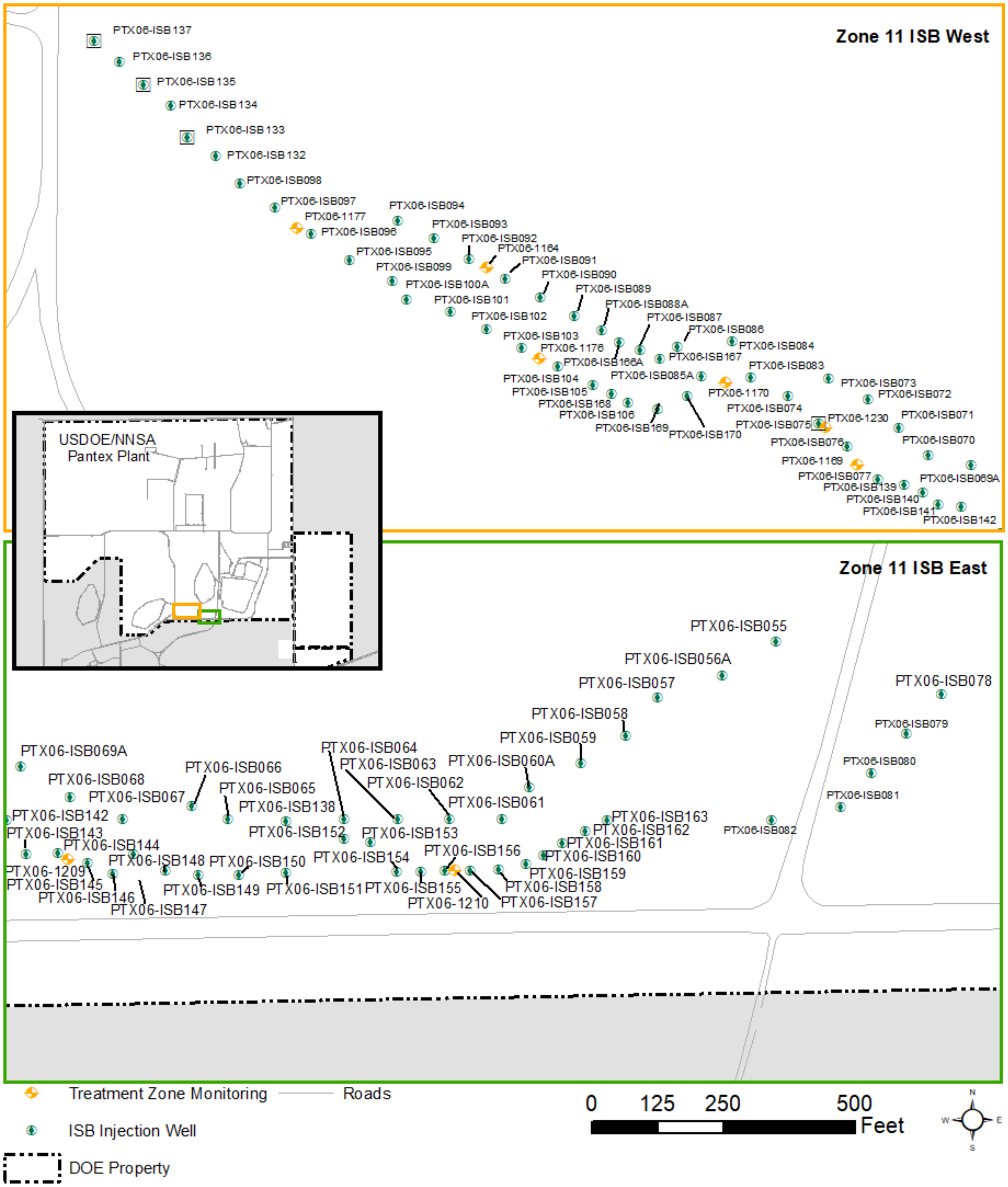

Fig. 1-16. Zone 11 ISB System wells.

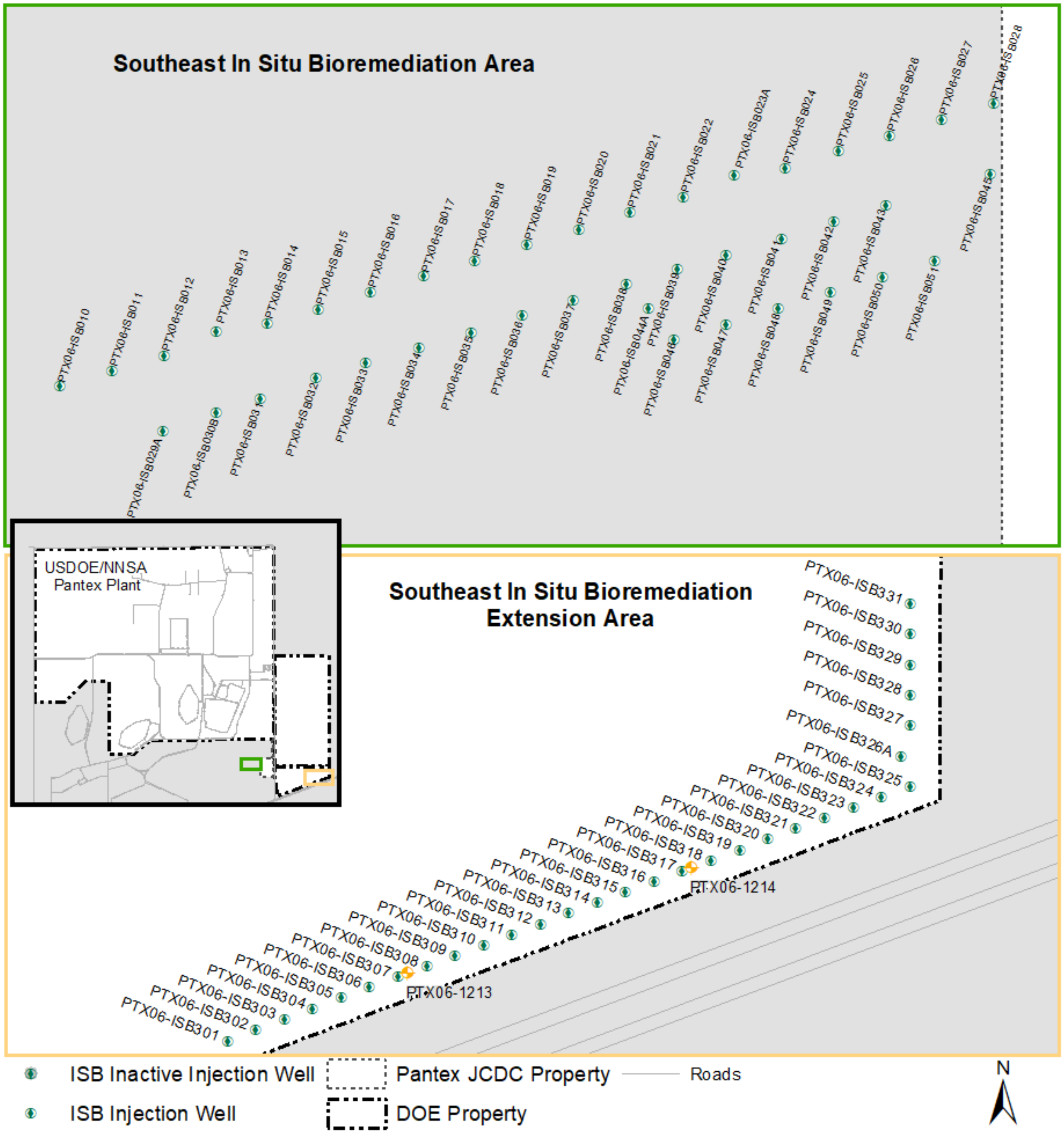

Fig. 1-17. Southeast ISB System wells.

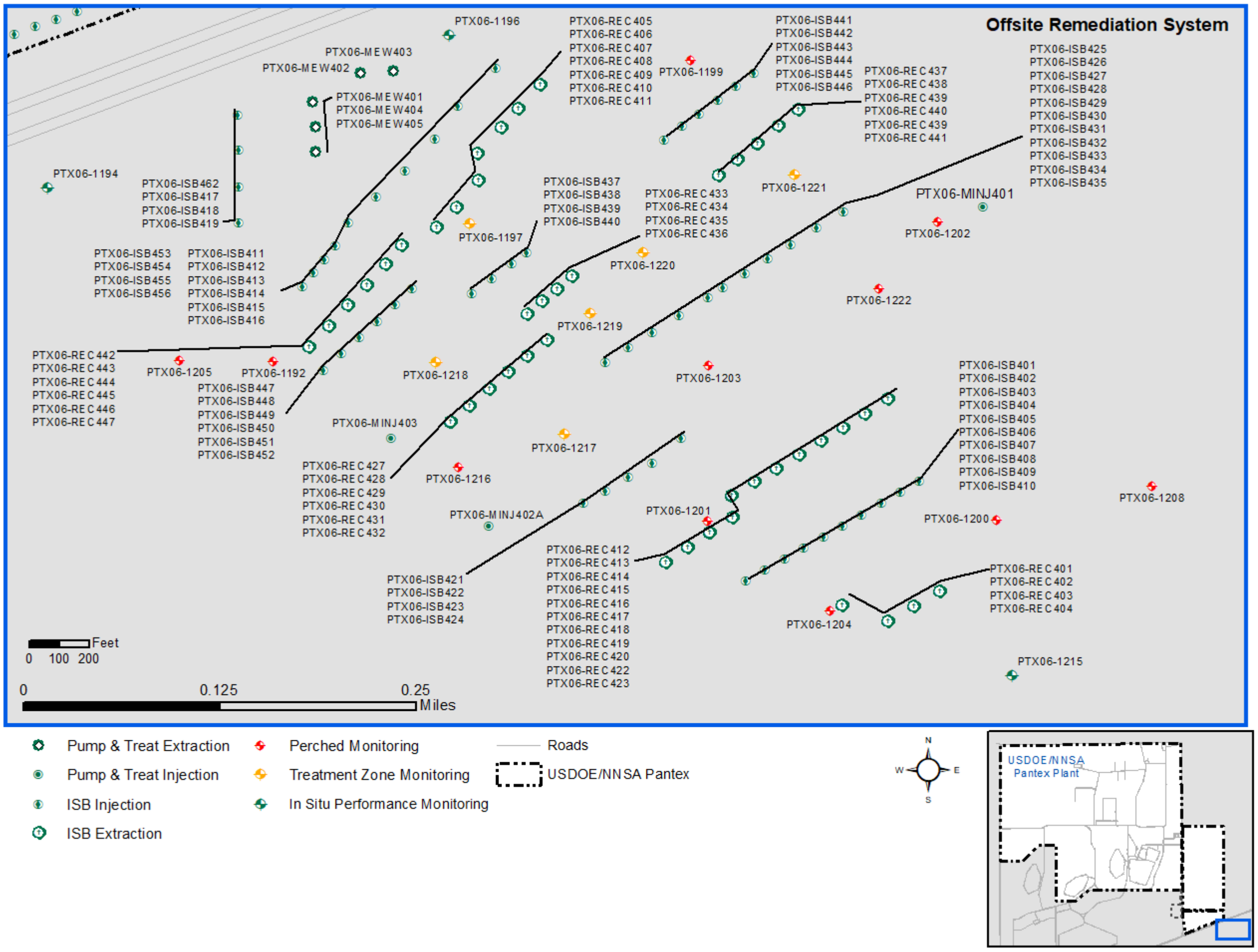

Fig. 1-18. Offsite ISB System wells.

Table 1-11. Burning Ground SVE System Wells

Name	Well Depth[1]	Completion Date	Current Status	Easting	Northing
SVE-I-06	Intermediate	12/1/2001	Inactive	630006.43	3771358.79
SVE-I-11	Intermediate	12/24/2001	Inactive	630140.42	3771223.11
SVE-I-13	Intermediate	11/10/2001	Inactive	630024.96	3770909.40
SVE-I-16	Intermediate	12/10/2001	Inactive	630264.66	3770916.85
SVE-I-21	Intermediate	12/10/2001	Inactive	630142.72	3770795.37
SVE-I-26	Intermediate	11/17/2001	Inactive	630022.91	3770678.74
SVE-I-29	Intermediate	11/13/2001	Inactive	630245.81	3770680.38
SVE-S-05	Shallow	11/20/2001	Inactive	629996.81	3771361.24
SVE-S-07	Shallow	11/20/2001	Inactive	630130.43	3771359.23
SVE-S-08	Shallow	11/20/2001	Inactive	630070.51	3771300.84
SVE-S-09	Shallow	11/19/2001	Inactive	630005.69	3771220.82
SVE-S-10	Shallow	11/21/2001	Inactive	630131.84	3771220.90
SVE-S-12	Shallow	11/12/2001	Inactive	630016.08	3770920.93
SVE-S-13	Shallow	11/10/2001	Inactive	630024.96	3770909.40
SVE-S-14	Shallow	11/12/2001	Inactive	630133.76	3770915.03
SVE-S-15	Shallow	11/9/2001	Inactive	630254.26	3770915.75
SVE-S-17	Shallow	11/12/2001	Inactive	630074.42	3770855.43
SVE-S-18	Shallow	11/9/2001	Inactive	630194.14	3770855.08
SVE-S-19	Shallow	11/11/2001	Inactive	630012.77	3770795.38
SVE-S-20	Shallow	11/9/2001	Active	630133.75	3770795.37
SVE-S-22	Shallow	11/10/2001	Inactive	630254.47	3770794.59
SVE-S-23	Shallow	11/11/2001	Inactive	630074.68	3770735.48
SVE-S-24	Shallow	11/10/2001	Inactive	630194.80	3770735.89
SVE-S-25	Shallow	11/11/2001	Inactive	630015.03	3770678.85
SVE-S-27	Shallow	11/12/2001	Inactive	630134.13	3770679.10
SVE-S-28	Shallow	11/19/2001	Inactive	630238.26	3770681.91
SVE-S-30	Shallow	11/20/2001	Inactive	630077.40	3771163.35
SVE-S-31	Shallow	11/19/2001	Inactive	630005.18	3771080.74
SVE-S-32	Shallow	11/21/2001	P&A	630147.02	3771079.12
SVE-S-32A	Shallow	11/26/2001	Inactive	630153.88	3771082.13

P&A = plugging and abandonment

[1]The shallow depth wells are screened from 20 to 45 ft and 50 to 90 ft bgs. The intermediate depth wells are screened from 95 to 180 ft and 190 to 275 ft bgs.

This well list represents the final configuration for the full-scale SVE system. SVE pilot test wells that were not appropriate for use in the final system were not included in this list.

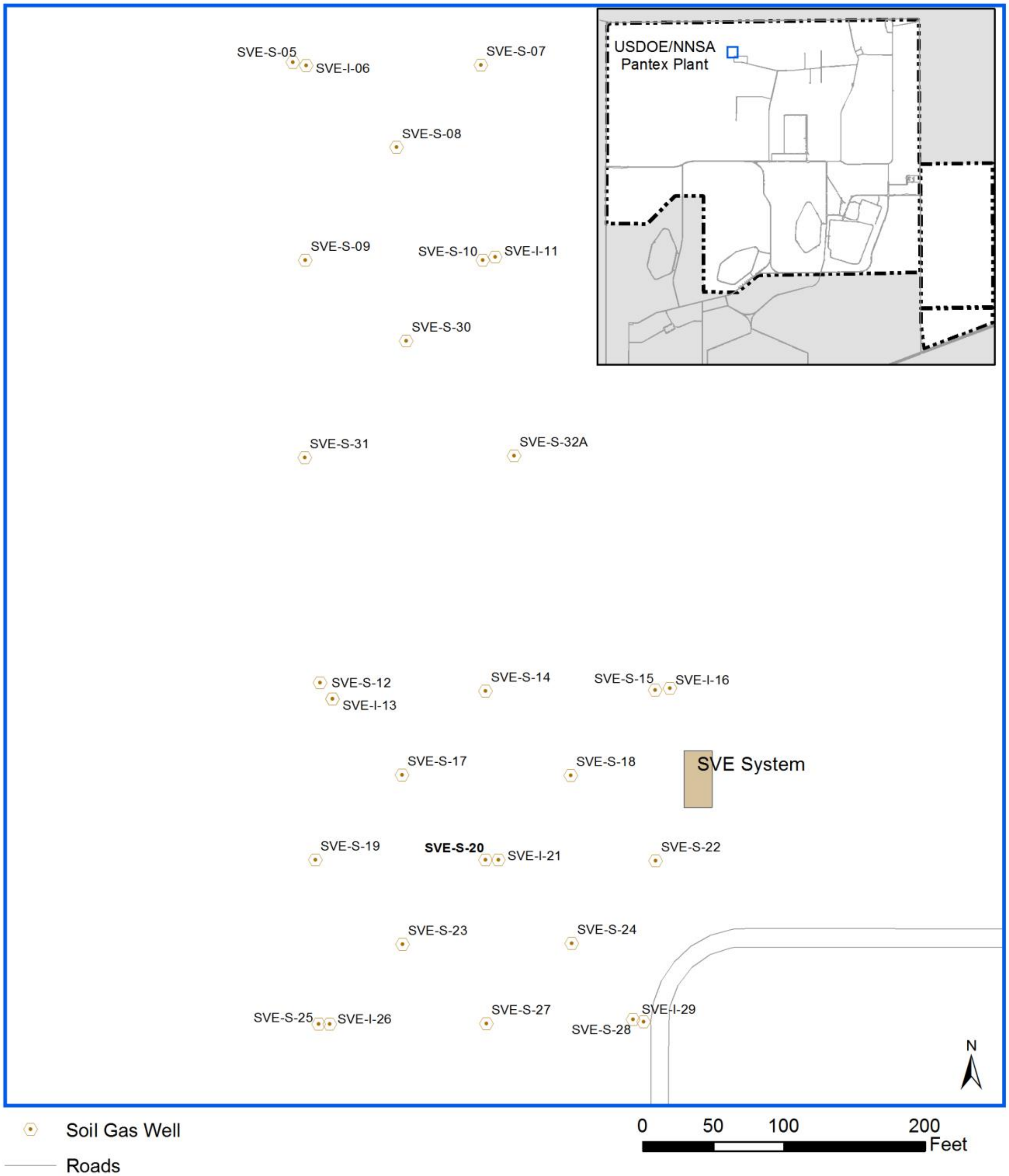

Fig. 1-19. Burning Ground SVE wells.

1.6.4 Schedule of Activities

As detailed in HW-50284 and the IAG, Pantex must meet requirements under CERCLA and RCRA. In accordance with the IAG, Pantex has submitted a site management plan that provides a list of required activities and planned dates of completion. This section provides a schedule of activities planned for the next year and projects required to be completed in accordance with HW-50284, CP Table VIII.

Table 1-12 summarizes activities completed in 2023 since the date of the last annual report, activities completed in 2024 prior to the publication of this report, and activities that have projected starts or completions between July 2023 and June 2024. The schedule of activities included in the 2022 Annual Progress Report was the basis for this table, which also includes revisions made to that schedule.

Pantex completed 2023 activities related to recommendations from previous reports while completing normally scheduled monitoring and operation of the RAs.

Pantex completed an FYR in 2013, 2018 and 2023. Most of the recommendations and issues to be addressed from the first FYR were completed before the second FYR. Some of the continuing evaluations, such as the expansion of plumes to the southeast, will continue to be addressed through issues and recommendations from the second FYR, from which a table of action items has been developed. New issues and recommendations were identified in the third FYR that was completed in 2023. Those actions are included in Section 5 of this report and will also be tracked to completion.

The significant actions completed in 2023 and early 2024 related to the FYRs include the following:

- Pantex provided a closure report to the TCEQ and EPA in August 2023 for the shutdown of the Burning Ground SVE. The closure report provided the termination criteria for the system, as required by the second FYR. TCEQ and EPA provided approval for the closure report in 2023. The application to renew HW-50284 requested removal of the SVE system from the compliance plan. The permit is expected to be issued in 2024.
- Three new Ogallala monitor wells were installed to evaluate the detections of 4-amino-2,6-dinitrotoluene (DNT4A) in the Ogallala Aquifer. Those wells were installed by the end of September 2023 and sampling was completed in December 2023.

- Pantex requested the removal of PTX06-1153 as a point of compliance well from HW-50284 so the well can be injected. HW-50284 renewal is expected in 2024, and injection of the well is planned for 2025.
- Pantex evaluated new system operational and flow goals for the SEPTS and P1PTS. Those goals were provided to the TCEQ and EPA and approval for implementation was received in 2023.
- Pantex has evaluated the pump and treat systems for the presence of PFAS. PFAS constituents were found in the influent to the systems and at sampled extraction wells. Evaluation of the GAC via studies and collection of process flow data indicates that the GAC is treating the PFAS below current TRRP PCLs and the newly promulgated MCLs.
- Pantex evaluated the effluent from the WWTF for PFAS. Data indicate that PFAS is present, but at very low concentrations. Pantex will evaluate use of the WWTF effluent at the pivot irrigation in 2024 so that water release to Playa 1 can be discontinued.
- Pantex committed to evaluating the expanding plumes of HEs east of FM 2373 in the first and second FYRs. To address the plume expansion, Pantex continues to evaluate and implement new actions to fully address the contamination. Pantex completed the following tasks:
    - Twenty ISB injection wells, 16 ISB extraction wells, 2 pump and treat injection wells, 3 TZM wells and one monitor well was installed on offsite property.
    - Injection was completed twice at the Offsite ISB System.
    - The Offsite Mobile PTS was constructed and installed at the Offsite System by October 2023. The system began operation in April 2024.
    - Infrastructure for the new wells was completed in 2023. The full Offsite ISB and MPT System was complete with the 2023 installation. The system was designed to mitigate HE plume expansion and cleanup the plume within a

25-year timeframe. Pantex will continue to evaluate the effectiveness of the system in Section 3 of this report.

Pantex has also implemented actions for the following recommendation made in the 2018 and 2019 Progress Reports:

- Pantex contracted for the design of a new center-pivot irrigation system east of FM 2373 in 2020. System design was completed in May 2021. Contracting for construction was completed in 2021, with construction beginning in November 2021. Construction of the pivot irrigation was completed in August 2023. System testing occurred in September with full operation beginning thereafter.

Pantex received comments from the Maria Sifuentes-Chavez of TCEQ (2022) on the supporting documents provided with the letter recommending changes to the Pantex RA (CNS, 2022). Pantex has agreed to complete some additional work and track the actions to completion in the annual progress reports, per letter dated February 15, 2023 (USDOE/NNSA, 2023). Those actions are required to be completed by December 2026. Due to the time required for requesting and implementing changes into the budget and the need to drill more Ogallala wells, Pantex will provide a status update in Section 5 of this report. When the agreed-upon activities are planned to be implemented within the timeframe for the annual report schedule of activities, they will be added to Table 1-12 below.

In-progress and upcoming activities for the next year continue to focus on the O&M and monitoring of the RAs, O&M of soil actions, reporting in accordance with the IAG and HW-50284, and progress on the second FYR’s issues and recommendation. Some of the reporting and plans will require regulatory review and approval and are provided in bold in Table 1-12.

In addition to the above-listed progress items, Pantex is planning to address an unexpected detection of RDX in newly installed Ogallala well PTX06-1229. Pantex began work in early 2024 to resample the well, collect a sample from the deeper sample interval installed for the well, to conduct a high-volume purge time-series sampling event, and conduct monthly samples at the well in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Groundwater Contingency Plan* (Pantex, 2019c). Further well installation will be required to evaluate the nature and extent of RDX in PTX06-1229, once funding is identified.

Pantex had previously recommended changes to the groundwater RA, in a letter dated August 9, 2022 and in previous annual and FYR reports. However, funding for fiscal year (FY) 2024 was reduced. In order to continue to maintain operation of our current actions, Pantex was unable to begin work on the following projects that were schedule for FY24:

- Construction of supervisory control and data acquisition (SCADA) systems for the SEPTS and P1PTS.
- Construction of the PCR ISB on the TTU property.
- Construction of one Ogallala well to continue evaluation of HE detections above GWPS in Ogallala well PTX06-1056.

The above FY24 projects will be completed as funding allows and will be reevaluated with regard to operational priorities annually. Although funding cuts occurred in FY23, the cuts had a low impact on the completion of planned projects. Pantex continues to work with NNSA to improve funding forecasts beginning in FY25.

Pantex has requested special funding for FY24 to address the detections from PTX06-1229. The following schedule provides a planned element for drilling new Ogallala wells in FY24, subject to availability of funding.

Table 1-12. Complete, In-Progress, and Upcoming Activities

Activity	Start Date	Scheduled Completion Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Completed Work (through Jun 2023)					
Annual Landfill Cover/Ditch Liner Maintenance – 2023	May 2023	May 2023	Sep 2023	IAG Article 8.9 HW-50284 Provision XI.E	
Construct Center Pivot Irrigation System East of FM 2373	Jun 2021	Sep 2022	Aug 2023	HW-50284 XI.B.1 and XI.B.2	4Q2018
Design/Construct Offsite Infrastructure – Phase 3 and 4	Sep 2021	Nov 2022	Nov 2023	HW-50284 XI.B.1 and XI.B.2	2Q2019
Closure Report for Burning Ground SVE	Mar 2023	Sep 2023	Aug 2023	IAG Article 7.2	2021A
Design SCADA upgrade for P1PTS and SEPTS	Jul 2022	Mar 2024*	April 2024	HW 50284 XI.B.3 and XI.B.5	
Hazardous Waste Permit Renewal Application – Provision XI Compliance Plan	Jan 2023	Dec 2023	Dec 2023	Texas Water Code Chapter 361 and 26	
Underground Injection Control Permit Application to increase injection wells	Mar 2023	Oct 2023	Dec 2023	IAG Article 8 HW-50284 Provision XI.E.1	
Offsite ISB Rehabilitation/Injection	Mar 2023 Sep 2023	Jun 2023 Nov 2023	Aug 2023 Dec 2023	IAG Article 8 HW-50284 Provision XI.E.1	
Southeast ISB Extension Rehabilitation and Injection	May 2023	Aug 2023	Oct 2023	IAG Article 8 HW-50284 Provision XI.E.1	
Well Drilling – 2023 Offsite Remediation System Wells (Phase 4) and three* new Ogallala monitor wells	Apr 2023	Sep 2023	Sep 2023	HW-50284 XI.B.1 and XI.B.2	2Q2019, 3Q2022
Design/Construct Offsite Infrastructure – Phase 4	Sep 2022	Sep 2023	Nov 2023	HW-50284 XI.B.1 and XI.B.2	2Q2019
Zone 11 ISB Rehabilitation and Injection	Apr 2023	Oct 2023	Dec 2023	IAG Article 8 HW-50284 Provision XI.E.1	

Activity	Start Date	Scheduled Completion Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
PTX06-1229 High-volume Purge Time-Series Sampling	Mar 2024	Mar 2024	Mar 2024	HW-50284 Provision XI.F	
PTX06-1229 Lower Interval Sampling	Mar 2024	Mar 2024	Mar 2024	HW-50284 Provision XI.F	
PTX06-1229 Monthly Sampling	Mar 2024	May 2024	Jun 2024	HW-50284 Provision XI.F	
Draft Final Five Year Review Reporting – Contracting, Evaluation, and Reporting	Mar 2022	Sep 2023	Sep 2023	HW-50284 CP Table VII, Item 26 and IAG Article 21	
2nd Semi-Annual 2023 Groundwater and ISB Sampling	Jul 2023	Dec 2023	Dec 2023	HW-50284 Provision XI.F	
1st Semi-Annual 2024 Groundwater and ISB Sampling	Jan 2024	Jun 2024	Jun 2024	HW-50284 Provision XI.F	
2nd Quarter 2023 Progress Report	Aug 2023	Sep 2023	Sep 2023	HW-50284 Provision XI.G.3 and IAG Article 16.4	
3rd Quarter 2023 Progress Report	Nov 2023	Dec 2023	Dec 2023	HW-50284 Provision XI.G.3 and IAG Article 16.4	
4th Quarter 2023 Progress Report	Feb 2024	Mar 2024	Mar 2024	HW-50284 Provision XI.G.3 and IAG Article 16.4	
2023 Annual Progress Report	Mar 2024	Jun 2024	Jun 2024	HW-50284 Provision XI.G.3 and IAG Article 16.4	
Work In-Progress					
Annual Landfill Cover/Ditch Liner Maintenance – 2024	May 2024	Dec 2024		IAG Article 8.9 HW-50284 Provision XI.E	
Offsite ISB Rehabilitation/Injection	Mar 2024 Aug 2024	Jul 2024 Nov 2024		IAG Article 8 HW-50284 Provision XI.E.1	
Southeast ISB Extension Rehabilitation and Injection	June 2024	Aug 2024		IAG Article 8 HW-50284 Provision XI.E.1	
Zone 11 ISB Rehabilitation and Injection	Apr 2024	Oct 2024		IAG Article 8 HW-50284 Provision XI.E.1	

Activity	Start Date	Scheduled Completion Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Sample PFAS at perched wells in accordance with the *Preliminary Per- and Polyfluoroalkyl Substances Sampling Plan for the Pantex Plant*	Nov 2023	Jul 2024		HW-50284 Provision XI.F.	3FYR
PTX06-1229 Lower Interval Sampling	Jun 2024	Jun 2024		HW-50284 Provision XI.F	
Upcoming Work (Jun 2024 through Jun 2025)					
Well Drilling – three new Ogallala monitor wells	Jul 2024	Oct 2024		HW-50284 XI.B.1 and XI.B.2	
Construct Phase I SCADA upgrade for SEPTS	Oct 2024	Sep 2025		HW 50284 XI.B.3 and XI.B.5	2020A
Drill two new Ogallala wells and two new Zone 11 perched monitor wells	Jun 2024	Sep 2024		HW-50284 XI.B.1 and XI.B.2	2022A
Drill two new ISB wells to infill at Zone 11	Jun 2024	Sep 2024		HW-50284 XI.B.1 and XI.B.2	2022A
Replace Ogallala well PTX06-1076	Jun 2024	Sept 2024		HW-50284 XI.B.1 and XI.B.2	2022A
Drill new wells for Perchlorate/Chromium ISB System	Mar 2025	Oct 2025		HW-50284 XI.B.1 and XI.B.2	2022A
Construct new ISB pad and water conveyance to East ISB	Jan 2025	Sep 2025		HW-50284 XI.B.3	2022A
Zone 11 ISB Rehabilitation and Injection	May 2024	Oct 2024		IAG Article 8 HW-50284 Provision XI.E.1	
Offsite ISB Rehabilitation and Injection	Mar 2025 Aug 2025	Jul 2025 Nov 2025		IAG Article 8 HW-50284 Provision XI.E.1	
Southeast ISB Extension Rehabilitation and Injection	Mar 2025	Aug 2025		IAG Article 8 HW-50284 Provision XI.E.1	
Annual Landfill Cover/Ditch Liner Maintenance – 2025	Mar 2025	Sep 2025		IAG Article 8.9 HW-50284 Provision XI.E	3FYR
Update priority of pumping at wells in the SEPTS System	Mar 2025	Sep 2025		HW-50284 Provision XI.E.1	3FYR

Activity	Start Date	Scheduled Completion Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Update the Pantex *Long-Term Monitoring System Design* and *Sampling and Analysis Plan*	Jul 2024	Nov 2024		HW-50284 CP Table VIII IAG Article 8	3FYR and CP Table VIII
Update the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan*	Dec 2024	Mar 2025		IAG Article 8	3FYR BG Closure Rpt
2024 Semi-Annual Progress Report	Nov 2024	Dec 2024		HW-50284 Provision XI.G.3 and IAG Article 16.4	
2024 Annual Progress Report	Mar 2025	Jun 2025		HW-50284 Provision XI.G.3 and IAG Article 16.4	

*Revised activity or date.

"Origin of Recommended Actions" refers to the report that first presented the recommendation to complete the project. Year plus "A" refers to the specific yearly annual progress report and the year plus "SA" represents the semi-annual progress report that presented the recommendation. Quarterly progress reports will include the quarter and year of the report that was used. Quarterly progress reports were discontinued at the end of 2023. The Five-Year Review Report is represented as the specific number of the review (e.g., 1, 2, 3…) and FYR.

BG – Burning Ground
FYR - Five-Year Review
Activities in bold require regulatory interaction and/or review and approval

2.0 Operation and Maintenance of Remedial Actions

Operation of the remedial actions is critical to meeting the remedial action objectives established in the ROD and HW-50284. Maintenance activities, both routine and unscheduled, ensure that the systems continue to operate optimally. This section summarizes the remedial action systems' O&M efforts to provide an understanding of the remedy's effectiveness.

2.1 Groundwater Remedial Actions

As discussed in Section 1, Pantex has implemented pump and treat and ISB for the final remedial actions for perched groundwater. Additionally, institutional controls, in the form of deed restrictions, have been placed in areas of impacted perched groundwater as part of the final remedial action. Pantex drafted all deed restrictions as part of the final remedy during 2009 and submitted them to TCEQ and EPA as part of the draft final IRAR. Those deed restrictions were filed in 2010 in conjunction with the approval of the final IRAR (Pantex, 2010a). Those deed restrictions were placed on Pantex, TTU, and one neighboring property where impacted perched groundwater is present. Pantex has added two additional neighboring property deed restrictions due to the plume extending offsite to the southeast. The deed restrictions were completed in June 2022 and will remain in place until the offsite remedial action is complete.

2.1.1 Pump and Treat Systems

The pump and treat systems were described in Section 1.4. In 2023, these systems continued to reduce saturated thickness and contaminant mass in the southeast perched groundwater, although they were impacted by reduced flow and shutdowns resulting from continuing issues with the subsurface irrigation. These data demonstrate that the systems are effective in removing mass and water from the perched aquifer, and system operation continues to move toward meeting Pantex's remedial action objectives.

Appendix B contains the monthly flow calculations for each active well and detailed O&M information.

Pump and Treat Systems Milestones

2023	Since Startup
• 160.4 million gallons treated	• 3.3 billion gallons treated
• 20.2% of treated water beneficially used	• 1.8 billion gallons beneficially used
• 616 lbs of contaminants removed	• 17,127 lbs of contaminants removed

2.1.1.1 Playa 1 Pump and Treat System

A description of the P1PTS is provided in Section 1.4.2. The operational goals for the systems were realigned in 2014 and are depicted in the highlight box in Section 1.4.1. These goals are prioritized and will be met as conditions allow.

The P1PTS was designed with a treatment capacity of 250 gpm or 360,000 gallons per day (gpd) and could potentially treat up to 131 million gallons (Mgal) of water per year running at design capacity and 100% operation. P1PTS releases all water through the WWTF, so operation is affected when water cannot be released to the WWTF. Operation of P1PTS has been impacted by a break at the irrigation system that occurred in late June 2017 and required an engineering evaluation and complex repairs. Repairs to the filter bank were completed in May 2019 and after completion of startup testing and repairs on the communication systems, a portion of the system became operational in March 2022. However, in April 2022, the communication interface on the system failed. System repairs were completed and the system became operationally available in late September 2022. However, a mishap with a bird caused an electrical failure of the system in early December 2022. The electrical system is repaired; however, the lagoons are undergoing repair and release to the irrigation system is on hold until repairs are complete. Pantex has completed construction of the center pivot irrigation system east of FM 2373. The system became operational in August, but was affected by a break at the wet well in early December that required repairs. Repairs were complete in February 2024.

While the irrigation system remains down, the WWTF’s treated water is being routed to Playa 1. Flow to Playa 1 is restricted by permit; therefore, Pantex also reduced the P1PTS operation to allow higher recovery at the SEPTS, which provides better control of the RDX plume’s movement to the southeast. This reduction in operation is reflected in the reduced number of operational days and throughput for the system. P1PTS was operated in the later part of the year when the pivot irrigations system became operational.

During 2023, P1PTS was operated partially or fully from July to December. Partial operation occurred when there was not a good outlet for water from the pump and treat system. In alignment with the new goals, the SEPTS is full operated at all times and P1PTS operation and/or flow is reduced to allow full operation of SEPTS.

The following figures depict the P1PTS operation, throughput, and well operation, providing the percentage of design capacity or operation achieved as well as goals for the system. While operation and throughput were reduced in 2023 to allow better capture of the RDX plume through the SEPTS increased operation, the 90% goals are still depicted in the graphs and used to identify potential issues with system or well operation.

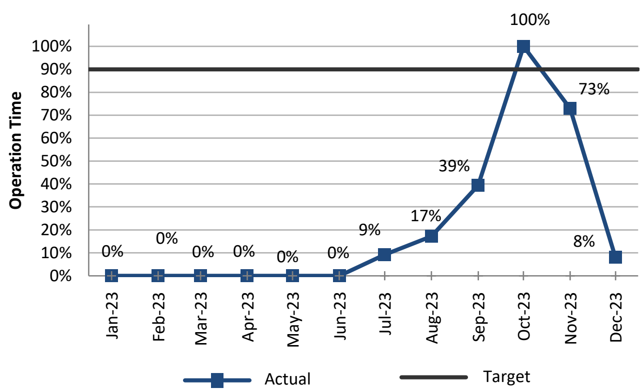

Fig. 2-1. P1PTS operation time vs target.

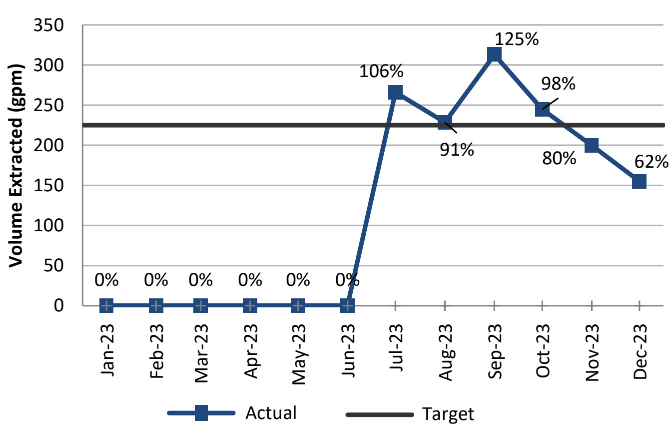

Fig. 2-2. P1PTS average GPM and % capacity.

The P1PTS was operational for 102 days during 2023 with an average annual operational rate of 21%, based on total hours operated versus total possible operation time. The actual percentage of monthly system operational time versus the target percentage is depicted in Fig. 2-1.

Fig. 2-2 depicts the average gpm extracted from all wells by month. The P1PTS extracted an average of 234 gpm (about 94% of design throughput) from the well field while operating in 2023. The calculated gpm accounts for water extracted from the well field when the system operated and is affected by each well's yield, downtime, or reduced flow required by the WWTF/irrigation system.

Fig. 2-3 reflects the operation time by well. The primary reason for downtime is due to the shutdown of P1PTS. PTX06-EW-70 went down in December and is on the well maintenance list for repairs. All other wells were running when the system was operated.

Fig. 2-4 reflects the P1PTS overall system efficiency considering system and well operation. The system treated an average of about 152,300 gpd when operating during 2023, which is approximately 42% of design capacity. The gpd is affected by system operational time, ability to extract water from the wells, and reduced flow to the WWTF and irrigation system. The system treated approximately 28.2 Mgal during 2023, with an average treatment volume of about 4.7 Mgal per month when operating.

The monthly treatment flow volumes and treated water usage are depicted in Fig. 2-5.

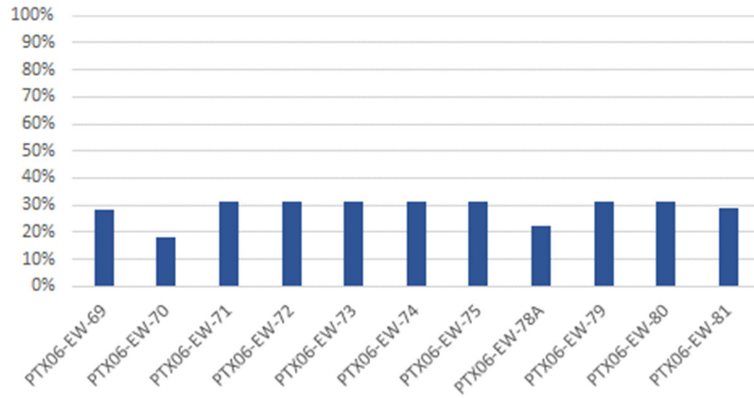

Fig. 2-3. P1PTS well operation time.

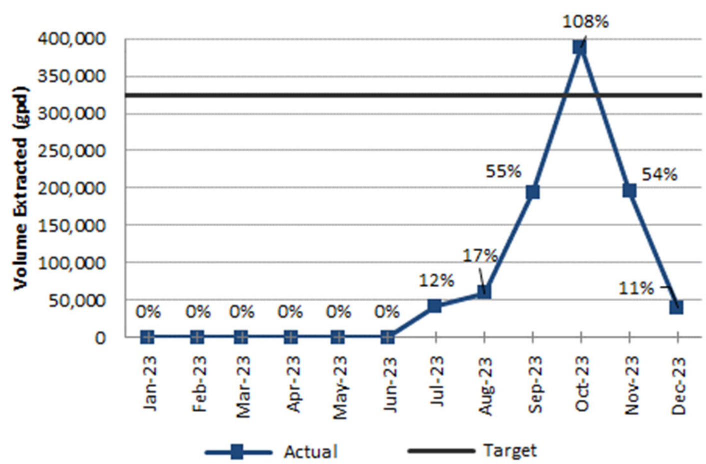

Fig. 2-4. P1PTS average GPD and % capacity.

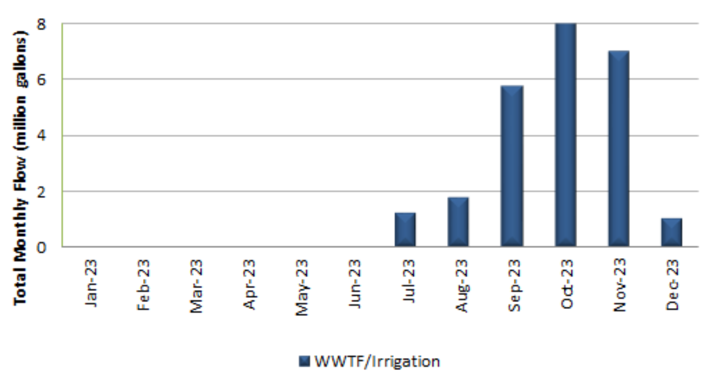

Fig. 2-5. P1PTS monthly total flow.

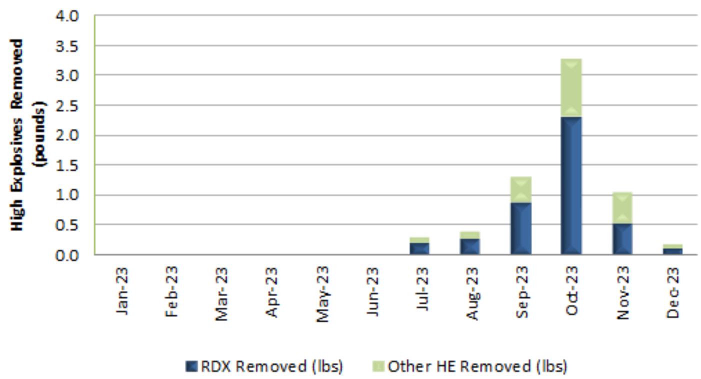

Fig. 2-6. P1PTS mass removal by month.

During 2023, the system removed approximately 4.4 lbs of RDX and 2.1 lbs of all other HEs (see Fig. 2-6). The average removal rate of HEs was approximately 0.23 lbs/Mgal of treated water. Since startup in September 2008, the system has removed a total of 555 lbs of RDX and 224 lbs of all other HEs. PFAS is also removed by this system, but due to low concentrations of these COCs, only about 1 lb per year is estimated to be removed. Therefore, the mass removal for PFAS is not tracked.

HE mass removal is dependent on the wells operated within the system, which affects influent concentrations and throughput. Source concentrations from Playa 1 are rapidly declining, with a small area directly beneath the Playa now demonstrating full treatment (see the plume maps in Section 3). Therefore, most wells are no longer in the higher-concentration HE plumes; thus, mass removal is low at P1PTS.

The average influent concentration of RDX was 148 ug/L in 2009 while the average influent concentration in 2023 was 17.9 ug/L. The maximum influent RDX concentration in 2009 was 200 ug/L and 23.8 ug/L in 2023. This system primarily reduces saturated thickness and head on the southeast perched groundwater, although mass removal is also achieved.

Evaluation of effluent data indicates that the system treated the recovered groundwater to concentrations below the GWPS. The complete set of effluent data collected during 2023 is included in the Appendix D electronic data tables.

In 2023, Pantex started evaluating PFAS at the pump and treat systems. PFAS is present at P1PTS. The GAC used at the system is effectively removing the PFAS to concentrations less than the TCEQ TRRP PCLs. Since the EPA promulgated a maximum contaminant level (MCL) for six PFAS constituents in April 2024, Pantex also compared effluent concentrations to those MCLs. None of those PFAS constituents were detected in effluent groundwater and detection limits were less than the MCLs. There is one PFAS constituent found in the effluent that does not currently have a promulgated standard and no information can be found in literature. 6:2FTS (1h,1h,2h,2h-perfluorooctane sulfonic acid) has been found in the effluent at concentrations ranging from 6.6 to 32.9 ng/L.

In 2023, the P1PTS was in its fifteenth year of operation. Operational performance was low for most of the year. Performance was affected by the continued subsurface irrigation system closure, which required reduced operations to allow full operation of the SEPTS to control the RDX plume moving to the southeast.

Pantex requested funding for 2022 through 2025 to design and install a new SCADA system at both pump and treat systems to ensure continued reliability of the system's operation. The new SCADA system design was completed in April 2024. Construction was planned to begin later in 2024; however, the construction will be implemented based on available funding.

Pantex has evaluated other methods to manage treated water and in 2018 recommended extending the line going to the Zone 11 ISB to an area east of Playa 2 and injecting treated water there. That project started in late 2019 and was completed in February 2022; however, it was designed to only receive water from SEPTS. Pantex also completed installation of a new center-pivot irrigation system east of FM 2373 in September 2023. The system was operated until early December when a break occurred, allowing P1PTS to be operated in the fall. The system was repaired in 2024, and operations resumed once freezing weather had passed. P1PTS future operation is expected to be more consistent with the availability of the Playa 2 injection system for SEPTS operation and the center pivot irrigation system operation. Winter months may require some reduction in P1PTS operation due to freezing weather that will prevent the use of the center pivot system.

2.1.1.2 Southeast Pump and Treat System

The SEPTS is designed to treat up to 300 gpm or 432,000 gpd and has the capability to treat 158 Mgal annually if operated at 100%.

During 2023, the SEPTS operated all or part of 361 days with an average operational rate of 96%, based on total hours operated versus total possible operation time. The percent operation time (i.e., hours per day) versus the target operation time is depicted in Fig. 2-7.

System operation was affected by necessary repairs, tie-in of components for the new pivot irrigation system and carbon/resin change-outs. Other than shutdowns in March for repairs and irrigation system tie-in, operation was consistent at the SEPTS due to shutdown of P1PTS, in accordance with the revised operational goals for the systems.

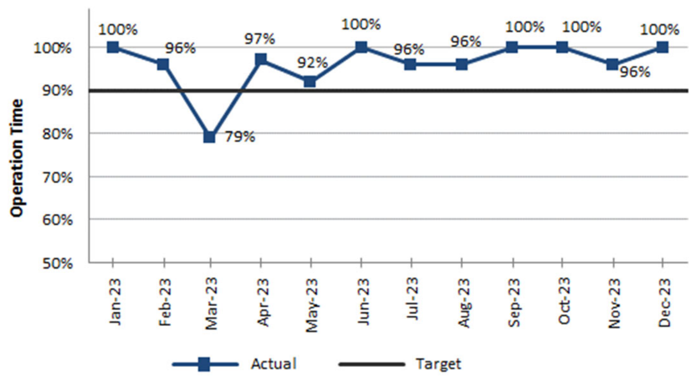

Fig. 2-7. SEPTS operation time vs target.

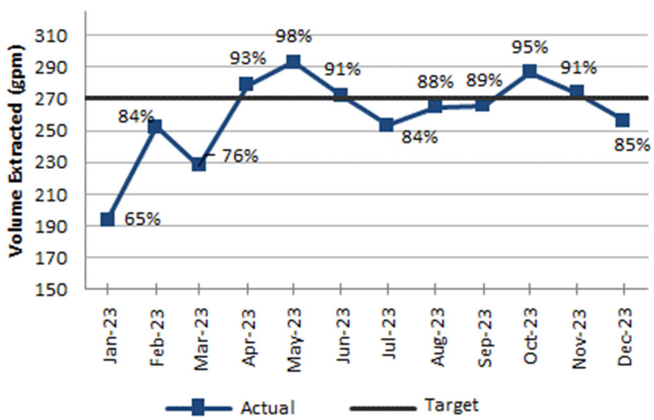

Fig. 2-8. SEPTS average GPM and % capacity.

As a measure of well operation efficiency, Fig. 2-8 depicts the average gpm extracted from all wells by month, the percentage of design capacity achieved, and system goals. Unless flow is affected by reduction of treated water outlets, the system operational rate has been the prioritized goal since 2023. In 2023, the system was operated fully, except in March to allow repairs to be completed and for irrigation controls to be added to the system. Well operation was below the 90% goal about half of the year.

The system extracted an annual average of 260 gpm (about 87% of design capacity) from the well field while operating. The calculated gpm accounts for water extracted from the well field during the time the system operated and is affected by the yield of each well, downtime, or reduced flow required due to limited water outlets. Because the WWTF/ irrigation system was unable to receive full flow from the pump and treat systems, flow was sent to Playa 1 in accordance with permit limits and injection into the perched groundwater was utilized to ensure full operation of SEPTS. However, the radio repairs at the Playa 2 injection system were not complete until March, so injection was limited to one well, which required reduced flow from SEPTS early in 2023. Since Playa 1 also receives treated water from the WWTF, SEPTS must reduce flow to the WWTF to ensure that permit limits are not exceeded at Playa 1.

Well operation and throughput were also affected by the number of extraction wells that were down in 2023. Well repairs require the use of an electrical contractor and coordination of lockout/tagouts (LOTOs) with the Pantex Plant Maintenance Department. Multiple LOTOs were scheduled during 2023 to repair wells and to continue maintenance of wells in accordance with the *Well Maintenance Plan for USDOE/NNSA Pantex Plant Groundwater Remedial Action Projects* (Pantex, 2020).

Throughput improved from September to early December, once the pivot irrigation system came online. However, flow was impacted again when a break occurred at the pivot irrigation system in December.

Shutdown of P1PTS allowed SEPTS to operate daily, allowing increased flow and treatment through the SEPTS when treated water outlets were available.

Because the SEPTS has 65 operating wells, it is currently capable of extracting more water than its maximum treatment capacity. For this reason, not all wells are pumping within the SEPTS on a daily basis. Estimated flow volumes for each well in the SEPTS are included in Appendix B.

Six new extraction wells, PTX06- EW-83 through EW-88, were installed in 2016 to control the movement of HE plumes to the southeast. Those wells were connected to the SEPTS and began consistent operation in May 2019. Due to declining water levels in that area, only the eastern three wells remain operational at this time. However, the two eastern wells operated most of the time, while the third well operated intermittently due to declining water levels. Operation of only two wells is likely to occur in the next year.

