Pantex Plant

2019 Annual Progress Report