Although perched groundwater levels are declining, the extraction rates from the well field currently exceed the capacity of the treatment system. Pantex extracts from the well field according to set priorities that best meet long-term objectives. The well-extraction priorities for operating wells are as follows and depicted in Fig. 2-9:

- Priority 1 wells: Wells along the eastern edge of the well field (i.e., along the eastern fence line of the main plant) and a line of wells east of FM 2373 that are used to control the continued movement of water and contamination to thinner saturated zones at the margin of the perched aquifer where pump and treat technology is ineffective. The new wells, PTX06-EW-83 through PTX06-EW-88, are included in this group.

- **Priority 2 wells:** Wells along the southern edge of the system that were installed to capture the highest concentrations of hexavalent chromium and prevent the plume's migration to thinner saturated zones or into areas where the fine-grained zone (FGZ) of the perched aquifer is more permeable.
- **Priority 3 wells:** Wells along the southeastern edge of the system that capture the highest concentrations of RDX and prevent the plume's migration to thinner saturated zones or into areas where the FGZ is more permeable.
- **Priority 4 wells:** Wells along the northern edge of the hexavalent chromium plume from the Zone 12 South area.
- **Priority 5 wells:** Wells close to the highest concentrations of RDX. These wells will continue to capture the RDX plume movement when the Priority 3 wells are not pumping.
- **Priority 6 wells:** Wells that capture the center of the hexavalent chromium plume from the former cooling tower on the eastern side of Zone 12.
- **Priority 7 wells:** All other wells in the SEPTS. With the exception of EW-49, these wells help reduce saturated thickness in the perched aquifer and remove head that pushes the groundwater horizontally and vertically but will not be as effective at controlling plume movement. EW-49 is in a low-transmissivity zone and, thus, is a very low-producing well. For this reason, it was not placed in a high priority for pumping.

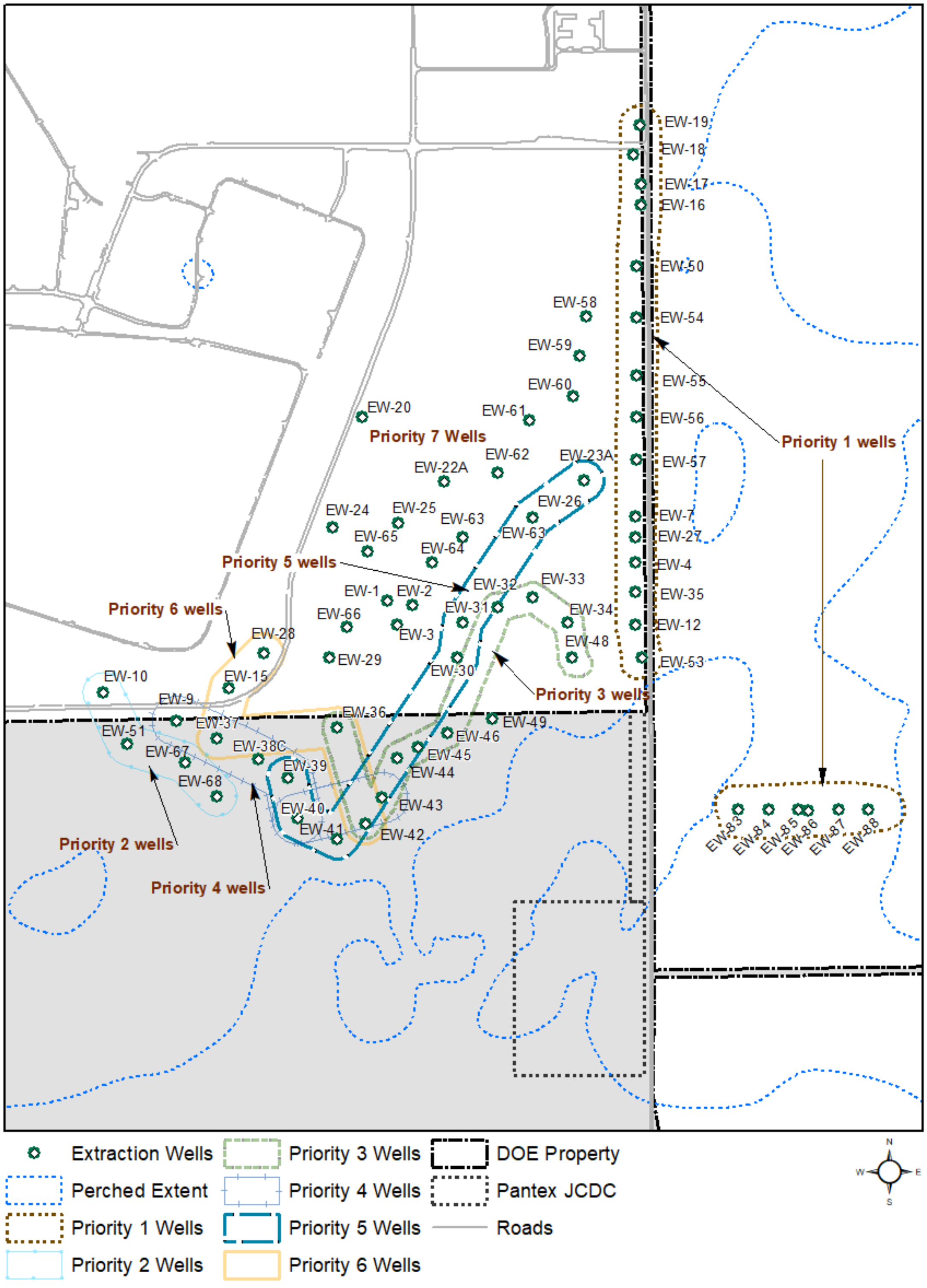

Fig. 2-9. Extraction well prioritization.

During 2023, the highest-priority wells were operated to meet extraction rates, unless issues with maintenance or low water levels occurred at the wells. Lower-priority wells were only operated to make up additional flow that was needed.

This prioritization scheme was implemented in 2009 after the system was expanded. Fig. 2-10 provides the percentage of days on which the wells were operated in the SEPTS. Priority 1 – Priority 5 wells were operated at higher frequencies with the exception of wells that had repair issues, were locked out due to repair issues with wells on the same line, or had low water levels that prevent them from operating properly. Due to a plant electrical failure, several wells in the vicinity of PTX06-EW-10 and PTX06-EW-51 stopped operating in December 2022. Electrical repairs were completed and the wells were back online in spring 2023.

Some of the high-priority wells are in areas that have rapidly declining water levels and/or are in low-yield portions of the formation. Those wells are operated intermittently due to pumps cycling on and off. As the system continues to remove water from the perched aquifer, this effect is becoming more prominent in wells in thin, saturated portions of the perched aquifer. In particular, many wells along the eastern fence line and to the south on TTU property are frequently cycling off due to the limited saturation in some areas. Currently, there is less than five ft of saturated thickness in those areas, as depicted in Fig. 2-16 in the following ISB section.

Several wells have gone dry and have been removed from the pumping network. Priority 6 and Priority 7 extraction wells were operated as needed to ensure that wells remain operational or to make up flow.

The prioritization of the well pumping will be changed based on results of the optimization of the pump and treat system (HGL, 2021a). The realignment of prioritization will be completed in conjunction with recommendations from the FYR and this report. Prioritization will be discontinued in the future when the pump and treat system's capacity exceeds extraction rates.

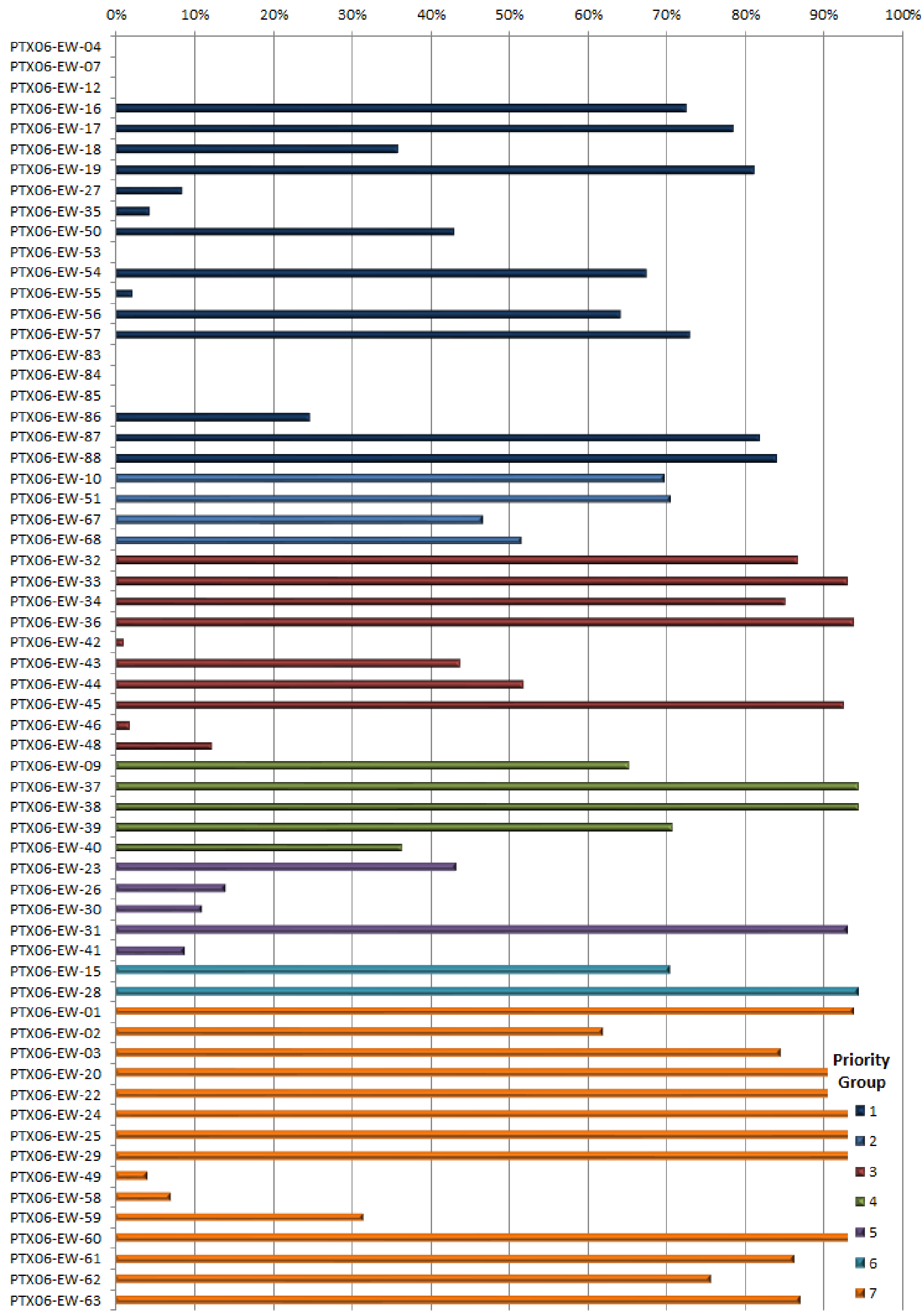

Fig. 2-10. SEPTS well operation time.

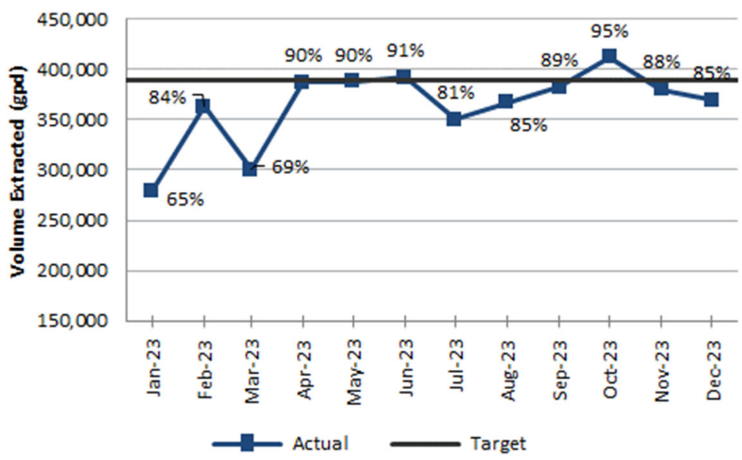

Fig. 2-11. SEPTS average GPD and % capacity.

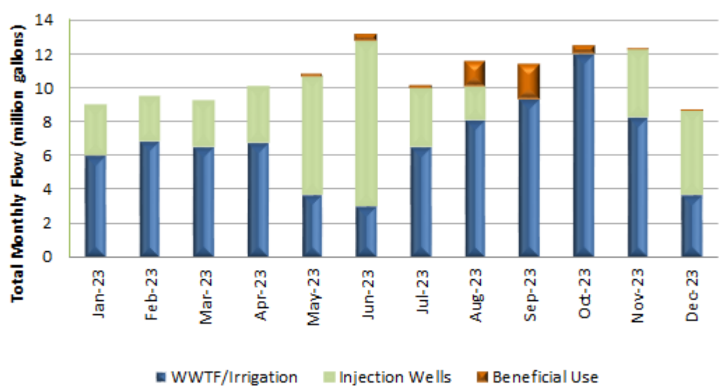

Fig. 2-12. SEPTS total flow volume and disposition of effluent.

Fig. 2-11 reflects the SEPTS overall efficiency considering system and well operation. The figure depicts the average daily treatment rate in gpd by month, the target, and the percentage of total capacity achieved at the SEPTS. In 2023, the SEPTS treated an annual average of approximately 364,333 gpd (about 84% of design capacity), based on total possible hours of operation and total inflow from the well field. System operation time was high, but flow was impacted by well downtime and limited outlets for treated water.

As discussed above, the system was primarily affected by the loss of wells that required repair, reduced throughput to the WWTF/irrigation system when the pivot irrigation system was not operational and limited injection capability until the Playa 2 injection system was operational. Operation time was high (96%) for 2023, so had little impact on the overall system throughput.

The system treated approximately 132.2 Mgal of extracted water during 2023. The total volume treated by month and the final disposition of the treated water are depicted in Fig. 2-12. Approximately 33% of the treated water was injected into the perched aquifer, 4% was used beneficially for ISB injection, and the remainder was released to Playa 1 via the WWTF.

The SEPTS primarily removes RDX, hexavalent chromium, and perchlorate from the perched groundwater. The system removed approximately 61 lbs of hexavalent chromium, 134 lbs of perchlorate, 211 lbs of RDX, and 203 lbs of all other HEs during 2023. The total mass removed for hexavalent chromium, perchlorate, and HEs, by month, is depicted in Fig. 2-13, Fig. 2-14, and Fig. 2-15. The average removal rate of hexavalent chromium was 0.46 lbs/Mgal of water and the average removal rate for perchlorate was 0.98 lbs/Mgal. The average removal rate for HEs was 2.9 lbs/Mgal of water.

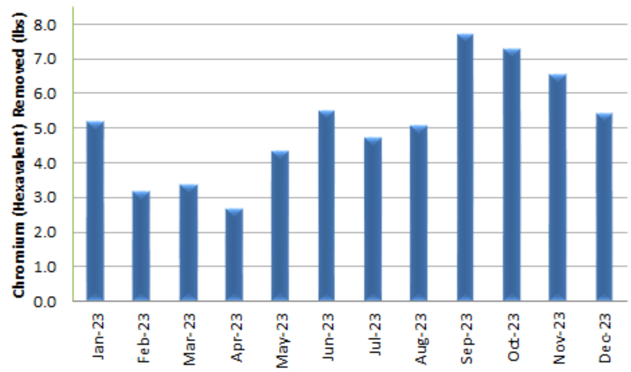

Fig. 2-13. SEPTS chromium mass removal by month.

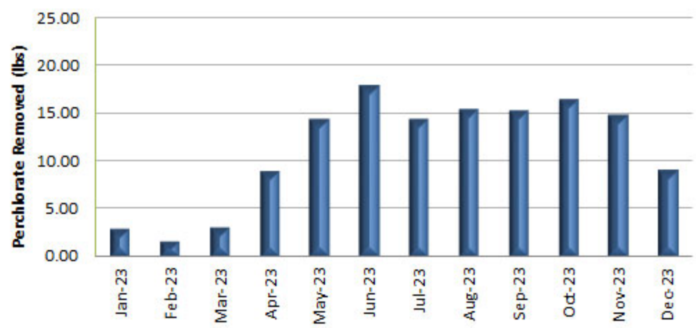

Fig. 2-14. SEPTS perchlorate mass removal by month.

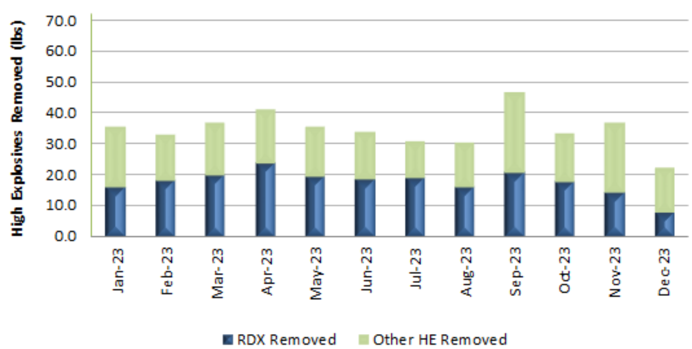

Fig. 2-15. SEPTS high explosive mass removal by month.

Hexavalent chromium mass removal is declining because concentrations in PTX06-EW-51 and nearby extraction wells continue to decline. PTX06-EW-51 was located in the heart of the hexavalent chromium plume south of Zone 12 and contributed heavily to the hexavalent chromium influent concentrations at the SEPTS. The plume has moved downgradient, and other extraction wells now capture portions of it even though concentrations are much lower at these wells. Average influent concentrations of hexavalent chromium were approximately 214 ug/L in 2009 and approximately 70.8 ug/L in 2023.

HE mass removal is affected by wells that operate in higher-concentration portions of the RDX plume. Overall, average concentrations of RDX in the SEPTS influent have declined with average concentrations about 570 ug/L in 2009, the first year of the full remedial action, to about 193 ug/L in 2023. This system has treated approximately 15,035 lbs of HEs, 1,931 lbs of hexavalent chromium, and 161 lbs of perchlorate since it started operating. Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below GWPS. This system also treated PFAS that was recently found in the southeast pump and treat well field, with all effluent concentrations below TRRP PCLs and the newly promulgated MCLs. PFAS removal is only estimated to be about 1 lb per year; therefore, the mass removal is not tracked for these COCs.

A summary of COC effluent detections at the SEPTS is included in Table 2-1, with the exception of boron, which is detected in all samples and continues to remain below the GWPS. The complete set of effluent data collected during 2023 is included in Appendix D.

Table 2-1. Summary of Effluent COC Detections at SEPTS

Sample Date	Analyte	Measured Value (ug/L)	Bkgd (ug/L)	> Bkgd?	PQL (ug/L)	> PQL?	GWPS (ug/L)	> GWPS?
1/3/2023	Hexavalent Chromium	0.02J+	3.2	N	0.02	NA	100	NA
1/3/2023	Perchlorate	3.69	0.96	Y	5	NA	15	N
1/16/2023	Perchlorate	4.51	0.96	Y	5	NA	15	N
2/6/2023	Hexavalent Chromium	4.105	3.2	Y	0.02	NA	100	N
2/6/2023	Perchlorate	6.07J	0.96	Y	1	NA	15	N
2/15/2023	Perchlorate	0.983J	0.96	Y	1	NA	15	N
3/1/2023	Hexavalent Chromium	0.227	3.2	N	0.02	NA	100	NA
3/1/2023	Perchlorate	0.944	0.96	N	1	NA	15	NA
3/15/2023	Perchlorate	1.34	0.96	Y	1	NA	15	N
4/3/2023	Hexavalent Chromium	1.115J	3.2	N	0.02	NA	100	NA
4/3/2023	Perchlorate	2.36J	0.96	Y	1	NA	15	N
4/17/2023	Perchlorate	2.9	0.96	Y	1	NA	15	N
5/1/2023	1,3,5-Trinitrobenzene	0.0374J		NA	0.105	N	220	N

Sample Date	Analyte	Measured Value (ug/L)	Bkgd (ug/L)	> Bkgd?	PQL (ug/L)	> PQL?	GWPS (ug/L)	> GWPS?
5/1/2023	Hexavalent Chromium	34.46J	3.2	Y	2	NA	100	N
5/1/2023	Perchlorate	3.38	0.96	Y	1	NA	15	N
5/15/2023	Perchlorate	3.86J	0.96	Y	1	NA	15	N
6/5/2023	1,3,5-Trinitrobenzene	0.0263J		NA	0.103	N	220	N
6/5/2023	Hexavalent Chromium	2.137	3.2	N	0.02	NA	100	NA
6/5/2023	Perchlorate	0.607	0.96	N	1	NA	15	NA
6/5/2023	TNT (2,4,6-Trinitrotoluene)	0.0808J		NA	0.103	N	3.6	N
6/21/2023	Perchlorate	0.998	0.96	Y	1	NA	15	N
7/5/2023	1,3,5-Trinitrobenzene	0.0275J		NA	0.108	N	220	N
7/5/2023	Hexavalent Chromium	6.132	3.2	Y	0.04	NA	100	N
7/5/2023	Perchlorate	1.38	0.96	Y	1	NA	15	N
7/17/2023	Perchlorate	1.98	0.96	Y	1	NA	15	N
8/1/2023	1,3,5-Trinitrobenzene	0.049J		NA	0.104	N	220	N
8/1/2023	Hexavalent Chromium	5.92	3.2	Y	1	NA	100	N
8/1/2023	Perchlorate	0.205	0.96	N	1	NA	15	NA
9/6/2023	Hexavalent Chromium	0.603	3.2	N	0.02	NA	100	NA
9/6/2023	Perchlorate	0.776	0.96	N	1	NA	15	NA
10/2/2023	Hexavalent Chromium	1.716	3.2	N	0.02	NA	100	NA
10/2/2023	Perchlorate	0.866	0.96	N	1	NA	15	NA
10/16/2023	Perchlorate	2.29	0.96	Y	1	NA	15	N
11/1/2023	Hexavalent Chromium	2.298	3.2	N	0.02	NA	100	NA
11/1/2023	Perchlorate	2.23	0.96	Y	1	NA	15	N
11/15/2023	Perchlorate	0.724	0.96	N	1	NA	15	NA
12/5/2023	Hexavalent Chromium	1.077	3.2	N	0.02	NA	100	NA
12/5/2023	Perchlorate	0.6	0.96	N	1	NA	15	NA
12/18/2023	Perchlorate	0.748	0.96	N	1	NA	15	NA

PQL – Practical quantitation limit Bkgd - background

J = Estimated value representing a concentration detected less than the practical quantitation limit and equal to or greater than the method detection limit (MDL).

J+ = The associated numerical value is an estimated quantity with a suspected positive bias.

Overall, the SEPTS continues to remove and treat water from the well field. The system was primarily affected by repairs, tie-in to the pivot irrigation system and carbon/resin change-out. P1PTS was shut down during the majority of 2023 due to allow SEPTS to fully operate when water outlets were limited.

The Playa 2 injection line became operational in April 2023, allowing for 150 to 180 gpm to be injected when needed. The pivot irrigation system also became operational in September, allowing greater throughput for the SEPTS and operation of P1PTS.

Pantex also completed repairs to the break at the older subsurface irrigation system. The subsurface irrigation system became operational in March 2022 but failed in April 2022 due to a communication interface issue. System repairs were completed and the system became operationally available in late September 2022 but failed again due to an electrical failure at the system caused by a bird in early December 2022. The system has been repaired, but flow through the systems remains limited due to repair of lagoon liners that started in 2022. Additional repairs must be made to one WWTF lagoon, so storage continues to be reduced to that system, thereby affecting release to the subsurface irrigation system. WWTF storage will remain limited through 2024. Pantex will continue to manage SEPTS in 2024 to meet the realigned operational goals, agreed upon by the regulators and Pantex and discussed in Section 1 of this report, using a combination of release to the WWTF, pivot irrigation system, injection, and reduction of flow or ceasing operation of P1PTS, as needed. Operations will continue to prioritize capture of RDX, perchlorate, and hexavalent chromium plumes.

2.1.2 ISB Systems

Pantex has installed and operates four ISB systems as part of the final Remedial Action for groundwater. One system is southeast of the plant on TTU property, one is south of Zone 11, one is southeast of the main plant (i.e., east of FM 2373) at the extreme southeast boundary of USDOE/NNSA-owned property, and the fourth is located offsite to the southeast of Pantex property, south of Highway 60. System information and maps are provided in Section 1.4.2. In 2023, the ISB systems consisted of 219 treatment zone injection wells, 44 ISB extraction wells, 16 TZM wells, and 19 ISPM wells. Some wells were just installed in 2023 and were not yet actively used. Some of the wells are now dry or inactive due to changing conditions at the ISBs.

In the past, the systems were injected with Newman Zone®, an emulsified soybean oil (EVO or emulsified vegetable oil). Based on indications that the amendment was not distributing well, Pantex conducted studies at the Zone 11 ISB to determine an approach that could impact monitoring wells located between the injection points. Based on the study, Pantex has moved to the use of a more soluble carbon source, molasses, in the systems where wells are widely spaced. This change has also required more frequent injection of amendment to ensure continued treatment of COCs. With the exception of the Offsite ISB, each system's frequency of injection is determined by the amount of saturated thickness and water movement through the system.

Injection volumes and amendment concentrations are planned based on the Zone 11 ISB study, which indicated that a higher volume of amended water was needed to affect areas between the wells. A dose response study was conducted early in the 2018 injection event to determine if a solution of molasses mixed with EVO would reach the areas between the wells at an appreciable concentration. Pantex also studied three TZM wells between the injected wells, allowing for a robust study on the effectiveness of injection.

For the study, fluorescein dye was injected into five injection wells (PTX06-ISB091, PTX06-ISB092, PTX06-ISB096, PTX06-ISB103, and PTX06-ISB104), and three monitoring wells (PTX06-1164, PTX06-1176, and PTX06-1177) were monitored to evaluate the distribution of the injection solution. Samples were collected for visual comparison to a pre-mixed fluorescein standard and for laboratory analysis for total organic carbon (TOC). Because TOC data analysis and reporting would be delayed, the fluorescein dye was used as a tracer to determine when injection should be discontinued. Dye arrival was not observed at the monitoring locations when the target volume was reached; therefore, injections were continued until dye arrival was confirmed or a volume equivalent to 20% mobile porosity was reached.

The study indicated that only the more soluble carbon (i.e., molasses) reached the monitoring points between the injection wells. Calculations using dye and TOC concentration results indicate that injection volumes must be increased. Information from this study is now used at all ISBs to determine injection volumes.

Based on the dose response study, future operation of the ISBs will focus on the use of a more soluble carbon (e.g., molasses) to achieve the distribution needed at the ISB systems when wells are widely spaced. Pantex has been in-filling wells and installing some areas of the system with wells approximately 50 ft apart so that the EVO could be used at those locations with less frequent injection. Most of the Zone 11 ISB and all of the Southeast ISB systems are configured with 100-ft spacing between injection wells. The Southeast ISB Extension was configured with 75-ft spacing to overcome known problems with distribution. This approach will be evaluated through continued monitoring, and results and recommendations will be provided in future reporting.

Recently installed wells at the Zone 11 ISB were appropriately spaced (50-60 ft centers) for injection of Newman Zone®. Those wells have been injected and future injections are planned once every three years due to the longevity of the EVO. Future systems are also planned with closer spacing so that EVO can be used.

The Offsite ISB was designed using an updated perched groundwater fate and transport model and wells were located optimally to achieve cleanup within 25 years. The system was planned for injection with molasses twice annually at locations the modeling indicated would require injection. Monitoring will be used to evaluate against modeled data to determine the effectiveness of the treatment and whether adjustments in injection or additional wells may be needed to achieve cleanup goals.

2.1.2.1 Zone 11 ISB

2.1.2.1.1 History of Zone 11 ISB

The Zone 11 ISB system is on Pantex property, south of Zone 11. The system, as operated in 2023, consists of 89 injection wells, 7 TZM wells, and 9 downgradient ISPM wells installed in a zone of a saturated thickness of approximately 15 to 20 ft. The system is detailed in Section 1.4.2.

Not all of the wells are injected each year, due to differences in the type of amendment injected throughout the system. Some of the differences are based on well spacing, while others may be paused for injection due to build-up of amendment from past injections, as commonly found in wells that had EVO injected for a long period of time.

Injection frequency has been decreased in wells where EVO was previously used. This is based on evaluation of three factors: PTX06-ISB082, long-term evaluation of the use of EVO, and pilot study data.

Data at the monitoring wells installed for the pilot study indicated that complete treatment of HEs and hexavalent chromium occurred in less than two years at most downgradient wells. Where monitoring was continued at the downgradient wells, results indicated that the ISB continued to treat RDX and hexavalent chromium into 2023 at all but one well, with no further injections in the pilot study wells, even though the system was only injected in 2005 and 2006. These results indicate that treatment has continued for more than 10 years after the final injection. While conditions at the pilot study differ from those of the Zone 11 ISB, pilot study data indicate that longer wait times for injection are appropriate when EVO, such as Newman Zone®, is used.

To evaluate the need for continued injection into the second-row wells on the eastern side of the ISB where build-up had occurred and injection was difficult, Pantex discontinued injection of EVO into PTX06-ISB082 after the fifth injection event in 2013. Data collected from 2014 through 2022 indicate that PTX06-ISB082 maintained deep reducing conditions and had ample food source for the continued degradation of perchlorate. PTX06-ISB079 has also been monitored since all treatment was discontinued in the second row of wells on the eastern side of the system, and data through 2022 indicate that treatment continued and that ample food source remains to continue treatment within the radius of influence of the well. The current downgradient ISPM well, PTX06-1156, continues to indicate that perchlorate is treated, even though it is downgradient of a single row of injection wells. Pantex continued to monitor these wells through 2022 but began successfully using them in 2023 to continue injections for treating the plume of TCE that is moving into the eastern side of the ISB. Due to the wider spacing of the wells, molasses was used to ensure effective distribution. Pausing injection in these wells indicates that a pause at other wells where EVO was originally used can successfully allow rehabilitation and injection of the wells in the future. Pantex has paused injection in 15 other first-row wells that have reduced capacity for injection.

Pantex has moved to the use of a more soluble carbon source throughout the Zone 11 ISB where wells are more widely spaced (75-100 ft centers) and modified injection frequencies to twelve months in portions of the system where EVO has not been used.

Newer wells installed as a second row in the eastern side of the system were more closely spaced (50-60 ft centers) so that EVO could be used for injections. Based on data collected over time at the Zone 11 ISB and the results from the pilot study wells discussed above, the new wells are planned for injection every three years. However, data will be collected to validate timing of the injections.

Older EVO-injected wells that have been paused for injection will be evaluated at the end of three years to determine if we can rehabilitate and inject the wells again. Molasses will be injected in the widely spaced wells once rehabilitation indicates that injection is possible.

Four other wells have been paused for injection, due to issues with injection. These wells seem to be in a tighter area of the formation, so injection became difficult after a few injection events. Pantex has in-filled wells in that area to replace injection of PTX06-ISB087, PTX06-ISB088, PTX06-ISB105 and PTX06-ISB106. However, Pantex will periodically evaluate the potential for re-injection into those wells.

2.1.2.1.2 Operation of Zone 11 ISB

During 2023, injection occurred across the Zone 11 ISB, with 69 wells rehabilitated and 70 injected. The rehabilitation and post-injection reports are included in Appendix H. All maintenance steps were not completed at PTX06-ISB101 due to the loss of a tool down the well that could not be removed. Further work will be completed to remove the tool before the next injection event.

Previously injected wells were first maintained to improve injection performance and mitigate the effects of biofouling so that the wells were suitable for amendment injection. Maintenance consisted of mechanical and chemical rehabilitation and was performed from March through May 2023. Maintenance was performed in the following steps:

1. An initial round of mechanical rehabilitation was conducted to remove gross deposits from the well and enhance the effectiveness of subsequent chemical rehabilitation. Mechanical rehabilitation consisted of an initial evaluation of the well followed by brushing, surging, and bailing to loosen and remove deposits from the well screen and filter pack.
2. Chemical rehabilitation involved the application of the Cotey Chemical Corporation Welgicide Cleaner (Welgicide). The purpose of chemical rehabilitation was to dissolve and remove mineral scale and/or biomass on the well screen and in the filter pack.
3. A second round of mechanical rehabilitation was conducted using brushing, surging, and bailing. Development was considered complete when extracted water color improved and pH was below 9.
4. Jetting was completed at two wells to determine if this method would increase injection performance.

After well maintenance, constant-rate injection tests were performed to calculate transmissivity and specific capacity values for each well. The objective of hydraulic testing was to evaluate present well performance compared to what is documented in historical testing results. Well maintenance effectively increased performance in 42% of the wells that were maintained; however, based on results of injection testing and actual injection rates achieved, overall transmissivity has decreased across the well field, with the greatest decreases occurring in older wells. Collectively, injection results indicated that target volumes were achievable at most wells.

Injection occurred from May through September 2023. For injection, Pantex used 80% strength molasses to enhance the distribution of amendment across the treatment zone. The injected solution was approximately 2.0% pure molasses by volume. EVO and molasses were injected at the 26 new wells that were installed as a second row in 2021. The injected EVO solution was approximately 3% by volume.

Injection activities consisted of injecting makeup water mixed with amendment followed by a clean water flush of 5% of the injected volume. Approximately 4,784,000 gallons of molasses and EVO (at 26 wells) solution were injected into 70 injection wells during the 2023 injection event. Target volumes were amended at two wells due to decreased injection performance, although <90% of target was achieved. The typical average flow rate at locations where the target volumes were achieved was 4.5 gpm. The PTX06-ISB079 through PTX06-ISB082 wells that had been paused for injection achieved injection rates of 5.4 to 15.4 gpm.

Target dosing of 2% pure molasses was achieved in 93% of the wells. The lowest target dose achieved was 1.8%. Target volumes of molasses and water was achieved at 98% of the wells. Target dosing of the EVO was achieved at the majority of wells, with 2.1% being the lowest dosing achieved. Target volumes and dosing for molasses was achieved at the EVO wells.

2.1.2.2 Southeast ISB

2.1.2.2.1 History of Southeast ISB

The Southeast ISB system is on TTU property, southeast of the main plant. The system consists of 42 injection wells and 5 downgradient ISPM wells installed in a zone of saturated thickness of less than 4 ft throughout most of the system. The system is detailed in Section 1.4.2.

Due to upgradient pump and treat operations, areas within and surrounding the Southeast ISB continue to demonstrate declining water conditions. An upgradient monitoring well, PTX06-1118, has not been sampled since 2010 when it went dry. Three of the five downgradient ISPM wells south of the system went dry in 2009, 2015, and 2018, although water came back into PTX06-1045 in 2018 because of water retention ponds installed at the administrative complex. PTX06-1167, which was installed to the north of the system in July 2013 to evaluate the water and COCs entering the western side of the system, remains dry. Several areas inside the treatment zone are dry, and injection does not typically occur in those wells.

Across all data, water-level trends generally indicate that water is declining or there is no trend. This system was impacted by decreased operation of the SEPTS for a period of time when the subsurface irrigation system was under repair. SEPTS is now preferentially operated fully to continue to capture RDX plumes before they move to the Southeast ISB or offsite. Recent trends are now indicating reversal of the past increasing short-term trends. The system continues to have very little saturated thickness (i.e., <10 ft of water), as shown in Fig. 2-16. About 31% of wells inside the treatment zone demonstrate greater than 5 ft of water, with all downgradient wells having less than 5 ft of water.

Evaluation of water-level trends indicates that water levels have generally decreased since the start of remedial action, with seven ISB wells now dry. The 2023 water-level mapping indicates that a small portion of upgradient perched water has reconnected to the central portion of the ISB. Where disconnected from the upgradient perched water source, any water remaining will continue to move through the system and be treated. With the focus on operating SEPTS at or near operational goals at all time, this connection is expected to reverse, and the ISB is expected to dry up over time and no longer require injections.

Note that downgradient well PTX06-1045, which was previously dry, demonstrated some recovery in water levels beginning in 2018. This is believed to be related to the construction of the Administrative Site Complex (ASC), south of the main Pantex property. Management of stormwater drainage required the installation of retention ponds at the northwest and southwest corners of the property. The northwest retention pond is near PTX06-1045 and believed to be a contributor to the increased water levels in that well, which has been sampled since 2019.

Pantex recommended in the *2016 Annual Progress Report* that injection at the Southeast ISB be repeated in 2019 (i.e., three years after the last injection event) and be re-evaluated thereafter. The latest injection event started in late 2021, finishing in early 2022. Due to declines in water levels, it is possible that much of this system will no longer require injection after the last injection event in 2022. However, monitoring data will be used to inform the timing and need for injection.

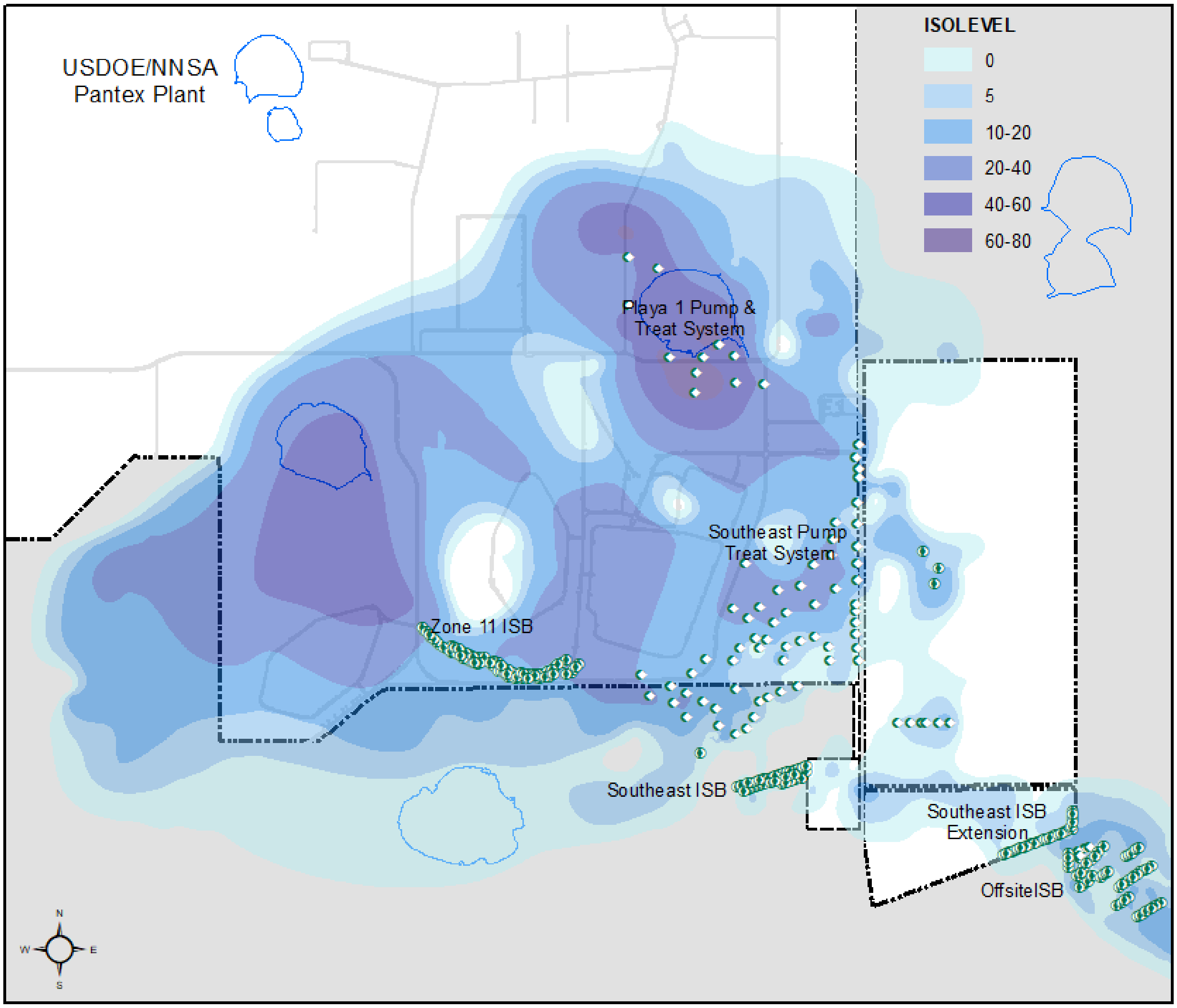

Fig. 2-16. Perched aquifer saturated thickness, 2023.

2.1.2.2.2 Operation of the Southeast ISB

No injection event occurred at the Southeast ISB during 2023. Further injections have not been planned for the immediate future as data indicate that reducing conditions are present in the ISB treatment area and there is still food source available.

2.1.2.3 Southeast ISB Extension

2.1.2.3.1 History of the Southeast ISB Extension

The Southeast ISB Extension system is on USDOE/NNSA property, southeast of the main plant, along the southeast fence line east of FM 2373. The system consists of 31 injection wells, 2 TZM wells, and 2 downgradient ISPM wells installed in a zone of saturated thickness of less than 12 ft throughout the system. The system is detailed in Section 1.4.2.

Similar to the Southeast ISB, this ISB extension will also be affected by the upgradient removal of water from the SEPTS. Water levels are anticipated to decline in this system over time, and future injections will be unnecessary. Currently, injections are budgeted every twelve months since this system has only been injected with a more soluble carbon source (i.e., molasses).

2.1.2.3.2 Operation of the Southeast ISB Extension

Injection and rehabilitation occurred at the Southeast ISB Extension in 2023. Twenty-seven wells were maintained during August to September. PTX06-ISB301 through PTX06-ISB304 were removed from injection as monitoring data indicate there is no longer a plume moving through that area of the ISB. If plume changes occur, those wells will be used for injection as needed. Maintenance was performed in three steps:

1. An initial round of mechanical rehabilitation was conducted to remove gross deposits from the well and enhance the effectiveness of subsequent chemical rehabilitation. Mechanical rehabilitation consisted of an initial evaluation of the well followed by brushing, surging, and bailing of the well to loosen and remove deposits from the well screen and filter pack. Bailing occurred until improvements were observed in solids content and clarity of the evacuated fluids, or the well was bailed dry.
2. Chemical rehabilitation involved the application of the Cotey Chemical Corporation Welgicide Cleaner (Welgicide), which consists primarily of sodium hydroxide (a strong base), with the well surged following application of the Welgicide. The purpose of chemical rehabilitation was to dissolve and remove mineral scale and/or biomass on the well screen and in the filter pack. After the Welgicide solution was allowed to react in the well for at least 24 hours, the solution was purged from the well.

3. A second round of mechanical rehabilitation was conducted using a combination of surging, brushing, and bailing. Development was considered complete when extracted water color improved and free of suspended solids, pH was below 9 SU.

After well maintenance, constant-rate injection tests were performed to calculate transmissivity and specific capacity values for each well. The objective of hydraulic testing was to evaluate well performance compared to historical testing results. Although transmissivity is decreasing at the wells over time, overall transmissivity is good across the well field, indicating that system injection will continue to be effective.

The 2023 injection occurred from September to October 2023, with 27 wells injected. Injection activities consisted of the injection of makeup water mixed with amendment, followed by a clean water flush. The amendment injection averaged about 2.3% pure molasses by volume and a total of about 1,298,000 gallons of amendment solution. The wells were then flushed with clean water with about 5% of the total volume injected into each well.

Target injection volumes and dosing were exceeded at all wells during the 2023 injection event. Approximately 105% of planned injection volume and 2.3% pure molasses was achieved during this event.

2.1.2.4 Offsite ISB Extension

2.1.2.4.1 History of the Offsite ISB

The Offsite ISB is located to the southeast of Pantex property, south of Highway 60. This system currently consists of 19 active ISB injection wells and 11 extraction wells. The Offsite ISB injection consists of two injection areas: North and South. The system is detailed in Section 1.4.2.

The system operation was determined using fate and transport modeling with an optimization approach to minimize the amount of infrastructure and injections needed to complete cleanup within a 25-year timeframe. System wells will be injected as needed, with injections occurring twice each year for 15 years and monitoring of the system performance for the remaining 10 years. Molasses is planned for injections at this system.

2.1.2.4.2 Operation of the Offsite ISB

Injection occurred at this system for the first time in 2021, with only the wells at the leading edge of the plume being injected. System installation continued through 2023, with new wells injected the following year after installation. By the end of 2023, the system included

56 injection wells (which includes one converted monitor well), 44 ISB extraction wells, 6 TZM wells and one downgradient ISPM well. Other monitor wells occur within the system and may eventually be converted to TZM wells as injections continue.

Because this system must derive all water from the site, ISB extraction wells are used to withdraw water and use for injection. However, due to limited saturated thickness, withdrawal of water is slow and injection rates exceed withdrawal rates. Additionally, challenges associated with new infrastructure required a conservative approach to ensure that spills would be avoided.

Injection and rehabilitation occurred at the Offsite ISB twice during 2023. During the spring event, 20 ISB wells (PTX06-ISB401 – PTX06-ISB419 and PTX06-ISB462) underwent maintenance from February to April. During the fall event, 32 ISB wells underwent maintenance from September to November. Maintenance is not performed at new wells because no injection has occurred since installation and development. Wells were first maintained to improve injection well performance and mitigate the effects of biofouling so that the wells are suitable for amendment injection. Maintenance was performed in three steps:

1. An initial round of mechanical rehabilitation was conducted to remove gross deposits from the well and enhance the effectiveness of subsequent chemical rehabilitation. Mechanical rehabilitation consisted of an initial evaluation of the well followed by brushing, surging, and bailing of the well to loosen and remove deposits from the well screen and filter pack. Bailing occurred until improvements were observed in solids content and clarity of the evacuated fluids, 30 gallons (approximately three well casings) was removed, or the well was bailed dry.
2. Chemical rehabilitation involved application of the Cotey Chemical Corporation Welgicide Cleaner (Welgicide), which consists primarily of sodium hydroxide (a strong base). The purpose of chemical rehabilitation was to dissolve and remove mineral scale and/or biomass on the well screen and in the filter pack. After the Welgicide solution was allowed to react in the well for at least 24 hours, the solution was purged from the well.
3. A second round of mechanical rehabilitation was conducted using a combination of surging, brushing, and bailing. Development was considered complete when extracted water color improved and free of suspended solids, and pH was below 9 SU.

After well maintenance, constant-rate injection tests were performed to calculate transmissivity and specific capacity values for each well. The objective of hydraulic testing was to evaluate well performance compared to historical testing results. Well maintenance declined after each injection event, but the overall transmissivity is good across the well field, indicating that system injection will continue to be effective.

Injection occurred twice during 2023, from March to August and November through December. Due to the lower saturated thickness in the offsite area, extraction rates are low and injection rates exceed extraction rates. Therefore, longer injection periods occur if any of the extraction wells are not available due to delays in infrastructure completion or required repairs. Concentrations in extraction wells are also considered before injection to ensure that water from a higher concentration area is not injected into an area of low concentration. These considerations continued to impact the Offsite ISB during 2023. Once the entire system is operational, fewer issues, other than repairs, are anticipated.

For the first injection, 32 wells were injected including PTX06-ISB401 through PTX06-ISB416, PTX06-ISB425 through PTX06-ISB432, PTX06-ISB437 through PTX06-ISB440, and PTX06-ISB453 through PTX06-ISB456. Injection activities consisted of the injection of makeup water mixed with amendment followed by a clean water flush. A total of 2,030,757 gallons of amendment solution was injected during the first injection event. About 111,478 gallons of flush water was then injected across the wells. Target dosing was 2.0% molasses by volume, with that amount or slightly higher achieved in all wells. Target volumes of mixed amendment and water were achieved or exceeded across the system, except for three wells.

During the second injection event, 18 wells were injected, including PTX06-ISB401 through PTX06-ISB416 and PTX06-ISB438 and PTX06-ISB440. An abbreviated injection was required due to loss of power in portions of the system while infrastructure completion continued, equipment conflicts with other injection events, and the onset of winter conditions. This injection event focused on the leading edge of the plume and the central portion of the system where concentrations of RDX are the highest. A total of about 812,708 gallons of amendment solution was injected into 18 injection wells. About 77,500 gallons of flush water was then injected across the wells. Target dosing was 2% molasses by volume. Target dosing was met or exceeded at all wells. Wells in the northern part of the system were affected by winter conditions and target volumes were not met at those wells.

2.2 Soil Remedial Actions

Soil remedial actions at Pantex include the Burning Ground SVE system, landfill covers, ditch liners, and institutional controls (see Section 1.3). The O&M of the soil remedies is discussed in these sections.

2.2.1 Burning Ground SVE

A description of the Burning Ground SVE is included in Section 1.3.1.

Fig. 2-17 depicts the SVE system operation for 2023. After system repairs, the system operated from September through October before the system failed. Overall, the system operated approximately 15% of the year. Fig. 2-17 depicts the system operation for 2023.

Calculated mass removal for 2023 is presented in Fig. 2-18. Mass removal was estimated based on concentrations reported from analytical sampling, system operation time, and system flow rates. VOC constituents contributing to the majority of the total VOC concentration were included in the calculation. The system removed approximately 47 lbs of VOCs during 2023, and since its inception the SVE system has removed about 21,378 lbs of VOCs. Trends of removal rates, concentrations, and general effectiveness of the SVE are provided in Section 4.

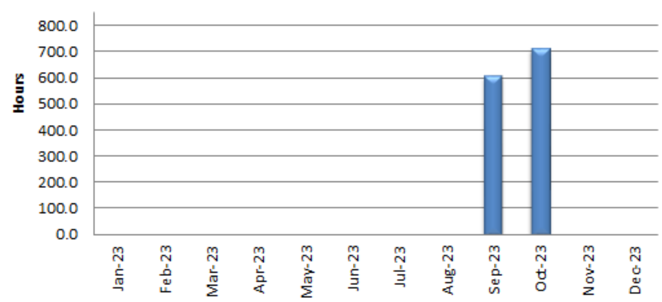

Fig. 2-17. SVE System operation.

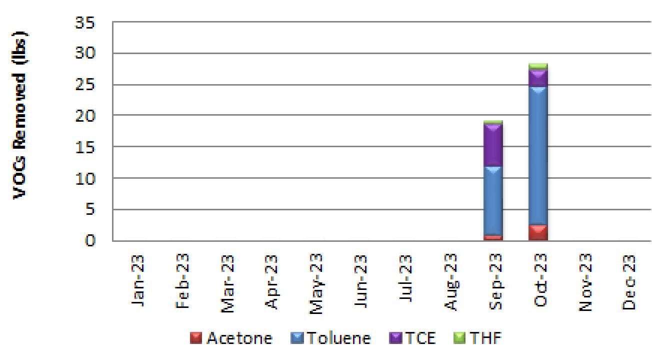

Fig. 2-18. Burning Ground SVE mass removal.

Since system modifications were completed in May 2017, the influent flow rate was increased from 32 scfm to approximately 44 scfm before the end of 2017. The 44-scfm flow rate has been generally maintained since late 2017. Flow rates increased from 13% to 24% from 2017's first quarter baseline, causing a rise in mass removal as well. However, data collected from 2018 to 2023 indicate that, although flow rate remained steady, mass removal rates declined due to lower influent concentrations.

As documented in the monthly air quality monitoring reports to the regional TCEQ office, all 2023 effluent photoionization detector (PID) readings for the system indicate that destruction efficiency was greater than 90%. The first two readings from the system were lower than expected due to the continuing decline in source at the system. All other destruction efficiency readings were greater than 98%.

2.2.2 Engineered and Institutional Controls

The soil remedial actions at Pantex are discussed in Section 1. The SVE system and containment of landfills and ditch soils are the only active soil remedies at this time; however, other soil remedies require long-term stewardship to maintain controls. Pantex drafted all deed restrictions required as an institutional control and as part of the final remedy during 2009 and submitted them to TCEQ and EPA as part of the draft final IRAR. Those deed restrictions were filed in 2010 in conjunction with the approval of the final IRAR (Pantex, 2010a). All remedial action units at Pantex are restricted to industrial use and groundwater deed restrictions are required in affected areas of perched groundwater. To support the deed restrictions, Pantex maintains long-term control of any type of soil disturbance in the SWMUs to protect human health and prevent spread of contaminated soils.

Pantex also regularly inspects and maintains soil covers on landfills to prevent infiltration of water into the contents of the landfills and any resulting migration of impacted water toward groundwater. In 2023, Pantex conducted landfill inspections in accordance with the updated *Maintenance Plan for Landfill Covers* (Pantex, 2017b). Pantex installed, inspects, and maintains a fence around FS-5 to control access and use of an area that is impacted by depleted uranium.

Additionally, Pantex installed a synthetic liner along a ditch system in Zone 12 where investigations indicate that the ditches continue to act as a source to perched groundwater. Installation of the ditch liner minimizes migration of contaminants because it prevents rainwater from infiltrating into soils. Inspections for the ditch liners were conducted in accordance with the recently updated *Maintenance Plan for SWMUs 2 and 5-05 Ditch Liner* (Pantex, 2017c). Inspections were also conducted for SWMU signs and postings at various times during 2023.

Maintenance is either contracted, as necessary, or work orders are placed with the onsite maintenance department. Findings from the inspections of landfills and ditch liners and maintenance actions are provided below.

2.2.2.1 Landfill Inspection and Maintenance

Many of the findings at the landfills are related to wildlife activities that disturb soils in the landfill covers. It is expected that Pantex will have ongoing activities at many of the landfills due to holes/voids from wildlife. Additionally, the landfills can be affected by heavy rainfall and drought conditions that frequently occur in the Texas Panhandle. Areas that become eroded from heavy rainfall can be impacted by loss of vegetation that can be worsened by drought conditions.

In the past, these smaller issues were addressed using Pantex maintenance personnel and equipment. However, to ensure consistent comprehensive support with the landfill covers, Pantex has contracted for long-term maintenance of the landfills. The landfills will be inspected each year and then maintenance will be contracted or assigned to onsite maintenance based on the evaluation. Larger issues are planned, budgeted, and contracted separately for design and construction. Each contracting effort is followed up with inspections to evaluate the effectiveness of the actions. Pantex continues to use onsite personnel for maintenance, as needed.

Key findings and maintenance actions completed from past soil inspections, including those completed in 2023, are included in Table 2-2. The results of the landfill site inspections from the *Third Five-Year Review* (HGL and Pantex, 2023) are also included.

Table 2-2. Key Findings and Corrective Actions for Landfill SWMUs

Findings	Corrective Actions
Previous Findings	
Burning Ground Former Ash Disposal Trench liner is exposed	Extra soil cover was placed over the line in August 2023.
Landfill 1 (SWMU 68b) sand missing from portions of the Closure Turf cover	Sand covering on Closure Turf liner is heavily eroded and requires replacement to avoid ultraviolet (UV) damage to the liner. Sand replacement was completed in 2023.

Findings	Corrective Actions
Landfill 2 (SWMU 38) sand missing from portions of the Closure Turf cover	Sand covering on Closure Turf liner is eroded and requires replacement to avoid UV damage to the liner. Sand replacement was completed in 2023.
Landfill 3 (SWMU 54) geocell is exposed along edges of the landfill	A work order was submitted in 2023 for additional soil and reseeding of the area.
SVS 7a prairie dog control, holes in four landfills and denuded areas	Prairie dogs have invaded newly covered landfills. Filling and seeding will be completed by onsite maintenance group. Prairie dog control and fill material was completed.
SVS 5 large and small holes in cover	Large and small holes that require fill material. Work was completed in 2023.
SVS 6 large and small holes and lack of vegetation in some areas	Large and small holes that require fill material and reseeding of areas without vegetation. This is a low priority landfill and filling of holes and reseeding will be completed by onsite maintenance group as time and resources allow. Work order has been submitted to complete this work.
New 2023 Findings	
Landfill 5 (SWMU 56) multiple holes in cover	This is a low priority landfill. A work order has been submitted to address the holes and to reseed the areas.
Landfill 10 (SWMU 61) replace SWMU signs	This is a low priority landfill and will be addressed as time and resources are available.
SVS 7b has prairie dog holes in two of the landfill covers	This is a low priority landfill and will be addressed as time and resources are available. Work will be contracted to be completed.
SVS 6 has small holes scattered through the landfills and vegetative cover will need to be improved in one area	This is a low priority landfill and will be addressed as time and resources are available. A work order has been submitted to address these findings.

SVS – supplemental verification site

Based on previous findings, Pantex will have to continue to prioritize landfill cover maintenance based on available funding. Some of the older construction debris landfills are given lower priorities than other landfills that had new additional cover placed at the end of the investigations, given their content. Pantex will always prioritize the following landfills for maintenance of the cover:

- Landfill 1 (SWMU 68b).
- Landfill 2 (SWMU 68c).
- Landfill 3 (SWMU 54).
- Landfill 12 (SWMU 63).

- Landfill 13 (SWMU 64).
- Burning Ground Landfills (SWMUs 37-44).
- Burning Ground Ash Disposal Trench.
- FS-5 facility cover located inside the berm (SWMU 70).

Other landfills will be addressed over time by a combination of available contract funding and onsite maintenance. Due to the settling caused by burrowing animal activity at some of these landfills, extensive maintenance is required and is typically covered by a combination of contracting and onsite maintenance support. This approach has been used to manage some of the larger areas to be filled and reseeded.

Pantex will continue to evaluate the landfills annually and report findings and plans developed to address holes, depressions, or bare areas. Problems identified will be addressed through the landfill cover maintenance contracts or limited onsite maintenance. The active landfill area at Pantex is continually maintained by the Waste Operations Department, and old landfills (i.e., SVS 8 and SWMU 68d) in that area continue to be addressed by onsite Waste Operations personnel.

2.2.2.2 Ditch Liner Inspection

Pantex installed a new liner over the old one, with construction completed in March 2017. As discussed above in Section 2.2.2, a new maintenance plan was developed for the new liner.

An inspection conducted in 2021 and 2022 at SWMUs 2 and 5/05 ditch liner indicated tears were present in the liner, and sedimentation and erosion of the anchor trench continue to be an issue. After issuing a contract for repairs, work commenced in May 2023 and was complete in July.

2.2.2.3 Review of Soil Disturbance

Pantex also conducts reviews of projects (referred to as SWMU interference) that will disturb SWMU soils. Project plans or work requests for repairs were reviewed to ensure that workers used necessary protective equipment and that soils were managed appropriately during the execution of work. Older listed projects from the completed project areas were verified after the completion of work to ensure that all soils were returned to the excavation or kept within the contamination extent. Long-term projects are reviewed periodically to ensure that contractors are adhering to SWMU interference permit requirements.

Table 2-3 provides information on projects that were not complete by this annual report as well as new SWMU interference projects from 2023. Three new projects were approved during 2023. Other projects are ongoing.

Table 2-3. SWMU Interference Log

SIN#	State Approval Date	SWMU #	Explanation of Work
Previous SWMU Interference Notifications (SINs)			
SIN18-001	2/27/2018	SWMU 5-09; 148	Lightning-protection system testing and upgrades at 11-17, 11-17A, 11-25. Status: Active
SIN18-003	2/27/2018	WMG 6/7; SWMU 1	Lightning-protection system testing and upgrades at 12-62 and 12-62 Berm (Berm in 12/18). Status: Active
SIN19-001	4/2/2019	WMG 13	Burning Ground lightning-protection system upgrades. Status: Active
SIN19-003	6/20/2019	SVS 7b	Clearing ditches around 16-24 Range Complex. Status: Active. Needed for extended period of time.
SIN19-005	10/22/2019	WMG 5/ SWMU 68a	Zone 12 South paving - South of 12-R-79. Status: Active
SIN20-001	1/22/2020	Zone 10 Extents	Zone 10 Lot 3 Electrical equipment installation. Status: Active
SIN20-002	2/26/2020	SWMU 97 & Extents	Building 12-34 SS demolition. Status: Complete
SIN20-003	6/30/2020	WMG 4, SWMU 87	Building 11-20 SS demolition. Status: Active
SIN20-004	7/27/2020	WMG 6/7 extents	Building 12-26E chiller replacement. Status: Complete
SIN21-002	3/9/2021	SWMU 4	11-50 KRONOS Installation. Status: Active
SIN21-004	4/7/2021	SWMU 5-15a	Zone 11 ISB Snow Fence Removal. Status: Active
SIN22-001	12/20/2022	SWMU 14	HESE Early Works West of 11-050. Status: Active
SIN22-002	2/13/2023	SWMU 149, SVS 2, and SWMU 60	HESE communication Line North of 11-026 Status: Active
SIN22-003	2/13/2023	SWMU 57 and 5-06	12-084 Generator Replacement. Status: Complete
2023 SWMU Interference Notifications			
SIN23-001	2/17/2023	SWMU 57 and 5-06	12-085HPFL Upgrades Status: Complete

SIN#	State Approval Date	SWMU #	Explanation of Work
SIN23-002		SWMU 1	12-63 Demolition Status: in preparation
SIN23-003		SWMU 1	12-17F1 Water Leak Status: Prepared, being sent for approval

SIN – SWMU Interference Notification

WMG – Waste Management Group

2.3 Long-Term Monitoring Well Network

2.3.1 Well Maintenance

As recommended in the *First Five-Year Review* (Pantex, 2013d), the *Well Maintenance Plan* (Pantex, 2013b) was completed in October 2013 and implemented in January 2014. This plan formalized the well-surveillance and inspection process already in place and incorporated analytical and empirical data collected over time to develop a well-maintenance schedule. The list of wells is updated yearly to add or remove wells and the plan underwent a comprehensive update in 2020 (Pantex, 2020) to change the frequency of maintenance where needed.

The plan completes the following significant tasks:

- Assigns an inspection and maintenance frequency of three years to all active Ogallala Aquifer monitoring wells, as recommended in the *Ogallala Aquifer Sampling Improvement Plan* (Pantex, 2013a).
- Assigns a maintenance frequency of three years for all wells with stainless-steel screens that have documented well corrosion and elevated chromium concentrations.
- Assigns a default inspection frequency of five years for all perched aquifer LTM wells to comply with requirements for total depth measurement in the Compliance Plan.

Additional program activities, such as redevelopment, down-hole videos, pump and tubing bundle replacements, vegetation control, and other associated tasks are completed when requested by the groundwater media scientist or identified by field technicians. Water levels are measured at each sampling event and twice annually while total well depths are only measured when dedicated equipment is not present in the well.

The 2023 maintenance log for groundwater wells is included in Appendix C, which contains all entries for well inspections, redevelopment of wells, changes in sample intake depths, and Bennett pump servicing at the wells. The log also contains the water depths and total well depths measured at wells when equipment was removed as well as the disposition of the purge water from well activities.

Through well videos, Pantex has identified evidence of bacteria in many of the stainless-steel wells. This condition is common in monitoring wells, especially those with lower groundwater flux. This is occurring in both newly installed wells and older wells in both the perched aquifer and Ogallala Aquifer, although the perched wells experience greater problems. The bacteria may be the source of stainless steel corrosion indicators (i.e., chromium, manganese, molybdenum, and nickel) that become elevated in wells; well videos recorded during routine well inspections indicate that a large percentage of stainless steel wells have some biofouling.

Pantex continues to evaluate rehabilitation methods for biofouling and in 2018 developed plans to evaluate a chemical rehabilitation program that addresses growth that has completely blocked portions of the screens in certain wells. A study was completed in 2020 on two parked wells that are not part of the active LTM network to evaluate the biofouling's impacts on water quality as well as the ability to effectively manage it. New perched wells are now installed with polyvinyl chloride (PVC) materials, rather than stainless steel, to avoid corrosion issues associated with the well materials; however, pumps still consist of stainless steel that is subject to corrosion.

When screens were found to be impacted by biofouling, calcium deposits, or sedimentation; or when elevated chromium levels were observed, Pantex redeveloped the wells by brushing, bailing, and pumping, as necessary. Based on well videos and total depth measurements, some wells were observed to have sediment in the sump, with a few having sediment built up into the bottom of the screen. However, no LTM wells had more than 20% of the saturated screen silted in, so Pantex will continue to monitor and sample the wells.

Pantex performed the following well-maintenance activities in 2023:

- One hundred and six well videos to evaluate the wells' installation or condition and determine if re-development or other maintenance was required. The effectiveness of rehabilitation was also confirmed through well videos.

- Pump service (i.e., removal and installation of the pump and tubing bundles) at 38 locations to prepare for well videos, re-development, special sampling, change-outs of pump and tubing bundle, lengthening of sampling depths, and/or the replacement of pumps.
- Extraction well service at 8 wells to support repair and maintenance of pump and treat extraction wells.
- Miscellaneous maintenance including adding drop tubes to pumps and collection of total depth.

2.3.2 Well Casing Elevations

In accordance with HW-50284, Pantex periodically surveys the top of casing elevations at the monitoring wells. This work must be performed every 10 years, at a minimum, for wells included in the monitoring network. To evaluate water levels, Pantex also maintains wells not included in the monitoring network, which are surveyed to ensure that the water table maps developed from water-level readings are correct.

Pantex re-surveyed all LTM wells and wells used for water-table mapping in 2020 using a real-time kinetic Global Positioning System (GPS) that is calibrated to the National Geodetic Survey. This system will be consistently used to re-survey wells in the future. The next survey is due in 2030.

The surveyed elevations for new wells are included in Table 2-4. Re-survey of wells was not completed in 2023.

Table 2-4. Well Elevations Collected in 2023

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
PTX06-1217	650101.19	3749645.37	3508.60	3510.75
PTX06-1220	650367.11	3750258.95	3510.03	3512.08
PTX06-1222	651163.21	3750136.29	3510.29	3512.25
PTX06-1223	642669.67	3753673.34	3530.02	3532.16
PTX06-1224	644065.72	3754118.10	3529.07	3531.13
PTX06-1229	642725.64	3754642.57	3532.13	3534.25
PTX06-ISB420	650162.600	3749414.180	3508.24	3510.37
PTX06-ISB421	650236.940	3749456.450	3508.49	3510.62
PTX06-ISB422	650315.410	3749501.380	3508.97	3511.04
PTX06-ISB423	650394.760	3749548.270	3509.71	3511.81
PTX06-ISB424	650493.880	3749634.530	3509.30	3511.37
PTX06-ISB433	650864.320	3750286.730	3510.80	3512.85
PTX06-ISB434	650951.710	3750341.340	3511.15	3513.30
PTX06-ISB435	651040.070	3750397.410	3511.01	3513.12
PTX06-ISB441	650437.340	3750638.450	3511.07	3513.17
PTX06-ISB442	650497.810	3750684.050	3511.42	3513.53
PTX06-ISB443	650553.740	3750724.760	3511.50	3513.64
PTX06-ISB444	650619.070	3750772.620	3511.91	3514.03
PTX06-ISB445	650677.260	3750818.520	3511.77	3513.88
PTX06-ISB446	650737.830	3750863.500	3511.85	3514.00
PTX06-ISB447	649286.700	3749862.880	3510.04	3512.10
PTX06-ISB448	649347.710	3749917.940	3510.11	3512.13
PTX06-ISB449	649407.570	3749973.280	3510.18	3512.20
PTX06-ISB450	649467.660	3750028.130	3509.66	3511.79
PTX06-ISB451	649528.050	3750083.490	3510.55	3512.60
PTX06-ISB452	649586.870	3750138.630	3510.53	3512.58
PTX06-ISB607	639890.400	3753175.990	3531.81	3533.86
PTX06-MINJ402A	649844.320	3749339.380	3507.68	3509.76
PTX06-MINJ403	649514.670	3749634.990	3509.17	3511.23
PTX06-REC412	650437.730	3749213.320	3508.44	3510.58
PTX06-REC413	650512.910	3749262.620	3508.62	3510.71
PTX06-REC414	650587.710	3749313.760	3509.13	3511.20
PTX06-REC415	650662.990	3749363.570	3508.68	3510.75
PTX06-REC423	651187.960	3749762.930	3509.75	3511.89
PTX06-REC427	649712.760	3749688.430	3509.30	3511.39
PTX06-REC428	649777.580	3749742.500	3508.92	3510.94
PTX06-REC429	649843.530	3749798.740	3509.41	3511.59
PTX06-REC430	649907.330	3749854.100	3509.76	3511.84
PTX06-REC431	649973.390	3749909.970	3509.72	3511.71
PTX06-REC432	650037.950	3749964.070	3509.93	3512.07
PTX06-REC437	650617.990	3750517.920	3511.46	3513.49
PTX06-REC438	650681.260	3750569.550	3511.17	3513.21
PTX06-REC439	650749.770	3750626.270	3511.59	3513.72
PTX06-REC440	650818.950	3750684.180	3511.73	3513.88

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
PTX06-REC441	650887.460	3750738.620	3511.77	3513.97

Northings and Eastings are Texas State Plane

amsl – above mean sea level TOC - top of casing

2.3.3 Water-Level Elevations and Total Depths

In accordance with requirements in Provision XI.F.3.d and CP Table VII of the HW-50284, Pantex must measure water-level elevations at each well during each sampling event and total well depths when dedicated pumps are removed or when the well is sampled if no dedicated pump is installed. Pantex also measures water levels at all wells twice per year to provide consistent measurements to map the water table. Water-level measurements are also taken during any well-maintenance activities. The measurements and corresponding water elevations and total depth measurements are included in Appendix C.

2.4 Management of Recovered/Purged Groundwater

In 2023, all purged, contaminated groundwater found to exceed the GWPS during sampling events and maintenance activities was containerized. Then, the volume of water was logged and treated through the SEPTS in accordance with Provision XI.B.8 of HW-50284, with one exception. Purge water from all ISB system wells was containerized and disposed of by the Plant's Waste Operations Department since the water was characteristically hazardous or contained contaminants that were not treatable by the pump and treat systems.

Most Ogallala Aquifer wells are unaffected and not required to be managed or their volumes tabulated, so the water is released to nearby ditches. Because Ogallala wells PTX06-1056, PTX06-1223, PTX06-1076 and PTX06-1229 had detections of HEs and one VOC at PTX06-1056 in 2023, Pantex containerized the purge water from sampling events and then logged and treated it through the SEPTS.

In accordance with Provision XI.B.8 of HW-50284, all recovered perched groundwater from the extraction wells is treated through the P1PTS or SEPTS. Treated water from the P1PTS is sent through subsurface lines to the WWTF's storage lagoon or through subsurface lines to the pivot irrigation lagoon. Treated water from the SEPTS is sent through subsurface lines to three ISB systems (Zone 11, Southeast, Southeast Extension) for use in injecting amendment, WWTF storage lagoon, pivot irrigation lagoon, or onsite perched injection wells. Lagoon water is sent through the WWTF filter building and subsequently released to the subsurface irrigation system, when operating, or the water is released to Playa 1.

Pantex has been authorized by permit (TLAP #0004397000, issued August 2020) to release treated wastewater for the irrigation of crops. Provisions were added in the permit, which allow treated water obtained directly from the SEPTS or P1PTS to be used in other ways, such as for construction projects, so long as the treated water meets the GWPS and criteria specified by the State of Texas. Pantex constructed a bulk water station at the SEPTS to deliver treated water for beneficial use at Pantex. Pantex set up procedures and record-keeping for this station, which became operational in July 2016.

A break at the irrigation system's filter bank caused all of the water from the WWTF to be routed to Playa 1 via Outfall 001 after June 2017, in accordance with TCEQ Permit #WQ00002296000. Repairs have been made, but, Pantex began repairing/upgrading the WWTF lagoons in 2022, and work is ongoing. During that time, it is difficult to release water to the subsurface irrigation system, so water is released to Playa 1. Pantex completed the installation of the new center pivot surface irrigation system in 2023. Since that time, water has been managed through the pivot system unless repairs were required. All treated water from the SEPTS was either injected back into the perched groundwater, released to Playa 1 via the WWTF, or beneficially used for ISB injection or well drilling until the pivot system was available for use. P1PTS treated water was released to Playa 1 via the WWTF until the pivot system was available in September.

As authorized by the Underground Injection Control, Authorization No. 5X2600215, Pantex injects treated water into select wells. Portions of the SEPTS treated water are injected through injection well PTX06-INJ-10, PTX06-INJ-13, PTX06-INJ-14, and PTX06-INJ-15 when needed. Some of the SEPTS treated water is also used for ISB amendment injections. Treated water is mixed with the amendment and injected into the treatment zone. The volumes of treated water injected, sent to the WWTF, or sent to the ISB system are provided in Section 2.1.

3.0 Groundwater Remedial Action Effectiveness

In this section, the groundwater remedial action is evaluated for overall effectiveness during 2023 operations. This evaluation focuses on the following four aspects of monitoring associated with the remedy for perched groundwater:

1. Plume stability
2. Remedial action effectiveness
3. Uncertainty management and early detection
4. Natural attenuation

In addition, POC and POE wells are evaluated against the GWPS to determine compliance with HW-50284.

3.1 Plume Stability

Plume stability is evaluated through the examination of water level and concentration data. Water-level data are used to generate hydrographs and trends for individual wells and contour maps of water elevations. Data from dry wells (e.g., continuing dry conditions or influx of water) support this analysis.

Concentration data are used to perform concentration trend analyses. Concentration trend data are mapped for the four major COCs (RDX, TCE, hexavalent chromium, and perchlorate) to identify trends in their spatial distributions. The concentration data are used to generate plume maps for each COC. The maps and trends, together, form the basis for an evaluation of overall plume stability.

To satisfy the objectives of the LTM design, expected conditions and trends were developed for each LTM network well in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a). Therefore, a comparison of observed versus expected conditions is conducted as part of the evaluation process. Appendix E includes the LTM expected conditions and current conditions based on 2023 analytical and water-level data.

3.1.1 WATER LEVEL MAPPING

Groundwater beneath the plant and vicinity occurs in two stratigraphic horizons within the Ogallala Formation. The most significant quantities of groundwater in the vicinity of the plant are found in the Ogallala Aquifer system. Considerably less water occurs in the upper Ogallala Formation since perched groundwater overlies an FGZ.

Presented in this section are water table maps of the Ogallala Aquifer and the primary perched aquifer underlying the plant. Water-level measurements used to create these maps were collected primarily during December 2023 from Pantex Ogallala and perched aquifer monitor wells. These data were supplemented with recent water-level measurements in the Ogallala Aquifer, collected by the Panhandle Groundwater Conservation District.

Fig. 3-1 presents the Ogallala Aquifer water levels while Fig. 3-2, Fig. 3-3, and Fig. 3-4 presents perched aquifer water levels.

3.1.1.1 Ogallala Aquifer

As shown in Fig. 3-1, flow in the Ogallala Aquifer underlying the plant is to the northeast. The northeast hydraulic gradient results from agricultural pumping as well as from the City of Amarillo's well field to the north and from the Pantex water supply wells in the northeastern part of the USDOE/NNSA property. The Amarillo well field produces approximately 12.7 Mgal per day from the Ogallala Aquifer, based on the City of Amarillo's 2018 data. The hydraulic gradient in the Ogallala Aquifer underlying the northern part of the plant is approximately 0.007 foot per foot (ft/ft).

3.1.1.2 Perched Aquifer

As shown in Fig. 3-2, Fig. 3-3, and Fig. 3-4, perched groundwater occurs as a number of separate flow systems beneath the plant. Each of these flow systems is associated with an area of focused recharge, usually a playa lake.

The main perched aquifer is associated with natural recharge from Playas 1, 2, and 4; past treated wastewater discharge to Playa 1; and historical wastewater releases to the ditches draining Zones 11 and 12. Small areas of perched groundwater occur in the vicinity of Playa 3, the Old Sewage Treatment Plant (OSTP) area, and Zone 6. Because of the limited extent and saturated thickness of these separate areas, water table contours for these areas are omitted from the perched aquifer contour map. The extents of saturation for the main perched aquifer and perched groundwater beneath the OSTP area show that these two bodies of groundwater are separated by only a short distance. However, observed water levels in both areas indicate that hydraulic interaction between these two areas is limited, even if the extents of saturation overlap. Perched groundwater has also been observed beneath the southern side of Pantex Lake, located approximately 2.5 miles northeast of the USDOE/NNSA property boundary, but this body of groundwater is not hydraulically connected to the perched aquifer underlying the Pantex Plant.

Historically, groundwater in the perched aquifer tended to flow radially away from Playa 1, but extraction of perched groundwater beneath Playa 1 by the P1PTS has shifted the highest elevations of perched groundwater northeast of the playa. Flow to the north and directly east of Playa 1 is limited by the structure of the FGZ. Flow to the south and southwest has extended several miles from Playa 1 and has been enhanced by recharge through Playas 2 and 4. Additionally, the large area of contaminated groundwater in the southeast corner of the USDOE/NNSA property occurred as a result of historical discharges of treated and untreated process waters from Zone 12. Two perched groundwater pump and treatment systems are currently removing water and contaminants from the perched aquifer, thus limiting the further migration of contaminated groundwater to the east and south.

The horizontal hydraulic gradient of the perched aquifer varies spatially across the plant. The hydraulic gradient is 0.006 ft/ft near Playa 1, 0.003 ft/ft near Playa 2, 0.006 ft/ft downgradient of Zone 12, and 0.003 ft/ft south of Zone 11.

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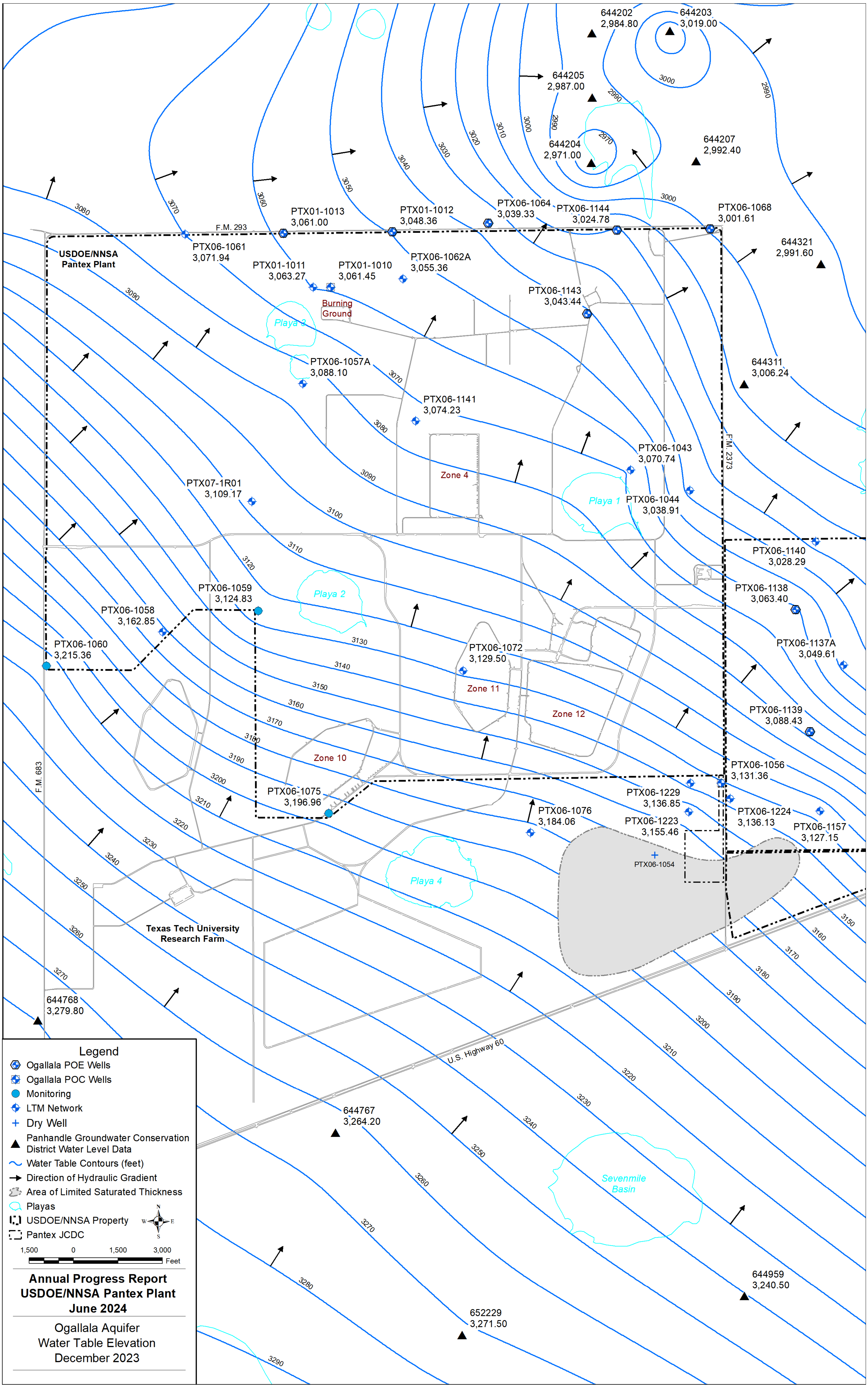

Fig. 3-1. Ogallala Aquifer water levels.

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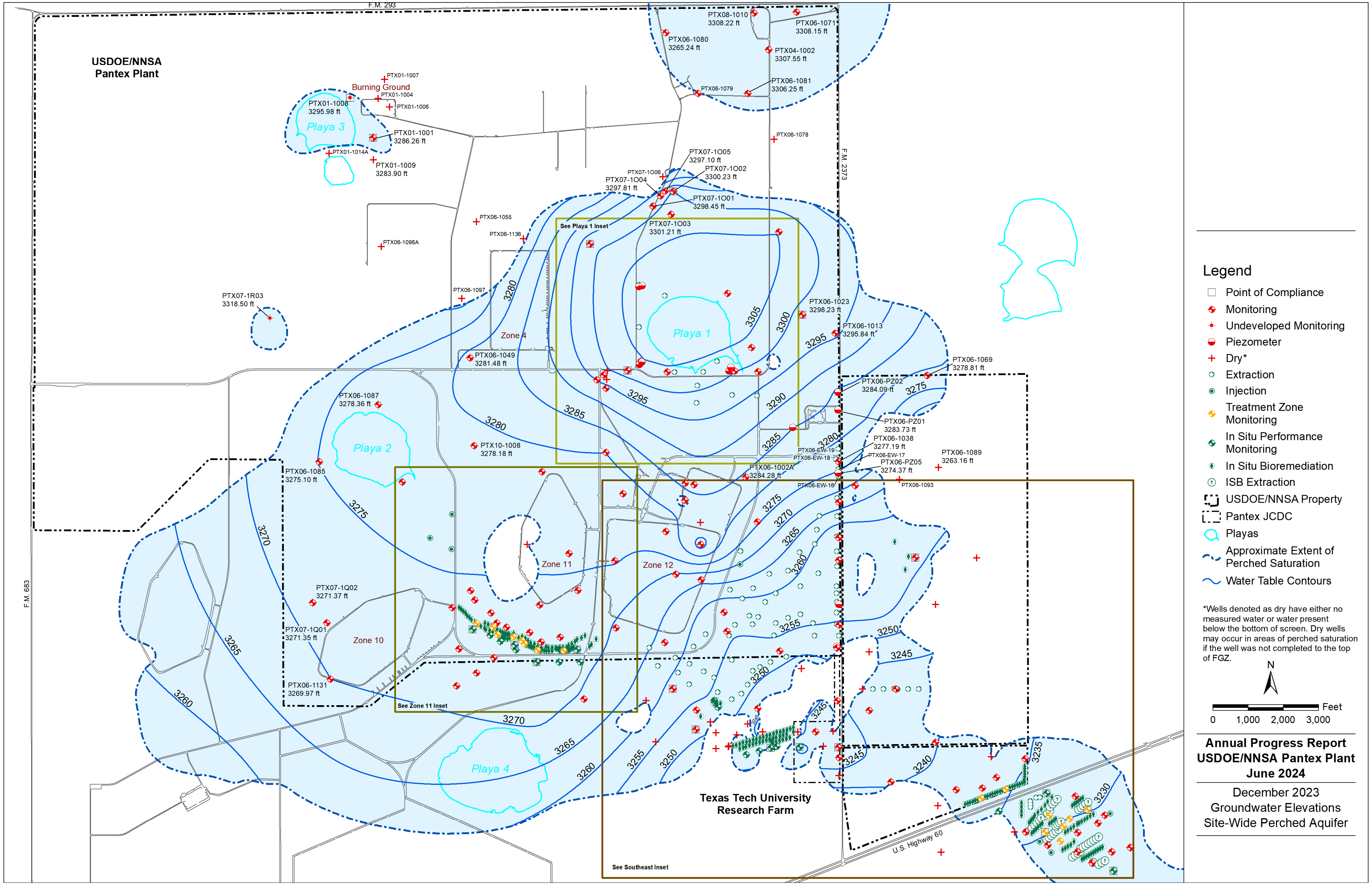

Fig. 3-2. Perched aquifer water levels.

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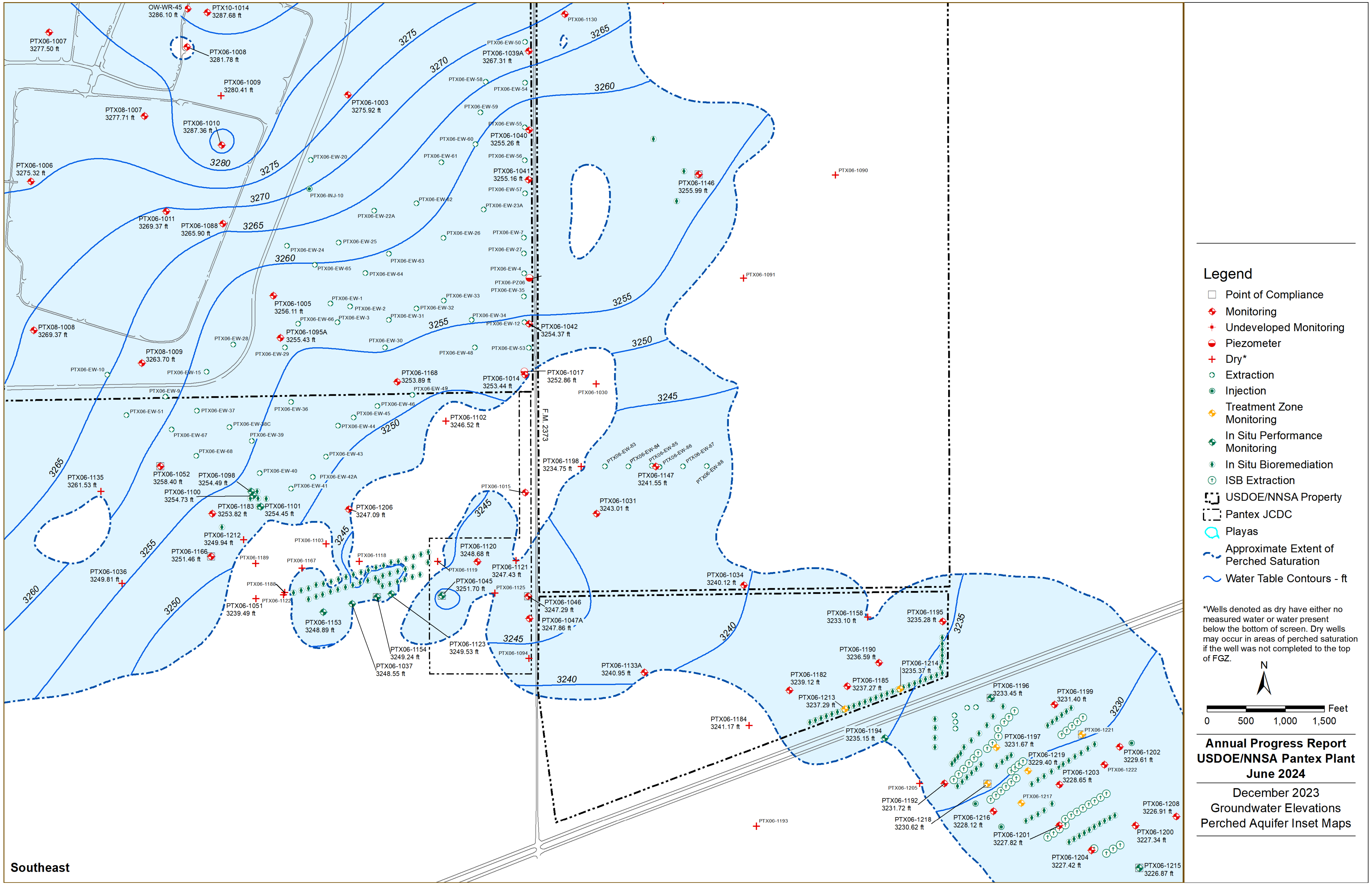

Fig. 3-3. Perched aquifer water levels, southeast inset map.

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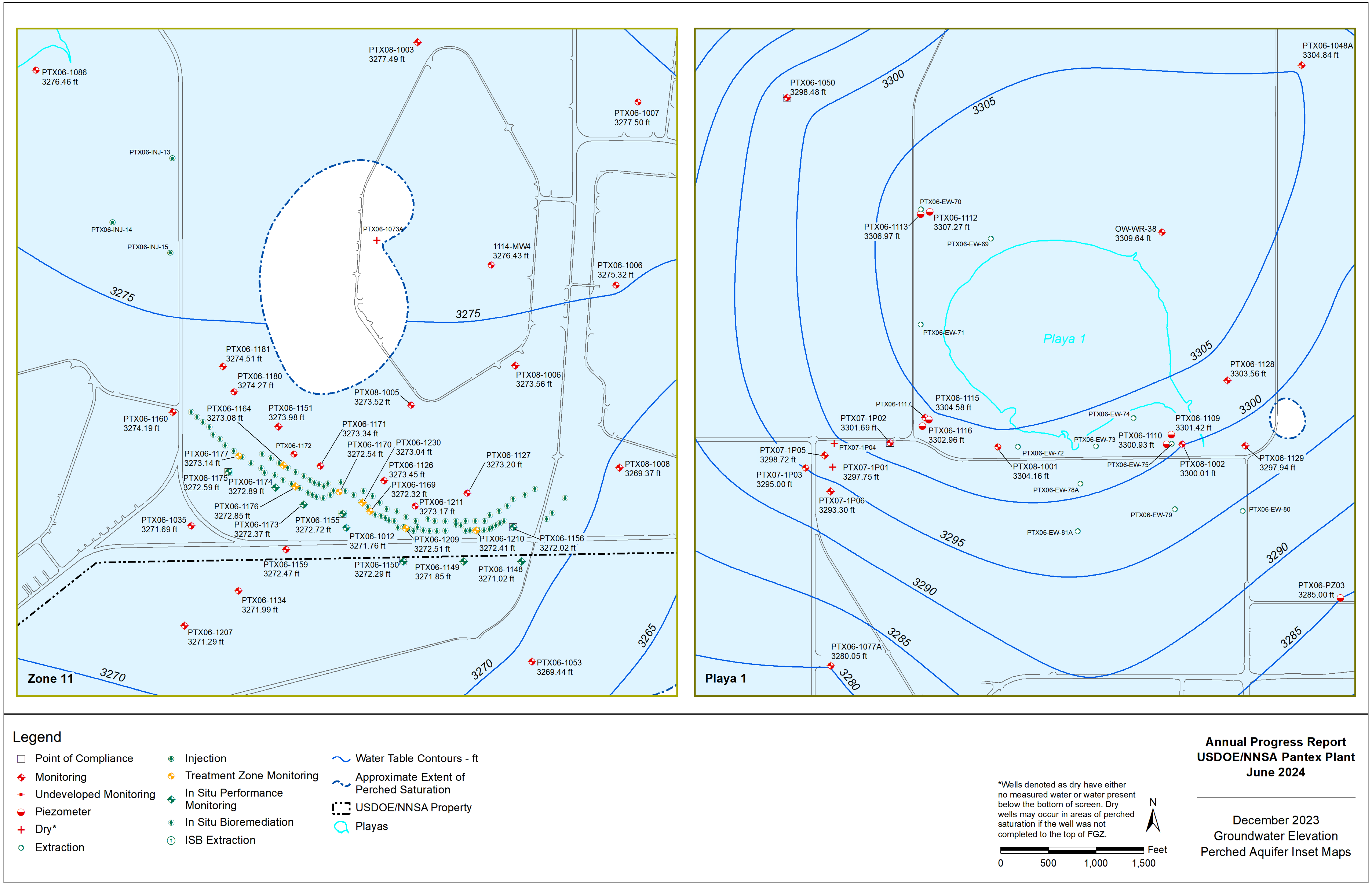

Fig. 3-4. Perched aquifer water levels, Zone 11 and Playa 1 inset maps.

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3.1.2 *Water Level Trending*

The Monitoring and Remediation Optimization System (MAROS) software linear regression methodology (AFCEE, 2007) outlined in the LTM Design Report was used to trend water levels at each well. Trends were calculated for the dataset of water levels collected since the start of remedial actions in 2009, in addition to the most recent two years of data at each well. The recent trends are expected to give more accurate measurements of the effectiveness of the two pump and treat systems since the P1PTS began operating in late 2008 and the SEPTS was operating near full capacity by April 2009. Long-term trends were also calculated using all data for a well, including measurements taken before the start of remedial action. These trends represent overall historical conditions of the perched aquifer and depict whether conditions are returning to baseline.

Figure 3-5 depicts the water-level trends in all LTM perched aquifer wells. Well hydrographs are included in Appendix F.

Trending results show positive effects of the remedial actions given that almost all wells currently recognized to be under the influence of the SEPTS and P1PTS have exhibited decreasing water-level trends in recent years, when systems are operational. Above-normal precipitation in May of 2023 filled the playas, resulting in increased water levels in several wells near Playa 1 and some ditches. Additionally, construction of a new center pivot system east of FM 2373 also impacted P1PTS operations. P1PTS was shut down for the majority of 2023 due to construction activities on the new irrigation system. Pantex finished installation of an irrigation alternative on the property east of FM 2373 in August 2023 that provides additional long-term use of the treatment system water. Installation of five irrigation pivots helps increase throughput for the pump and treat systems. The pivot system will be able to operate during warmer months (primarily March – November), decreasing water released to Playa 1.

The subsurface drip irrigation system was not utilized during 2023. Operation of the subsurface system is, and will continue to be, hindered by lowered lagoon storage capacity due to ongoing construction of repairs to the Plant WWTF storage lagoons. During periods the drip irrigation system is unavailable, Pantex continues to release WWTF water to Playa 1 as approved in the Texas Commission on Environmental Quality wastewater permit. However, the permit restricts the amount of water that can be released to the playa, so pump and treat throughput is reduced if other outlets are not available for use.

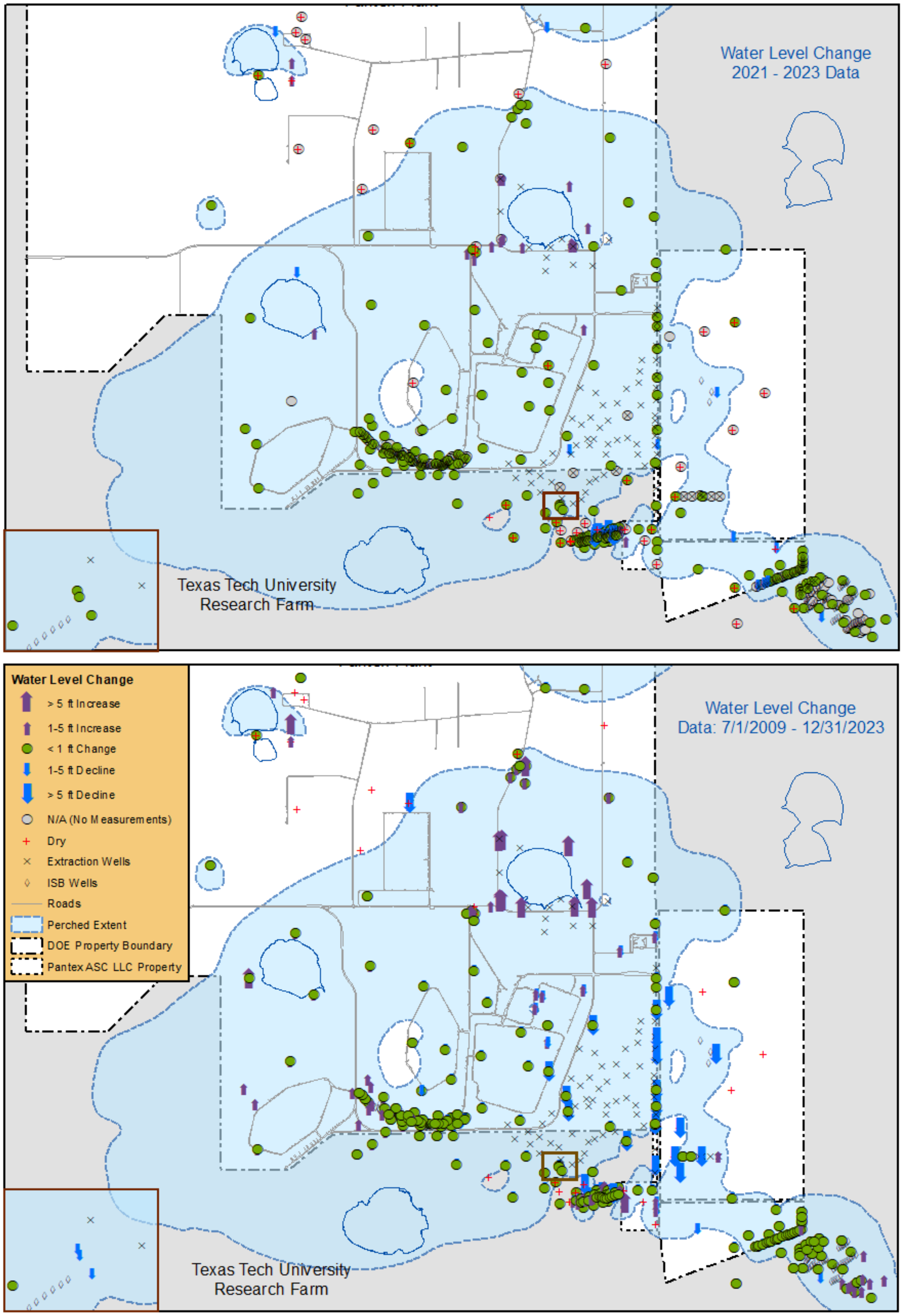

Fig. 3-5. Water level trends in the perched aquifer.

Current and future operations will be impaired by the restricted flow to the WWTF. The SEPTS has the capability to reinject, so the system has operated at a higher capacity, with the treated water being injected into the 4 SEPTS injections wells and/or released to the WWTF and Playa 1. Reduced extraction of perched groundwater at P1PTS, combined with injection or release of treated water to Playa 1, limits the ability of the remedial actions to influence water levels. A discussion of the remedial action effectiveness is included in Section 3.2.

3.1.3 Water-Level Trends Compared To Expected Conditions

Overall, calculated groundwater level trends are consistent with expected conditions defined in the LTM Design Report, which is summarized in Appendix E. Of the 46 monitoring wells with expected decreasing water-level trends, limited water, or dry conditions defined in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a), 23 wells depicted in Fig. 3-6, exhibited conditions inconsistent with current expected conditions or trends. These include 11 wells with recent increasing trends and 12 wells with recent “no trend” conditions. In addition, six wells are exhibiting apparent long-term increasing trends.

A recent increasing trend was observed at four wells near Playa 1 (OW-WR-38, PTX06-1013, PTX06-1023, and PTX08-1001). These trends are associated with a combination of increased recharge through the playa resulting from the discharge of treated wastewater effluent and treated perched groundwater to the playa along with decreased extraction of perched groundwater from the P1PTS. Additionally, a heavy rainfall event in May 2023 most likely contributed to recharge of Playa 1. The long-term water-level trend is decreasing or demonstrating “no trend” for all wells near Playa 1 except OW-WR-38, PTX08-1001, and PTX08-1002, which are increasing but remain below historically observed high levels.

A recent increasing trend was observed in two wells in the southeast area (PTX06-1002A and PTX06-1039A), and recent no trend conditions were observed at PTX06-1038, PTX06-1088, PTX06-1098, PTX06-1100, PTX06-1101, and PTX08-1008. Most of these wells exhibited a marked increase in 2017 water levels, followed by less varied increasing trends or declines through 2023, due to limited operation of SEPTS extraction wells and multiple years with above-normal precipitation. The hydrographs for all of these wells show that water levels have fluctuated in recent data and the long-term water-level trend is decreasing. Hydrographs for all active perched wells are found in Appendix E. The

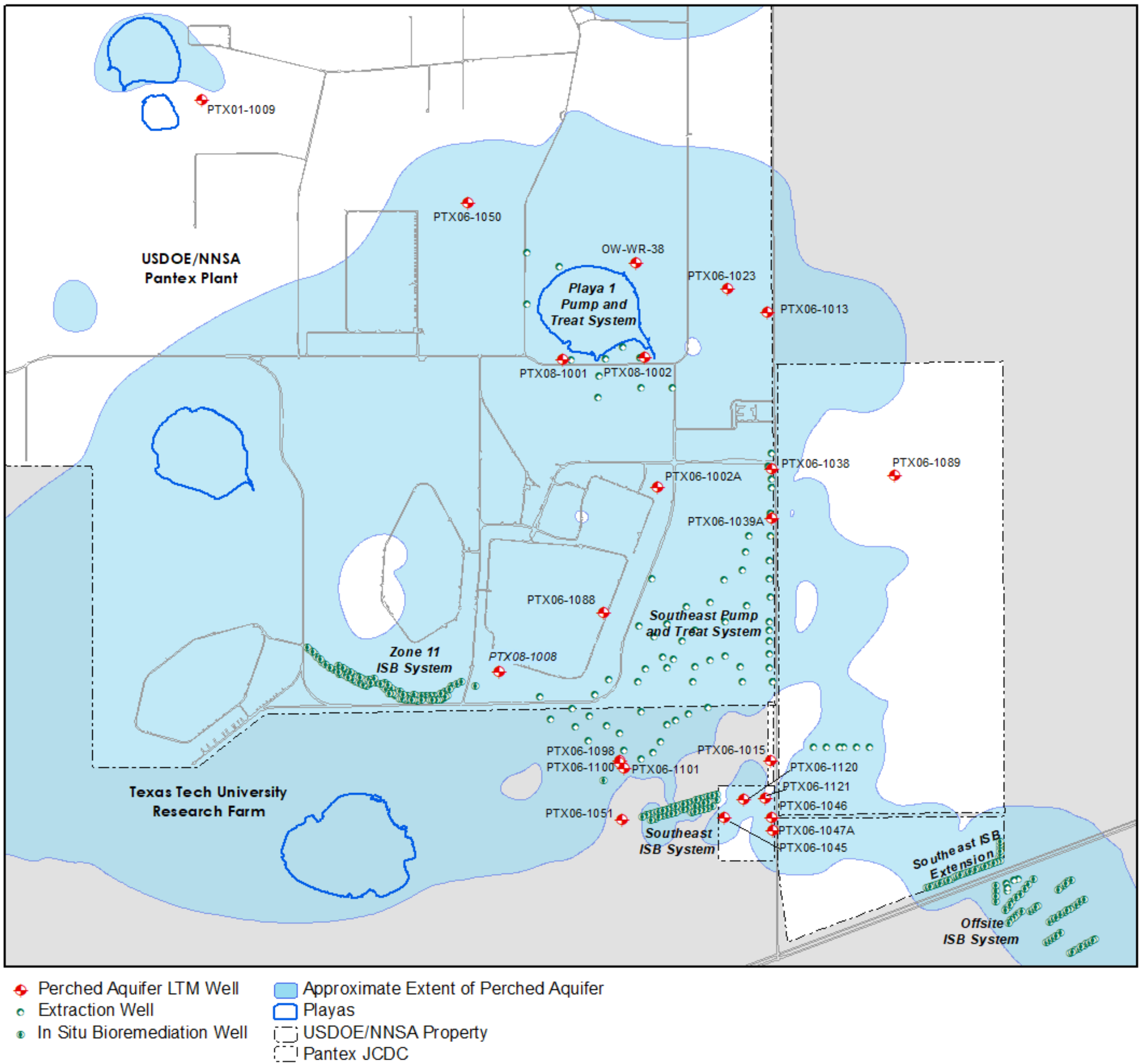

Fig. 3-6. Perched wells with unexpected water level trends.

observed fluctuations may be associated with recharge to the ditches and areas that pond in Zone 12 as well as reduced extraction of perched groundwater from the SEPTS before operational goals were changed to operate SEPTS as a priority.

A recent no trend condition was observed in PTX06-1015 and PTX06-1121, two wells located in the southeast area along FM 2373. These wells, in the past, have only demonstrated minor variations in water levels since 2019 and have a long-term decreasing trend. Similarly, a recent no trend condition was observed at PTX06-1089, a historically dry well beyond the extent of perched saturation east of FM 2373. Water has intermittently been detected in the sump of this well since 2010 but has not been measured in the screen. Observation of water in the well sump does not indicate the presence of perched groundwater at this location.

A recent increasing trend condition has been observed at four wells (PTX06-1045, PTX06-1046, PTX06-1047A, and PTX06-1120) located southeast of the Southeast ISB system near the Pantex ASC south of the main Pantex property. Management of drainage required the installation of retention ponds at the northwest and southwest corners of the property along with new drainage ditches to the north and south. Recent increasing water levels in these wells is believed to be related to the recharge of stormwater runoff from this facility. Historically, however, all wells are demonstrating a decreasing trend.

An apparent long-term increasing trend was identified for PTX06-1051, although recent data indicate no trend. Historically, this well has been dry, with no water measured; however, the current well is a replacement well completed in October 2015. Water was measured in the sump starting in June 2016 and again in December 2016; then, a maximum of 0.15 ft of water was measured above the bottom of the well screen in 2017 and has since fallen below the bottom of the screen. The water level indicated by these measurements is approximately 10 ft below the elevation where perched water would be expected if it occurred in this area. Pantex completed a well video survey in July 2018 to evaluate the condition of the well and potential sources of this water. The video showed seepage of water into the well screen at and just above the level of standing water in the well but did not identify any structural issues with the well. This well will continue to be monitored for changes in water level.

Increasing water levels have been observed at PTX01-1009 near Playa 3. This well has historically been dry, but water was first measured in the screen in June 2019. The subsequent December water-level measurement was dry, but water has been observed in the screen in both measurements in 2023. These recent increased water levels may be associated with above-normal precipitation in recent years and increased recharge through the playa.

3.1.4 COC Concentration Trending

COC concentration trends were calculated using both the non-parametric Mann-Kendall and parametric linear regression statistical methods adapted from the MAROS software (AFCEE, 2007). Trends were calculated for the entire dataset for each LTM network well (i.e., long-term), data from the four most recent sampling events (i.e., short-term), and data collected since the start of remedial actions in 2009. The results of these analyses can be found on the concentration trend graphs located in Appendix E. In addition, the Mann-Kendall trending results since the start of remedial actions for RDX, hexavalent chromium, perchlorate, and TCE are depicted in Fig. 3-7, Fig. 3-8, Fig. 3-9, and Fig. 3-10, respectively, to illustrate the effectiveness of the groundwater remedial actions.

Linear regression is a parametric statistical procedure that is typically used for analyzing trends in data over time. However, with the usual approach of interpreting the log slope of the regression line, concentration trends may often be obscured by data scatter arising from non-ideal hydrogeologic or sampling and analysis conditions. The Mann-Kendall test is a non-parametric statistical procedure that is well suited for analyzing trends in data over time (Gilbert, 1987). The Mann-Kendall test can be viewed as a nonparametric test for zero slope of the first-order regression of time-ordered concentration data versus time. The Mann-Kendall test does not require any assumptions as to the statistical distribution of the data (e.g., normal, lognormal) and can be used with data sets that include irregular sampling intervals and missing data (i.e., non-detects). More information on these statistical methods can be found in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a).

3.1.4.1 RDX Trends

Evaluation of concentration trends indicates that RDX is decreasing or does not demonstrate a trend at all monitoring points near the ditch along the eastern side of Zone 12. This continued condition is expected, given that the source areas are predicted to continue contributing to the perched aquifer for at least 20 years, if not longer, but at much lower concentrations than in the past (Pantex, 2006).

Some wells near Playa 1 are exhibiting increasing trends because of system operations at the P1PTS, which have dramatically affected water levels and gradients in this region of perched groundwater. The SEPTS has had some effect on the plume since the majority of COC concentrations are declining or exhibit no trend within the boundaries of the well field. The Southeast ISB has had some effect on wells to the south on TTU property, exemplified by stable or declining concentrations in downgradient wells, including the trend of recent data at PTX06-1153. This is a key area for declining concentrations because portions of that area are potentially more sensitive to vertical migration to the deeper drinking water aquifer. The trends are depicted in Fig. 3-7.

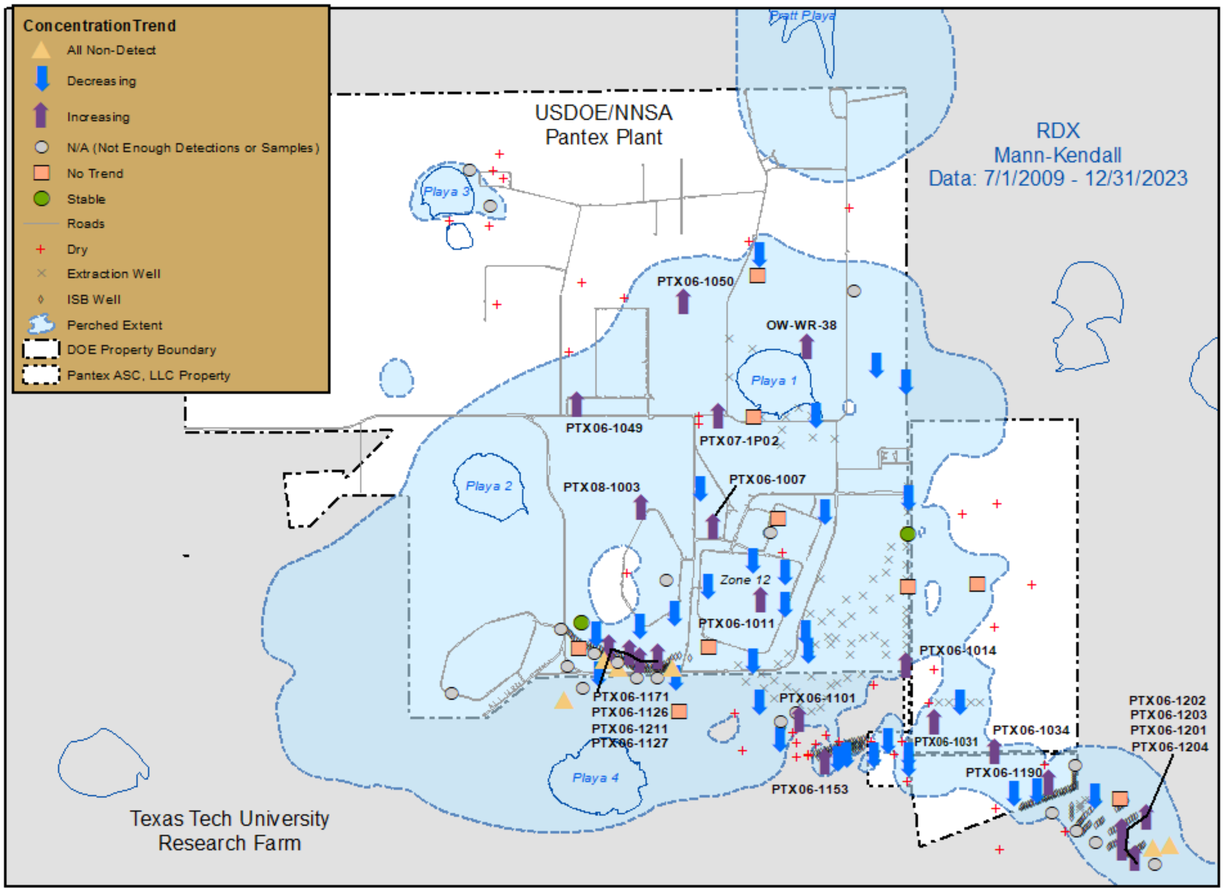

Fig. 3-7. RDX trends in the perched aquifer.

According to data collected since the start of remedial actions, the following 20 monitoring wells exhibited increasing trends in RDX, as depicted in Fig. 3-7:

- OW-WR-38, located north of Playa 1, is exhibiting an increasing trend in RDX. RDX concentrations have been fluctuating near the GWPS since 2009 but increased to 32.4 ug/L in the most recent sample collected in 2023. Although elevated RDX has not been previously observed at this well, other wells north of Playa 1 (e.g., PTX07-1O03) have exhibited higher concentrations of RDX in the past. The trend may be due to the P1PTS operation or recent changes in the discharge of treated water to Playa 1, which have dramatically affected water levels and gradients in this region of perched groundwater.

- PTX07-1P02, located southwest of Playa 1, is exhibiting an increasing but variable trend just above the GWPS, but fluctuating concentrations remain far below historical levels for this well. The apparent increasing trend may be due to the effects of the P1PTS operation, which has dramatically affected water levels and gradients in this region of perched groundwater.
- PTX06-1050 located northwest of Playa 1 is exhibiting probable increasing trends in RDX. However, this well has exhibited higher historic RDX concentrations and exhibit decreasing trends considering all data. These increasing trends may be due to P1PTS effects as system operations have dramatically affected water levels and possible gradients in this region of perched groundwater.
- RDX was first observed at low concentrations in PTX06-1049 in 2011 and has since fluctuated at levels slightly above the GWPS. This well is located on the far western side of the perched aquifer, which is outside the influence of remedial action. These trends are likely due to groundwater flow from the Playa 1 vicinity.
- PTX08-1003, is exhibiting an increasing trend, but all values are near the practical quantitation limit (PQL) and well below the GWPS. Data for the last four samples indicates no trend.
- PTX06-1007, located between and north of Zones 11 and 12, is exhibiting an increasing trend in RDX. In 2023, RDX was measured above the GWPS (2 ug/L) at 2.7 ug/L. This is a decrease from 2020 and 2021 where RDX was detected around 26 ug/L.
- PTX06-1014 is exhibiting an increasing trend, although data for the last two years shows no trend. This well is within the influence of the SEPTS well field. Recently observed concentrations are similar to levels observed since 2009 and remain below historical maximums for this well.
- PTX06-1101 is located immediately downgradient of the Southeast ISB pilot study well field. RDX has not been detected in this well since its installation in 2007 until 2014 and has been increasing since then. The increasing trend results from loss of

treatment effectiveness in the ISB pilot area and concentrations returning to baseline conditions.

- PTX06-1153, a downgradient ISPM well for the Southeast ISB system, is exhibiting an increasing but highly variable trend in RDX since the start of remedial actions. However, the recent trend shows a decreasing trend. This well is detailed in Section 3.2.3.2.
- PTX06-1126, PX06-1127, PTX06-1171 and PTX06-1211, located south of Zone 11 and outside the effects of remedial action, are exhibiting long-term increasing RDX trends. However, recent data indicate a decreasing trend in PX06-1127 and no trend in PTX06-1126 and PTX06-1171. These wells are located upgradient of the Zone 11 ISB system and, based on the data collected in the Southeast ISB system, RDX will be effectively treated by the system.
- Two wells (PTX06-1031 and PTX06-1034) located in the southeast lobe of perched groundwater east of FM 2373 are exhibiting increasing trends in RDX, likely due to plume movement into these wells. However, recent data indicate no trend conditions.
- PTX06-1190, PTX06-1201, PTX06-1202, PTX06-1203, and PTX06-1204 located in the southeastern lobe of perched groundwater, are exhibiting increasing RDX trends. These five wells are part of the 14 monitoring wells installed in 2018 and 2019 to define the extent of the plume to the southeast. The increasing trends are expected because these wells are monitoring the leading edge or core of the RDX plume in this area. Pantex has installed a combination ISB/pump and treat system to control the plume and prevent further movement downgradient. Increasing concentrations in these wells are expected for several years as the treatment system influence expands with repeated injections.

A comparison of current trends to expected conditions for specific wells in the LTM network is included in Section 3.1.5.

3.1.4.2 Hexavalent Chromium Trends

As depicted in Fig. 3-8, the following 10 perched aquifer wells are exhibiting increasing trends in hexavalent chromium below the GWPS since remedial actions began:

- An increasing trend was identified for PTX06-1031. Concentrations of total chromium, molybdenum, and nickel in this well have also fluctuated over the past several years; therefore, portions of observed fluctuations in hexavalent chromium may be due to corrosion of the stainless-steel screen in this well. PTX06-1031 has had decreasing water levels over the past 5 years and has minimum water in the sump and cannot be resampled.
- PTX06-1095A is within the influence of the SEPTS well field but is also located less than 50 ft downgradient of the permeable reactive barrier (PRB) pilot study wells PTX06-PRB01A and PTX06-PRB02. Since 2013, detections have been highly variable. The probably increasing trend is likely due to the PRB losing treatment effectiveness and concentrations returning to baseline conditions. No trend was exhibited in the last four samples. Concentrations have been far below the GWPS since 2015.
- An increasing trend was identified for PTX06-1126; however, a decreasing trend was identified for the last four samples. All concentrations remain far below the GWPS.
- An apparent increasing trend was identified for PTX06-1146; however, no trend was identified for the last four samples. Concentrations of total chromium in this well have also fluctuated over the past several years; therefore, observed fluctuations in hexavalent chromium may be due to corrosion of the stainless-steel screen of the well. All concentrations remain far below GWPS.
- An increasing trend was identified for PTX06-1166. Concentrations exceeded the GWPS for the first time in 2020, but concentrations dropped back below the GWPS since 2021. This well is located along the southern edge of the hexavalent chromium plume, so the observed fluctuations are related to the movement of the plume to the southeast and operation of SEPTS.
- An apparent increasing trend was identified for PTX06-1190, PTX06-1192, and PTX06-1199; however, a no trend was identified for the last four samples for PTX06-1192 and PTX06-1199 and a decreasing trend was identified for PTX06-1190. All concentrations remain far below the GWPS.
- A probably increasing trend was identified for PTX06-1195 and an increasing trend was exhibited for PTX06-1201. However, all concentrations remain far below the GWPS. The identified probably increasing trend is partially the result of low-level detections and the use of one-half the detection limit in the trending.

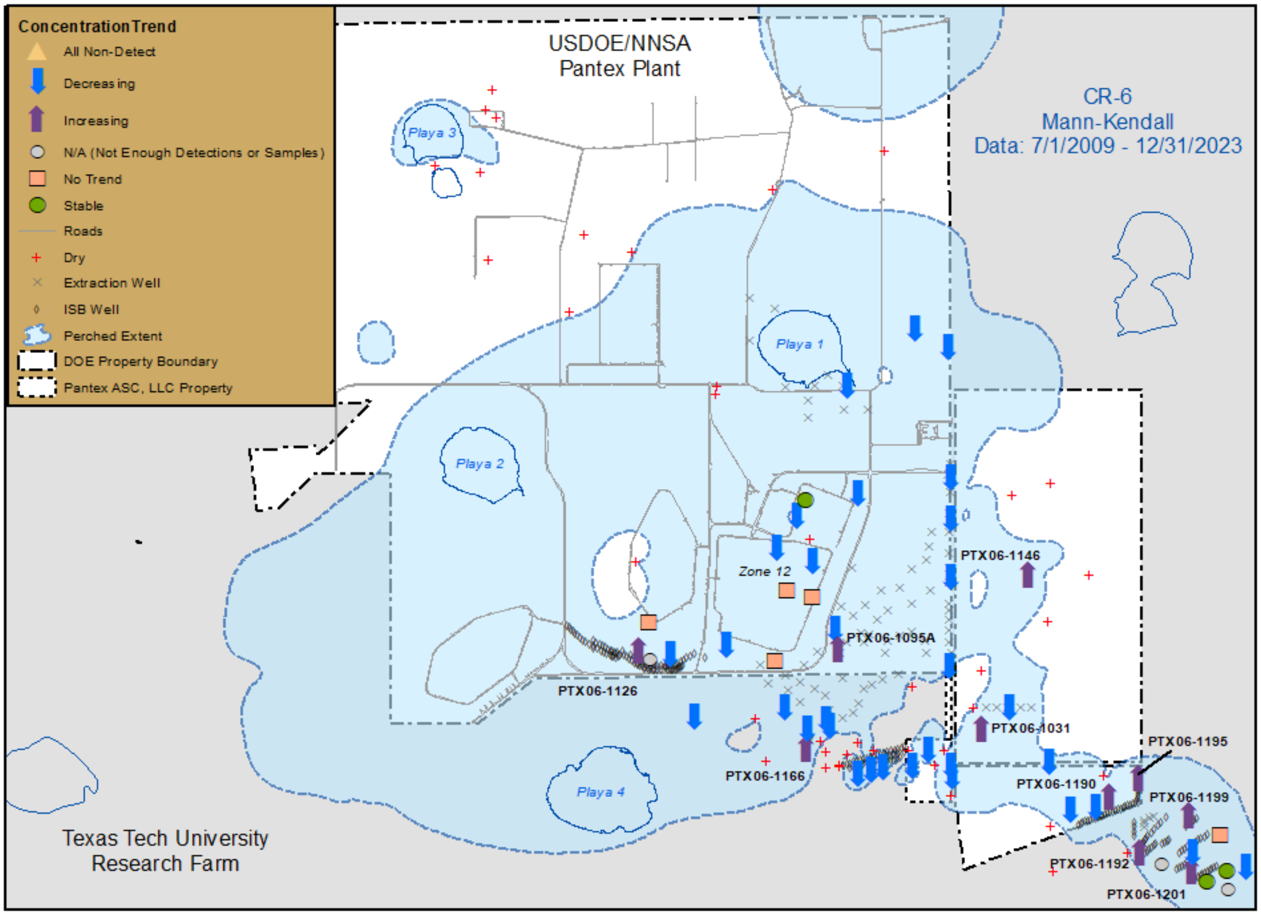

Fig. 3-8. Hexavalent chromium trends in the perched aquifer.

3.1.4.3 Perchlorate Trends

As depicted in Fig. 3-9, six monitoring wells are exhibiting increasing trends in perchlorate concentration:

- PTX06-1035, PTX06-1134, and PTX06-1207 which are located southwest of the Zone 11 ISB system, are demonstrating increasing trends in perchlorate concentrations likely due to general plume movement downgradient. These wells are located downgradient of the Zone 11 ISB system, and treated water was not expected to reach these wells for many years following the establishment of reducing conditions in the treatment zone. However, a no trend was identified for the last four samples for these wells.

- PTX06-1006 was exhibiting a decreasing trend in perchlorate from the time it was first detected in the well until 2014; the Mann-Kendall analysis indicates a probably increasing trend based on data collected since the start of remedial actions in 2009. However, concentrations have remained relatively constant since 2014, and no trend is indicated for the last four samples. These fluctuations could be caused by changes in gradients and plume movement from the SWMU 5-13A ditch. Another possible cause of these shifting trends could be caused by historical injection and the resulting return to unaffected perchlorate concentrations after injection ceased. As discussed in several prior annual progress reports, historical injection from 1996 to 2006 at the SEPTS injection well PTX06-INJ-02 affected COC concentrations and trends in wells installed east of PTX06-1006.
- PTX08-1007 is exhibiting an overall increasing trend in perchlorate. Perchlorate has been detected below the PQL since 2014, but recent data do not indicate a trend.
- Perchlorate increased in PTX08-1008 from 2014 into 2017; however, perchlorate has been stable with fluctuations in this well since 2017. The variation in perchlorate in this well may be due to general plume movement to the southeast in this area, which may also be influenced by the SEPTS operations.

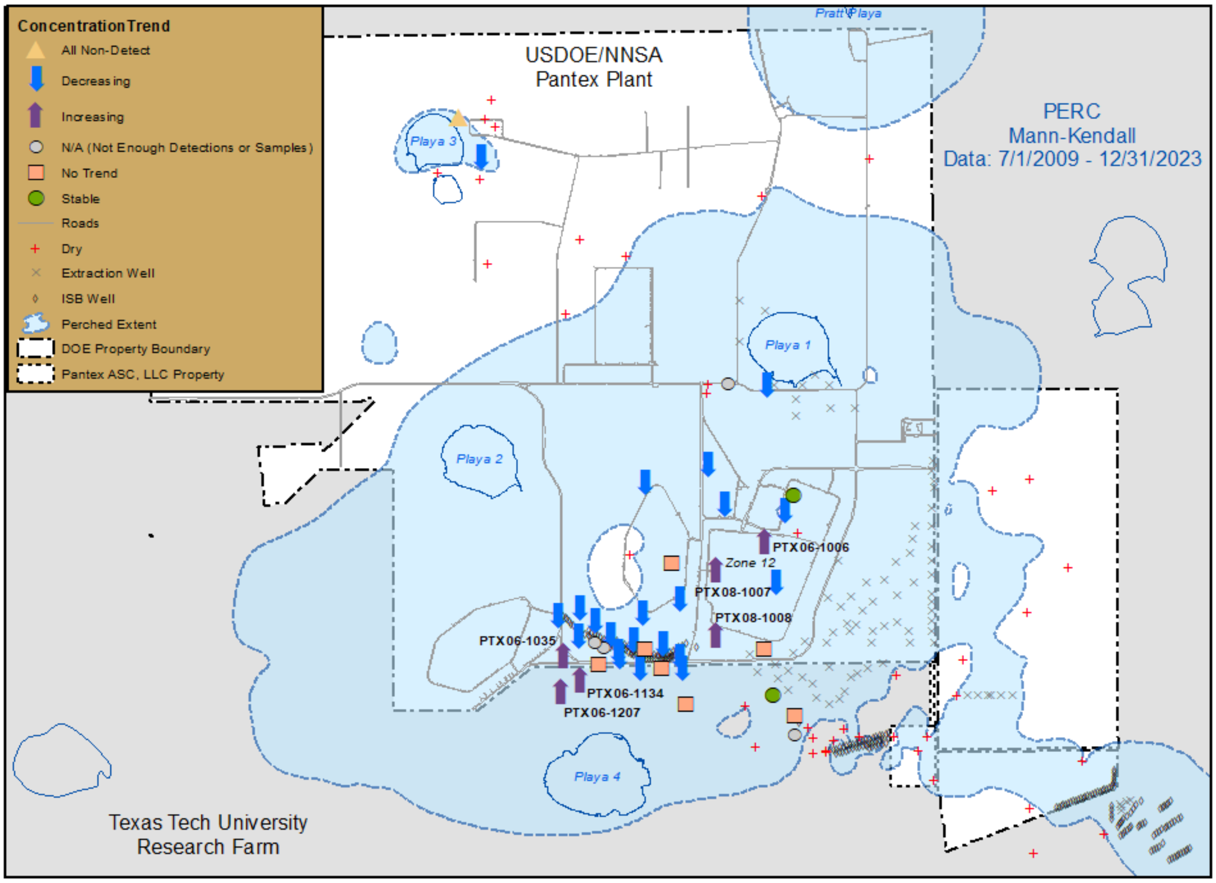

Fig. 3-9. Perchlorate trends in the perched aquifer.

3.1.4.4 TCE Trends

As depicted in Fig. 3-10, the following 21 monitoring wells are exhibiting increasing or probably increasing trends in TCE concentration since the start of remedial actions:

- An apparent increasing trend was identified for OW-WR-38 located northeast of Playa 1. Detections have been sporadic since 2009, and all sample results have been either below the sample PQLs or non-detect. The identified increasing trend is the result of low-level detections and the use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area.

- TCE is exhibiting a probably increasing trend in PTX06-1048A, located northeast of Playa 1, which has not historically been nor is expected to be under the effect of remedial action. TCE was first detected in this well in 2000 and has generally been detected at levels near the PQL and below the GWPS. The last four samples indicate no trend.

- A probably increasing trend was identified for PTX07-1O02, located north of Playa 1. This well has consistently measured values of TCE below the PQL since the start of remedial action. When trending all historical data, it exhibits a no trend.
- TCE was first detected in PTX06-1006 in 2011. The Mann-Kendall analysis indicates an increasing trend based on data collected since the start of remedial actions in 2009. However, concentrations have remained relatively low (below the PQL) since 2018, and no trend is indicated for the last four samples. The increasing concentrations could be caused by changes in gradients and plume movement from the SWMU 5-13A ditch or the return to unaffected TCE concentrations after injection ceased. As discussed in several prior annual progress reports, historic injection at SEPTS injection well PTX06-INJ-02 (1996–2006) affected COC concentrations and trends in wells installed east of PTX06-1006.
- An increasing trend was observed for PTX06-1010 in the eastern part of Zone 12. Although the trend indicates increasing TCE concentrations in this well, TCE concentrations have declined to below the GWPS from historical levels that were above GWPS. Concentrations have remained below GWPS since 2009, and the last four samples indicate no trend.
- PTX06-1011, located in Zone 11, has fluctuating detections of TCE near the GWPS since 1995. No trend is indicated for the last four samples and for all data.
- PTX08-1006 is exhibiting an increasing trend in TCE, although the expected condition is a long-term decreasing trend. The increasing trend in PTX08-1006, which is located downgradient from the identified sources in Zone 11, is likely due to general plume movement to the southeast that may also be influenced by SEPTS operations. Concentrations have been highly variable in this well, and the last four samples indicate a decreasing trend.
- An increasing trend was identified for PTX06-1127 located upgradient of the Zone 11 ISB system. Concentrations began increasing in 2015, but no trend is indicated for the last four samples. This well is located downgradient from the identified sources in Zone 11, so the variations likely reflect impacts by the SEPTS withdrawal that has changed general flow of the plumes in that area to the southeast.
- PTX06-1035, PTX06-1134 and PTX06-1207, which are downgradient of the western side of the Zone 11 ISB, are exhibiting increasing trends in TCE concentration due to

general plume movement downgradient. The ISB system conceptual site model predicted treated water would not reach these wells for many years, and these wells are not expected to demonstrate TCE treatment until 10 years or longer after system operations began. TCE concentrations in PTX06-1035 and PTX06-1134 exceeded the GWPS in both samples collected in 2023 and the last four samples show an increasing trend. Data for the last four samples at PTX06-1207 indicate a stable trend, with concentrations still below GWPS for TCE in both 2023 samples.

- TCE was at or right above the GWPS in 2023 at PTX06-1052 and PTX06-1183, located southeast of Zone 12. An increasing trend is likely due to general plume movement to the southeast and operation of the SEPTS wellfield.

- PTX06-1148, PTX06-1149, and PTX06-1150 are downgradient of the original part of the Zone 11 ISB. TCE concentrations at PTX06-1150 have been increasing since 2010, while TCE concentrations at PTX06-1148 and PTX06-1149 began increasing in 2018. Concentrations of TCE are above the GWPS in all three wells. An increasing trend is likely due to general plume movement to the southeast. Additional evaluation of the ISB system performance is provided in Section 3.2.3.1.

- An apparent increasing trend, with concentrations below GWPS, was identified for PTX06-1098, located on the upgradient side of the ISB pilot system. These results correspond to a decrease in cis-1,2-dichloroethene (cis-1,2-DCE) and indicate reduced treatment provided by the ISB pilot system along with movement of the plume out of this area.

- A probably increasing trend was identified for PTX06-1101; however, the most recent sample was slightly below the GWPS, and the last four samples indicate a decreasing trend. This well is located on the downgradient side of the Southeast ISB pilot study well field, and these results correspond to recent decreases in cis-1,2-DCE to below the PQL. The increase in TCE indicates reduced treatment provided by the ISB pilot system along with movement of the plume out of this area.

- TCE was not detected in 2023 at PTX06-1196 and PTX06-1203, downgradient of the Southeast ISB Extension. TCE has been detected below the PQL since 2018 and concentrations are decreasing. The past four samples were all non-detect.

- TCE was below the GWPS in 2023 at PTX08-1008, located southwest of Zone 12. TCE has been detected above the PQL, but below GWPS, for a number of years, and recent data does not indicate a trend.
- The increasing trend in PTX08-1006, which is located downgradient from the identified sources in Zone 11, is likely due to general plume movement to the southeast.

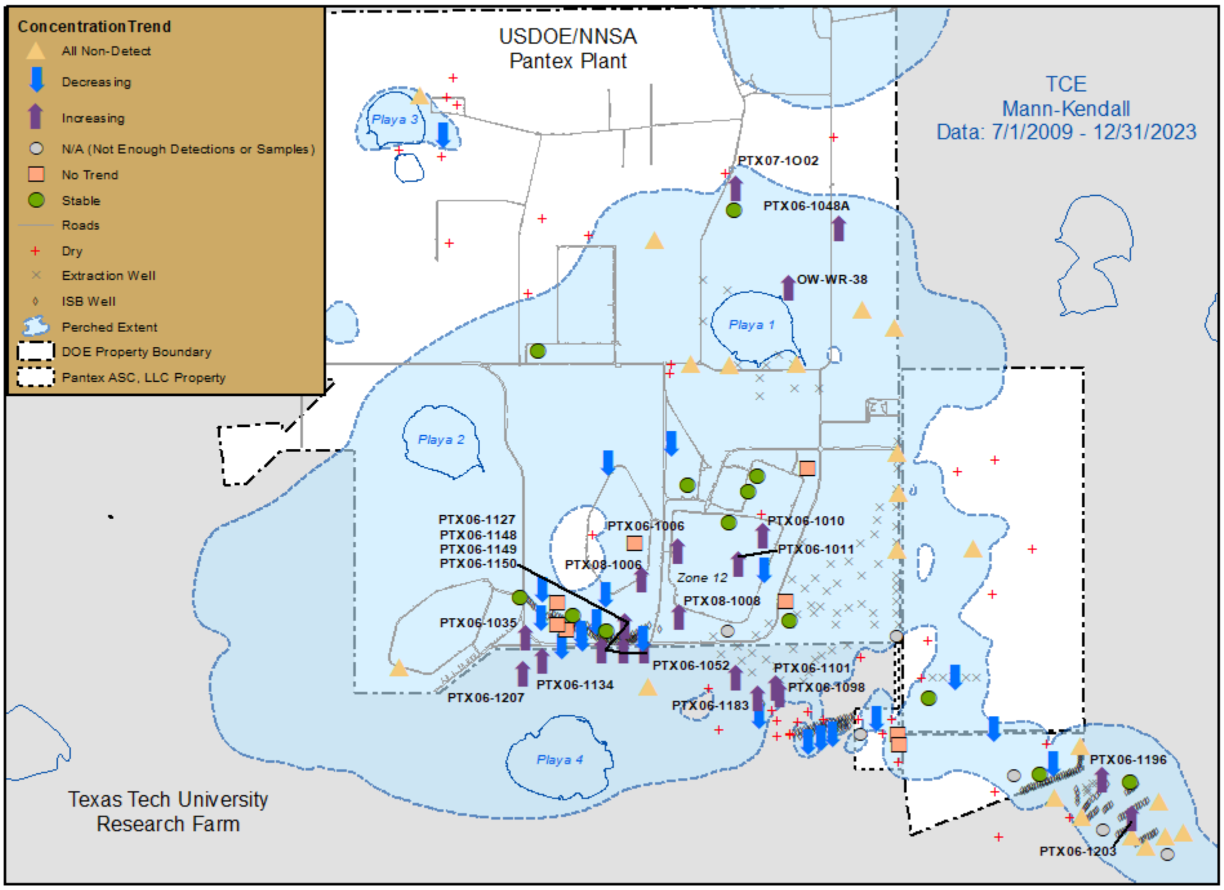

Fig. 3-10. TCE trends in the perched aquifer.

3.1.5 Concentration Trends Compared To Expected Conditions

Of the 117 monitor wells with expected COC concentration conditions defined in the LTM Design Report, the 45 wells depicted in Fig. 3-11 did not exhibit trends consistent with the expected conditions since the start of remedial actions. These wells were discussed in Section 3.1.4. Additional detail on all LTM wells is located in Appendix E, Table E-1.

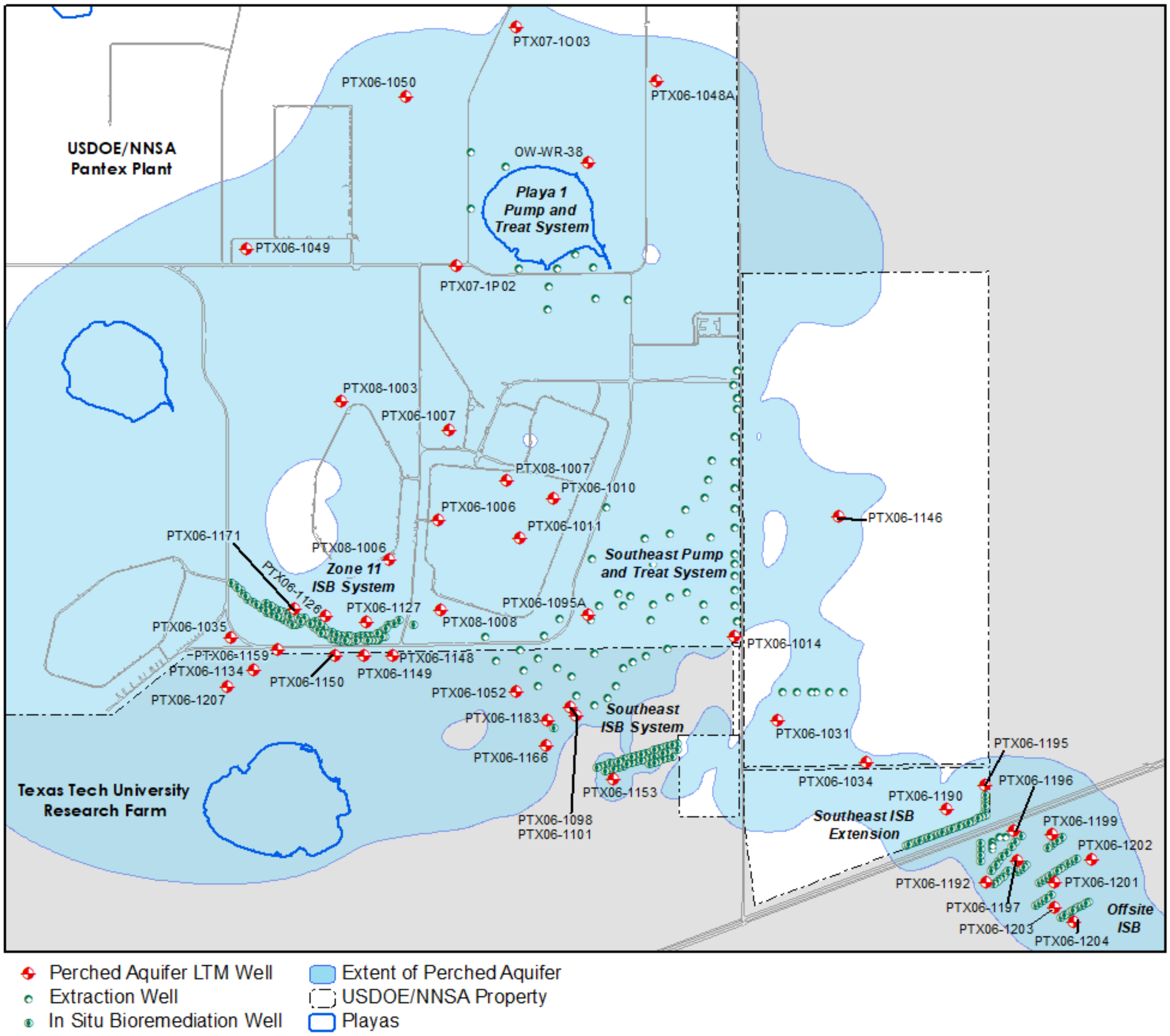

Fig. 3-11. Perched wells with unexpected COC trends.

3.1.6 Plume Mapping

This section presents isoconcentration maps of indicator constituents (i.e., COCs and breakdown products of RDX and TCE) in the perched aquifer. Perched aquifer indicator parameters are documented in CP Table IIIA of HW-50284 and included in the SAP. Isoconcentration maps for this annual report were produced from groundwater data collected in 2023.

Each isoconcentration map presents the highest detected concentration for each constituent using validated analytical data from January to December 2023. COC plumes were delineated to the approved GWPS as was first done for the *2014 Annual Progress*

Report (Pantex, 2015). The GWPS isoconcentration contour is highlighted by a yellow line outlined in black.

Constituent concentrations for samples from the extraction wells located within the two extraction well fields were used to generate the isoconcentration contours, but the analytical concentration data from these wells may differ from those of the investigative wells because of the different sampling techniques used for the extraction wells. The extraction wells are clearly identified on the figures with an “EW” in the well identification label and a distinct symbol. Pump and treat system injection wells are identified on the figures with an “INJ,” and ISB injection wells are identified with an “ISB” in their respective well identification labels.

Constituent concentrations for samples collected from wells within the ISB treatment zones and downgradient zones of influence were generally used to generate the isoconcentration contours; however, for some constituents, including metals and HEs, these data were not used because the concentrations were indicative of the ISB treatment zone rather than the surrounding formation. Additionally, most downgradient ISPM wells are indicating treatment effects of the ISB treatment zone as well as the effects of expansion of the treatment zone. When these effects resulted in concentrations that were not believed to be representative of the surrounding formation and the overall plume shape, they were not included in the contouring process. The estimated downgradient areas under the influence of the ISB systems are depicted on plume maps, where appropriate. COC data obtained from the wells immediately downgradient from the three in-situ remediation pilot project areas were not used to generate the isoconcentration contours. Concentrations observed at these wells are typically much lower than surrounding plume concentrations and represent the localized influence of the pilot-scale remediation projects.

Table 3-1 identifies all indicator constituents for the perched aquifer. Fig. 3-12 through Fig. 3-26 are isoconcentration maps for RDX; 4-amino-2,6-dinitrotoluene (DNT4A); hexavalent chromium; perchlorate; and TCE. Maps for hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine (MNX); hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine (DNX); hexahydro-1,3,5-trinitroso-1,3,5-triazine (TNX); 2,4,6-trinitrotoluene (TNT); 2-amino-4,6-dinitrotoluene (DNT2A); 1,3,5-trinitrobenzene; 1,4-dioxane; 1,2-dichloroethane (DCA); cis-1,2-DCE; and vinyl chloride are presented in Appendix F.

Table 3-1. Perched Aquifer Indicator Parameters

HEs	Metals	Inorganics	Volatile Organics
RDX	Boron	Perchlorate	Chloroform
HMX	Chromium		1,2-DCA
MNX	Hexavalent Chromium		1,4-Dioxane
DNX			*cis*-1,2-DCE
TNX			*trans*-1,2-DCE
TNT			PCE
1,3-Dinitrobenzene			TCE
DNT2A			Vinyl Chloride
DNT4A			
2,4-DNT			
2,6-DNT			
1,3,5-Trinitrobenzene			

Isoconcentration maps for other indicator constituents, such as octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX); 1,3-dinitrobenzene; 2,4-dinitrotoluene (DNT); 2,6-DNT; boron; *trans*-1,2-DCE; tetrachloroethylene (PCE); and chloroform, were not prepared because none of the measured concentrations exceeded the GWPS or detections were isolated to only a few wells and could not be used to map a distinct plume. The following paragraphs provide specific information detailing the reasons maps were not prepared for these constituents as well as for total chromium.

HMX

HMX was not detected above the GWPS of 360 ug/L in any perched aquifer well sampled in 2023. Therefore, an isoconcentration map was not prepared for this compound.

1,3-Dinitrobenzene

1,3-Dinitrobenzene was not detected above the PQL or GWPS in any perched aquifer well sampled in 2023. Therefore, an isoconcentration map was not prepared for this compound.

2,4-Dinitrotoluene

2,4-Dinitrotoluene was detected above the GWPS of 1 ug/L in two perched aquifer monitor wells in 2023. These isolated exceedances could not be used to map a distinct plume. Low levels of 2,4-dinitrotoluene are expected within the capture zone of the SEPTS. Therefore, an isoconcentration map was not prepared for this compound.

2,6-Dinitrotoluene

2,6-Dinitrotoluene was detected above the GWPS of 1 ug/L in one perched aquifer monitor well in 2023. This isolated exceedance could not be used to map a distinct plume. Low levels of 2,6-dinitrotoluene are expected within the capture zone of the SEPTS. Therefore, an isoconcentration map was not prepared for this compound.

Boron

Boron did not exceed the GWPS of 7,300 ug/L in any perched aquifer well sampled in 2023. Therefore, an isoconcentration map was not prepared for this compound.

Chromium

A map of total chromium isoconcentrations for the perched aquifer was not prepared for 2023. Historically, wells constructed with stainless-steel well screens have exhibited elevated concentrations of chromium and other components of stainless steel. Several of these wells have been shown by video observation to be corroded and/or have bacterial growth present, and statistical analyses of the concentrations of chromium and other components of stainless steel (i.e., manganese, molybdenum, and nickel) show strong correlations among the concentrations of these metals in samples obtained from these wells. This evidence indicates some degree of corrosion occurring in all perched aquifer stainless-steel wells at Pantex. In addition, chromium risks are associated with the hexavalent form of chromium. Because the map of hexavalent chromium shows the extent of chromium contamination in the perched aquifer, a separate map based on total chromium concentrations was not prepared.

Chloroform

Chloroform was not detected above the GWPS of 80 ug/L in any perched aquifer well sampled in 2023. Therefore, an isoconcentration map was not prepared for this compound.

Trans-1,2-Dichloroethene

Trans-1,2-DCE was not detected above the PQL or GWPS in any perched aquifer well sampled in 2023. Therefore, an isoconcentration map was not prepared for this compound.

PCE

PCE was not detected above the GWPS of 5 ug/L in any perched aquifer well sampled in 2023. Therefore, an isoconcentration map was not prepared for this compound.

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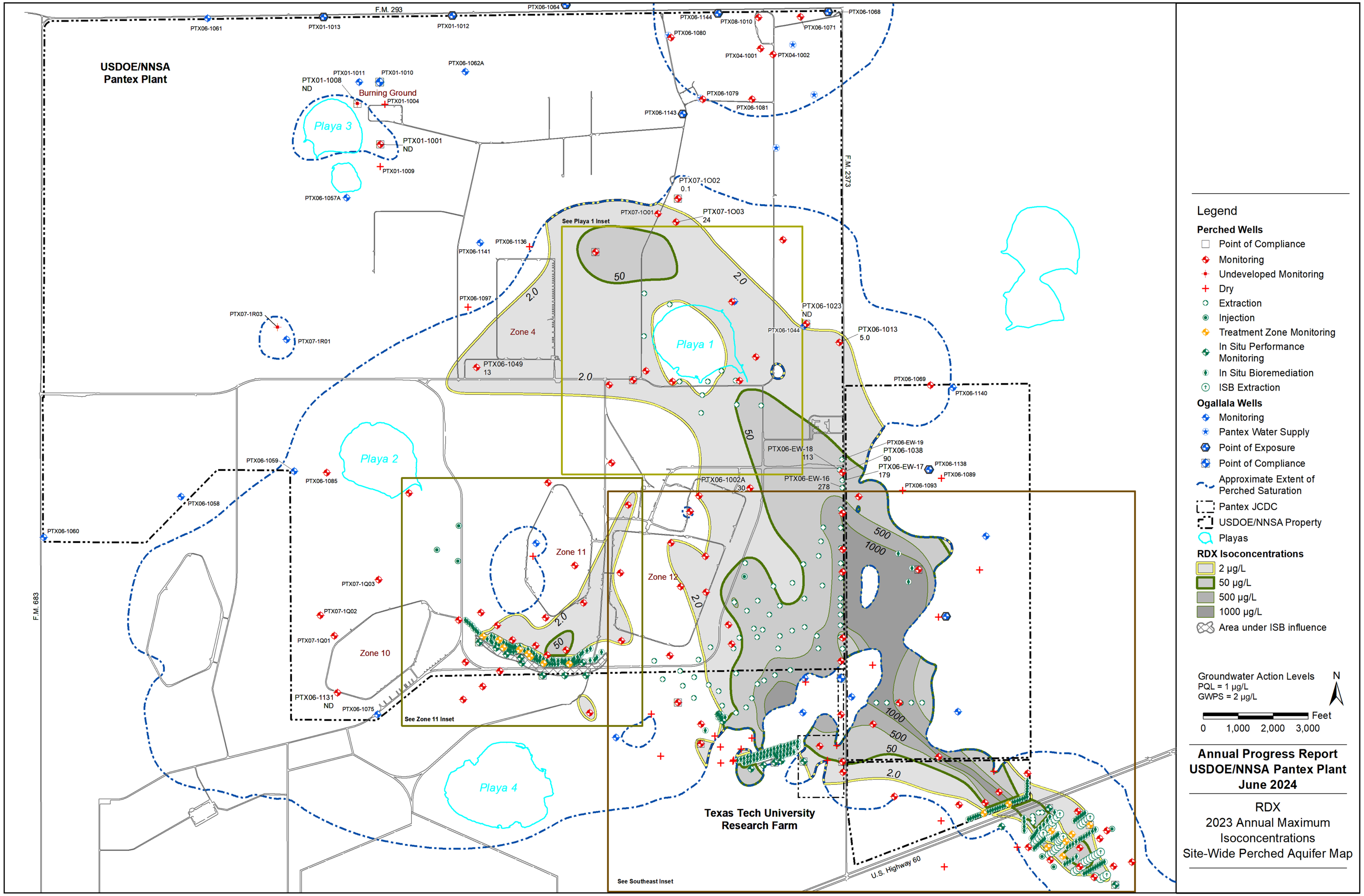

Fig. 3-12. RDX isoconcentration map.

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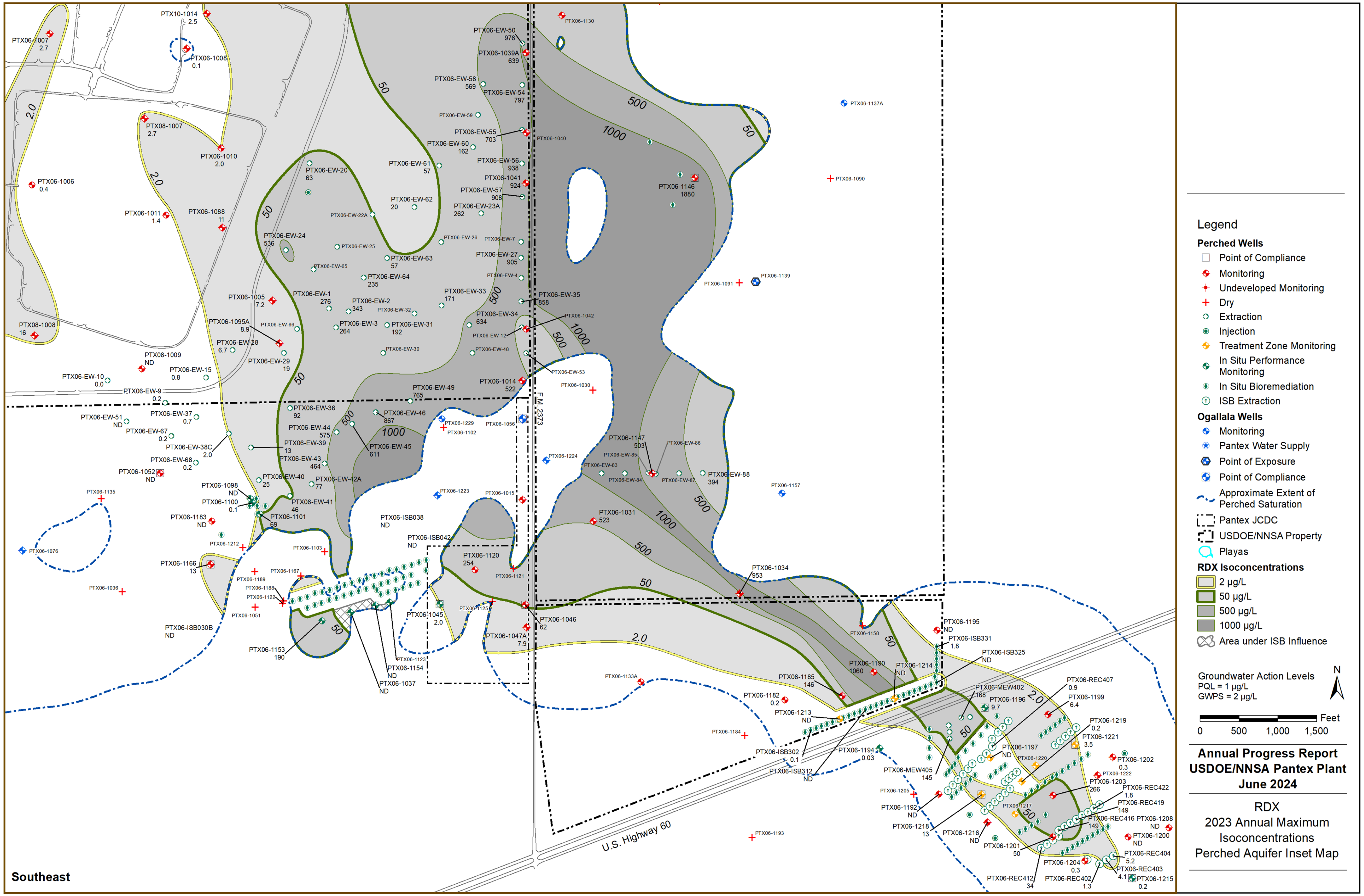

Fig. 3-13. RDX isoconcentration southeast inset map.

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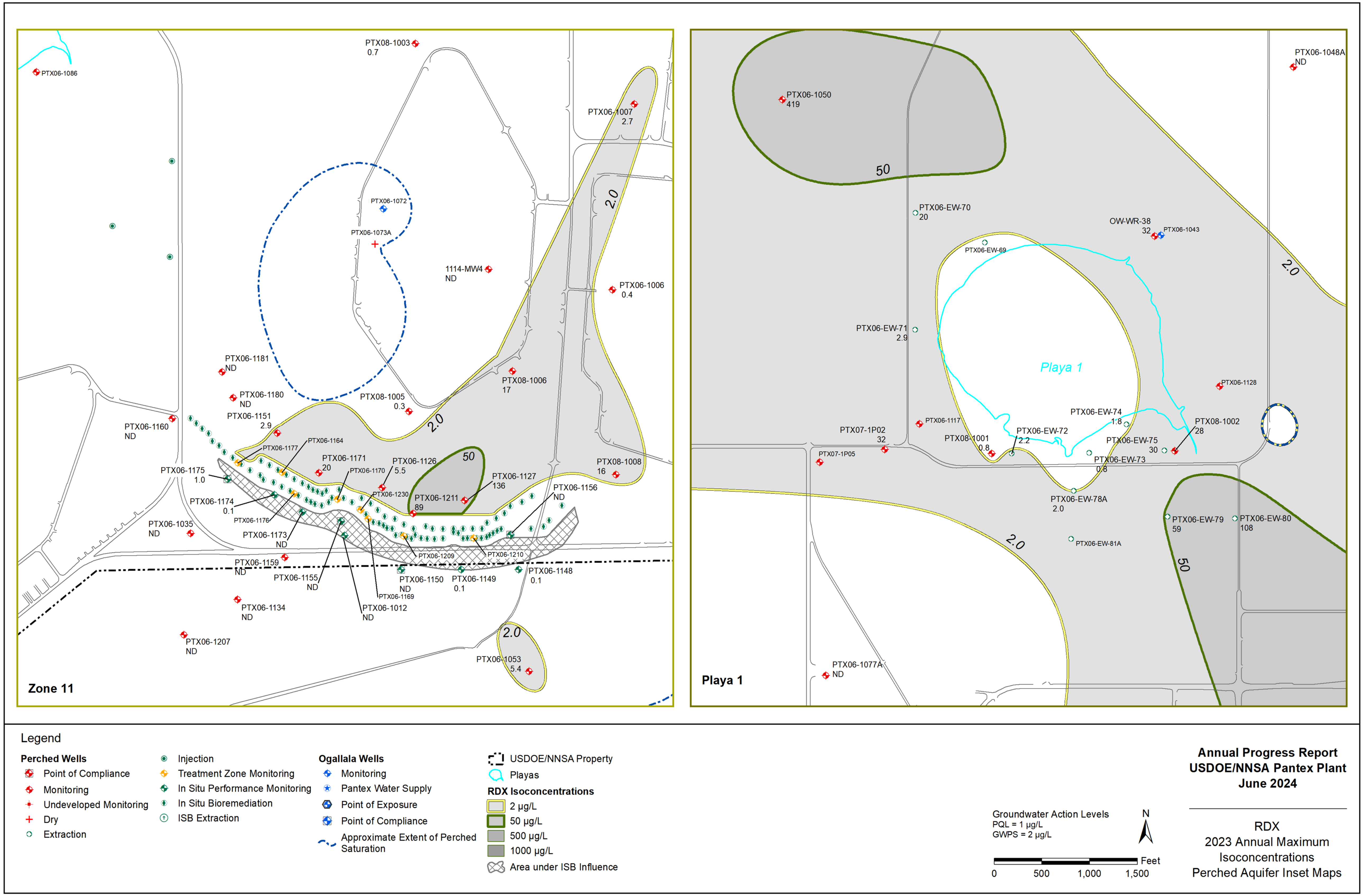

Fig. 3-14. RDX isoconcentration Zone 11 and Playa 1 inset maps.

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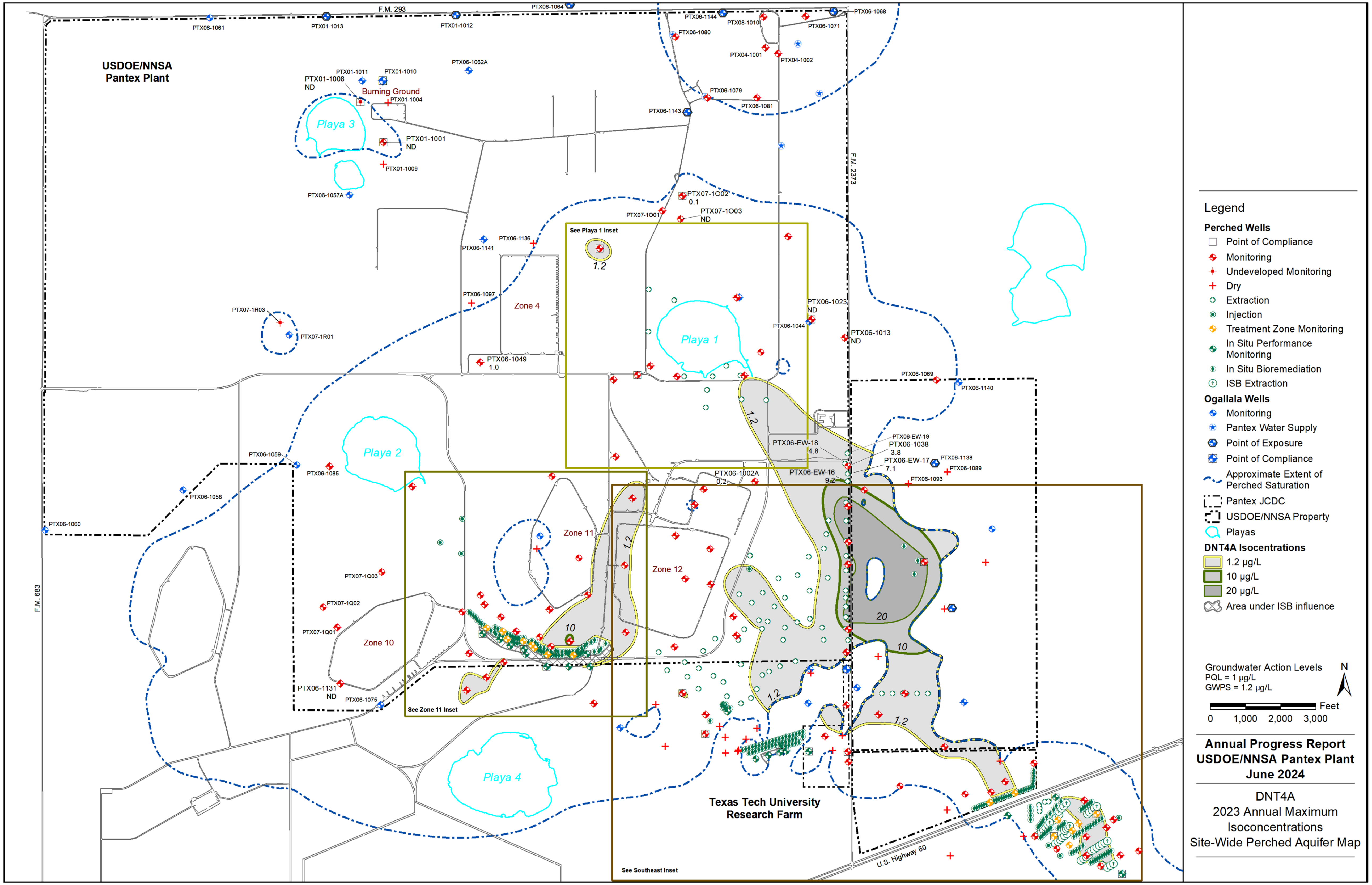

Fig. 3-15. DNT4A isoconcentration map.

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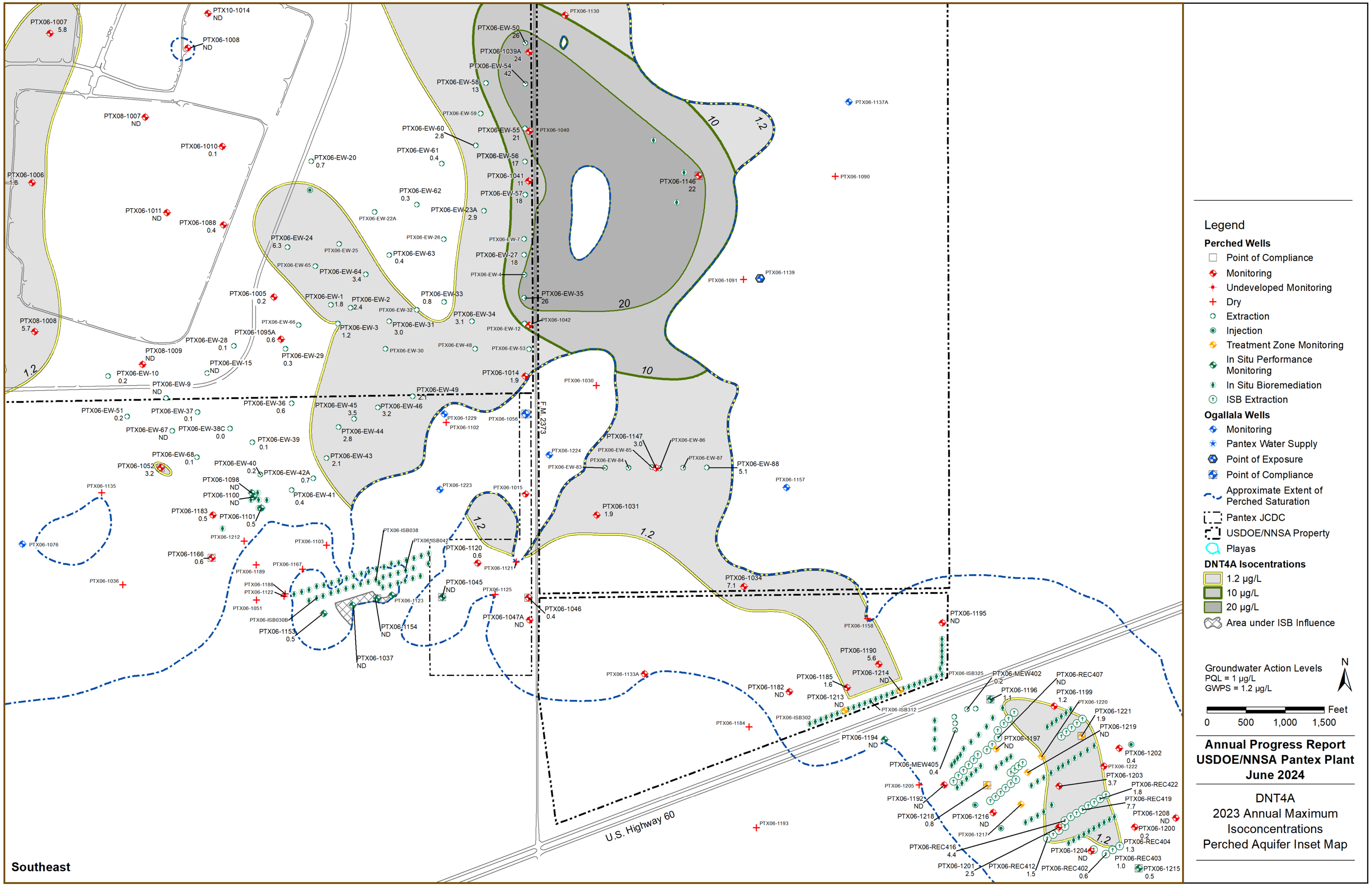

Fig. 3-16. DNT4A isoconcentration southeast inset map.

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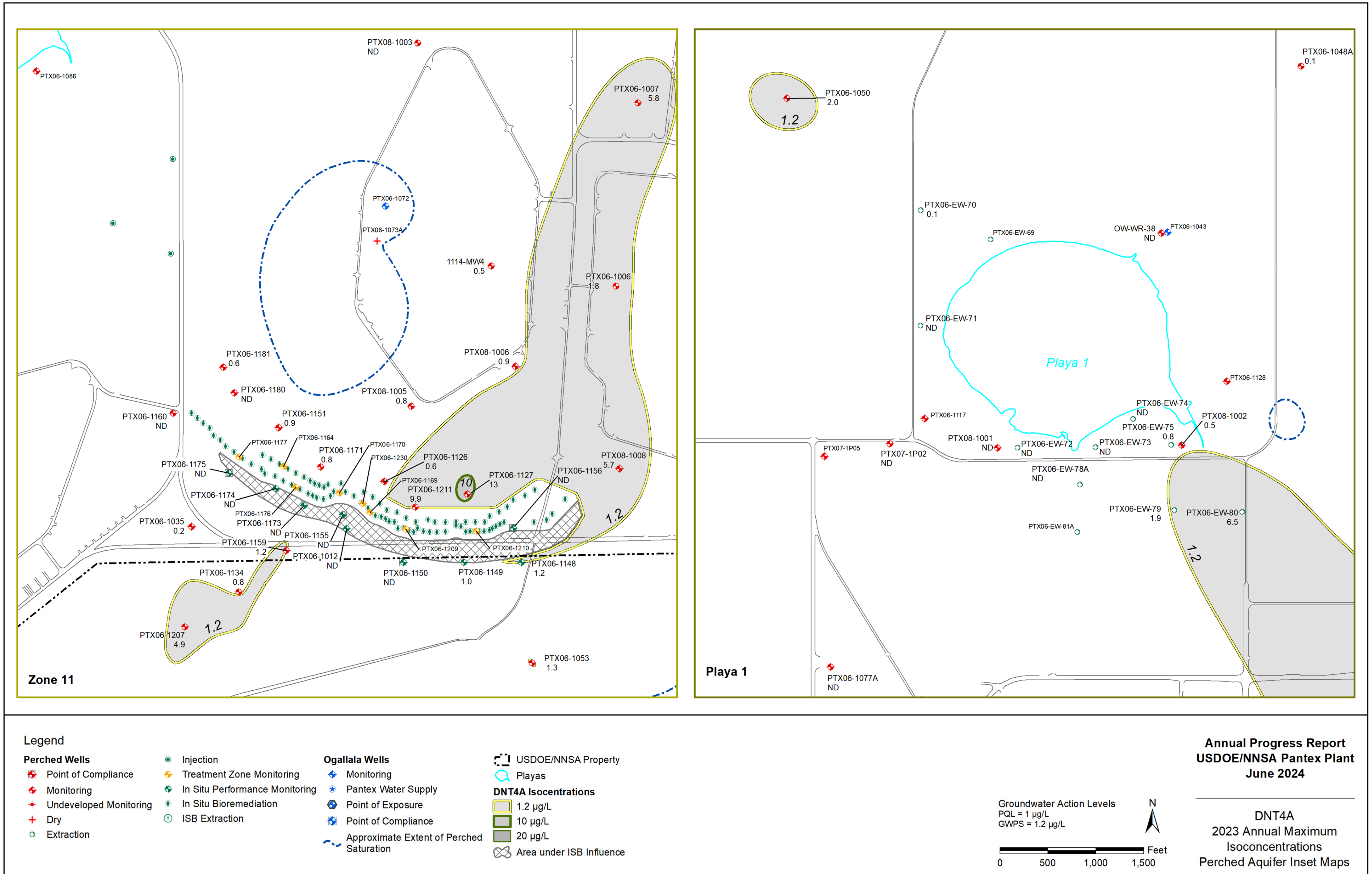

Fig. 3-17. DNT4A isoconcentration Zone 11 and Playa 1 inset maps.

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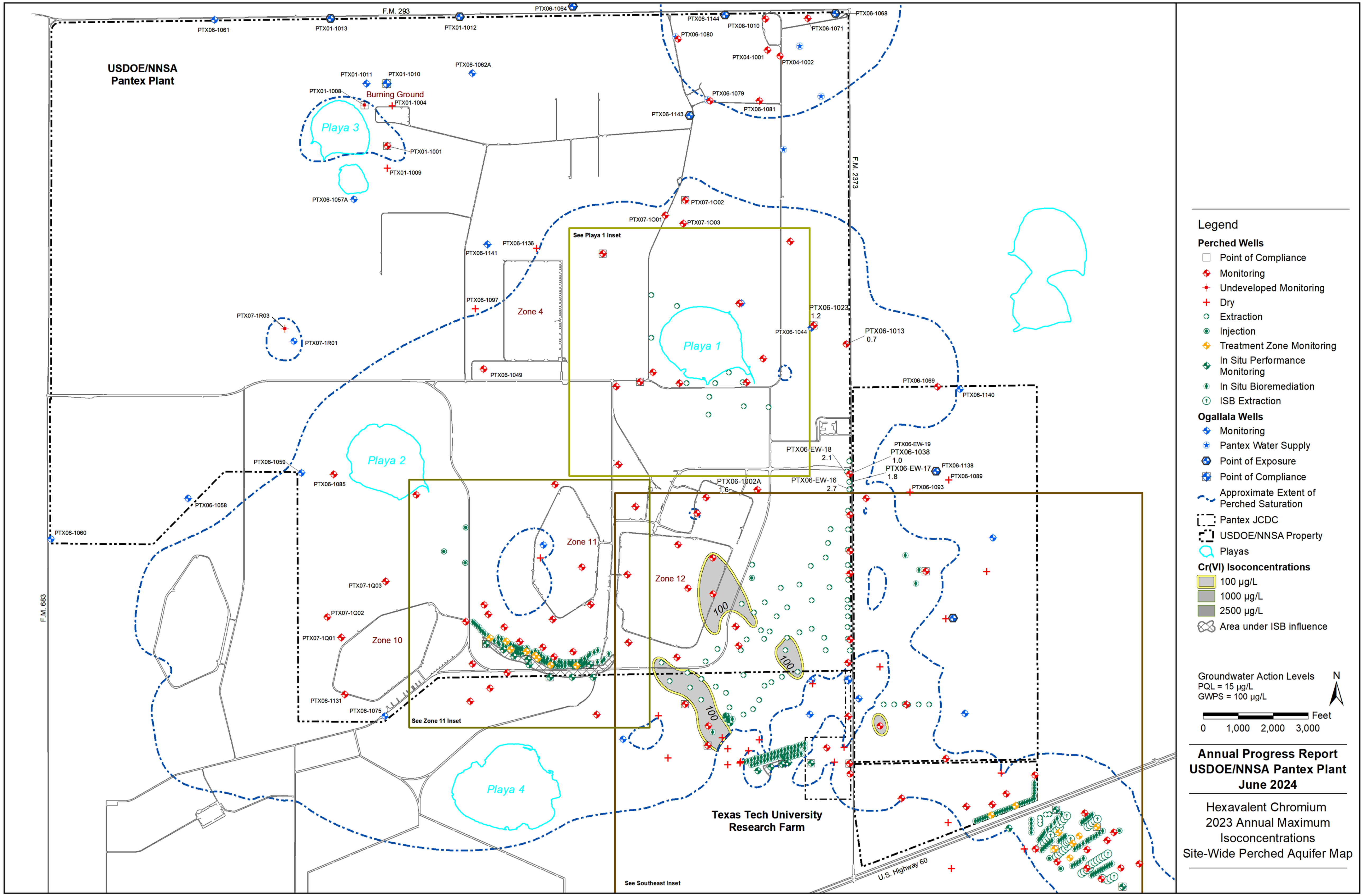

Fig. 3-18. Hexavalent chromium isoconcentration map.

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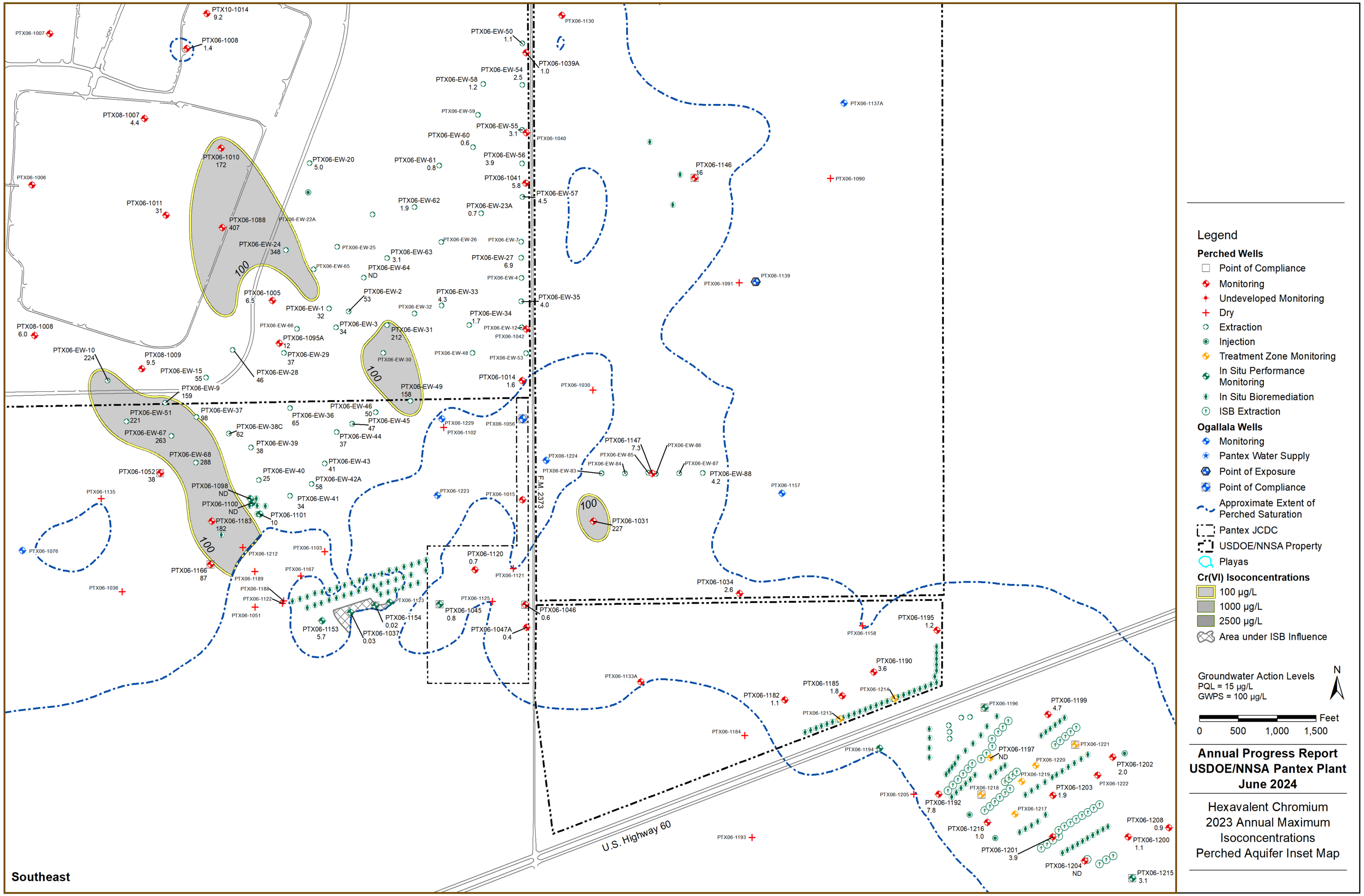

Fig. 3-19. Hexavalent chromium isoconcentration southeast inset map.

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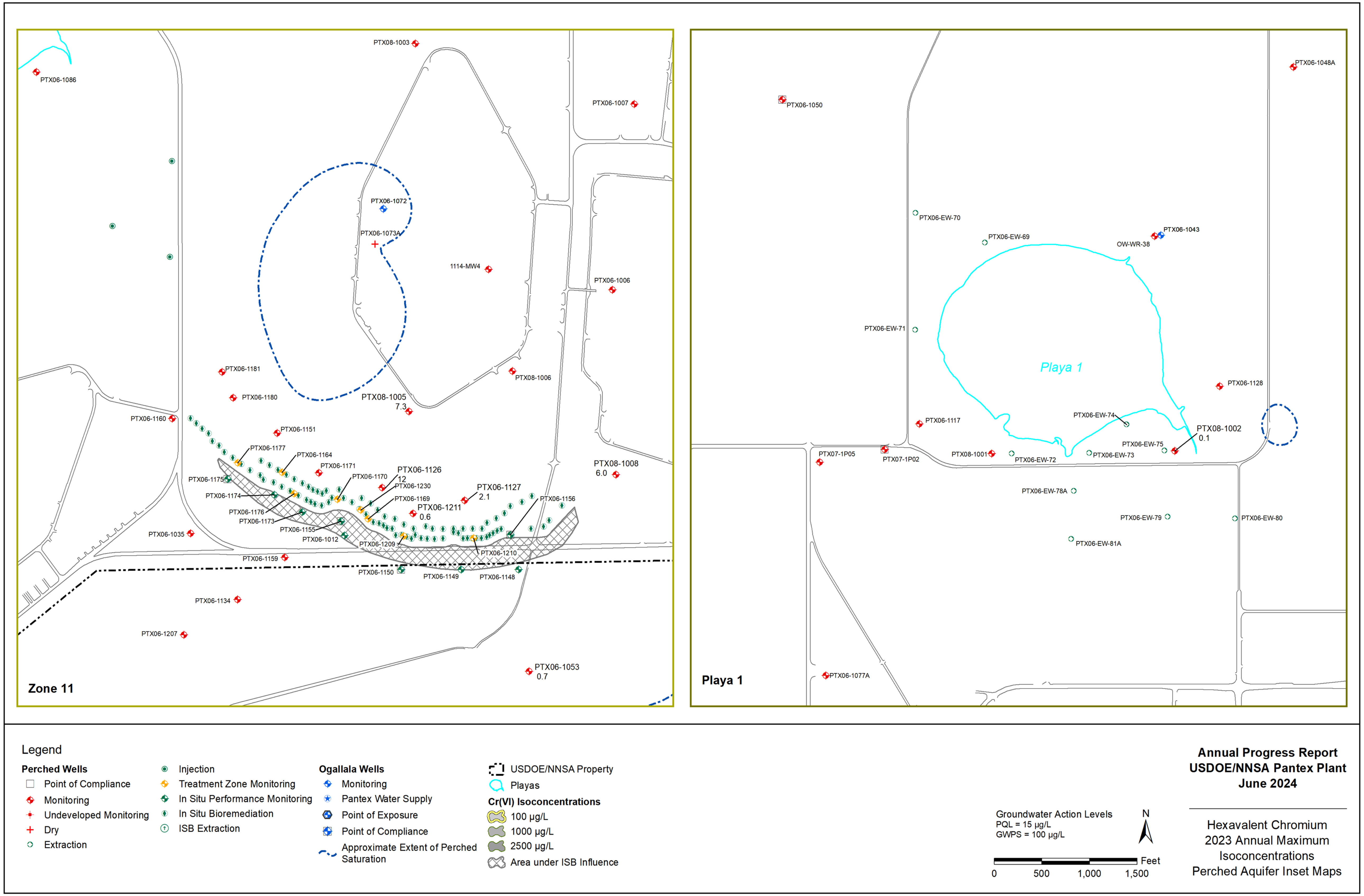

Fig. 3-20. Hexavalent chromium isoconcentration Zone 11 and Playa 1 inset maps.

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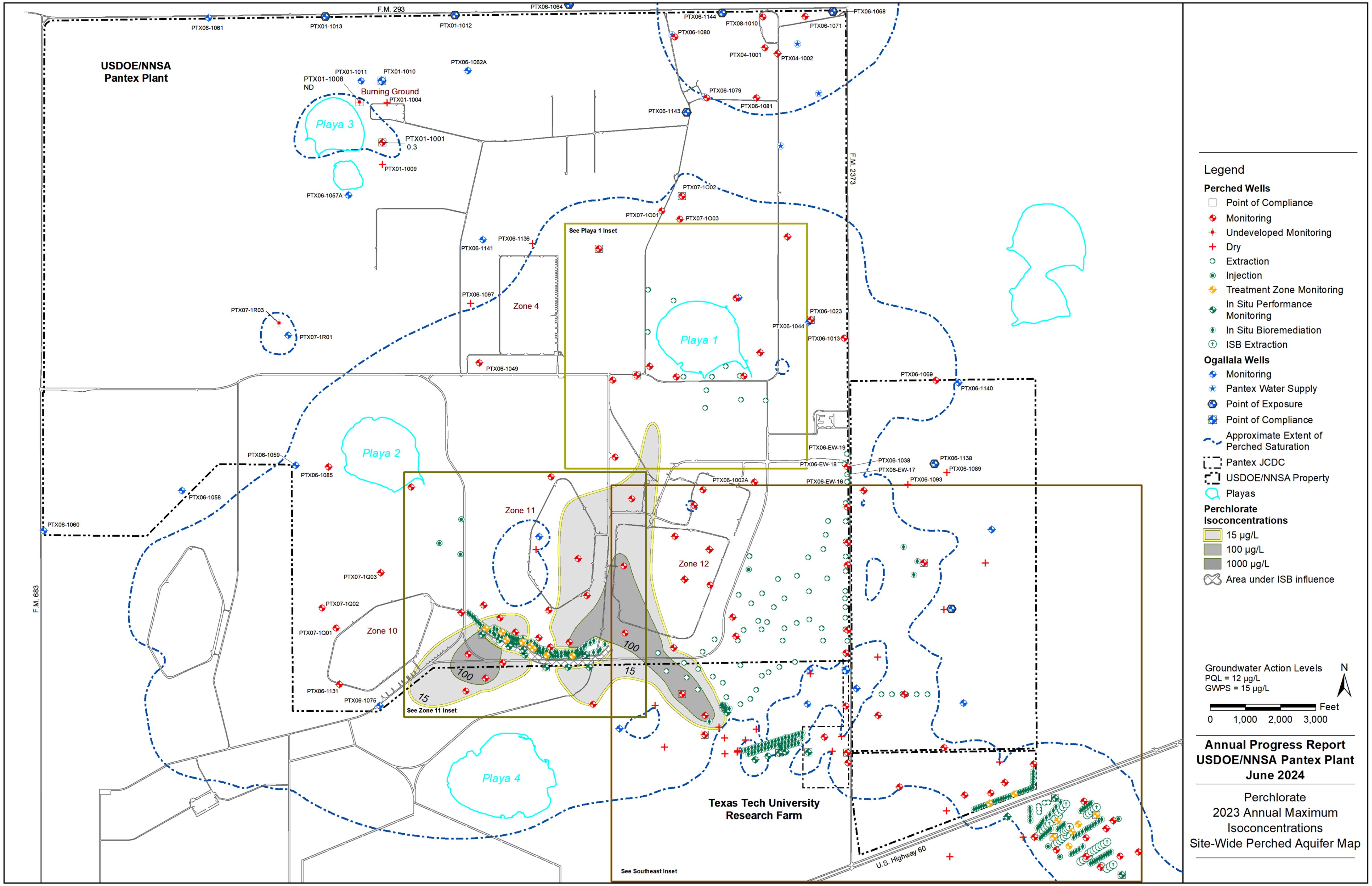

Fig. 3-21. Perchlorate isoconcentration map.

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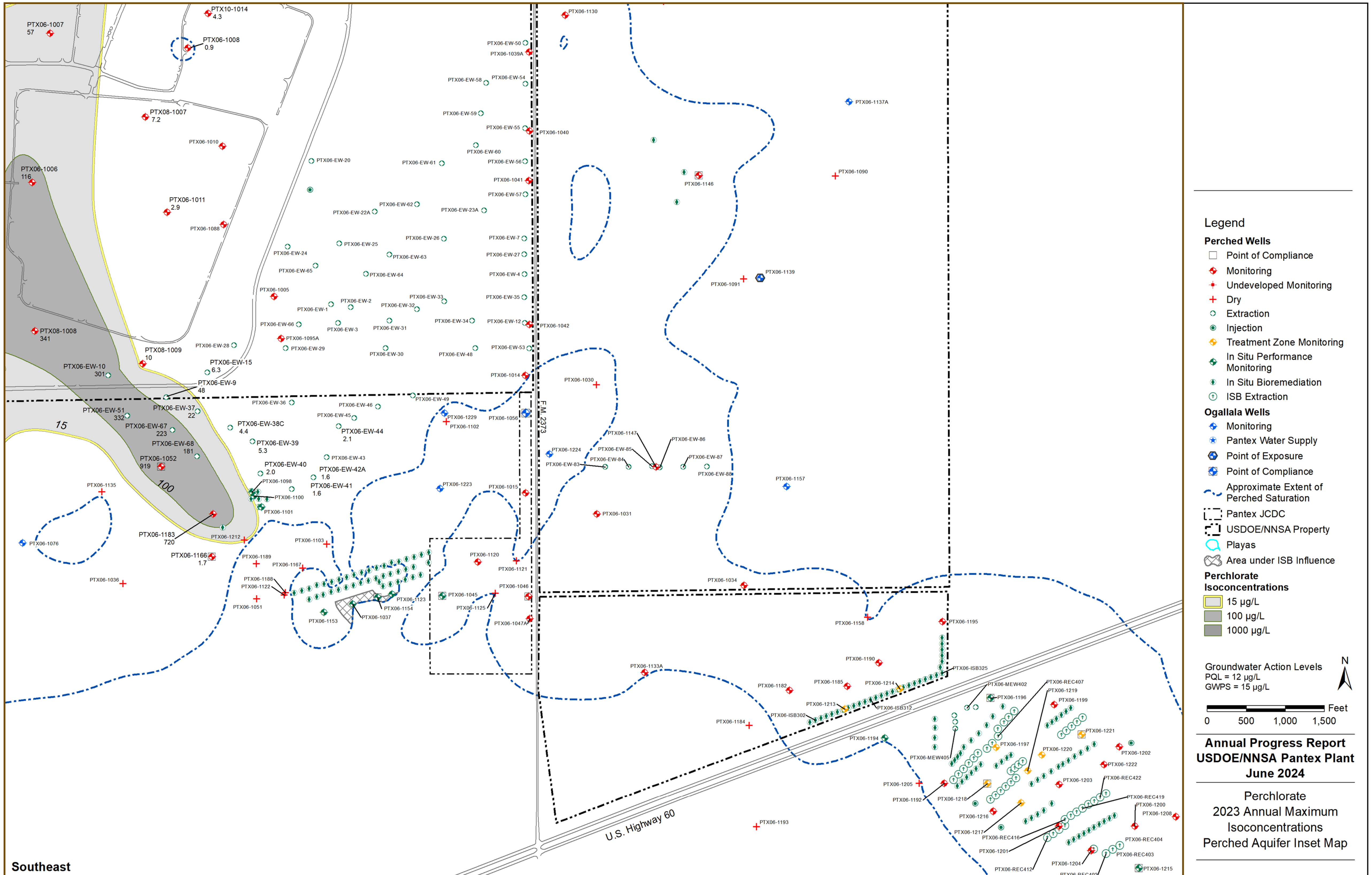

Fig. 3-22. Perchlorate isoconcentration southeast inset map.

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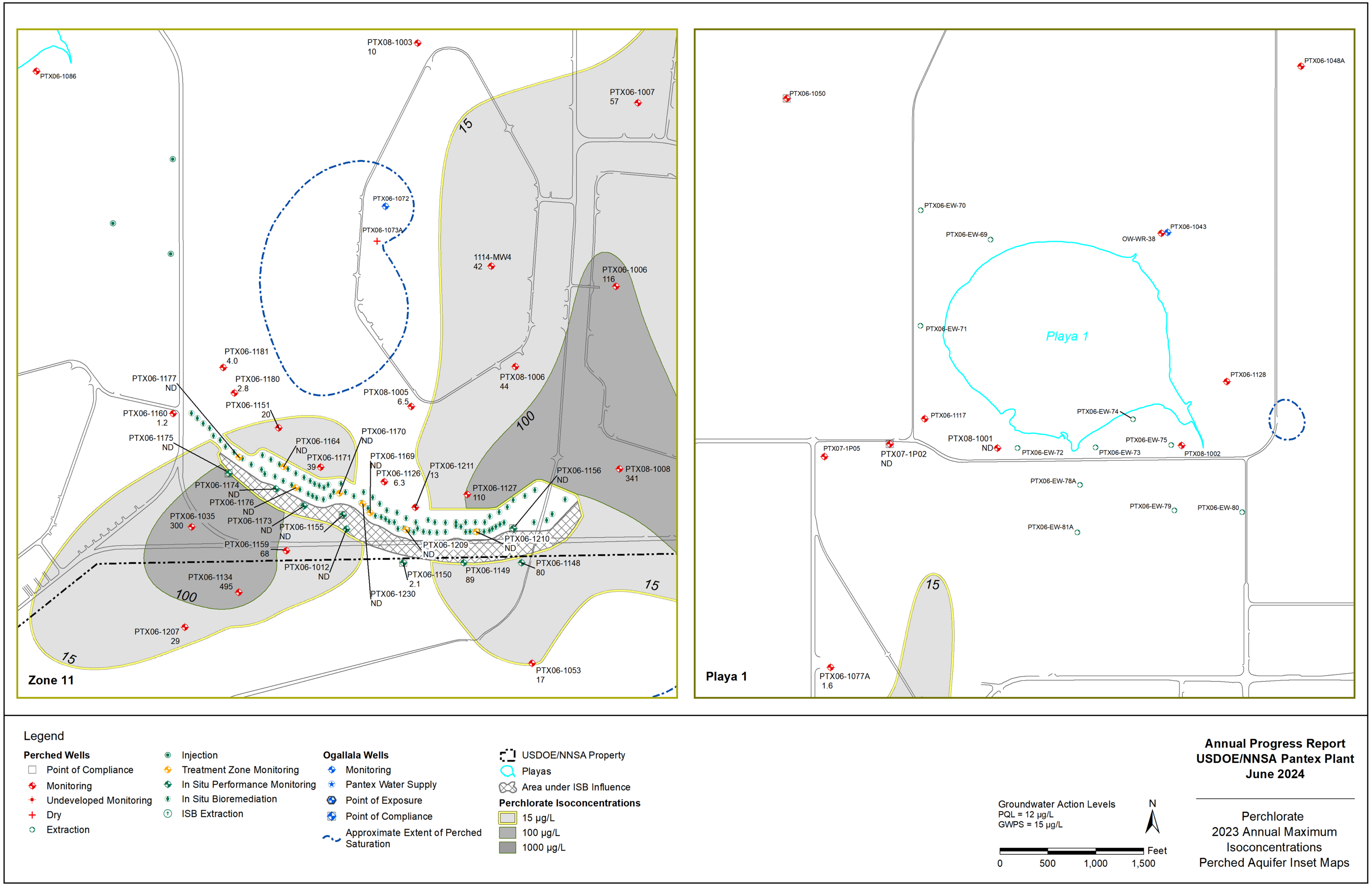

Fig. 3-23. Perchlorate isoconcentration Zone 11 and Playa 1 inset maps.

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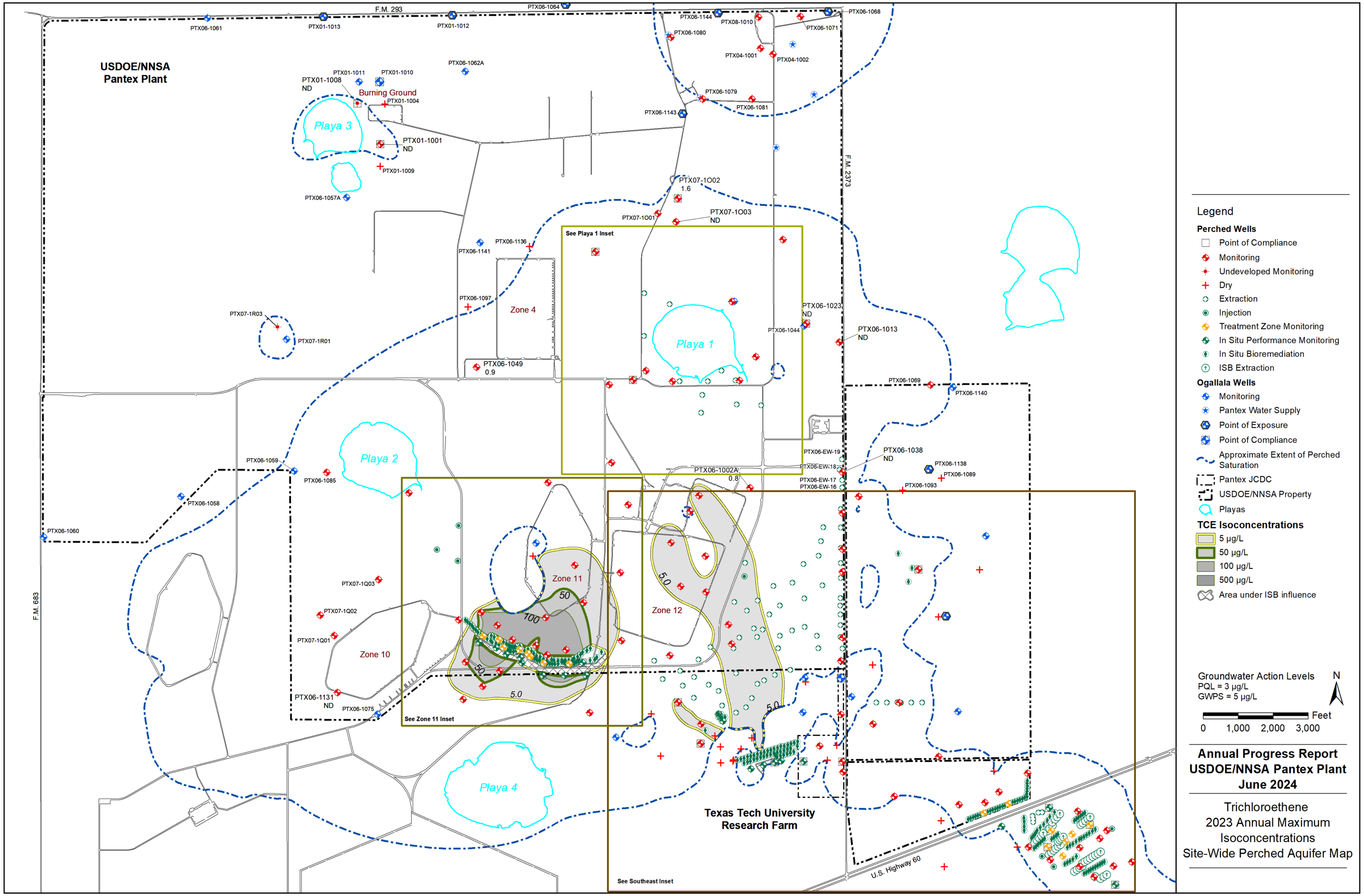

Fig. 3-24. TCE isoconcentration map.

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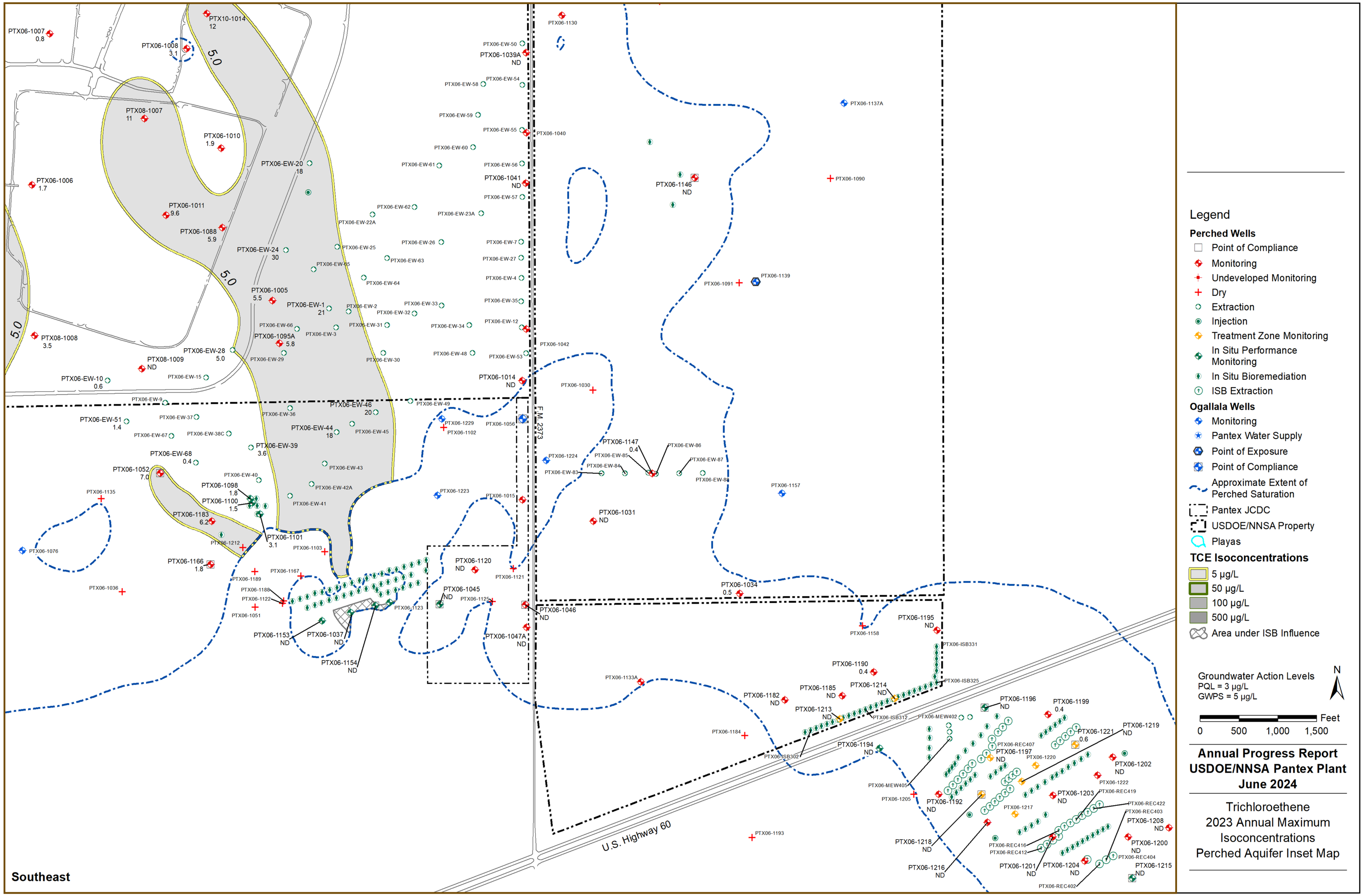

Fig. 3-25. TCE isoconcentration southeast inset map.

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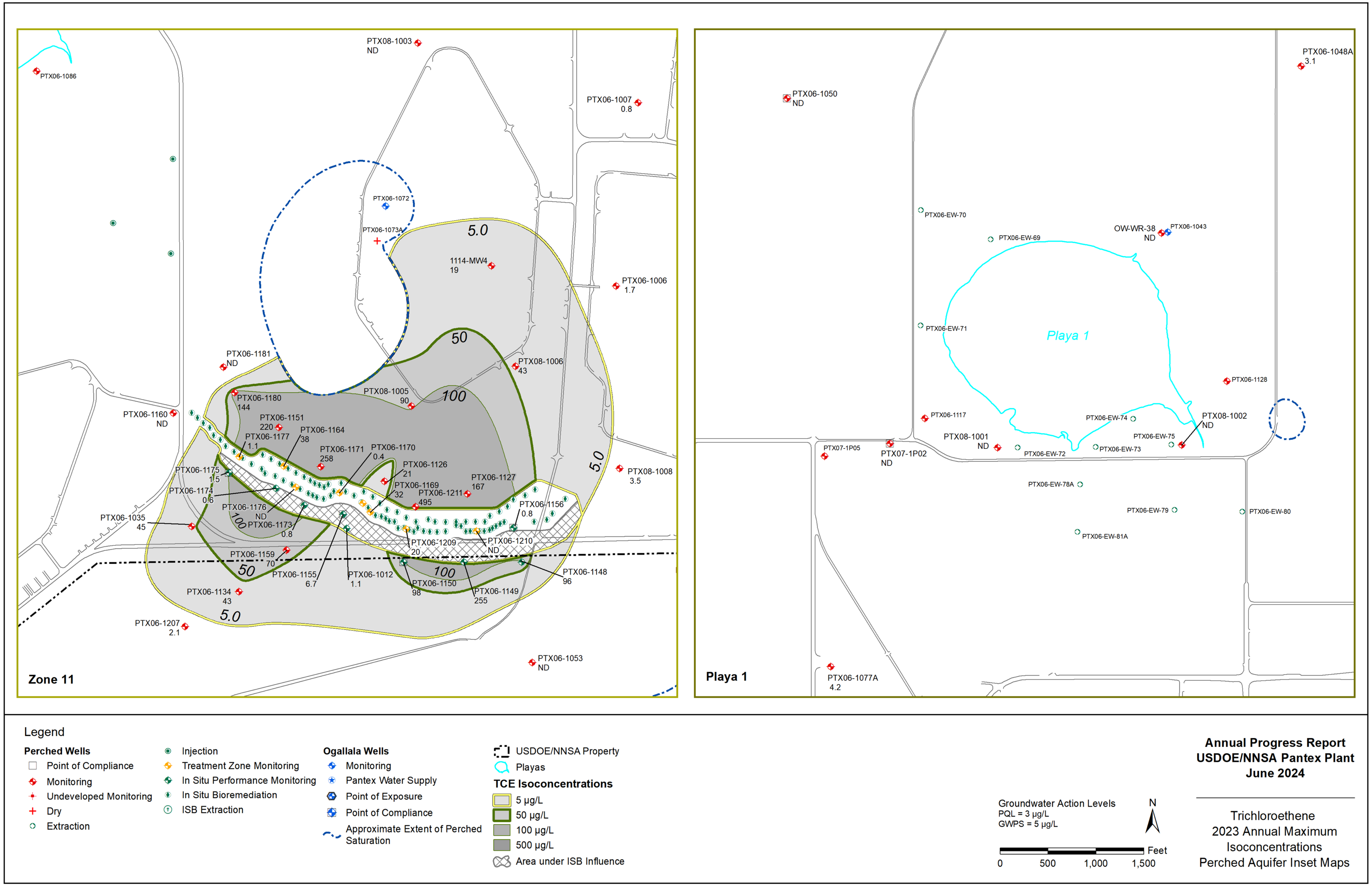

Fig. 3-26. TCE isoconcentration Zone 11 and Playa 1 inset maps.

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3.1.7 Estimate of Plume Movement

The unique characteristics of the perched aquifer, including the limited areal extent of the aquifer, cause difficulty when estimating the rate of migration of groundwater contaminants. Unlike a typical contaminant plume in a regional aquifer, the HE plumes associated with Pantex (see Fig. 3-12) extends to the edge of aquifer saturation, because this part of the aquifer was largely created by the infiltration of industrial wastewater discharges from legacy activities at Pantex. Furthermore, the movement of contaminants within the plume is difficult to assess because of the impacts of the groundwater treatment systems. COC concentration trends for individual wells are presented in Appendix E.

The approved LTM network has been in place since 2009, making it possible to compare the size and shape of plumes from specific time periods. Previous attempts to quantify plume movement by calculating plume centroids were unsuccessful, possibly due to asymmetrical plume shapes and remedial action effects. Therefore, only a qualitative discussion of plume movement from 2009 to 2023 is included in the following sections. Estimated plume boundaries for 2023 and/or select contours were compared with the 2009 isocontour maps. As additional data are collected, quantification of plume movement may be attempted again.

Groundwater contamination in the perched aquifer occurs as several overlapping plumes associated with historical release areas. Each of the principal plumes is discussed below.

3.1.7.1 High Explosive Plumes

Several HE plumes are present in the perched aquifer. These plumes are primarily composed of RDX and TNT, including breakdown products of those compounds, and other HE constituents. The largest plume having the highest concentrations, referred to as the Southeast Plume, is located east and southeast of Zone 12 and Playa 1 and extends offsite to the south and east to the extent of perched saturation. A second HE plume occurs beneath the southeast portion of Zone 11. Other HE plumes are present in the areas surrounding Playa 1.

The Southeast Plume was formed as a result of the historical discharge of HE-contaminated process waters into unlined ditches in Zone 12. The contaminated wastewater flowed through the ditches to Playa 1, but significant volumes of the water infiltrated through the ditches. The HE plume maps presented show that the highest concentrations of HEs in groundwater occur away from the ditches, indicating that contaminated perched groundwater has moved to the southeast, away from the source areas, and that concentrations of contaminated recharge water have declined over time.

Trends in this plume's historic analytical data indicate that source areas along the ditches continue to leach HEs into perched groundwater but at much lower concentrations than what has occurred historically.

This plume is being actively remediated by the SEPTS, which limits further migration of contaminants to the east. In addition, the P1PTS is actively treating the remaining HE plume in the vicinity of Playa 1 as well as reducing the head driving the Southeast Plume movement. The Southeast ISB system is also actively treating the HE plume before reaching the area beneath TTU property where the FGZ becomes less resistant to vertical migration.

The Zone 11 plume was formed as a result of the discharge of HE-contaminated process waters into unlined ditches and ponds in Zone 11. Groundwater contaminant concentrations in wells located along the southeast perimeter of Zone 11 are increasing while concentrations at the south end of Zone 11 are decreasing. These increasing concentrations indicate movement of the plume away from upgradient source areas rather than increasing concentrations related to a source near the well.

HE plumes surrounding Playa 1 are likely associated with water infiltrating from the playa. Wells installed near Landfills 1 and 2 along with OW-WR-38 and PTX06-1049 are exhibiting some increasing trends in HEs. However, these trends are likely due to the reduction of saturated thickness and shifting gradients in the northern perched groundwater due to the P1PTS's operations rather than sourcing from the landfills. Trends will continue to be monitored at these locations.

To evaluate HE plume movement from 2009 to 2023, the RDX plume was chosen due to its size and distribution near the remedial actions. Considering the size and complexity of the RDX plume and the fact it is defined by the perched aquifer extent in many areas, the 1000-ug/L contours were included in the evaluation. These two contours represent the "hearts" of the two original plume sources (i.e., Playa 1 and Zone 12 ditches) that have since commingled in the southeast portion of the perched aquifer and are under the effects of the remedial actions.

As depicted in Fig. 3-27, the 1,000-ug/L plume outlines have slightly shifted in the SEPTS well field and shifted to the southern and eastern edge of the perched aquifer extent. This is likely due to a combination of the SEPTS operations and general plume movement in areas that are not under the SEPTS influence. For 2023, the RDX contour has extended into the far eastern and southern lobe of the perched groundwater. This shift is the result of increases in RDX to above 1,000 ug/L at PTX06-1034, PTX06-1146, and PTX06-1190 coupled with recent additional investigation of the perched groundwater in this area. Movement of the plume in this area appears to be associated with faster groundwater flow paths along channel-type features on the top of the FGZ. Pantex determined the downgradient extent of the plume in early 2019 with the installation of six new wells to the southeast and, to intercept this plume as it migrates to the southeast, has completed a line of injection wells as part of an extension of the Southeast ISB remedy.

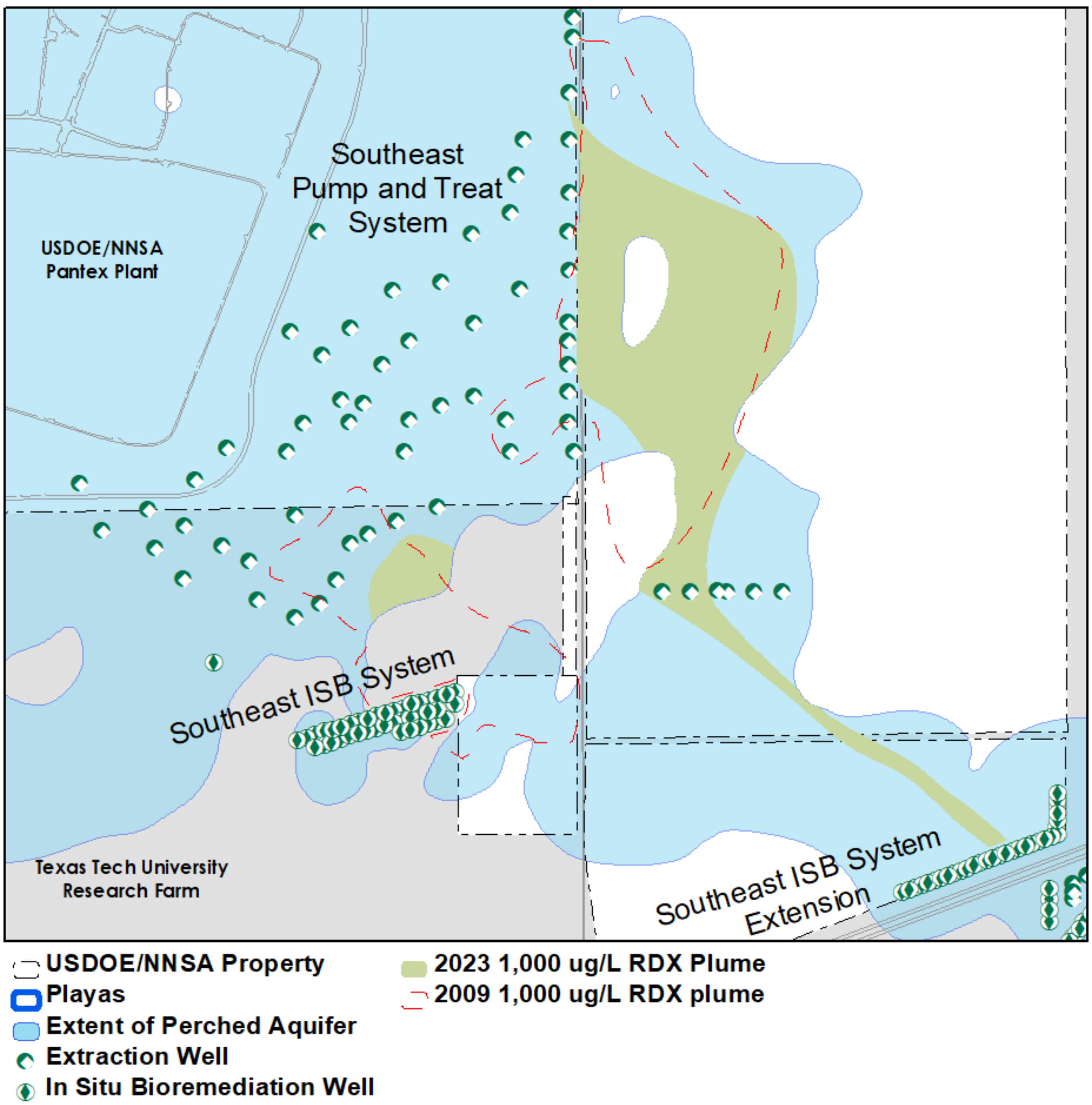

Fig. 3-27. RDX plume movement, 2009-2023.

3.1.7.2 Hexavalent Chromium Plumes

As shown in Fig. 3-18 and Fig. 3-19, hexavalent chromium is present in the perched aquifer in three plumes originating in Zone 12. These plumes are being actively remediated by the SEPTS.

The highest concentrations are associated with a source in Waste Management Group 5 outside the southwestern corner of Zone 12. Concentrations near the source area are decreasing (based on trend analysis of nearby wells), indicating that the source is declining. However, concentrations within the plume and in the far downgradient wells are variable, and the plume continues to move offsite to the southeast and extends to the limit of perched aquifer saturation on TTU property.

A smaller plume of hexavalent chromium emanates from the area of the Former Cooling Tower on the east side of Zone 12. Concentrations in this plume have decreased, but data from PTX06-1010 indicate the source area continues to leach contamination to the perched groundwater.

When compared with the 2009 hexavalent chromium maps (see Fig. 3-28), the shapes are similar, with the following exceptions:

- The northern lobe of the plume has apparently shifted to the east, likely due to a combination of the SEPTS extraction well pumping and reduction of injection in the area.
- The resulting southern plumes are a result of historical high injection rates that have pushed the plume to the southeast. Removal of injection and continued treatment of the plume by SEPTS has again resulted in two distinct plumes. The southwest plume is generally moving downgradient, with portions extending beyond the SEPTS system. The plume is also contracting across the southeast plume. These portions of the plume are expected to be captured by SEPTS.

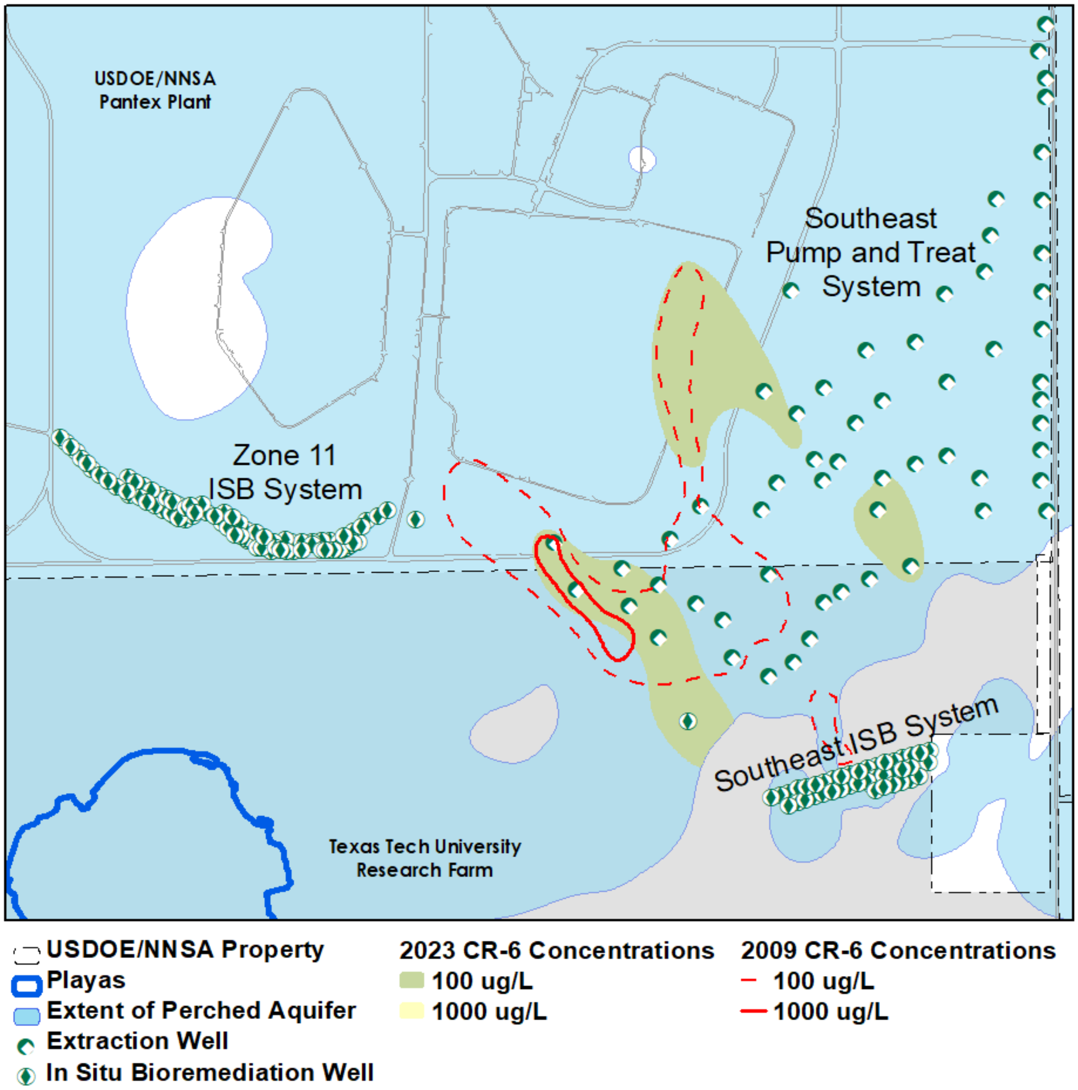

Fig. 3-28. Hexavalent chromium plume movement, 2009–2023.

3.1.7.3 Perchlorate Plume

A single plume of perchlorate occurs in the perched aquifer underlying Zone 11 and the western portion of Zone 12. This plume extends northeast toward Playa 1 and southwest beneath the TTU property, as shown in Fig. 3-21, Fig. 3-22, and Fig. 3-23. This plume is associated with the historical release of perchlorate from processes in Zone 11 to unlined ditches that carried the untreated water to the playa.

Concentrations of perchlorate in areas underlying the potential source areas in Zone 11 are generally decreasing, and perchlorate concentrations are decreasing or remain steady near the ditch to Playa 1. Perchlorate concentrations near the southern boundary of the plant continue to generally increase. This plume is being actively remediated by the Zone 11 ISB system, though portions of the plume have moved outside of the Zone 11 ISB area of influence and into the SEPTS wellfield and beyond.

In 2022 as part of the ESD, the action level (GWPS) was updated for perchlorate from 26 ug/L to 15 ug/L. For comparison purposes, the 2023 26 ug/L contour is depicted in Fig. 3-29 to not only show the difference in the updated lower limit but also for comparison of the 2009 plume shape versus the 2023 plume shape. As depicted in Fig. 3-29, the perchlorate plume shape is similar to the 2009 plume map, with the following notable exceptions:

- The southern lobe of the plume has shifted to the south and west likely due to advection and dispersion, as indicated by data collected from newly sampled monitoring wells. Recharge from Playa 4 to the south may also have an influence on plume movement south of Zone 11.
- The southeastern boundary of the plume has shifted east because of the increase of perchlorate in PTX08-1008 first observed in 2008 and in the four westernmost SEPTS extraction wells. Additionally, two wells located south of the SEPTS wellfield had detections of perchlorate near or above 500 ug/L further expanding the plume to the southeast.

The hydraulic gradient in the area between the southern parts of Zones 11 and 12 has shifted more eastward because of the influence of the SEPTS and the decline in perched water levels. This shift in the hydraulic gradient has allowed perchlorate to migrate east and southeast, with perchlorate moving into the SEPTS well field.

Portions of the perchlorate plume are being actively remediated by SEPTS at this time. In 2022, extraction wells with the highest perchlorate concentrations were tied into a new treatment process at SEPTS. Two new perchlorate resin vessels were installed in August 2022 at SEPTS to capture perchlorate as it came into the SEPTS wellfield. However, the southern portion of the plume may be outside the SEPTS capture zone. Installation of a new perchlorate/chromium (PCR) ISB is planned for the future to address the leading edge of the southeastern moving plume.

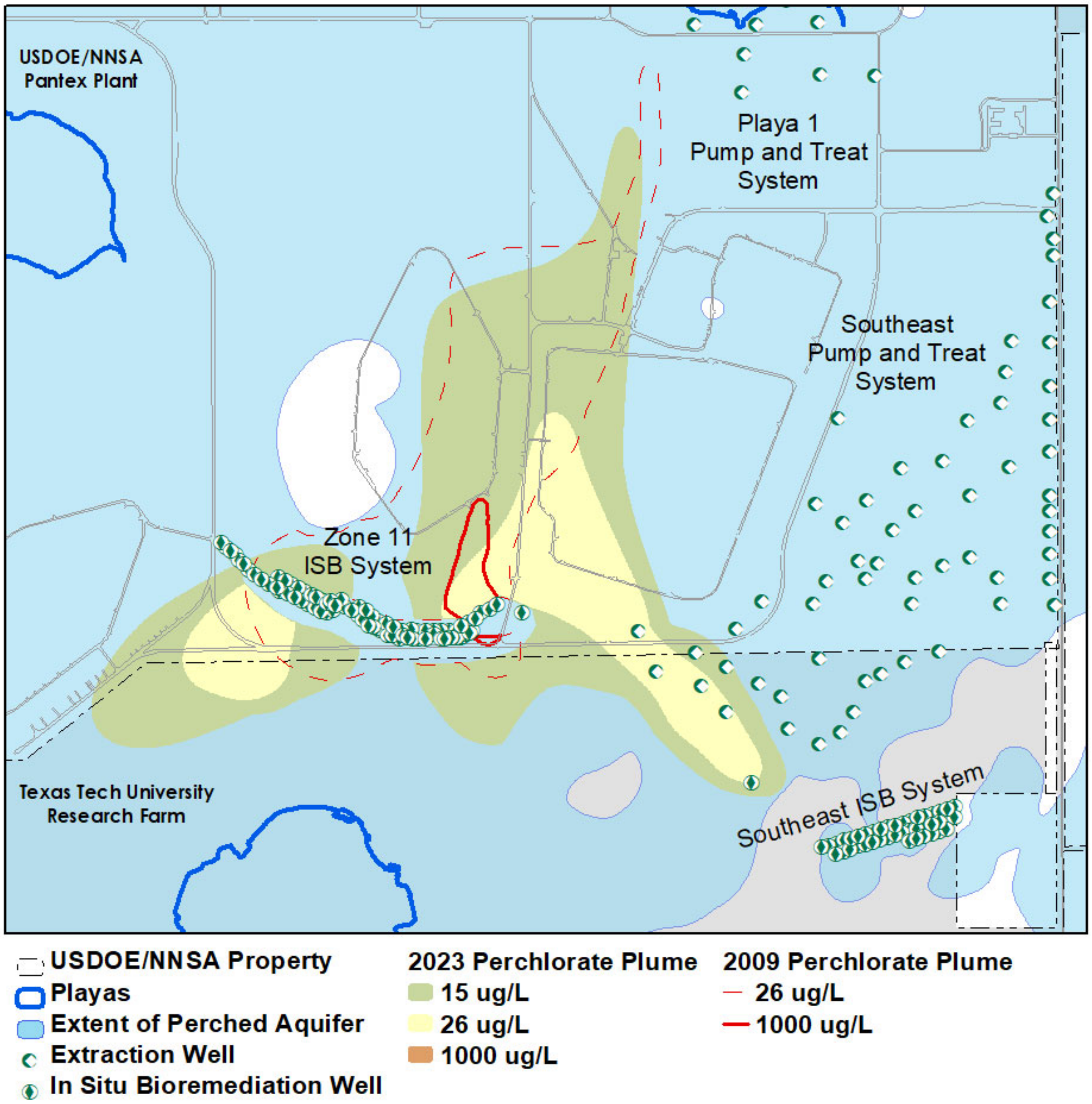

Fig. 3-29. Perchlorate plume movement, 2009-2023.

3.1.7.4 TCE Plumes

Several TCE plumes are present in the perched aquifer, as shown in Fig. 3-24, Fig. 3-25, and Fig. 3-26. TCE plumes in Zone 12 originate in the north (source area in WMG 10) and the east (source area in SWMU 122b) side of Zone 12 and extend to the southeast. Another TCE plume originates beneath Zone 11 and extends to the south off-site. TCE in the perched aquifer occurs from partitioning of TCE in soil gas into perched groundwater and TCE-contaminated process water associated with legacy discharges leaching into unlined former pits and ponds.

Groundwater concentrations of TCE in the wells on the east side of Zone 12 indicate a continuing source of TCE to the groundwater. This plume is being actively remediated by the SEPTS. PTX10-1014, which is near WMG 10 in the northern part of Zone 12, is exhibiting a stable trend in TCE.

The TCE plume underlying Zone 11 is associated with legacy HE operations that resulted in industrial wastewater infiltrating into the subsurface and TCE in soil gas originating from several areas within that zone. Concentrations in this plume are decreasing at all wells beneath Zone 11, except PTX08-1006 where concentrations are increasing; this indicates continuing migration of TCE in the perched groundwater from beneath Zone 11. This plume is migrating southward and observed concentrations at the TTU property boundary are increasing. As discussed in Section 3.2.3.1, this plume is being actively remediated by the Zone 11 ISB system.

As depicted in Fig. 3-30, the 2009 and 2023 TCE plume shapes are similar, with the following notable exceptions:

- The plume originating from Zone 12 has contracted and split into to two plumes near the source areas. The Zone 12 plume has shifted directions over time due to injection of treated water into injection wells near Zone 12. Data collected in the Southeast ISB System ISPM wells indicate the plume has been treated and the plume has contracted above the Southeast ISB.
- The plume originating from Zone 11 has shifted to the south and west due to the general gradient in the area and recently installed wells to the west. The TCE plume beneath Zone 11 continues to expand to the east as a result of the shifting flow gradients in perched groundwater.

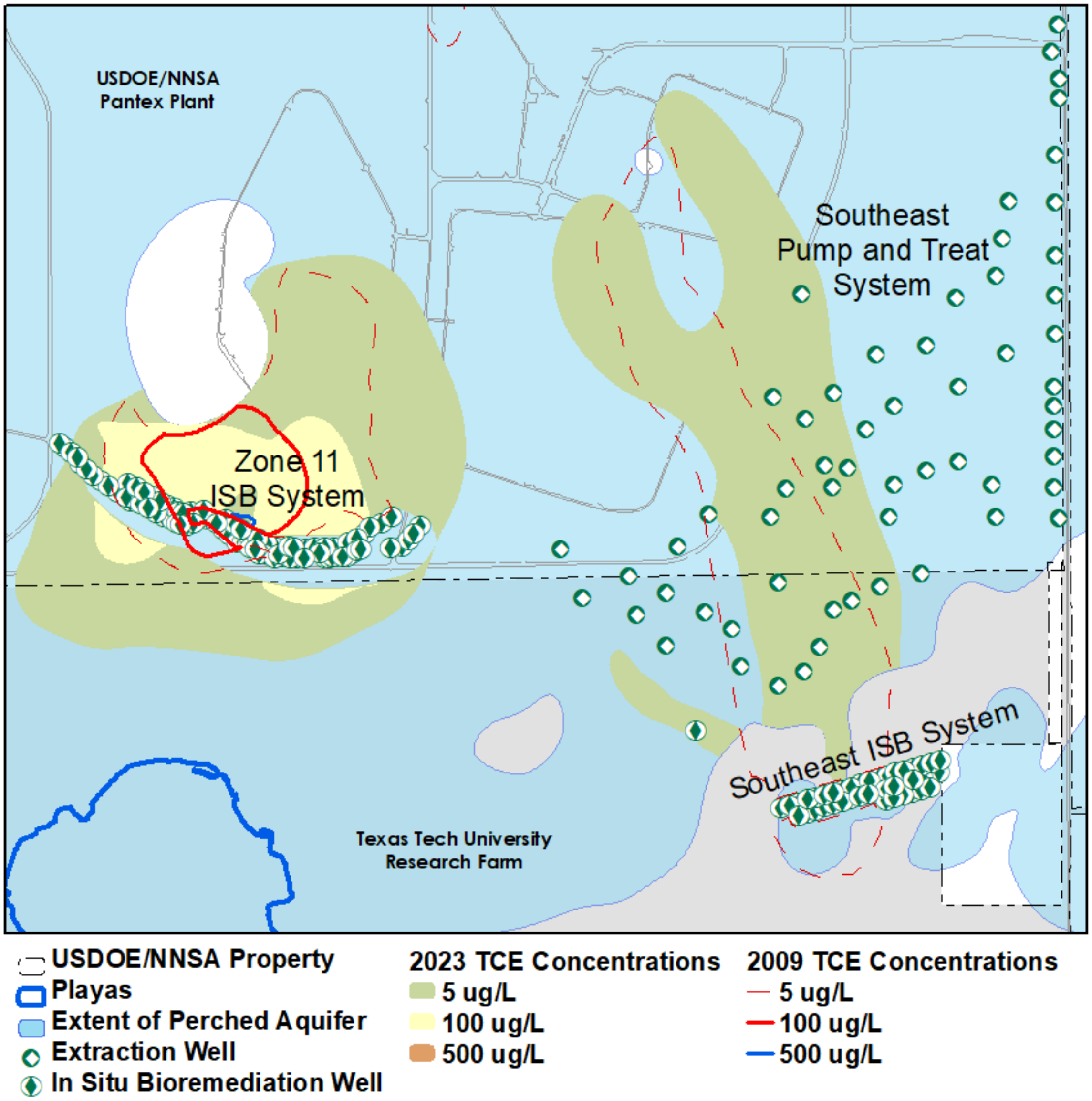

Fig. 3-30. TCE plume movement, 2009-2023.

3.2 Remedial Action Effectiveness

3.2.1 Southeast Pump and Treat System

The objective of the SEPTS (see Fig. 1-7) is to remove contaminated perched groundwater and treat it for industrial and/or irrigation use. While the capability is being maintained for injection of treated water back into the perched zone, the intent is to permanently remove perched groundwater to gradually reduce the saturated thickness in this zone and to achieve the following two important goals:

- A gradual reduction of the volume of perched groundwater and contamination moving downgradient toward the extent of saturation
- A reduction in the head (i.e., driving force) for vertical migration of perched groundwater into the FGZ and toward the drinking water aquifer

The SEPTS has altered the groundwater flow direction and gradient at localized areas near the extraction wells in the perched aquifer. Figure 3-31 illustrates the influence of this pump and treat system and the P1PTS. Water levels measured at the extraction wells were not used in the interpretation of water table contours so that cones of depression would not be overestimated. Localized cones of depression are present surrounding several extraction wells, but the formation of an extensive cone of depression throughout the system is limited by the thin saturated thickness in the perched aquifer.

The water table map indicates groundwater is still flowing southeastward across the USDOE/NNSA property boundary onto TTU property. However, extraction wells located on the TTU property limit the further migration of perched groundwater contaminants to the south. Water table contours along FM 2373 indicate groundwater is flowing primarily to the south along the USDOE/NNSA property boundary, thus limiting the transport of perched aquifer contaminants eastward. The hydraulic gradient varies greatly in this area because of the influence of the SEPTS. Very steep gradients occur locally near many of the extraction wells, and the southerly flow direction is reversed in some areas.

3.2.1.1 Hydrodynamic Control

By using extraction wells to alter the hydraulic gradient, hydrodynamic control limits the horizontal migration of contaminants. Because of the limited saturated thickness of the perched aquifer, complete hydraulic containment of the contaminant plume is not possible. However, the SEPTS has effectively altered the hydraulic gradient to limit the movement of contaminants.

Analysis of groundwater flow directions, as indicated by water table contours, shows that the SEPTS has reduced the eastward movement of perched groundwater across FM 2373 and limited expansion of the plume south of the extraction wells on TTU property. In addition, removing perched groundwater has caused the extent of perched saturation on TTU property to retreat significantly. Figure 3-31 shows the approximate radius of influence of the groundwater treatment systems and the directions of perched groundwater flow gradients outside the radius of influence. Capture zones, shown in Fig. 3-31 for the extraction wells, were calculated using a single-layer groundwater flow model of the perched aquifer. Average 2023 extraction flow rates for each well were used in the calculations.

Operation of the pump and treat systems was affected in 2023 by repairs at the WWTF, limiting use of the subsurface irrigation system, and tie-in of components for the new pivot irrigation system. As a result, the capture zone is expected to be impacted. Operation of new wells east of FM 2373 that were tied into the system in March 2019 has improved the capture of water to the east of FM 2373, but as the new wells are prioritized for operation, other areas may continue to be impacted by the lower flow rates at the SEPTS.

Pantex completed repairs to the break at the older subsurface irrigation system, but flow through the systems remains limited due to replacement of lagoon liners that started in 2022. Additional repairs must be made to the WWTF lagoon, which will limit WWTF storage through 2024. To address issues regarding the release or use of treated water, Pantex is pursuing more than one option to enable consistent operation of the systems in the future and provide the flexibility needed to balance the impacts associated with each option implemented alone. To provide additional long-term use of treated water, Pantex finished installing in 2023, other irrigation alternatives on the property east of FM 2373. Funding was received in fiscal year 2021 to construct infrastructure for irrigation on land east of FM 2373 using center pivot sprinklers. Pantex completed the design of the new irrigation system in May 2021. Construction of the system began in November 2021, with final commissioning and operation in August 2023.

Pantex also constructed three new perched injection wells to the east of Playa 2 and northwest of the Zone 11 ISB. Construction of the injection wells and infrastructure was completed in 2022. These new injection wells provide a consistent outlet for approximately 150 gpm of treated water when irrigation is unavailable for the beneficial use of treated water. These wells also provide a method to inject the treated water without affecting the movement and capture of plumes in the southeast area.

With both of these options implemented, the systems will be able to consistently operate at or near capacity.

3.2.1.2 System Effectiveness

Because the primary goal of both pump and treat systems is to affect plume movement and reduce saturated thickness in the perched aquifer, the plume stability discussion in Section 3.1 can be used to determine the effectiveness of these systems. Overall, when operating, the pump and treat systems continued to be effective in 2023. When comparing 2023 conditions to the LTM design's expected conditions, the majority of monitoring wells are meeting expected conditions in the fourteenth year of the remedial action. The LTM wells not meeting expected conditions for water levels are summarized in Section 3.1.4. The wells have primarily been impacted by the inability to send water to the onsite subsurface irrigation, requiring release of wastewater and treated perched water to Playa 1 and reduced operation of P1PTS, as well as an above-average yearly rainfall.

As a part of the secondary goal of mass removal for the SEPTS, the system continued to remove HEs, hexavalent chromium, and perchlorate and treated 132.2 Mgal of extracted water to concentrations below the PQL and the GWPS during 2023. As discussed in Section 2.1.2, the SEPTS was primarily affected by the loss of throughput to the WWTF and construction activities related to the new pivot irrigation system. As a result, the SEPTS did not consistently meet all throughput goals during 2023; however, Pantex continues to optimize the system operation. During 2023, P1PTS was shut down until July 2023 for installation of new components for the new center pivot irrigation system allowing SEPTS to operate continuously.

In 2023, Pantex started evaluating PFAS at the pump and treat systems. PFAS is present in the influent water treated by SEPTS and is also found in the extraction wellfield. The GAC used at the systems is effectively removing the PFAS to concentrations less than the TCEQ TRRP PCLs. Additionally, the six PFAS constituents with MCLs promulgated in April 2024 were detected in the influent groundwater, but SEPTS effluent detections were less than the MCLs, demonstrating effective treatment of PFAS through the system.

Pantex conducted a formal optimization analysis for the SEPTS and P1PTS using a fate and transport model of the perched aquifer. The results of the analysis were delivered to Pantex in September 2021 and will be used to develop an extraction strategy that maximizes mass removal and plume control while reducing saturation and guide the operation of the pump and treat systems in the future. It was determined through the optimization, the systems may only be feasibly operated for another 10-15 years, due to reduction in saturated thickness across the extraction wellfield. It has been determined that over 50% of the RDX mass has been removed by the systems.

3.2.2 Playa 1 Pump and Treat System

The P1PTS was completed in 2008 with operations starting in September 2008. This system extracts water from 11 wells near Playa 1 (see Fig. 1-6) and treats the water through a series of GAC beds and ion exchange process units to reduce HEs and metals below the GWPS established in HW-50284 and the ROD. The objective of this system is to achieve mass removal and reduce the mound of perched groundwater associated with Playa 1, which affects the movement of the Southeast Plume by reducing the hydraulic head.

The P1PTS appears to be influencing local water levels, as well as the hydraulic gradient, in the Playa 1 area, when operating. Figure 3-31 illustrates the influence of both groundwater pump and treat systems. Water levels measured at the extraction wells were not used in the interpretation of water table contours so that cones of depression would not be overestimated.

The water table map indicates the mound of groundwater beneath Playa 1 has been reduced since the groundwater high in the perched aquifer is now to the north; however, groundwater levels near the playa are increasing because of the volume of treated water extracted and discharged to the playa due to limitations of beneficial reuse. Groundwater is still generally flowing away from the Playa 1 region then to the south and southeast across the USDOE/NNSA property boundary onto TTU property or the offsite property to the southeast. As the perched aquifer saturated thickness continues to be reduced in this region, this flow should decrease and reduce the driving head. In addition, the SEPTS extraction wells limit further migration of perched groundwater contaminants to the south.

The hydraulic gradient is affected by pumping at the P1PTS well field and is difficult to estimate. Very steep gradients occur locally near most of the extraction wells, and the general flow patterns are reversed in some areas.

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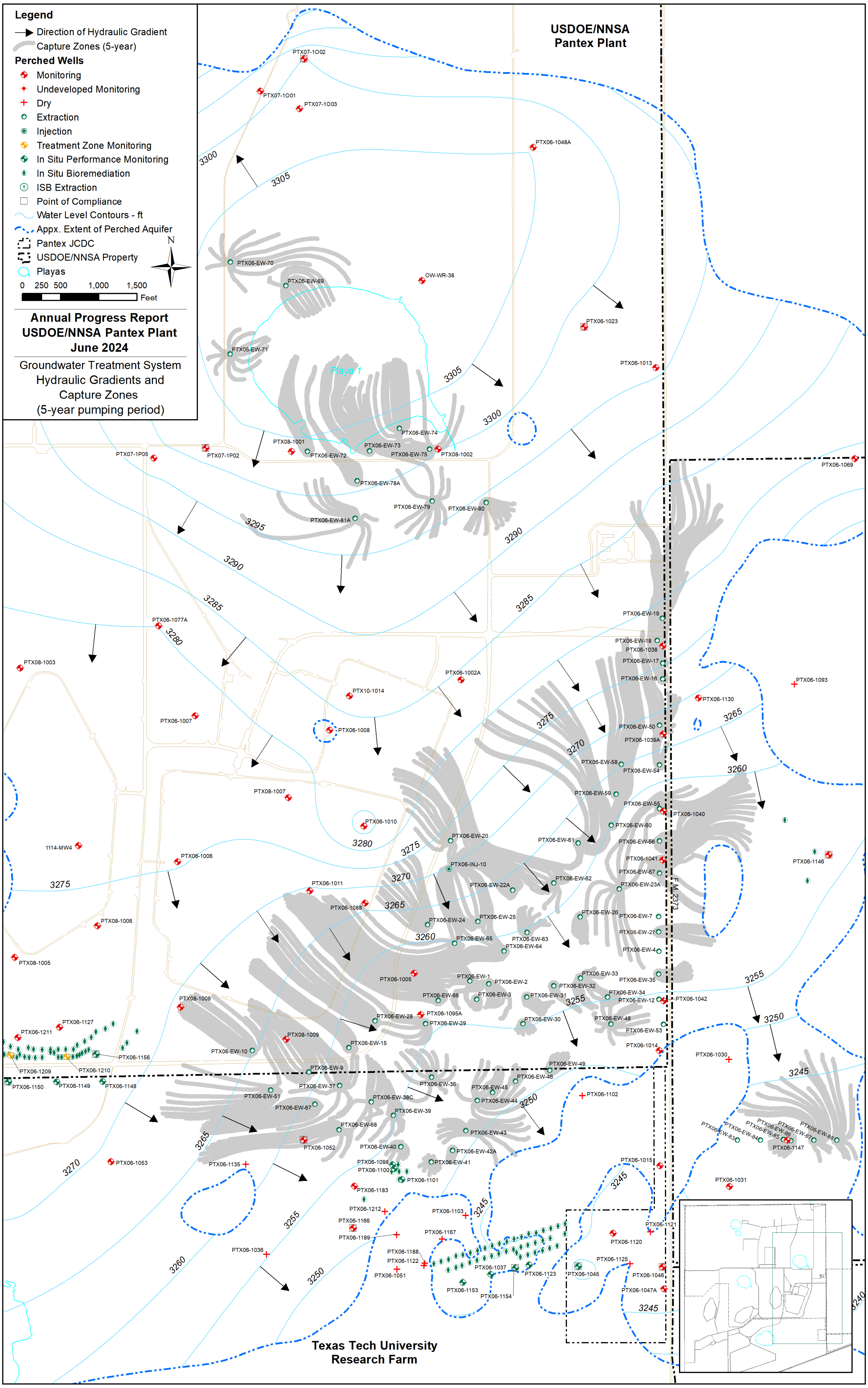

Fig. 3-31. Pump and Treat System capture zones.

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3.2.2.1 System Effectiveness

As noted for the SEPTS, the pump and treat systems continue to be effective in 2023. When comparing 2023 conditions to the expected conditions detailed in the LTM design, most wells are meeting expected conditions.

During 2023, the system treated approximately 28.2 Mgal of extracted water. As discussed in Section 2.1.1, total flow at the P1PTS was affected by construction activities or limited to allow for higher recovery at the SEPTS because increased recovery at SEPTS provides better control of the RDX plume movement to the southeast.

Impacts from the irrigation system break and construction activities related to the new center pivot irrigation system were the primary reasons for reduced operations at the P1PTS. Evaluation of effluent data indicates P1PTS treated the recovered groundwater to concentrations below the PQL and GWPS.

PFAS is present at P1PTS, but the GAC used at the system is effectively removing the PFAS to concentrations less than the TCEQ TRRP PCLs and EPA MCLs. None of those PFAS constituents that were detected in the effluent had MCLs and detection limits were less than the TRRP PCLs. There is one PFAS constituent found in the effluent that does not currently have a promulgated standard and no information can be found in literature. 6:2FTS (1h,1h,2h,2h-perfluorooctane sulfonic acid) has been detected in the effluent at concentrations ranging from 6.6 to 32.9 ng/L.

3.2.3 ISB Systems

Pantex has installed and operates four ISB systems: the Zone 11 ISB, Southeast ISB, Southeast ISB Extension, and the Offsite ISB. The objective of the ISB systems is to establish anaerobic biodegradation treatment zones capable of reducing COCs to the GWPS by injecting the necessary amendments and nutrients to stimulate resident bacteria. The microbial growth first consumes oxygen and then, in turn, consumes other electron acceptors, creating reducing geochemical conditions. Under reducing conditions, biotic and abiotic treatment mechanisms occur.

The following sections provide an understanding of the expected conditions at the ISB systems and downgradient concentrations of COCs. This information is used to determine whether further injections are required for continued treatment of COCs and to ensure that COC concentrations are being reduced downgradient of the treatment zone.

To monitor the effectiveness of the treatment zones, geochemical conditions and amendment longevity become important. These indicators are used to determine if conditions are within an acceptable range for oxidation-reduction (i.e., redox) potential, electron acceptor concentrations (i.e., dissolved oxygen, nitrate, and sulfate), and nutrient supply (i.e., TOC). These parameters are important because reducing conditions and adequate nutrients must be present to treat COCs.

Because of problems with plugging of the wells, Pantex has moved to increasing soluble carbon during injection events and reducing the emulsified vegetable oil (EVO), as recommended in the *2018 Annual Progress Report* (Pantex, 2019d). An amendment dose response study performed in 2018 found that the use of more soluble carbon source amendments, such as molasses, in combination with the use of larger volumes of water and amendment results in better distribution of amendment between the injection wells and produces deeper reducing conditions within the treatment zone.

Based on the dose response study, future operation of all ISBs is primarily focused on using a more soluble carbon (e.g., molasses) to achieve the distribution needed at the systems. Molasses was injected at the Zone 11 ISB and Southeast ISB in 2023 and used exclusively at the Southeast ISB Extension and the Offsite ISB. This measure is expected to help avoid issues with well plugging or stagnation by the EVO and resulting biomass. Pantex moved to closer spacing of newly installed wells at the Zone 11 ISB in 2021 and then injected the new wells with a molasse and EVO mixture, allowing less frequent injections of EVO while maintaining a proper radius of influence for treatment. Other areas may use this approach when feasible. Pantex will continue to evaluate available data and make appropriate recommendations for treatment in future progress reports. Geochemical conditions can be evaluated to determine if adequate reducing conditions exist to achieve reduction. Figure 3-32 presents the redox ranges for the reduction of various COCs. TCE and perchlorate are the primary COCs in the Zone 11 area while HEs, primarily RDX, and hexavalent chromium are the primary COCs in the southeast area. Perchlorate degradation does not require as strongly reduced conditions as RDX or TCE.

To document the effectiveness of COC removal, downgradient wells are monitored for specific target indicators chosen for each ISB system. Target indicators include COCs that are most widespread and have the potential to affect human health if the water were to be used for residential purposes (note that perched groundwater use is controlled to prevent any potential for exposure). In addition, breakdown products are monitored to determine if complete degradation is occurring. Specific indicators are discussed separately for each system below.

In addition to specific indicators that help determine if additional injections are required, Pantex monitors for TOC, metals, and general chemistry parameters. TOC was selected as an indicator for adequate carbon sources that have remained available for continued ISB treatment. Specific metals are monitored in downstream ISPM wells to ensure that metals are returning to background conditions after leaving the treatment zone. Specific metals are expected to increase in the treatment zone because of reducing conditions that release naturally occurring metals in the formation soils. However, as water moves away from reducing conditions, the metals are expected to precipitate onto the soil matrix. The general chemistry parameters are also monitored to determine if the water is returning to baseline conditions.

3.2.3.1 Zone 11 ISB

The Zone 11 ISB system (see Fig. 1-8) has a well-established treatment zone in the original portion of the system where injection has occurred since 2009. Portions of the expansion area have received more than three injections, so deeper reducing conditions are likely established at the injection wells. In 2021, a second row of wells was added across the southern and eastern most side of the system and was injected with a mixture of molasses and EVO. More frequent injections are anticipated for molasses and are planned at least annually for the Zone 11 ISB due to the need to continue reducing conditions. Pantex will continue to evaluate the system to ensure appropriate timing of injections using molasses and a mixture of molasses/EVO.

COCs targeted for treatment by this system are perchlorate and TCE. Indicator constituents evaluated for trends at downgradient ISPM wells include TCE and its degradation products (i.e., cis-1,2-DCE and vinyl chloride) along with perchlorate. Indicator constituent concentrations are expected to decline at the downgradient monitoring wells at their estimated travel times from the treatment zones, which are discussed later in this section.

Dissolved oxygen, redox potential, nitrate, sulfate, and TOC are evaluated in the ISB treatment zone performance wells to determine if the treatment zone is rebounding to baseline conditions, thus requiring amendment injection. Redox potential and electron acceptor (i.e., dissolved oxygen, nitrate, and sulfate) concentrations in the treatment zone wells are expected to decline after injection. As shown in Fig. 3-32, strongly reducing conditions must be achieved for the reductive dechlorination of TCE to occur. The redox potential should decline from the baseline and be below –50 millivolts (mV) to reduce TCE and near 0 mV to reduce perchlorate. Concentrations of TOC should increase after injection but decline over time as the amendment is consumed.

During 2023, Pantex monitored eight TZM wells, four injection wells, and nine downgradient ISPM wells in accordance with the SAP to evaluate the Zone 11 ISB (see Section 1.4.2 map). The ISPM wells are used to monitor characteristics indicative of overall performance of the remedial system.

Table 3-2 summarizes the current and maximum COC concentrations in each ISB, TZM, and ISPM well. One of the monitored treatment zone wells (PTX06-1230) is a replacement of the original ISB injection well PTX06-ISB075 and was renamed in 2023, to avoid confusion. The original PTX06-ISB075 well continues to receive amendment and will be used until the well fails.

The Zone 11 ISB has a well-established treatment zone in the original portion of the system, as well as in the northwest expansion area, that has received five injections; therefore, deeper reducing conditions are likely established at those injection wells. Improved conditions have been noted across the western side of the Zone 11 ISB after moving to the use of molasses in recent years. However, some wells have limited ability to accept injection, and those areas will likely continue to demonstrate milder reducing conditions until the wells can be replaced. All wells downgradient of the system have indicated the arrival of treated water.

Evaluation of data in the treatment zone indicates very mild to strong reducing conditions, with the oxidation-reduction potential (ORP) ranging from -135 to 229 mV and sulfate from 0.3 to 404 mg/L across the Zone 11 ISB. At this time, sulfate is not used as an indicator of reducing conditions, due to potential addition of high level of sulfates in the treatment zone from molasses used during injections. Monitored conditions inside the treatment zone indicate negative ORP was observed in all but three wells, indicating deeper reducing conditions in most areas. Additionally, arsenic, barium, and methane remain high in most treatment zone wells indicating that deeper reducing conditions exist across most of the ISB.

By the end of 2023, perchlorate was not detected at any monitored injection well or treatment zone monitoring well. TCE continues to be reduced to cis-1,2-DCE, with TCE concentrations below the GWPS in 10 of 12 monitored wells inside of the treatment zone and cis-1,2-DCE present at concentrations below the GWPS in all but one of the sampled wells.

When greater amounts of TCE and cis-1,2-DCE are being degraded, ethene and vinyl chloride are expected to be detected. Vinyl chloride was detected in the nine sampled wells inside the treatment zone, and ethene was detected at low concentrations in three wells. The low vinyl chloride results, coupled with the detection of ethene, indicate that a portion of the TCE is being completely degraded in most areas of the treatment zone. When TCE concentrations inside the treatment zone are low (i.e., <300 ug/L), these low degradation rates are enough to treat TCE and its breakdown products to the GWPS, as indicated by downgradient monitoring well data. Upgradient data still indicate TCE concentrations periodically fluctuating right below 500 ug/L, with a maximum concentration of 495 ug/L indicated at an upgradient monitoring well in 2023.

Pantex evaluates performance at nine downgradient ISPM wells for the Zone 11 ISB. Perchlorate was detected above the GWPS in two downgradient ISPM wells in 2023, but was not detected or was below the GWPS in the other seven wells. TCE concentrations are below the GWPS in five of nine ISPM wells.

At the end of 2023, TCE was detected at or above the GWPS in four downgradient wells, PTX06-1148, PTX06-1149, PTX06-1150, and PTX06-1155. The first breakdown product of TCE, cis-1,2-DCE, was not detected above the GWPS in 2023, but all downgradient wells had detections of cis-1,2-DCE. In 2023, perchlorate was detected at or above the GWPS in two downgradient wells, PTX06-1148 and PTX06-1149. PTX06-1148 and PTX06-1149 had demonstrated complete treatment of perchlorate until early in 2021 when perchlorate was detected above the GWPS. These exceedances may indicate problems with injection in the upgradient ISB wells. Pantex added an additional row of injection wells upgradient of the eastern located wells to ensure the treatment of TCE, as well as perchlorate. The two TZM wells, PTX06-1209 and PTX06-1210, installed in the second row of wells indicate overall increased treatment of all COCs across the second row, but downgradient wells will not see impacts of increased treatment for another 3 – 5 years. The results for upgradient well PTX06-1127 and PTX06-1211 indicate that TCE is increasing above the GWPS on the eastern side of the ISB.

In previous years, the downgradient well PTX06-1175 was not demonstrating strong treatment of RDX and TCE. PTX06-1175 is downgradient of the expansion area on the northwest side of the system and downgradient of a single row of injection wells. Because of its distance downgradient of the injection wells and expected time of travel, this well was not expected to show strong treatment for several years. However, increases in one of the breakdown products of RDX (MNX) and a decrease in overall concentration in RDX were seen in 2023, demonstrating the arrival of treated water to the well. Decreasing TCE concentrations and the increase of cis-1,2-DCE, also indicates that treated water is now reaching this well.

Metals concentrations have been increasing in all downgradient ISPM wells since the start of remedial actions and some are exceeding GWPS. For example, arsenic concentrations in PTX06-1155, PTX06-1156, PTX06-1173 and PTX06-1174 and barium concentrations in PTX06-1156 and PTX06-1174 exceeded the GWPS in 2023. However, metals concentrations in the downgradient ISPM wells are lower than observed in the treatment zone. These concentrations are expected to decrease as the treated water moves downgradient, the water returns to more oxidized conditions, and the metals precipitate onto the soil matrix, as discussed in Section 3.2.3.

Table 3-2. Summary of 2023 Zone 11 ISB Monitoring Well Data for Perchlorate and TCE

Well ID	Perchlorate			TCE		
	Max[a]	1S	2S	Max[a]	1S	2S
In-Situ Bioremediation Wells						
PTX06-ISB055	3000	<20UJ	<20	16	<5	<12.5
PTX06-ISB059	970	<20UJ	<20	<3	<5	<12.5
PTX06-ISB064	<100	<20UJ	<20	<250	0.44	<2.5
PTX06-ISB137	2.2	<20UJ	<20	12.2	<2.5	1.7
In-Situ Treatment Zone Monitoring Wells						
PTX06-1164	130	<1	<1	180	38.4	8.62
PTX06-1169	<12	<5	<5	13	31.5	12.4
PTX06-1170	<120	<5	<5	500	<5	0.42
PTX06-1176	240	<1	<5	220J	<2.5	<2.5
PTX06-1177	210	<1	<5	130	<2.5	1.06
PTX06-1209	52J	<1	<5	329	19.9	1.84
PTX06-1210	<1	<1	<10	230	<2.5	<2.5
PTX06-1230[b]	97	<5UJ	<5	440	<2.5	0.34
In-Situ Performance Monitoring Wells						
PTX06-1012	341	<5	<5	580	0.52	1.07
PTX06-1148	1290	80.2	24	95.8J	43	95.8J
PTX06-1149	1290	69.6	88.6	255J	211	255J
PTX06-1150	235	2.11	0.79	39	70.2	98J
PTX06-1155	487	<5	<5	660	6.73	1.85
PTX06-1156	2140	<5	<5	43.3J	<2.5UJ	0.84
PTX06-1173	16J	<1	<5	140J	0.85	0.85
PTX06-1174	170J	<1	<5	160J	0.62	0.64
PTX06-1175	340J	<1	<5	150	1.53	1.4

Concentrations provided in µg/L.
Highlighted cells indicate concentrations less than or equal to the GWPS. GWPS: Perchlorate = 15 µg/L and TCE = 5 µg/L.
When COC was not detected, a "<" with the detection limit is provided.
[a]The maximum value reported in each well is used as a baseline for comparison, regardless of the date on which it was collected.
[b]Due to well damage, PTX06-ISB075 was replaced in September 2012. In 2023, the well that was previously named PTX06-ISB075_1 was renamed to PTX06-1230. The replacement well (now PTX06-1230) has been sampled in place of PTX06-ISB075 since 2013.
J Analyte was detected below the PQL but above the MDL.
UJ The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

3.2.3.2 Southeast ISB

The Southeast ISB system is on TTU property south of Pantex (see Fig. 1-9). Constituents targeted for treatment by this system are RDX, other HE COCs (e.g., dinitrotoluenes and 1,3,5-trinitrobenzene), and hexavalent chromium. Indicator constituents evaluated for trends at downgradient performance monitoring wells include RDX and its degradation products (i.e., DNX, MNX, and TNX) and total and hexavalent chromium. Concentrations of indicator constituents in the performance monitoring wells are expected to decline over time, and all degradation products of RDX are anticipated to be non-detect or present in only low concentrations, thus indicating complete breakdown is occurring. Dissolved oxygen, redox potential, nitrate, sulfate, and TOC are also evaluated at the ISB treatment zone performance wells.

Redox potential and electron acceptor (i.e., dissolved oxygen, nitrate, and sulfate) concentrations in the treatment zone wells are expected to decline after injection. Redox potential should be less than 0 mV for the reduction of RDX and hexavalent chromium.

As provided in the SAP, six treatment zone wells and four downgradient performance monitoring wells are used to evaluate the Southeast ISB. One ISPM well (PTX06-1123) for the Southeast ISB has gone dry and has not been monitored since 2015. PTX06-1045, a point of compliance well, was dry from 2011 until the fourth quarter of 2018 when water was reported in the well. Water levels were sufficient to collect samples in the first quarter of 2023. However, PTX06-1045 is the furthest downgradient ISPM well that may have little to no hydraulic connection to the Southeast ISB treatment zone. Discussion of data for this well is not included for this reason. Limited sampling has occurred at PTX06-1037 since November 2017 because of declining water levels; this well had sufficient water to allow sampling in 2023. Five of the six treatment zone wells were sampled in 2023. PTX06-ISB048 was unable to be sampled due to the well going dry. As SEPTS operates consistently, saturated thickness is expected to decrease in the Southeast ISB and more wells will be unable to be sampled due to insufficient water.

Table 3-3 summarizes the current and maximum COC concentrations in each ISB and ISPM well. Graphs of the amendment indicators and COCs for the sampled ISB injection wells, as well as concentrations for target indicators at the performance monitoring wells for this system, are included in Appendix E. The conditions in the treatment zone and performance monitoring wells are discussed below.

Evaluation of treatment zone data indicates that during 2023 mild to deep reducing conditions were present for the treatment of HEs and hexavalent chromium. The ORP was between –157.6 and 102.3 mV at all six wells in 2023. TOC results indicated that a continued food source was available to maintain reducing conditions. RDX was detected below the GWPS at all sampled wells in 2023; MNX, DNX, and TNX were not detected in the sampled treatment zone wells.

The ISB system has effectively treated HEs and hexavalent chromium at two of the closest downgradient ISPM wells, PTX06-1037 and PTX06-1154 for the Southeast ISB. RDX and hexavalent chromium concentrations in these wells are either non-detect or below the GWPS. These wells indicate that the reducing zone has extended beyond the treatment zone because the ORP is negative or less than -10 mV (with the exception of one semi-annual sample from PTX06-1153), nitrate and sulfate concentrations are reduced, and organic carbon is present.

Table 3-3. Summary of 2023 Southeast ISB Monitoring Well Data for RDX and Hexavalent Chromium

Well ID	Hexavalent Chromium or Total Chromium			RDX		
	Max[a]	1S	2S	Max[a]	1S	2S
In-Situ Bioremediation Wells						
PTX06-ISB021*	287	--	25.4	3570	--	--
PTX06-ISB030B*	33.4	18.8	11.9	2.7	<0.42UJ	<0.51J
PTX06-ISB038*	45	32.4	32	421	<4UJ	--
PTX06-ISB042 *[b]	667	0.66	--	2920	<0.10UJ	--
PTX06-ISB046*	160	9.2	6.7	4350	R	R
PTX06-ISB048 *[c]	--	--	--	0.82	--	--
In-Situ Performance Monitoring Wells						
PTX06-1037	109	<0.02	0.03J+	2800	<0.42UJ	<0.10
PTX06-1123[d]	10	--	--	4300	--	--
PTX06-1153	159	5.68I	0.52	838	190J	150
PTX06-1154	29.2	<0.02U	0.02J-	630	<0.41UJ	<0.10UJ

Concentrations provided in µg/L.
Highlighted cells indicate non-detect or concentrations less than the GWPS. GWPS: Cr(VI) = 100 µg/L and RDX = 2 µg/L.
* – Hexavalent chromium was not evaluated in the ISB treatment zone due to interference from the amendment. In lieu of hexavalent chromium, total chromium data is presented for these wells.
The "--" symbol indicates that no data are available.
[a]The maximum value reported in each well is used as a baseline for comparison, regardless of the date in which it was collected.
[b] PTX06-ISB042 had limited water and was not sampled for some analytes.
[c] PTX06-ISB048 was dry and could not be sampled in 2023.
[d] PTX06-1123 was dry and could not be sampled in 2023.
Data from ISPM Well PTX06-1045 is not included in this table. PTX06-1045 is the furthest downgradient ISPM well that may have little to no hydraulic connection to the Southeast ISB treatment zone.
I Sample was diluted prior to analysis.
J Analyte was detected below the PQL, but above the MDL.
J+ The associated numerical value is an estimated quantity with a suspected positive bias.
J- The associated numerical value is an estimated quantity with a suspected negative bias.
R The data is unusable (compound may or may not be present).
UJ The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

Although PTX06-1153 continues to exhibit RDX concentrations above the GWPS, a steep decline in RDX has occurred since the peak observed in August 2019. Hexavalent chromium concentrations continue to demonstrate a decreasing trend and have remained below the GWPS since 2016. Pantex is continuing to investigate the cause of the unexpected results in PTX06-1153. The conditions could be due to any number of hydrologic issues and proving (or disproving) them may be difficult, though it is possible that this well is not hydraulically connected to the Southeast ISB. Several confounding issues complicate the investigation efforts in the area, including significant heterogeneity in the FGZ, potential changes in formation properties due to biologic growth or other injection effects, and the potential reduction of saturated thickness upgradient due to the pump and treat operations.

Pantex injected this system with molasses during the 2019 injection to attempt better distribution of amendment. Additionally, to affect treatment at PTX06-1153, Pantex extracted water from the well at a flow rate of approximately 1.25 gpm for two weeks during the fourth quarter of 2019. During 2020, PTX06-1153 demonstrated signs of partial treatment with the sharp decline in RDX, and breakdown products of RDX were detected at concentrations above the GWPS. In 2023, RDX concentrations decreased between sampling events and the continued presence of breakdown products suggests partial treatment.

Metals concentrations have increased in all downgradient performance monitoring wells, with some exceeding the GWPS. Arsenic and barium concentrations exceeded the GWPS in PTX06-1037 and PTX06-1154 during 2023. TOC data suggest the treatment zone has expanded into these wells, and the reduced conditions continue to mobilize naturally occurring metals. However, these concentrations are expected to decrease as the treated water moves out of the treatment zone and returns to more oxidized conditions.

Pantex also monitors for degradation products of RDX to evaluate whether or not complete breakdown is occurring. Monitoring results for the system indicate that RDX and breakdown products (i.e., MNX, DNX, and TNX) are present in downgradient performance monitoring wells. 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). Both RDX and TNX have been reduced to concentrations below the GWPS at PTX06-1037 and PTX06-1154 since 2011 and 2015, respectively, indicating complete breakdown of RDX. RDX and TNX were not detected or below the PQL at both wells throughout 2023. These results indicate that near-complete treatment of RDX is occurring in all wells except PTX06-1153, as discussed previously.

3.2.3.3 Southeast ISB Extension

The Southeast ISB Extension was installed in 2017 as an extension of the chosen remedy for the southeast perched groundwater. Four additional wells were installed in late 2020 and an additional two in 2021 along the eastern property line in a north-south alignment to further encompass the plume. These new wells were injected for the first time in April 2021, with the exception of PTX06-ISB331, which was injected in August 2022. Two treatment zone monitoring (TZM) wells were also installed in late 2021. Overall, seven injection events have been completed at this system, with the most recent injection finishing in September 2023. Due to the success with distribution of a more soluble carbon (molasses), Pantex began injection at the Southeast ISB Extension using only soluble carbon (molasses), as recommended in the *Fourth Quarter 2018 Progress Report* (Pantex, 2019e). Pantex plans to continue injection at this system using only molasses to improve distribution and treatment. Because this system has not been treated with EVO, injections have been scheduled at approximately every twelve months.

Table 3-4 summarizes the current and maximum COC concentrations in each ISB and ISPM well. As part of the SAP, four ISB wells, two TZM wells and two downgradient ISPM wells were sampled for 2023. Treatment zone data indicates very strong to mild reducing conditions are present for treatment of HEs. ORP was negative in 2023 and nitrate was reduced in all sampled wells. Soluble metals (arsenic and manganese) increased, indicating that reducing conditions are established. Total organic carbon results indicate that a sufficient food source is available to support establishment of reducing conditions at the wells.

Downgradient wells demonstrated partial treatment in 2023. TOC has slightly increased in downgradient wells since beginning of sampling in 2018. Monitoring results for the system indicate that RDX and breakdown products are present in downgradient performance monitoring wells and metals (i.e., arsenic and manganese) are starting to increase.

Table 3-4. Summary of 2023 Southeast ISB Extension Monitoring Well Data for RDX

	RDX		
Well ID	**Max[a]**	**1S**	**2S**
In-Situ Bioremediation Wells			
PTX06-ISB302	<1.3UJ	<0.12J-	--
PTX06-ISB312	718	<0.11UJ	--
PTX06-ISB325	21.8	<0.49UJ	--
PTX06-ISB331	7.4J+	0.05J-	1.8J-
In-Situ Treatment Zone Monitoring Wells			
PTX06-1213	1.25	<0.11UJ	<0.99UJ
PTX06-1214	0.26	<0.10UJ	<0.11UJ
In-Situ Performance Monitoring Wells			
PTX06-1194	0.15	0.03J-	<0.10
PTX06-1196	33.5	9.7J-	6.2

Concentrations provided in μg/L.
Highlighted cells indicate non-detect or concentrations less than the GWPS. RDX GWPS = 2 μg/L.
The "--" symbol indicates that no data are available.
[a]The maximum value reported in each well is used as a baseline for comparison, regardless of the date on which it was collected.
J- The associated numerical value is an estimated quantity with a suspected negative bias.
UJ The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

3.2.3.4 Offsite ISB

The installation of the first phase of wells for the Offsite ISB system was completed in 2020. The first phase of the installation focused on treatment at the leading edge of the plume. Infrastructure to support an injection event was completed in June 2021, with first injection of molasses completed in October 2021 at the leading edge of the plume. Three new ISB wells were installed on the neighboring property in late 2021 and were injected in 2022. The system was further expanded in 2022 with nineteen new ISB wells, which were injected for the first time in 2023. The last phase of wells was installed in summer 2023, but will not be injected until spring 2024. Based on the use of molasses, injections are planned every six months at differing parts of the system. Injection plans will follow the schedule that was designed using fate and transport and optimization modeling.

All water used in the injection process must be withdrawn from beneath the offsite property, so downgradient ISB extraction wells were installed. These wells were installed downgradient of the injection wells and assist in pulling the amendment towards the removal wells, providing an expanded zone for COC treatment.

Table 3-5 summarizes the current and maximum COC concentrations in each ISB and ISPM well. Eight ISB extraction wells (labeled REC wells due to the recirculation they provide) were sampled in 2023. Six TZM wells were also sampled. Evaluation of the baseline data from 2022 at these wells indicated very mild reducing conditions with ORP ranging from 19 to 281 mV. As of the end of 2023, reducing conditions improved and ORP ranged from -119.2 mV to 44.8. Concentrations of HEs remain low in the REC wells at the leading edge of the plume. Total organic carbon was also present at a higher concentration in all six REC wells. Treatment zone data for the new TZM wells indicates the treatment zone is being established, but portions of the plume are not expected to fully establish treatment until 2025 or later. Concentrations at the downgradient ISPM well PTX06-1215 indicate that all high explosives remain below the GWPS indicating that the system is arresting downgradient movement of the plume.

Table 3-5. Summary of 2023 Offsite ISB Monitoring Well Data for RDX

	RDX		
Well ID	**Max[a]**	**1S**	**2S**
In-Situ Bioremediation Recirculation Wells			
PTX06-REC402	1.3	1.3J+	0.51J-
PTX06-REC403	10.9	4.1	1.6J-
PTX06-REC404	12.5	2.7J+	5.2J-
PTX06-REC407	327J	0.86J	--
PTX06-REC411[b]	70.5J	--	--
PTX06-REC416	149J	149J	148J-
PTX06-REC419	149J	127J	149J
PTX06-REC422	1.8J	1.1J	1.8J
In-Situ Treatment Zone Monitoring Wells			
PTX06-1197	279	<0.26	<0.10UJ
PTX06-1217	--	--	--
PTX06-1218	14.9	12.5J-	11.3
PTX06-1219	443	0.23J-	0.22
PTX06-1220	--	--	--
PTX06-1221	3.5	--	3.5
In-Situ Performance Monitoring Wells			
PTX06-1215	0.25	0.25	0.23

Concentrations provided in µg/L.
Highlighted cells indicate non-detect or concentrations less than the GWPS. RDX GWPS = 2 µg/L.
The "--" symbol indicates that no data are available.
[a]The maximum value reported in each well is used as a baseline for comparison, regardless of the date on which it was collected.
[b] PTX06-REC411 was unable to be sampled in 2023 due to a broken transducer.
J Analyte was detected below the PQL, but above the MDL.
J- The associated numerical value is an estimated quantity with a suspected negative bias.

3.3 Natural Attenuation

Natural attenuation is the result of processes that naturally lower concentrations of contaminants over time. Pantex monitors this process to help determine where and under what conditions natural attenuation is occurring and to possibly identify a rate of attenuation. This is an important process for RDX, the primary risk driver in perched groundwater, because it is widespread and extends beyond the reach of the groundwater remediation systems in some areas.

> ***Natural Attenuation Processes***
>
> - Biodegradation: Soil microbes cause the contaminants to break down into less harmful products.
> - Sorption: Contaminants are bound to soil particles so that movement through groundwater is stopped or slowed, allowing time for other processes to work.
> - Dispersion: Contaminants are dispersed through the groundwater as they move away from the source so that concentrations are diluted.

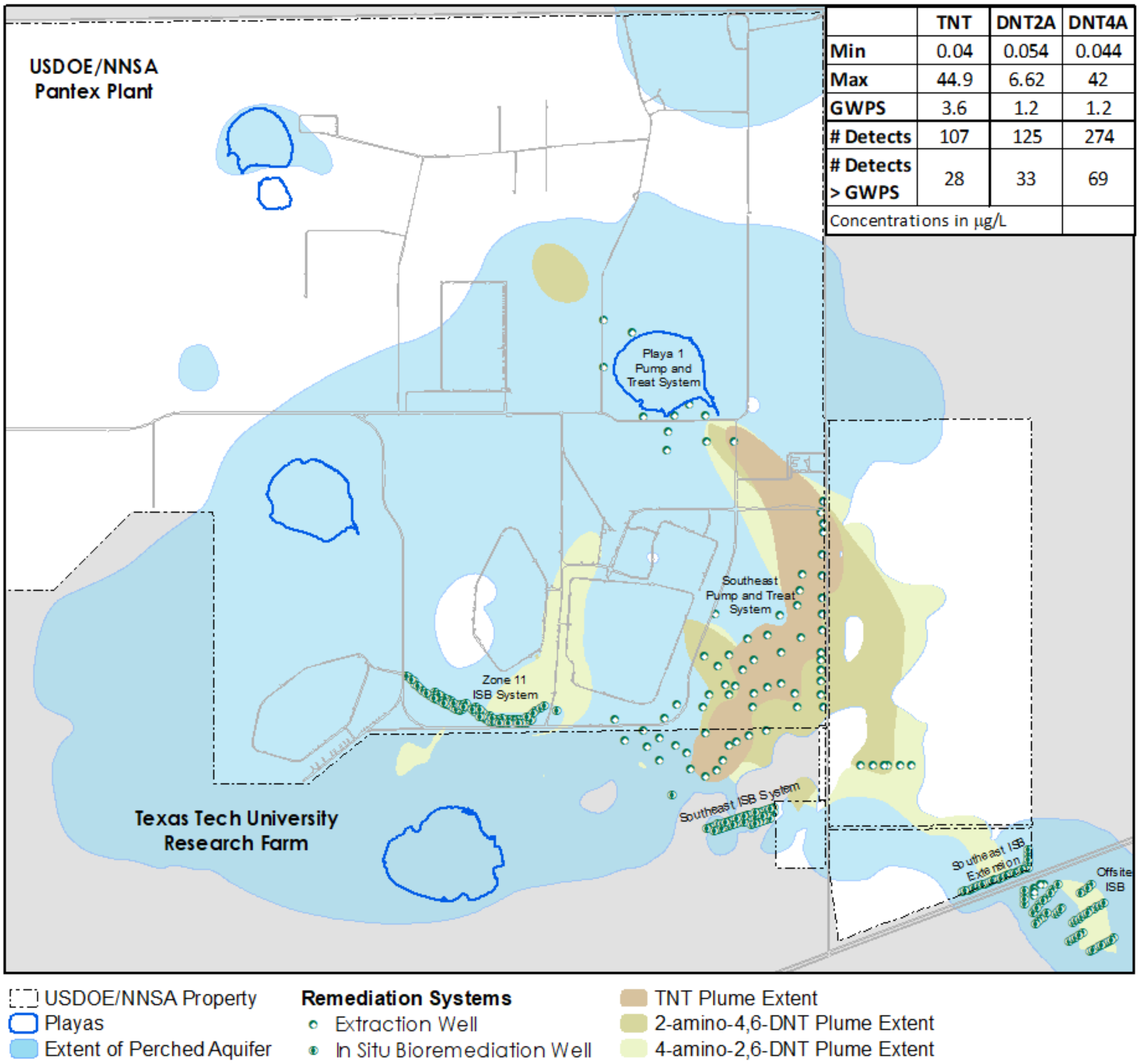
Because the right microbes for biodegradation are present in the perched sediments, Pantex is also interested in monitoring for breakdown products of RDX. In July 2009, Pantex started monitoring for degradation products of RDX in all monitoring wells after testing analytical methods to ensure they can reliably detect and quantify those products. Since analytical methods are readily available, Pantex has monitored degradation products of TNT and TCE in the past and continues to monitor them in key areas.

Other groundwater conditions that may affect attenuation, such as dissolved oxygen and redox potential, are also monitored in each well. The concentration data, as well as dissolved oxygen and redox potential, are detailed in electronic form in Appendix D.

RDX can degrade under aerobic and anaerobic conditions but achieves the best reduction under anaerobic conditions. As more data are collected, trending and statistical analyses can be used to evaluate the degradation of RDX. 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, DNT2A and DNT4A, TNT has naturally attenuated over time (see Fig. 3-33). TNT has been manufactured at Pantex since the 1950s and yet is only present in the central portion of the overall southeastern plume, within the SEPTS well field and near Playa 1. The first TNT breakdown product, DNT2A, occurs near the TNT plume and extends slightly beyond.

The final monitored breakdown product, DNT4A, extends out to the edges of the perched aquifer 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 the GWPS, but most wells with detections have recently shown decreasing or stable trends. A table of natural concentration ranges for wells outside the influence of the ISB systems is included in Fig. 3-33.



	TNT	DNT2A	DNT4A
Min	0.04	0.054	0.044
Max	44.9	6.62	42
GWPS	3.6	1.2	1.2
# Detects	107	125	274
# Detects > GWPS	28	33	69
Concentrations in µg/L			

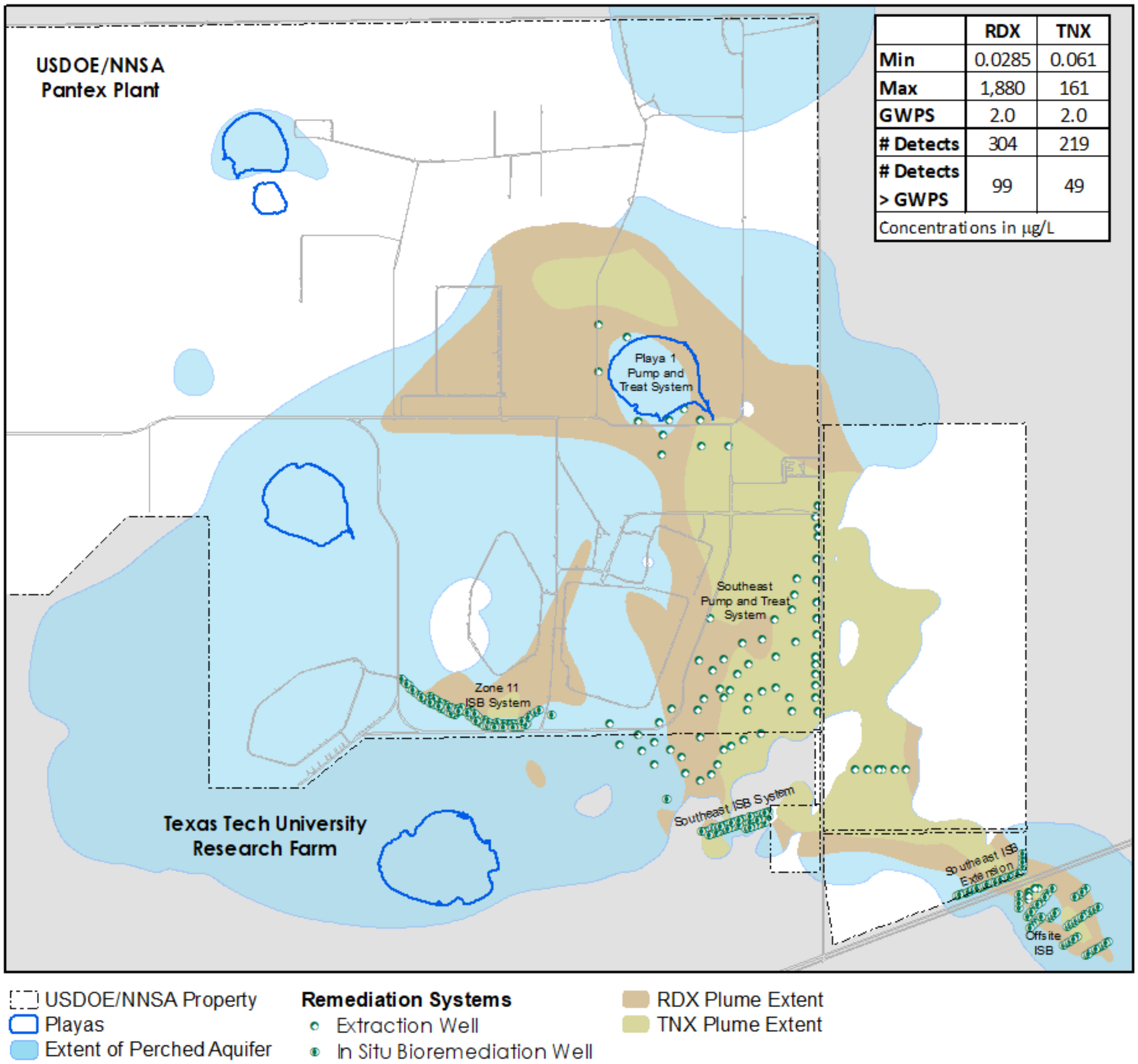
Fig. 3-32. TNT and degradation product plumes.

Perched aquifer sampling results for RDX and breakdown products (i.e., MNX, DNX, and TNX) indicate that the breakdown products are present throughout most of the RDX plume, with TNX, the final degradation product, being the most widespread. If complete biodegradation of RDX were occurring, RDX and all breakdown products would be expected to decrease over time. Fig. 3-34 depicts the overall RDX and TNX plume as well as a table of concentration ranges for wells outside the influence of the ISB systems.

A Strategic Environmental Research and Development Program (SERDP) study (2014) provided evidence that aerobic degradation is occurring in the Pantex RDX plume but was unable to quantify the rates of attenuation. This study provided new methods for evaluating RDX degradation including carbon and nitrogen fractionation (Compound Specific Isotope Analysis) approaches. These approaches, along with the ability to quantify 4-nitro-2,4-diazabutanal (NDAB), an aerobic degradation product, allows Pantex to better evaluate the degradation of RDX.

Pantex subsequently contracted with the SERDP study leading researcher, Dr. Mark Fuller with APTIM Corporation, for a project to evaluate lines of evidence for the natural attenuation of RDX at the plant (Fuller, 2018). The study included both aerobic and anaerobic degradation with evidence of both occurring. The predominant attenuation process is aerobic biodegradation by bacterial strains. Biodegradation rates of 0.016 to 0.168 per year were calculated, translating into RDX half-lives of approximately 5 to 50 years.

The project found that the rates of RDX biodegradation are likely limited by the available labile organic carbon in the groundwater. The project went on to identify several lines of evidence for natural attenuation of RDX as well as the potential to enhance aerobic biodegradation of RDX by introducing low levels of labile organic carbon. Recommendations were presented for additional treatability studies, bioaugmentation, and additional proteomics analyses of degrading bacterial strains.



	RDX	TNX
Min	0.0285	0.061
Max	1,880	161
GWPS	2.0	2.0
# Detects	304	219
# Detects > GWPS	99	49
Concentrations in µg/L		

Fig. 3-33. RDX and degradation product plumes.

Pantex has monitored breakdown products of TCE for many years, and a strong indication of natural attenuation of TCE has not been observed in the perched aquifer. Quantitative polymerase chain reaction (qPCR) data collected upgradient and within the Zone 11 ISB system does not indicate that indigenous microbes are able to completely degrade TCE. However, the TCE plumes at Pantex are being actively treated by the SEPTS and ISB treatment zones.

3.4 Uncertainty Management/Early Detection

The uncertainty management wells in perched and Ogallala groundwater have the following purposes:

- To confirm expected conditions identified in the RCRA facility investigations and ensure there are not any deviations
- Fill in potential data gaps
- Fulfill long-term monitoring requirements for soil units evaluated in a baseline risk assessment.

Meanwhile, the purpose of early detection wells is to monitor for the breakthrough of constituents to the Ogallala Aquifer from the overlying perched aquifer or from potential source areas in the unsaturated zone before potential points of exposure are impacted. These wells were proposed in the LTM design to evaluate the effectiveness of the soil and groundwater remedial actions. Additionally, the perched aquifer data were evaluated with respect to field observations. In 2023, no evidence of NAPL was observed in the sampled perched aquifer wells.

This report focuses on subsets of the uncertainty management/early detection wells, as depicted in Fig. 3-35. The wells are evaluated with respect to the following groups:

- Group 1: 37 locations (designated by boxes in Fig. 3-35) where contamination has not been detected or confirmed, or previous plume locations where concentrations have fallen below the GWPS, background, or PQL (e.g., Burning Ground and OSTP areas). These are typically Ogallala Aquifer wells, although some perched aquifer wells are located in areas without active groundwater remedial actions. These wells were evaluated in the quarterly reports.
- Group 2: 27 uncertainty management wells (all other wells in Fig. 3-35) near groundwater contamination source areas. This group is established to confirm that source strength and mass flux are decreasing over time. Every five years, these wells are also evaluated for new COCs from source areas.

Because of differing frequencies in sampling, all available data for the uncertainty management/early detection wells are used in this evaluation.

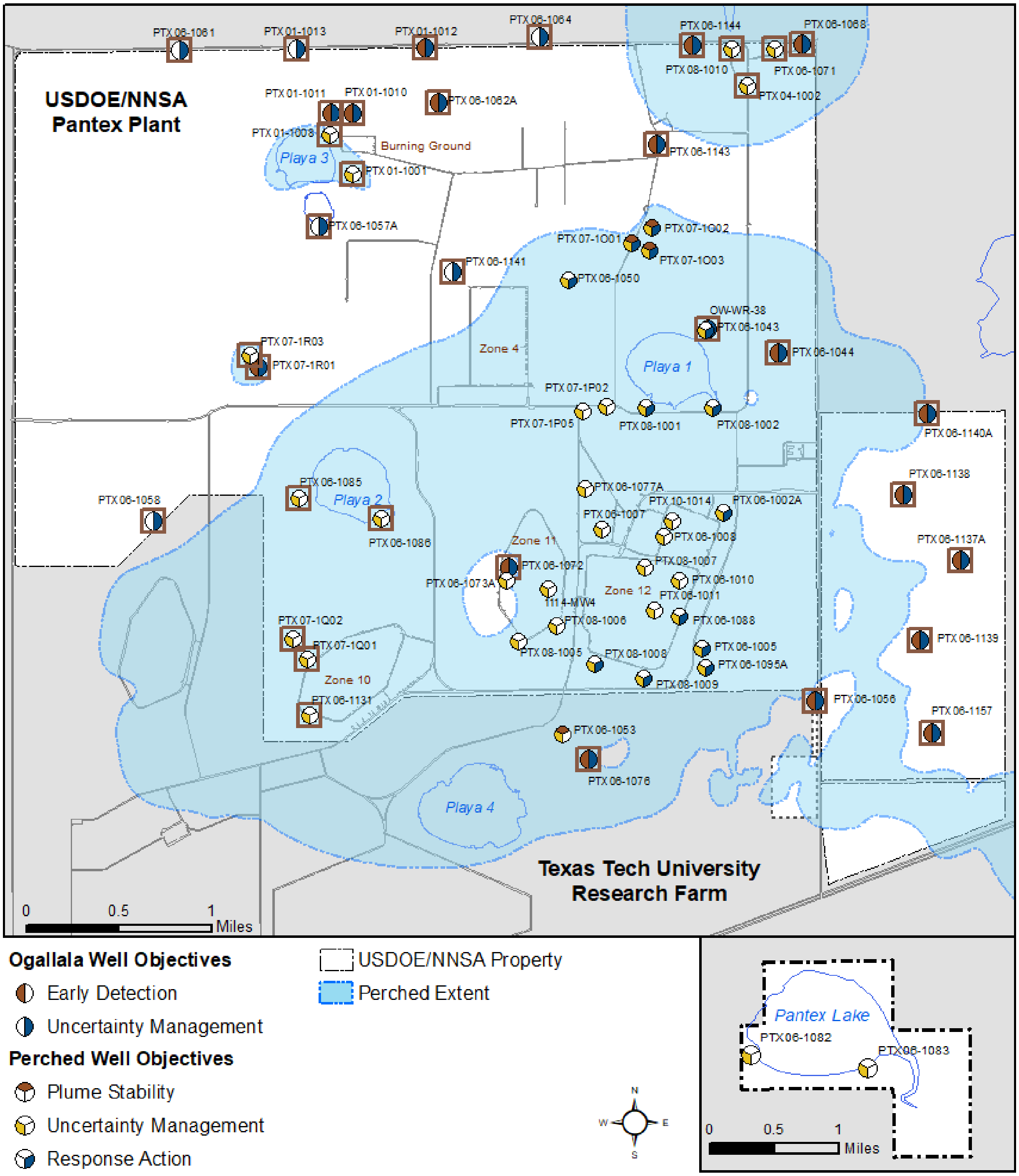


Fig. 3-34. Uncertainty management and early detection wells for 2023.

3.4.1 Group 1 Wells

Only one Group 1 perched aquifer well had an unexpected condition in 2023. Pantex PTX01-1001 had a detection of a new emerging contaminant, PFAS. A constituent of PFAS, perfluorodecanoic acid (PFDA), was detected at PTX01-1001 at concentrations below the current promulgated TRRP residential PCLs. This well was sampled as part of a strategic subset of existing perched groundwater LTM wells to determine the extent of PFAS impacts at the Pantex Plant. This recommendation came from the Third Five Year Review as part of an issue that recognized PFAS were present in products used at the Pantex Plant and have been detected in SEPTS influent groundwater. At this time, no further action is required, but these data will be used to develop a work plan to complete a PFAS site investigation. Data for this detection is provided in Table D-2, Appendix D. Detections of indicator COCs occurred in all perched aquifer wells, but detections of indicator COCs at the wells were below the GWPS.

3.4.1.1 Ogallala Aquifer Wells

In 2023, detection of organic constituents above background occurred in four Ogallala wells. Data for these detections are provided in Table D-3, Appendix D. Boron was detected at levels slightly above background in six wells; these detections represent natural variability in background. Boron detections are summarized in Table D-4, Appendix D.

Hexavalent chromium was detected above background in one well, PTX06-1044, in 2023; this detection was below the GWPS of 100 ug/L. At PTX06-1044, perchlorate was detected slightly above the background value of 3.2 ug/L at a measured value of 3.207 ug/L. This detection likely represents background variability.

TNT was detected below the PQL (0.103 ug/L) at PTX07-1R01 during the third quarter of 2023. Due to the low detection, no further action will be taken and sampling will continue as approved in the *2019 Sampling and Analysis Plan* and in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan*.

4-amino-2,6-dinitrotoluene (DNT4A), a breakdown product of 2,4,6-trinitrotoluene (TNT), has been detected at PTX06-1076, with the initial detection occurring in June 2020. Sample results collected since that time have been variable, with values from May 2023 exceeding the PQL for the first time. As a result, a verification sample was completed at PTX06-1076 in August 2023. Results from the verification sample confirmed detections of DNT4A above the PQL. In accordance with the Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan, sampling was increased from semi-annual to monthly sampling for a three-month duration starting in October 2023. Notification to regulators were sent in advance of sampling actions. Review of installation logs for PTX06-1076 indicate that the well might not have been sealed properly at the fine-grained zone. Pantex is planning to plug and abandon this well and replace it with a new well downgradient of the present location in FY 2024.

DNT4A has been detected at PTX06-1056, with the initial detection occurring in April 2014. Sample results collected since that time have been variable, with values exceeding the PQL since late 2016. A trend of DNT4A (performed using Mann-Kendall statistics) continues to indicate an increasing trend across all data. PTX06-1056 also continues to demonstrate detections of 1,2 dichloroethane (DCA12). DCA12 has been variably detected since August 2015, with the most recent detection below the PQL. Additionally, 2,6-Dinitrotoluene (DNT26), another breakdown product of TNT, was also detected but was below the PQL. The third quarter result detected DNT4A above the GWPS at 1.78 ug/L and RDX above the PQL (0.104 ug/L) at 0.26 ug/L. DCA12 was also detected, but was below the PQL

In response to the recent detections of high explosives in PTX06-1056, Pantex installed three new Ogallala monitoring wells in 2023 to investigate nature and extent of the contamination (see Figure 3-36 for new well locations). The new wells were installed in areas identified in earlier plume modeling for being at risk of vertical contamination migration from the perched to the Ogallala Aquifer and within the Ogallala flow path. Two wells were initially installed in May 2023. PTX06-1223 was installed upgradient of PTX06-1056 and PTX06-1224 was installed as a side gradient well to PTX06-1056. Initial sampling at PTX06-1224 detected no contaminants of concern. Initial results from PTX06-1223 measured DNT4A and RDX at similar concentrations to recent samples from PTX06-1056, though all concentrations were below the GWPS. Table 3-6 provides the detected results for PTX06-1223.

Table 3-6. Summary of 2023 Unexpected Detections at PTX06-1223

Well ID	Sample Date	Analyte	Measured Value (µg/L)	PQL (µg/L)	GWPS (µg/L)
PTX06-1223	12/06/2023	DNT4A	1.03	0.104	1.2
		RDX	1.03	0.102	2
		TNXZ	0.308	0.104	2

PTX06-1229 was installed in September 2023 as part of continuing efforts to investigate the detections. PTX06-1229 was installed north of PTX06-1223 to evaluate a potential northward flow path, after early sampling results indicated the presence of high explosives in PTX06-1223. Initial sampling results received in late December 2023 for PTX06-1229 indicated the presence of three high explosives constituents in the Ogallala Aquifer at concentrations well above GWPS. Table 3-7 provides the detected results for PTX06-1229.

Table 3-7. Summary of 2023 Unexpected Detections at PTX06-1229

Well ID	Sample Date	Analyte	Measured Value (µg/L)	PQL (µg/L)	GWPS (µg/L)
PTX06-1229	12/06/2023	DNT4A	0.407	0.104	1.2
		DNT2A	5.97	0.104	1.2
		HMX	8.93	1.03	360
		RDX	307	10.3	2
		MNX	0.08	0.0103	2
		TNX	20.0	1.03	2
		DNT26	0.04	0.103	1

At this time, Pantex is investigating whether the detections are a result of cross-contamination from a nearby perched well that was drilled too deep. The installation of a perched well (PTX06-1103, originally identified as PTX06-EW52), located upgradient of PTX06-1229, may have created a previous preferential pathway for the migration of high explosive contaminants from the perched groundwater into the Ogallala Aquifer. The perched well in question was drilled in 2005 for the intent of extraction and treatment of contaminated perched groundwater and treatment in the Southeast Pump and Treat System. This well was plugged in October 2010 after indications that it was acting as a preferential pathway to the Ogallala Aquifer. A verification sample was completed at PTX06-1229 in January 2024 that confirmed the high explosive detections above the GWPS. Pantex has requested special funding to implement measures to begin evaluating extent of the detections by installing three additional Ogallala monitor wells in 2024. Further installations will be evaluated after gaining information from the new wells. Further actions will be determined based on future sampling results and in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan*.

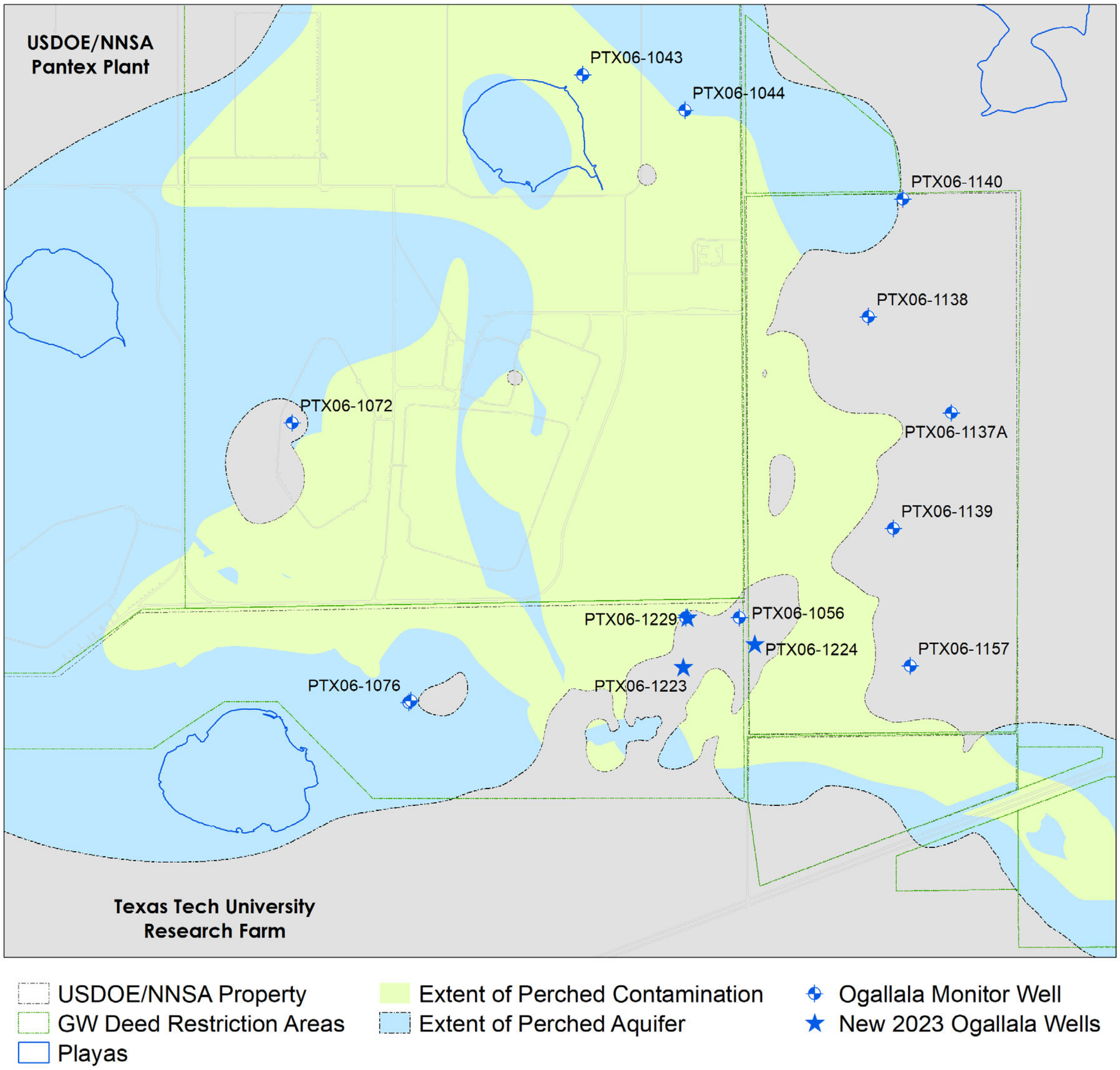


Fig. 3-36. Location of Ogallala Wells Installed in 2023.

As presented in Table D-4, boron was detected at concentrations slightly above the background value of 194 ug/L in six Ogallala wells in 2023, including PTX06-1012, PTX06-1044, PTX06-1056, PTX06-1068, PTX06-1139, and PTX06-1157. Because boron concentrations at these wells were very close to background and observed boron concentrations tend to vary considerably, these concentrations also appear to represent background. Evaluation of historic boron data in these wells results in variable trends. However, the measured concentrations are significantly below the GWPS of 7,300 ug/L. Pantex will continue to monitor these wells according to the SAP.

In addition to the comparison of measured concentrations to the GWPS, all Ogallala Aquifer wells were evaluated to determine if specific constituents that were detected are trending upward (see Appendix E). For the trending analysis, chromium, hexavalent chromium, boron, and a small list of HEs (i.e., RDX and the dinitrotoluenes) were evaluated. The metals are naturally occurring, and the HEs have been sporadically detected in the past at a few wells.

The Mann-Kendall trending results, summarized in Table 3-8, indicate that across all data 15 wells are indicating increasing or probably increasing trends.

Table 3-8. Increasing Trends in Ogallala Aquifer Wells

Well	COC	Concentration Trend
PTX01-1012	B	Increasing
PTX06-1043	B	Increasing
PTX06-1043	CR	Increasing
PTX06-1044	B	Increasing
PTX06-1056	RDX	Increasing
PTX06-1056	DNT4A	Increasing
PTX06-1056	DCA12	Increasing
PTX06-1056	CR	Increasing
PTX06-1056	MO	Increasing
PTX06-1058	B	Increasing
PTX06-1058	CR	Increasing
PTX06-1061	B	Increasing
PTX06-1064	B	Increasing
PTX06-1068	PERC	Increasing
PTX06-1068	B	Increasing
PTX06-1072	PERC	Increasing
PTX06-1072	B	Increasing
PTX06-1076	DNT4A	Increasing
PTX06-1138	CR	Probably Increasing
PTX06-1138	MO	Increasing
PTX06-1140	B	Increasing
PTX06-1144	B	Probably Increasing
PTX06-1157	B	Increasing
PTX06-1157	CR	Probably Increasing
PTX06-1157	MO	Increasing
PTX07-1R01	PERC	Increasing
PTX07-1R01	B	Increasing

CR = total chromium
DCA12 = 1,2-dichloroethane
B = Boron
MO = molybdenum
DNT4A = 4-amino-2,6-dinitrotoluene
PERC = perchlorate

Five wells indicate increasing trends for chromium. However, the detections were below background. These chromium trends may also be related to the stainless-steel screens and the confirmed presence of bacterial growth that has been found in many perched aquifer and Ogallala Aquifer wells at Pantex. Typically, chromium levels drop in these wells after they are brushed and bailed. PTX06-1033 was plugged and abandoned in 2017 because well damage made it unusable; that well had similar chromium detections, which may indicate that corrosion of the stainless-steel well screens is also affecting these five wells.

Mann-Kendall trending across all data also indicates that boron is increasing or probably increasing in 12 Ogallala Aquifer wells. However, all boron detections are well below the GWPS of 7,300 ug/L and likely represent background variability.

As discussed above, PTX06-1056 exhibited increasing trends in RDX, DNT4A, and 1,2-DCA across all data. Detected concentrations are above GWPS for DNT4A, but remain below the GWPS for RDX and 1,2-DCA and recent data indicate a recent increasing trend for across the three COCs.

Mann-Kendall trending across all data indicates a probably increasing trend for molybdenum in PTX06-1056, PTX06-1138, and PTX06-1157. However, molybdenum was detected at levels far below background, and recent data indicate stable or no trend. Molybdenum is a component of stainless steel and can indicate corrosion of the wells is occurring.

3.4.2 Group 2 Wells

These wells are near source areas and generally have contamination at levels above the GWPS. These wells all occur in the perched aquifer. The purpose of this evaluation is to determine if source strength is declining and if new COCs have migrated to wells near source areas.

The ditches and playas are expected to continue contributing contamination to the perched aquifer for at least 20 years or more but at much lower concentrations than in the past (Pantex, 2006). For many of these wells, concentrations are expected to stabilize, with an eventual long-term decreasing trend below the GWPS.

Table D-5 in Appendix D presents the evaluation of the Group 2 well COC trends since the start of remedial actions against expected conditions that were developed in the LTM Design Report. A full reporting of all trends versus expected conditions is included in Appendix E.

The following indicator parameters were not included in Table D-5:

- HE breakdown products (i.e., MNX, TNX, DNX, 1,3-dinitrobenzene, DNT2A, and DNT4A) were not included since increasing trends are not indicators of continued sourcing.

- TCE breakdown products (i.e., cis-1,2-DCE; *trans*-1,2-DCE; and vinyl chloride) were not included since increasing trends are not indicators of continued sourcing.
- Total chromium was not included in lieu of hexavalent chromium.

Nine wells that have detections of COCs are already meeting the expected conditions, including PTX06-1077A. Several wells have increasing or probably increasing historical COC trends. PTX06-1005 and PTX06-1095A are exhibiting increasing trends in multiple COCs, but these wells are under the influence of remedial actions, and these trends more likely reflect the influences of the remedial actions rather than increased mass flux from the source areas.

One or more constituents in PTX06-1050, PTX06-1053, PTX07-1O03, PTX08-1001, PTX06-1002, PTX08-1005, PTX08-1009, and PTX10-1014 are not exhibiting a trend or were non-detect, although expected conditions are long-term decreasing trends. However, statistical trends are not increasing.

The thirteen wells that are exhibiting increasing trends (excluding PTX06-1005 and PTX06-1095A that were discussed above), when their expected condition is a decreasing or stable trend, are discussed below. The trends in these wells are affected by changing flow gradients in perched groundwater that have been caused by the remedial actions and a decline in perched water levels. Thus, all of the increasing trends discussed below are associated with changes in plume movement rather than the continued or increasing release of contaminants from source areas.

- 1114-MW4, located in central Zone 11, is exhibiting an increasing trend for chloroform, possibly due to changing flow gradients and plume movement away from the source (i.e., Hypalon pond and nearby ditches). The last four samples indicate no trend for chloroform.
- OW-WR-38, located northeast of Playa 1, is exhibiting increasing trends for RDX and TCE. RDX concentrations have been fluctuating near the GWPS since 2009 but was over 30 ug/L in the most recent sample collected in 2023. Although elevated RDX has not been previously observed at this well, other wells north of Playa 1 (e.g., PTX06-1050 and PTX07-1O03) have exhibited higher concentrations of RDX in the past. The trend may be due to the effects of the P1PTS or recent changes in the discharge of treated water to Playa 1, which have dramatically affected water levels and gradients in this region of perched groundwater. Detections of TCE have been

sporadic at levels below the PQL and GWPS. The identified increasing trend is the result of low-level detections and the use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area. TCE was not detected in the sample collected in 2023.

- PTX06-1007, located between and north of Zones 11 and 12, is exhibiting an increasing trend in RDX. RDX has been detected at levels near the PQL in this well since 2002 with only one detection above the GWPS of 5 ug/L in 2017. However, in 2020, RDX increased from near the PQL to 27 ug/L. In 2023, the RDX was measured at 2.7 ug/L. This increasing trend could be caused by changes in flow gradients and plume movement from the SWMU 5-13c ditch.
- PTX06-1008, located in Zone 12, is exhibiting increasing concentrations of chloroform and 1,2-DCA above the GWPS. 1,2-DCA has been gradually increasing in this well and has been above the GWPS since 2009. Chloroform has similarly been gradually increasing since 2009 but remained below the GWPS in 2023. Recent data for both constituents indicate no trend. Both constituents are associated with a soil gas plume from SWMU 136. The increasing trends may be linked to the repair of several major water leaks that occurred in Zone 12 in recent years. The leaking water from the surface may have diluted VOC concentrations in groundwater beneath Zone 12. If these plumes migrate from beneath Zone 12 to the southeast, the plumes should be captured by the SEPTS, and both constituents will be effectively treated by GAC.
- PTX06-1010 is exhibiting increasing trends in TCE and chloroform, although the expected condition is a long-term decreasing trend. Although the trend indicates increasing TCE, concentrations in this well have declined to below the GWPS from historical levels and have remained below the GWPS since 2009. Chloroform is fluctuating near the PQL with an overall increasing trend, but concentrations, again, remain below the GWPS. The last four samples indicate no trend for both TCE and chloroform.
- PTX06-1011 is exhibiting a probably increasing trend in TCE and an increasing trend in chloroform and RDX, although the expected condition is a stable or decreasing trend below the GWPS. TCE has fluctuated in this well since 1998. The identified probably increasing trend is partially the result of low-level detections and use of one-half the detection limit in the trending but may also reflect the variable

influence of the remedial actions and general plume movement in this area; however, data for the last four samples indicate no trend for both COCs. Recent chloroform concentrations in this well remain stable and near the PQL. RDX was not detected for many years, but was recently detected below the GWPS in 2023. The indicated increasing trend is the result of using one-half the detection limit in the trending.

- PTX06-1050 located north of Playa 1 is exhibiting probably increasing trends in RDX. However, this well has exhibited higher historic RDX concentrations and exhibit decreasing trends considering all data. These increasing trends may be due to P1PTS effects as system operations have dramatically affected water levels and possible gradients in this region of perched groundwater.

- PTX06-1088 has exhibited an increasing trend in chloroform since the start of remedial actions. Chloroform has been increasing since 2017 but has been stable in recent data, and concentrations remain well below the GWPS.

- PTX07-1O02 is exhibiting a probably increasing trend in TCE, although the expected condition is a long-term decreasing trend. TCE concentrations, all below the PQL, have fluctuated in this well since 1996. The observed increasing trend is partially the result of low-level detections and use of one-half the detection limit in the trending. When considering all data, the TCE trend has no trend. The continued presence of TCE at this well is not believed to be related to Landfill 1.

- PTX07-1P02 is exhibiting an increasing but variable trend in RDX, but concentrations remain far below historical levels for this well. The apparent increasing trend may be due to the effects of P1PTS since system operations have dramatically affected water levels and gradients in this region of perched groundwater.

- PTX08-1006 is exhibiting an increasing trend in TCE, although the expected condition is a long-term decreasing trend. The increasing trend in PTX08-1006, which is located downgradient from the identified sources in Zone 11, is likely due to general plume movement to the southeast that may also be influenced by SEPTS operations. Concentrations have been highly variable in this well, and the last four samples indicate no trend.

- PTX08-1007 is exhibiting increasing trends in perchlorate, chloroform, 1,2-DCA, and 1,4-dioxane, although expected conditions are long-term decreasing trends.

Perchlorate has been detected below the PQL since 2014, and recent data do not indicate a trend. Chloroform concentrations have fluctuated at levels below the GWPS since the well was completed in 1996; however, concentrations have been increasing since 2012, though they remain below the GWPS. 1,2-DCA has been detected near the PQL for many years and was detected above the GWPS in 2017; concentrations have continued increasing through 2023. Concentrations of 1,4-dioxane have been increasing since 2019, with the most recent detect just below the GWPS of 7.7 ug/L. Concentrations of chloroform, 1,4-dioxane, and 1,2-DCA are associated with changing gradients and Zone 11 discharge to the SWMU 5/13A ditch. The increasing trends may be linked to the repair of several major water leaks in Zone 12 in recent years. The leaking water from the surface may have diluted past VOC and VOA concentrations in groundwater beneath Zone 12.

- PTX08-1008 is exhibiting increasing trends in perchlorate, TCE, PCE, 1,4-dioxane, 1,2-DCA and chloroform, although the expected condition is a long-term stabilization of concentrations. As discussed in Section 3.1.1.3, the increasing trend in perchlorate may be due to general plume movement to the southeast, which has been influenced by SEPTS operations. 1,4-Dioxane had been detected at low levels near the PQL since 2016; in 2023, concentrations increased to 11.1 ug/L in the first semi-annual sample, above the GWPS of 7.7 ug/L, but the second semi-annual sample dropped to 8.8 ug/L. TCE has been detected near the PQL for a number of years; an increase to over 3 ug/L was observed in 2023, but recent data do not indicate a trend. PCE has been detected below the GWPS since 2023, with the exception of the first semi-annual sample of 2021, which exceed the GWPS. No trend was identified in the last four samples. The increasing trend for PCE may be linked to the repair of several major water leaks in Zone 12 in recent years. Chloroform was detected below the PQL in 2023; chloroform has been below the PQL or non-detect in all samples since 2001, and the apparent trend is caused by using one-half the sample detection limit in the trend analysis.

Many other wells show the stabilization of concentrations or no trend rather than a decreasing trend. However, the expected condition is that most of these wells will present a long-term decreasing trend over the next few years.

Table D-6 in Appendix D summarizes all detections of analytes above the laboratory PQL and site-specific background, if calculated, that are not considered indicator parameters.

Manganese and nickel were detected above background in 2023. Manganese was detected in PTX10-1014 above the background value of 16 ug/L but far below the GWPS of 1,716 ug/L. Detections of nickel occurred in PTX06-1002A and PTX10-1014 above the background value of 15 ug/L at a measured value of 22.3 and 832 µg/L, respectively. Manganese and nickel are naturally occurring but can be an indicator of corrosion of stainless-steel screens. All of these wells have stainless-steel screens.

3.4.3 Other Unexpected Conditions

Pantex routinely evaluates data as results are received from the laboratory to determine if data are off-trend, at an all-time high, or represent a new detection that may require further sampling or evaluation. Through the well maintenance program, Pantex also inspects wells at least every five years to ensure they are not silting in and evaluate whether or not the wells remain in contact with the formation. Based on evaluations in 2023, one well (PTX06-1095A) was determined to have potential issues with silting, causing problems with the sampling interval. This well is scheduled for well maintenance in 2024. No additional unexpected conditions were noted in 2023.

3.5 Point of Compliance and Point of Exposure Well Evaluation

As part of the approved changes to HW-50284, Pantex has designated POC and POE wells. As defined by HW-50284, POC wells demonstrate compliance with the GWPS and are used to evaluate the effectiveness of the remediation program. POE wells demonstrate compliance with the GWPS.

POC/POE Wells

- 20 perched aquifer POC wells, with 14 exceeding the GWPS.
- 2 Ogallala Aquifer POC wells, with one GWPS exceedance.
- 8 Ogallala Aquifer POE wells, with no GWPS exceedances.

The remediation program must continue until the POC and POE wells are compliant with the GWPS. The POC and POE wells approved in HW-50284 are depicted in Fig. 3-37. All but two POC wells are in the perched aquifer. All POE wells are in the Ogallala Aquifer and are not expected to exhibit detections of organic COCs or detections above background values for inorganic COCs.

All POC and POE wells were evaluated against the established GWPS. Evaluation of the data indicates twenty perched aquifer POC wells had concentrations below the GWPS for some or all of the COCs. All COCs are below the GWPS at the Burning Ground perched wells (PTX01 wells), PTX06-1023, PTX06-1045, PTX06-1215 and PTX07-1002. This is an expected condition because the full remedial actions were started in 2009 and full treatment across all wells will take time. The Ogallala Aquifer wells were evaluated as early detection wells in Section 3.4 to determine if any COCs were detected above the background or PQL. One Ogallala POC well (PTX06-1056) had a detection above GWPS. All well data, along with comparisons to the laboratory PQL, background, and GWPS, are provided in Appendix D.

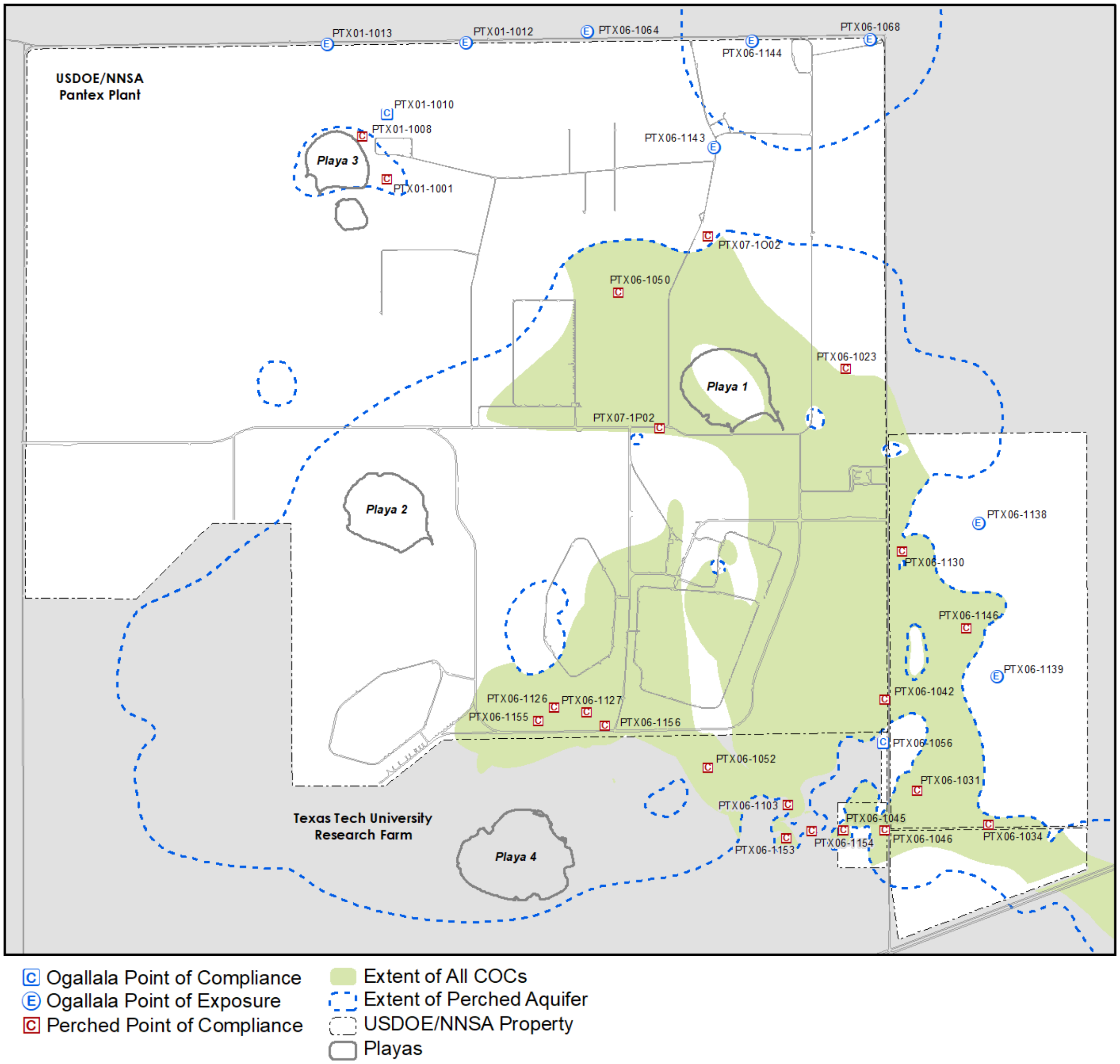


Fig. 3-37. POC and POE wells.

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4.0 SOIL REMEDIAL ACTION EFFECTIVENESS

To prevent cross-contamination from soils to groundwater, three soil remedial actions were implemented, including (1) soil covers on landfills, (2) ditch liner in Zone 12, and (3) the Burning Ground SVE. This evaluation focuses on the following two aspects of effectiveness:

1. Remedial action effectiveness of the SVE
2. Uncertainty management

4.1. SOIL VAPOR EXTRACTION REMEDIAL ACTION EFFECTIVENESS

The Burning Ground SVE system consists of a small-scale CatOx system that has been operating since April 2012, when it replaced a large-scale CatOx system that was operated as an early remedial action to address risk to groundwater. The small-scale system is used to treat residual NAPL and soil gas at a single extraction well, SVE-S-20, near the source area.

The Burning Ground SVE system operated during one event in 2023, occurring from September to the end of October when the system failed. The system was down during the year due to a failure that occurred in late 2022. Parts were difficult to obtain so the system was not repaired until late August 2023. As discussed in Section 2.2.1, the system operated about 15% of the year, with 1,316 hours of operation. Fig. 4-1 depicts the operation of the SVE during 2023.

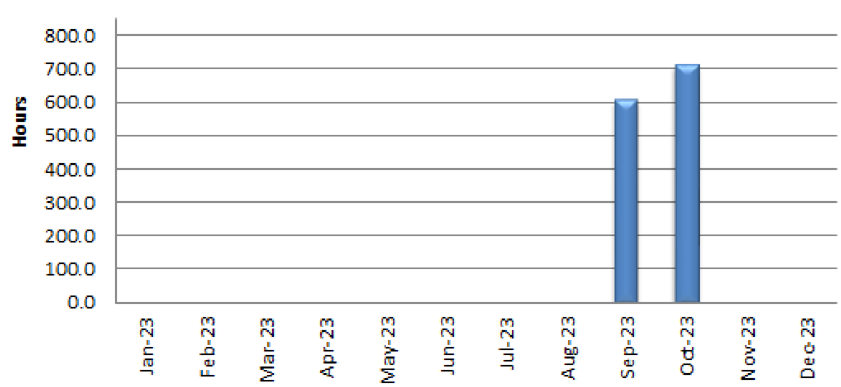

Fig. 4-1. SVE System operational hours in 2023.

The small CatOx/wet scrubber system continues to focus on treating residual soil contamination and soil gas at SVE-S-20, where soil gas concentrations continued to remain relatively high after operation of the first larger-scale CatOx system. To enhance the removal of the NAPL source through increased volatilization and stimulation of aerobic bioremediation, the system was modified in 2017; specifically, airflow was increased through the formation by opening pipes from wells surrounding SVE-S-20 to ambient air. The system removed approximately 47 lbs of VOCs during 2023.

Figure 4-2 shows the mass of the four highest VOC compounds [i.e., acetone, toluene, TCE, and tetrahydrofuran (THF in the figure)], removed each month of 2023. The hourly VOC removal rate has declined significantly since modifications occurred in 2017. Data since 2021 indicate the greatest drop in mass removal since the system began operating.

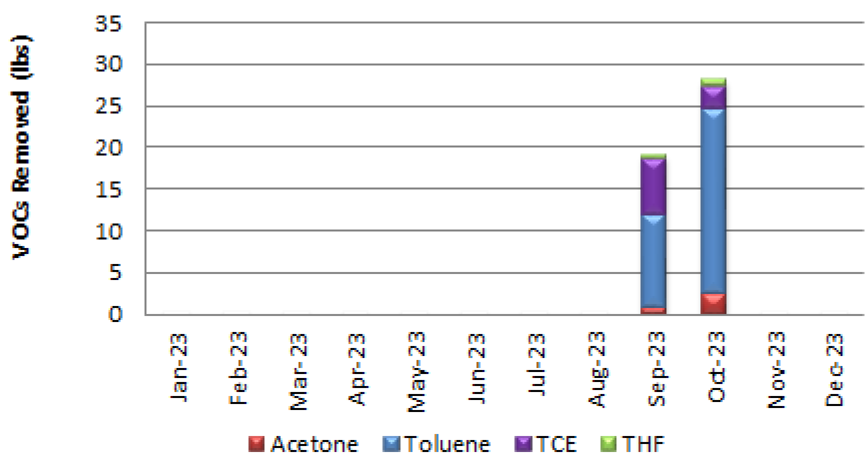

Fig. 4-2. SVE System 2023 VOC removal.

Influent and effluent PID readings are taken at the SVE system prior to the oxidizer and at the scrubber stack. The sampling frequency is weekly to ensure compliance with the permit-by-rule. Pantex also collects monthly influent samples that are sent to a laboratory for analysis. PID and laboratory data are also collected when the system is first started. The analytical samples are used to estimate the SVE system mass removal. In 2023, a total of three samples were collected for laboratory analysis from August 31 through October.

Table 4-1 summarizes detected 2023 data in influent samples and the average concentrations from 2007 to 2008. The 2023 data were collected at the current SVE system's influent port. The average of 2023's measured values is lower than what was documented from 2007 to 2008. Maximum and average values are also significantly lower than the baseline concentrations for the major constituents. Additionally, acetone, toluene, and THF were not detected when the system was first operated, but only the detected concentrations were summarized in the table.

Table 4-1. Burning Ground SVE Data Summary

Analyte	2023 Measured Value			2007-2008 Measured Value		
	Mean*	Max	Min	Mean	Max	Min
Acetone	8,426	10,900	7,110	82,666	140,000	38,000
Toluene	53,266	59,500	41,440	477,307	990,000	45,000
1,1,2,2-Tetrachloroethane (PCA)	3,790	7,360	651	3,356	6,300	760
Trichloroethene (TCE)	10,400	18,500	3,540	26,714	41,000	13,000
Tetrahydrofuran (THF)	2,543	3,470	1,160	20,107	26,000	9,500

Results for 2023 are based on laboratory analysis of samples of influent to the SVE system. Measured concentrations in parts per billion by volume (ppbv).

*Mean of measured values; non-detect results not included.

Minor concentrations of other VOCs were noted, due to the lowered detection limits for the SVE samples. As concentrations have declined, dilution of samples is not necessary and other minor VOCs are detected. Current data indicate that total VOC concentrations for each sample was below 100 ppmv for total VOCs.

Fig. 4-3 demonstrates the change in daily removal rates since modification of the system occurred in May 2017. Removal rates have declined to 1 lbs or less per day, or up to 92% decrease from May 2017 removal rates. The removal rate has dropped up to 95% from the peak removal rate in fourth quarter 2017.

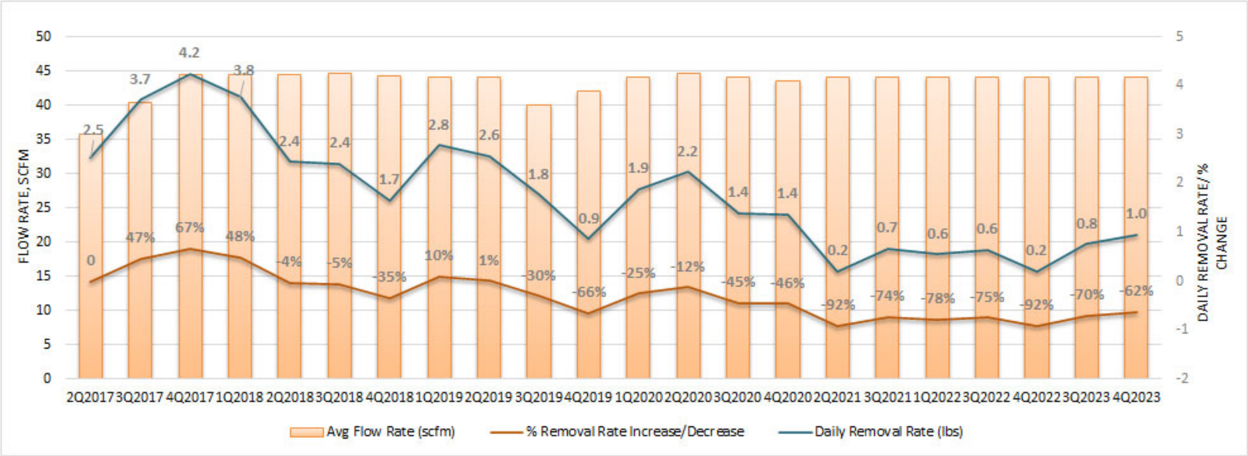

Fig. 4-3. Daily removal rate change since 2017 modification of the SVE System.

Concentrations were also evaluated to determine whether concentrations would increase after a long pause in operations. Samples collected in 2023 indicate that a low total VOC concentration is observed at start-up (20 ppmv). With continued operation, concentrations increase, remaining below 100 ppmv, then drop off again in a short period of time. This pattern has been observed since the start of 2021. These data demonstrate the source at SVE-S-20 is significantly depleted. A small nearby source may be indicated by the rise in concentrations over time, but the data indicate that those concentrations also decline quickly, suggesting a minor source that is also near depletion. Total VOC concentrations since the installation of the current system are depicted in Fig. 4-4.

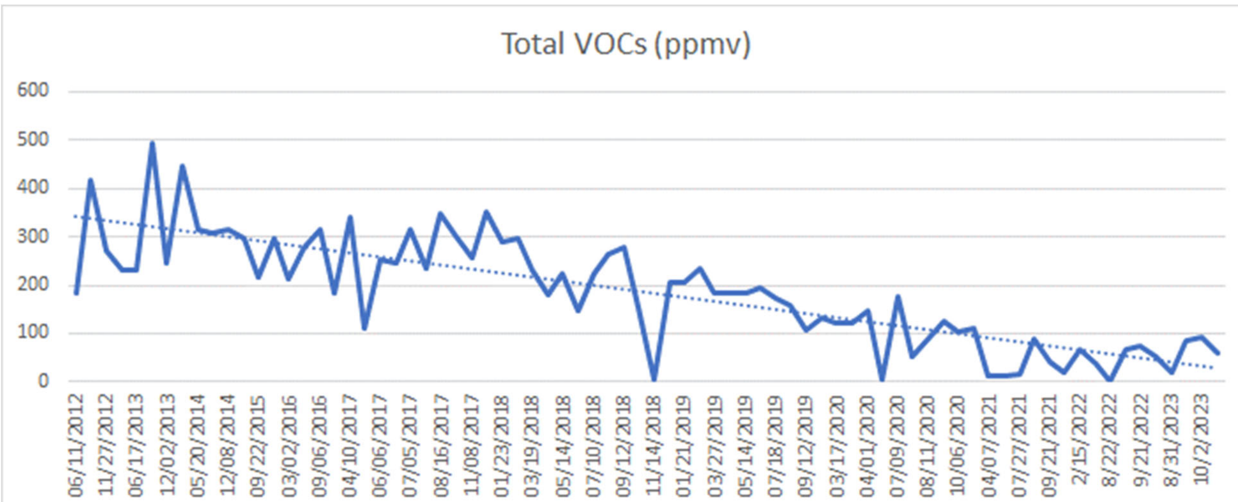

Fig. 4-4. Total VOCs since installation of current CatOx system.

To verify whether VOC concentrations are decreasing, the nonparametric Mann-Kendall trend test was applied. This method of statistical investigation was performed on all available SVE analytical data collected since the small-scale CatOx system was installed in early 2012.

Mann-Kendall trends were calculated based on all data collected from 2013 to the present and using recent data (i.e., the last four measurements collected at the system influent port). Since the analytical results can be affected by multiple factors (e.g., extraction equipment, sample port location, system conditions), no effort was made to statistically trend the new results with the analytical data associated with the old systems. Generally, current concentrations are lower than those collected in the previous large-scale CatOx or GAC system. These lower concentrations appear to reflect a significant decline in the residual NAPL source.

Table 4-2 summarizes the statistical trending. The results indicate that all four main COCs (i.e., acetone, toluene, TCE, and THF) exhibit decreasing trends, considering all data collected since 2013. The last four concentration measurements indicate either stable or no trend for the four primary VOCs.

Table 4-2. Mann-Kendall Results for Soil Gas COCs

COC	Trend-All Data	Recent Trend
Acetone	Decreasing	Stable
Toluene	Decreasing	No Trend
TCE	Decreasing	Stable
THF	Decreasing	No Trend

The average monthly PID measurements collected at the system influent, summarized in Fig. 4-5, show some variability, but 2023 monthly averages for September and October were 69 ppm, only one measurement was collected on the last day of August, which was at 20 ppm. The blue circles on the chart show the 12-month rolling average, which illustrates a strong decline in average concentrations since the system modification in mid-2017. Two very high PID readings in June 2018 that were determined to be unrepresentative were omitted from the 12-month averages. Through the end of 2023, average PID readings were lower than those observed since the small-scale system began operating in 2012. The observed decline in influent PID readings was expected and indicates NAPL source depletion.

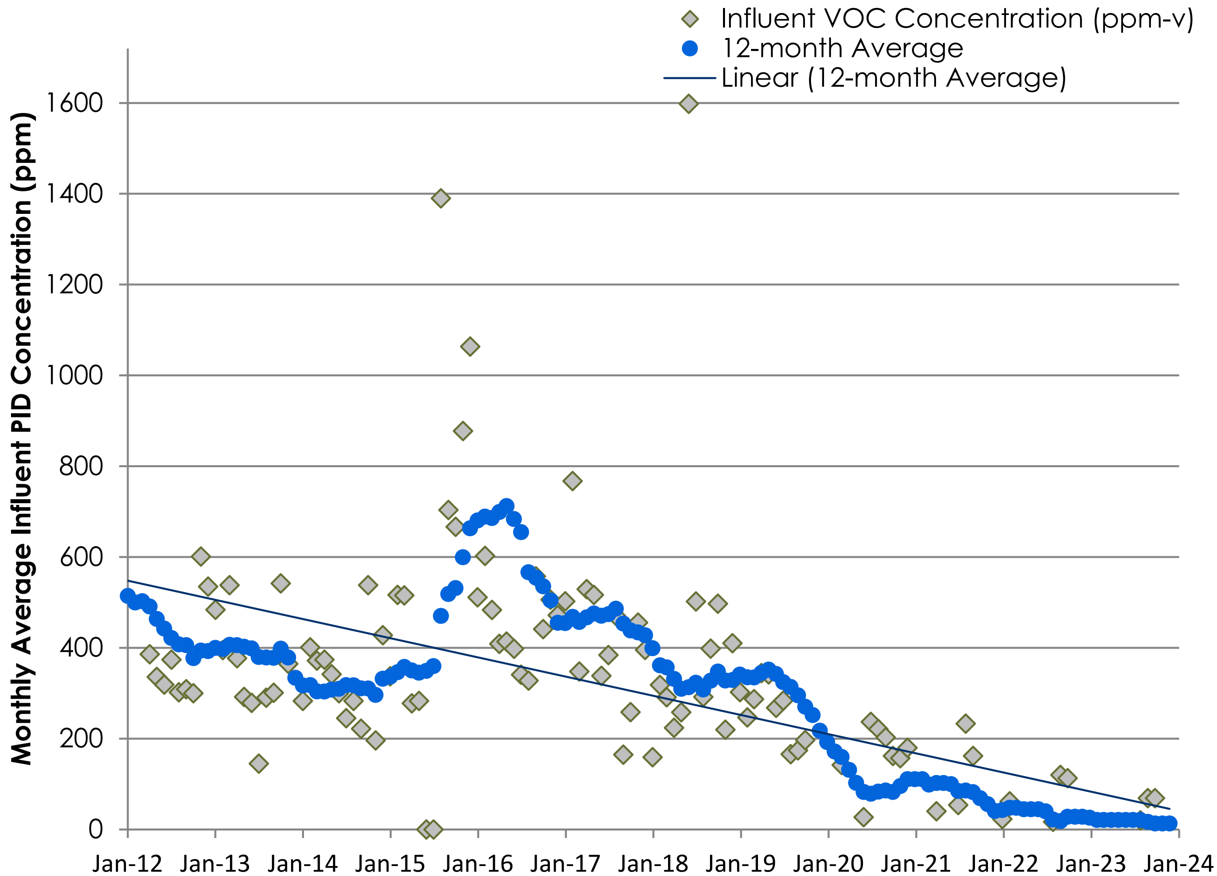

Fig. 4-5. Influent average PID VOC concentrations vs time.

In the *Five-Year Review Report* (Pantex, 2013d), Pantex recognized the conflicting data and uncertainty concerning the reduction of soil gas VOCs and mass of NAPL remaining in the soil near SVE-S-20. However, no expected conditions or paths toward closure were defined for the SVE system, other than "significant reduction in soil gas VOCs."

Therefore, in the first FYR, Pantex recommended developing a Burning Ground SVE Performance Monitoring Plan to define expected conditions of system performance as well as a clear path toward an endpoint of active SVE operations. In anticipation of this plan, four rebound tests were attempted in 2014 and 2015 to establish baseline conditions against which future rebound tests could be compared; however, none of the rebound tests were successful. Based on the system operational data and data collected during the four attempted rebound tests, it does not appear the SVE performance-based approach will be technically practicable in attaining closure at the SEP/CBP area of the Burning Ground.

Pantex has evaluated other paths to an endpoint of active remediation for this system. After evaluation of influent concentrations and system performance, Pantex recommended an approach to enhance bioremediation and volatilization.

In the *4th Quarter 2016 Progress Report* (Pantex, 2017d), Pantex recommended that up to seven inactive SVE extraction wells surrounding the active extraction well SVE-S-20 be modified with goose-neck pipes extending aboveground with screens and shut-off valves so that while the system is operating, airflow through the formation can be enhanced by opening the pipes to ambient air. This enhancement helps to stimulate naturally occurring aerobic bacteria that degrade the NAPL source and increase volatilization.

The modifications were completed in May 2017, with baseline samples collected in June. Flow was increased from an initial rate of approximately 32 scfm to 44.5 scfm during the fourth quarter of 2017. Hourly VOC removal rates increased with increased flow. In the fourth quarter of 2017, the SVE system's performance improved with a 50% increase in VOC mass removal rate over first-quarter baseline values and an increase of 34% in the extraction air flow rate. The mass removal rate improvement lasted through the first quarter of 2018 and has since declined, and the hourly removal rate has remained consistently low throughout 2023.

The drop in influent concentrations, mass removal rates, and declining influent PID measurements indicate that the system has reached a point where the residual NAPL mass will not be effectively treated through continued operation of the system. Pantex recommended closure of the system, with continued monitoring of groundwater in a report sent to TCEQ and EPA in August 2023 (Pantex, 2023). The TCEQ and EPA provided approval of the closure report in December and October, respectively. Pantex removed the system from the application to renew HW-50284 in late 2023. Pantex has committed to continuing evaluation of groundwater data in the area of the SVE system to ensure that concentrations in groundwater do not rebound after closure of the system. The Pantex Groundwater Contingency Plan will be updated to reflect the uncertainty management monitoring and contingent response if concentrations above GWPS occur in groundwater.

Through 2023, the SVE system has removed approximately 21,378 lbs of VOCs from soil gas and residual NAPL in the SEP/CBP area and has successfully mitigated the potential vertical movement of VOCs to groundwater.

4.2. Uncertainty Management

One of the purposes of the uncertainty management wells is to confirm the following expected conditions from the soil units:

1. Declining source contributions from soil units that have historically contributed to groundwater.
2. No new source contributions to currently impacted groundwater.
3. Areas that have no historical contamination in the uppermost groundwater will not exhibit signs of sourcing to groundwater.

In accordance with the SAP, Pantex analyzes indicator constituents at all wells to determine possible impacts to areas that were previously unaffected or to ensure that source area strength is declining in impacted areas. This evaluation is presented in Section 3.4.

In 2023, one Group 1 perched aquifer well had an unexpected condition due to the detection of an emerging constituent, PFAS. PFAS was detected at low concentrations. No further action will be taken at this time, but the data from this sampling event will be used in the future to develop a PFAS sampling work plan. Organic constituents were detected in four Ogallala wells. Metals, including hexavalent chromium, manganese, nickel, and boron were detected above background, but below GWPS. Boron frequently shows higher detections in wells that are towards the southern side of Pantex, due to the influence of the Dockum Aquifer. Other detections are likely the results of background variability or corrosion. This review indicates there are no unexpected conditions from the soil source areas.

PTX06-1056 continued to demonstrate detections of the HEs, DNT4A and RDX, since the initial detection of DNT4A in April 2014. Sample results for DNT4A have been variable, with values slightly exceeding the PQL since 2016. This trend continued in 2022, with DNT4A values exceeding the GWPS for the first time in the third quarter of 2022. As a result of the detection above the GWPS, Pantex installed three new Ogallala monitoring wells to investigate nature and extent of the contamination.

Additionally, the VOC, 1,2- DCA, has been variably detected in well PTX06-1056 since August 2015, but all detections had been equal to or below the PQL. DNT4A, RDX and 1,2-DCA continue to demonstrate an increasing trend across all data. All 3 COCs also demonstrate an increasing trend across recent data (last four measurements).

PTX06-1056 is distant from soil sources, so detections are not related to movement from source areas. This uncertainty management well is used to evaluate potential movement of impacted perched groundwater to the Ogallala Aquifer.

DNT4A was also measured above the PQL for the first time in 2023 at PTX06-1076. As a result, a verification sample was completed at PTX06-1076 in August 2023. Results from the verification sample confirmed detections of DNT4A above the PQL. DNT4A demonstrates an increasing trend for the long term, but recent data is demonstrating no trend. This well is distant from soil sources and is used to evaluate potential movement of impacted perched groundwater to the Ogallala Aquifer.

A single detection of TNT was observed below the PQL, at Ogallala well PTX07-1R01. This well is also distant from soil sources.

No Ogallala Aquifer uncertainty management wells indicated impacts from a soil source area.

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5.0 Conclusions and Recommendations

5.1 Conclusions from the 2023 Annual Report

Overall, the groundwater remedial actions have been effective in 2023. They continue to operate and meet short-term expectations for cleanup of the perched groundwater in areas under the influence of the remediation systems. While the remedial actions continue to operate to meet long-term goals, perched water levels are declining in most areas, COC mass is being removed or reduced, and institutional controls protect against the use of impacted groundwater. The influence of both pump and treat systems will continue to expand as saturated thickness is reduced in the perched aquifer.

The groundwater remedies are considered to be protective for the short term since untreated perched groundwater use is controlled to prevent human contact. Two Ogallala Aquifer wells, PTX06-1056 and PTX06-1229, indicate the presence of high explosives above the GWPS. PTX06-1056 had continued detections of DNT4A and 1,2-DCA, with DNT4A exceeding the GWPS for the first time in 2022, indicating the possible migration of perched groundwater to the Ogallala Aquifer. In response to these detections, Pantex has completed the following actions in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan*:

- A high-volume time-series sampling event was conducted August 8, 2022 at PTX06-1056 to determine if DNT4A was part of a wider plume area. Detections were confirmed throughout the sampling event, indicating the DNT4A was more widespread than occurred in a sampling event conducted August 5, 2014, after the first detections of DNT4A occurred.
- Pantex drilled three new Ogallala wells in 2023. Samples were collected from the wells and data indicate the presence of low-level detects of RDX and DNT4A in PTX06-1223. Higher detects were observed in PTX06-1229. No detections of high explosives or VOCs were observed in PTX06-1224.

RDX, DNT4a, and TNX (a breakdown of RDX) was observed above GWPS in PTX06-1229. A resample in early 2024 confirmed the higher concentrations in this well. Further sampling is planned for this well and will be completed in 2024. This well is downgradient of a perched well that was discovered to be potentially contributing to the Ogallala and was plugged in 2010. Pantex plans to install more wells in 2024 to evaluate nature and extent of the high explosive detections. Further work will be planned after evaluating results from the new wells.

The throughput performance of the pump and treat systems was affected by shutdowns for repairs to the WWTF lagoons, which caused a reduced storage capacity, and construction activities related to the installation of the new pivot irrigation system. In accordance with Permit #WQ0002296000, all treated wastewater effluent and treated water from the pump and treat systems was routed to Playa 1. The P1PTS was shut down in April 2022 to complete installation of new components for the new center pivot irrigation system. That system was not operated until the pivot irrigation system became operational in August 2023. This allowed SEPTS to fully operate during 2023 to capture water in high-priority locations. This operation scheme was implemented to control downgradient migration of plumes. Pantex formalized this operational priority by setting new operational goals for both systems.

The Zone 11 ISB system has a well-established treatment zone through most of the system. Improved conditions have been noted across the western side of the Zone 11 ISB after moving to the use of molasses amendment in recent years. However, some wells have limited ability to accept injection. Pantex in-filled wells on the western side to address some of the low-performing locations. Pantex will continue to evaluate pausing injections in older wells to allow the well to clear out the EVO. In-filling of wells will be used when necessary to continue treatment in portions of the system. To address the change in flow directions that are causing plumes to move to the southeast, a second line of injection wells was installed across the southern portion of the Zone 11 ISB and TZM results from that area indicate improvement in treatment conditions.

All wells downgradient of the Zone 11 ISB have indicated the arrival of treated water, including PTX06-1175, which had been slower to respond, but data indicate that TCE and RDX are trending appropriately now. In 2023, perchlorate was detected above the GWPS in two downgradient ISPM wells, but was not detected or was below the GWPS in the other seven wells. TCE concentrations are below the GWPS in five of nine ISPM wells. Two wells downgradient of the southern part of the system (PTX06-1148 and PTX06-1149), where the second row of injection wells were added in 2021, are indicating increased concentrations of TCE while the other two wells indicate concentrations near the GWPS. The second row of wells is expected to improve the treatment of TCE in that area of the

ISB within the next five years. Overall, implementation of a new amendment and infill of wells across the system has improved reducing conditions across the Zone 11 ISB.

The Southeast ISB system has been effectively treating HEs and hexavalent chromium at two of the closest downgradient ISPM wells, PTX06-1037, PTX06-1154, and historically at PTX06-1123. PTX06-1123 has limited or no water and can no longer be sampled. These wells indicate that the reducing zone has extended beyond the treatment zone and RDX and hexavalent chromium concentrations in these wells are either non-detect or below the GWPS.

PTX06-1153 continues to exhibit RDX concentrations above the GWPS at the Southeast ISB, but hexavalent chromium concentrations continue to demonstrate a decreasing trend and have remained below the GWPS since 2016. This well has demonstrated signs of partial treatment since 2019. TNX, a RDX breakdown, was detected at concentrations above the GWPS with other breakdown products being present, indicating partial treatment has occurred. Trends across recent data indicate decreasing trends in RDX at this well, though long-term data demonstrate an increasing trend. Pantex is removing this well from the Hazardous Waste Permit as a POC well, so the well can be injected to ensure treatment in that area of the ISB.

The new Southeast ISB Extension was injected once during 2023, using molasses. Downgradient wells demonstrated partial treatment in 2023. TOC has slightly increased in downgradient wells since beginning of sampling in 2018. Monitoring results for the system indicate that RDX and breakdown products are present in downgradient performance monitoring wells and metals (i.e., arsenic and manganese) are starting to increase indicating the arrival of treated water.

The Offsite ISB was injected twice during 2023, using molasses. The system was designed to clean up the offsite area within 25 years, with approximately 15 years of injections planned. This system was fully installed by the end of 2023. Concentrations of HEs remain low in the recirculation extraction wells at the leading edge of the plume. Total organic carbon was present at a higher concentration in all sampled recirculation and in a few of the TZM wells. Treatment zone data for the new TZM wells indicates the treatment zone is being established, but portions of the plume are not expected to fully establish treatment until 2025 or later. Treatment zone expansion will occur with time and repeated injections across the system. Concentrations at the downgradient ISPM well PTX06-1215 indicate that all high explosives remain below the GWPS indicating that the system is arresting downgradient movement of the plume.

Soil remedies have been effective at Pantex. Workers and the public are protected from exposure to contaminated soils, and data do not indicate that new contamination is migrating to the underlying groundwater from soil source areas. The landfill covers and ditch liner are operating as designed and occasional rainfall continues to improve vegetative cover on the landfills.

Yearly inspections and the second FYR indicated several landfills that require the soil covers to be maintained. Pantex has completed all of the second FYR landfill actions using a combination of onsite and contract resources. Pantex will continue to address the needed landfill maintenance observed during annual inspections, as budget and availability of onsite resources allow.

The ditch liner prevents the infiltration of water that would cause HEs in soils to migrate to the perched aquifer. Maintenance of the ditch liner is required to ensure continued conveyance of runoff through the ditch system. Contracting and maintenance was completed in 2023.

The SVE system has actively removed soil gas and residual NAPL in soils at the Burning Ground, thereby mitigating vertical movement of VOCs to the Ogallala Aquifer. The system went down at the end of 2022 and repairs were not completed until late August 2023. The system was operated once in 2023. Data indicate a strong decline in influent concentrations since the system was modified. Data from 2021 and 2022 indicated that the NAPL source was near depletion. A closure report was prepared in August 2023. TCEQ and EPA approved closure of the system in late 2023 and the system has been requested for removal from HW-50284. Monitoring will continue at the Burning Ground to evaluate the effectiveness of the removal. Monitoring results will be included in future reports.

Institutional controls are in place for soils and groundwater, providing short-term protection of human health and the environment while active remedies continue to operate. Pantex will continue to evaluate areas that are not currently under the influence of active remedies to determine if additional actions are needed to provide permanent, long-term protection.

Pantex updated the conceptual and fate and transport models in 2021 and completed an evaluation to optimize pump and treat and/or ISB remedies to affect the southeast plume of RDX, perchlorate, and hexavalent chromium. The optimization indicated that further work would be required to control the continued movement of RDX that extends offsite. Further work is also required to address the hexavalent chromium and perchlorate plume that is outside the influence of the SEPTS. Pantex has planned and requested budgets for projects that will improve cleanup of RDX, perchlorate and hexavalent chromium and will implement those projects when funding is provided.

5.2 Conclusions from the Five-Year Reviews

Pantex has completed three FYR reviews. The latest FYR Report was approved in September 2023.

The results of the FYRs indicate that the selected remedy is performing as intended and is protective of human health and the environment in the short term because there are no completed exposure pathways to human receptors for soil or perched groundwater. Ecological pathways that are complete were determined to be within acceptable risk ranges and no further actions are necessary to protect ecological receptors.

To achieve long-term protectiveness of human health, operation and maintenance of the remedial action systems must continue, and enhancements to existing systems and institutional controls must be evaluated, planned and implemented.

This section is provided to track the recommendations and actions from the FYRs to completion. All items from the second FYR were complete by the end of 2022, with the exception of evaluating the SVE System for shutdown after completion of upgrades in 2017. Pantex prepared a closure report for the system and submitted that to TCEQ and EPA in August 2023. Both agencies approved the closure report in 2023. Pantex removed the SVE System from the application to renew HW-50284, when it was submitted in December 2023. The system has been shut down and is not planned for further operation. Pantex committed to continuing to evaluate groundwater at the Burning Ground to ensure long-term effectiveness of the action to remove residual NAPL in soils.

One recommendation from the first and second FYR was carried into the third FYR. The issue of incomplete treatment at the Southeast ISB at well PTX06-1153 was identified. While previous work had improved conditions at PTX06-1153, concentrations of RDX persist in that area, indicating that complete treatment is not occurring. It was recommended that this well be injected. Pantex has requested the removal of PTX06-1153 as a POC well in the application to renew HW-50284. This well will be planned for injection after HW-50284 is renewed.

Table 5-1 details the issues and recommendations contained in the second FYR. Items that have been addressed have been greyed out. Plans for completion or summary of work completed are provided for each item.

Table 5-1. Third FYR (2023) Issues and Recommendations

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Issues				
Soil Remedies				
Minor deficiencies in protective soil covers, including erosion, animal burrows, and settling.	Prepare and implement a work plan to fill holes on soil cover surfaces and investigate erosion around a culvert at Landfill 5 (SWMU 56).	Sep 2025		This work will be scheduled either through contracting or onsite resources.
Tears observed in the SWMU 2 and 5-05 Ditch Liner during the 2021 inspection, and sedimentation and erosion of the anchor trench.	Prepare and implement contracting to repair tears in the ditch liner.	Apr 2024	Sep 2023	Completed through contracting at end of FY 23.
Groundwater Remedies				
Perched groundwater elevations and RDX concentrations are increasing around Playa 1.	1. Eliminate all treated perched groundwater discharges to Playa 1 and resume operating the P1PTS at operational goals once the center-pivot irrigation system is operational. 2. Continue to monitor LTM wells near Playa 1 to verify that perched groundwater elevations drop during the next FYR period and RDX concentrations decrease.	Jul 2024 Continuing		Pivot irrigation operational in Sept 2023. PFAS in wastewater was evaluated through October 2023. Pantex is collecting more data to verify the presence of PFAS in the treatment effluent. Removal of all water from Playa 1 will be delayed until early 2025 while further data are collected at the WWTF. Evaluate water levels annually in progress report.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Incomplete treatment of contaminants (HE and CR [VI]) downgradient of the west end of the Southeast ISB (PTX06-1153).	Continue to collect and evaluate data from the Southeast ISB area and consider targeted injections in the area of PTX06-1153. Evaluate options for optimized injection of amendments to address contamination in this area.	Sep 2025		Pantex requested removal of PTX06-1153 as a point of compliance well in the application to renew HW-50284 so that the well can be injected. Permit will be issued in 2024. Well will be planned for injection in FY 25, pending receipt of funding.
DNT4A was detected above the GWPS in Ogallala monitoring well PTX06-1056.	1. Install additional Ogallala monitoring wells near PTX06-1056 and upgradient between the Southeast ISB and PTX06-1056 to define the extent of the impacts to the Ogallala Aquifer and evaluate migration potential toward Site boundaries. 2. Prepare a workplan to complete the investigation of DNT4A in the Ogallala Aquifer.	Sep 2025 Mar 2026		Three additional Ogallala wells were installed and sampled in FY 23. One new well will require further investigation to identify extent of impacts to the Ogallala Aquifer. New wells are planned in FY 24. Further work will be determined based on results from those wells. A workplan will be prepared to complete the investigation of DNT4A and RDX in the Ogallala Aquifer.
1,4-Dioxane is present in the perched aquifer and is not treated by active remedies.	Incorporate 1,4-dioxane into the next *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* update with steps to take if concentrations increase.	Mar 2025		Incorporate 1,4-dioxane into the next *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* update with steps to take if concentrations increase.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
PFAS were present in products used at the Pantex Plant and have been detected in SEPTS influent groundwater.	1. Sample a strategic subset of existing perched groundwater LTM wells to determine the extent of PFAS impacts at the Pantex Plant.	Sep 2024		Currently implementing a groundwater sampling plan for PFAS that is scheduled for completion in FY 24. Pantex is currently evaluating effluent from WWTF before sending to the pivot system, will implement monthly sampling if needed.
	2. Assess whether existing remedies are removing PFAS, and assess if existing remedies are spreading PFAS through injection of treated water or in waste streams for spent ion exchange resin or GAC.	Sep 2024	Jun 2023	Have completed GAC study at the pump and treat system and have implemented automated change-outs.
	3. Prepare a work plan to complete a PFAS site investigation.	Mar 2026		Work Plan to be developed based on information collected through 2024.
Sections of the Zone 11 ISB demonstrate mixed results, with incomplete degradation of TCE near TZM wells PTX06-1164 and PTX06-1169.	1. Review amendment injection volumes to confirm that they are sufficient to distribute amendment away from the injection wells.	Sep 2024	Dec 2023	Pantex has reviewed amendment near TZM wells PTX06-1164 and PTX06-1169. Amendment volumes will be increased where needed.
	2. Test alternative well maintenance approaches, such as sequential application of different chemical agents, longer surge times, or a heated water maintenance approach, to improve transmissivities around the well screens.	Sep 2024		Pantex is working towards amending the contract to add alternatives for well maintenance. This work will not be implemented until 2025.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Recommendations for Remedy Optimization and Monitoring				
Soil Remedies				
Request that the current operating permit for the SVE system be modified to terminate operation of the system.	1. Provide evaluation of the Burning Ground SVE system performance and request concurrence to cease operations.	Sep 2024	Aug 2023	Burning Ground Closure Report was submitted to regulatory agencies in August 2023. EPA and TCEQ approval provided by the end of 2023. The SVE System was requested for removal in the application to renew HW-50284 in December 2023. The permit will be renewed in 2024.
	2. Continue the groundwater sampling program at wells PTX01-1001, PTX01-1010, and PTX01-1011 to obtain data to support termination of the Burning Ground SVE system.	Sep 2024	Nov 2024	Pantex committed to continuing to sample the point of compliance and exposure wells identified for the Burning Ground. Pantex will incorporate evaluation and response requirements into the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan*, planned for update in early 2025. Pantex will also continue to include the sampling of these wells in the 2024 update of the LTM Design and SAP that is due to regulatory agencies by November 15, 2024.
Groundwater Remedies				
Consider reassessing P&T system operational goals as water levels in extraction wells reach practical limits for extraction.	Develop a planned approach to transition away from the current extraction rate goal when extraction rates can no longer feasibly be met.	Sep 2025		Goals were updated in early 2023 and are included in Section 1 of this report.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Prioritize locations for groundwater extraction from recommendations in the 2021 optimization study (HGL, 2021).	1. Operate the P1PTS and SEPTS with wells prioritized based on the results of the 2021 optimization study. 2. Continue evaluating the benefit of adding new wells in areas recommended in the 2021 optimization study.	Sep 2025		Pantex plans to evaluate priority of pumping using optimization study information and latest information on concentrations of priority contaminants and flow rates at the well. Inclusion of new wells has been evaluated. Northeast pump and treat wells were added east of FM 2373. New wells are planned for ISBs identified in the study. No additional extraction wells will be included in the pump and treat system.
Consider periodically measuring pH in injection wells and adding buffering agents as needed.	Add pH to monitoring of the ISB wells during pre-injection activities and add a buffering agent such as sodium bicarbonate as needed, to counteract the acid production by microorganisms.	Sep 2024		The contractor has gathered pH data after well maintenance. These data indicate a pre-maintenance pH of 5 to 7 standard units. Additional data will be acquired via changes to the ISB O&M contract in 2025.
Consider increasing the duration between injection events at the Southeast ISB Extension.	Increase the time until the next injection event at the Southeast ISB Extension to assess if TOC concentrations remain elevated for longer than expected and the system can be injected less frequently.	Sep 2024	June 2024	Pantex has been evaluating lengthening the injection timeframes at the Southeast ISB Extension. Injection was completed in December 2021, September 2022 and October 2023. TZM data have indicated that reducing conditions have been adequate to treat the high explosives. Pantex plans to continue yearly injections as discussed in this 2023 annual progress report.
LTM Network				

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Update LTM Network Design and SAP documents to capture changes and recommendations from the Third FYR, after regulatory approval.	*Long-Term Monitoring System Design* and *Sampling and Analysis Plan* documents need to be updated to reflect applicable recommendations from the 2022 LTM optimization review after approval by TCEQ/EPA. Adjust sampling frequencies and add analytes where identified. Other needed revisions resulting from this FYR should be incorporated in this effort.	Dec 2024		These documents are planned for submittal by November 15, 2024, in accordance with the schedule to be included in the newly issued HW-50284.

5.3 Recommendations

Pantex plans to continue currently approved remedial actions. The groundwater remedies are considered protective for the short term since untreated perched groundwater use is controlled to prevent human contact and Ogallala Aquifer data continues to indicate COC concentrations are either non-detect or below the GWPS in areas near onsite and offsite water resources. The systems are also proving to be effective in reaching long-term objectives for cleanup in areas that are under the influence of a remedial action. Pantex has some recommended changes provided below to address areas outside of the influence of the remedial action.

Pantex has one new Ogallala monitor well (PTX06-1229), distant from water resource locations, that demonstrated significant concentration detections of three high explosives above the GWPS. Pantex is following the recommendations in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* and will install three new wells to aid in determining nature and extent for that plume. Further information and recommendations will be provided as data become available.

Soil remedies have also been effective at Pantex; workers and the public are protected from exposure to contaminated soils, and data do not indicate that new contamination is migrating to the underlying groundwater from soil source areas. The SVE system has effectively removed soil gas and residual NAPL in soils at the Burning Ground, thereby mitigating the vertical movement of VOCs to the Ogallala Aquifer.

Based on issues identified in the second FYR and this report, changes are recommended or have already been implemented to enhance the effectiveness of the remedies in some areas and improve monitoring of the overall effectiveness of the actions. Those recommendations are provided in the following sections.

5.3.1 Recommended Changes to the Selected Remedies

Pantex continues to request funding for new systems that were proposed in the 2022 ESD. Pantex will install those systems as funding becomes available. No new recommendations are necessary at this time.

5.3.2 Recommended Changes to the Pump and Treat Systems

Pantex has implemented the new operational goals that prioritize operation of the SEPTS to more effectively capture perched groundwater and contaminant plumes moving to the southeast. Pantex plans to further evaluate priority of pumping at the SEPTS to ensure that plumes and water are efficiently removed. This evaluation was also recommended in the third FYR.

5.3.3 Recommended Changes to the ISB Systems

Pantex continues to evaluate the ISBs and make changes, as appropriate, to address incomplete treatment in certain areas. The third FYR recommended changes to ISB operations in some areas and Pantex is working toward implementing those changes.

5.3.3.1 Southeast ISB

Although Pantex has injected a more soluble carbon (i.e., molasses) to improve the distribution of amendment at the ISB and injected in dry upgradient wells, RDX has declined, but continues to persist above GWPS at PTX06-1153. Pantex has requested the removal of PTX06-1153 as a point of compliance monitoring well from HW-50284 and plans to inject the well after the new permit is issued and as recommended in the third FYR.

5.3.3.2 Southeast ISB Extension

Pantex has evaluated moving to yearly injections at the Southeast ISB. This system is recommended for yearly injections starting in FY 24.

5.3.3.3 Zone 11 ISB

Pantex has installed additional infrastructure to address the hydraulic changes in the system and has in-filled wells where old injection wells will no longer accept amendment injections. Amendment volumes were reviewed for the wells surrounding PTX06-1164 and PTX06-1169 to determine if extra volume was required during injections. Volumes will be increased in 2024, as needed. Pantex continues to monitor the effect of these changes.

Pantex was unable to install two wells that were planned as part of the second row of wells on the southeastern side of this ISB. Those wells will be installed in FY 24 to address a gap in coverage at the ISB.

5.3.3.4 Offsite ISB

Injections began in 2021 with injections occurring the year following installation of each phase. All phases of installation were complete by the end of 2023 and the system is planned for full operation in FY 24.

No changes to the ISB are recommended at this time.

5.3.4 Recommended Changes to the Monitoring Network

Pantex will implement select recommendations from the MAROS monitoring evaluation completed for the third FYR. Those changes will be included in the updated *Long-Term Monitoring System Design* and *Sampling and Analysis Plan* that is scheduled for completion in November 2024.

Due to detections of three high explosives above GWPS at the new Ogallala well PTX06-1229, Pantex will begin drilling wells to evaluate nature and extent of a plume in the Ogallala Aquifer. As recommended in the third FYR, Pantex will develop a work plan to evaluate the nature and extent of these detections.

Due to low-level detections of high explosives in PTX06-1076 that could be attributed to well construction, Pantex is planning to plug and abandon this well in FY 24, pending receipt of funding. A new well will be drilled approximately 50 ft downgradient of PTX06-1076 so that high explosives and other COCs can continue to be evaluated.

5.3.5 Recommended Changes to Soil Remedies

No changes to the landfill or ditch remedies are recommended.

Pantex prepared a closure plan for the Burning Ground SVE. The system closure was approved by regulatory agencies in 2023. Pantex plans to continue groundwater monitoring at the point of compliance and exposure wells at the Burning Ground to evaluate the long-term effectiveness of this remedial action. Pantex will also include requirements for response to detections in those wells in an updated *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* scheduled for completion in FY 25.

5.3.6 Recommended Changes Based on Regulatory Comments

Pantex received comments from the TCEQ on the supporting documents for the recommended changes to the Pantex Remedial Action (TCEQ, 2022). Pantex has agreed to complete some additional work and track the actions to completion in the annual progress reports, per letter dated February 15, 2023 (USDOE/NNSA, 2023). Table 5-2 provides the two items that must be tracked to completion, the recommended timeframe of completion, and the current status of each action.

Table 5-2. Status of Actions from Recommended Changes Letter Response, USDOE/NNSA (2023)

Recommended Actions to Complete	Milestone Date	Completion Date	Status
Review/update the well information data table to include updated bottom of FGZ picks from Ogallala wells.	Dec 2026		Pantex is currently preparing to update this table by the end of 2024.
Put in two additional wells at the southeast and southwest perimeter of Zone 11 to better evaluate the Zone 11 plumes.	Dec 2026		Those wells are currently being planned for installation in FY 24, pending receipt of funding.

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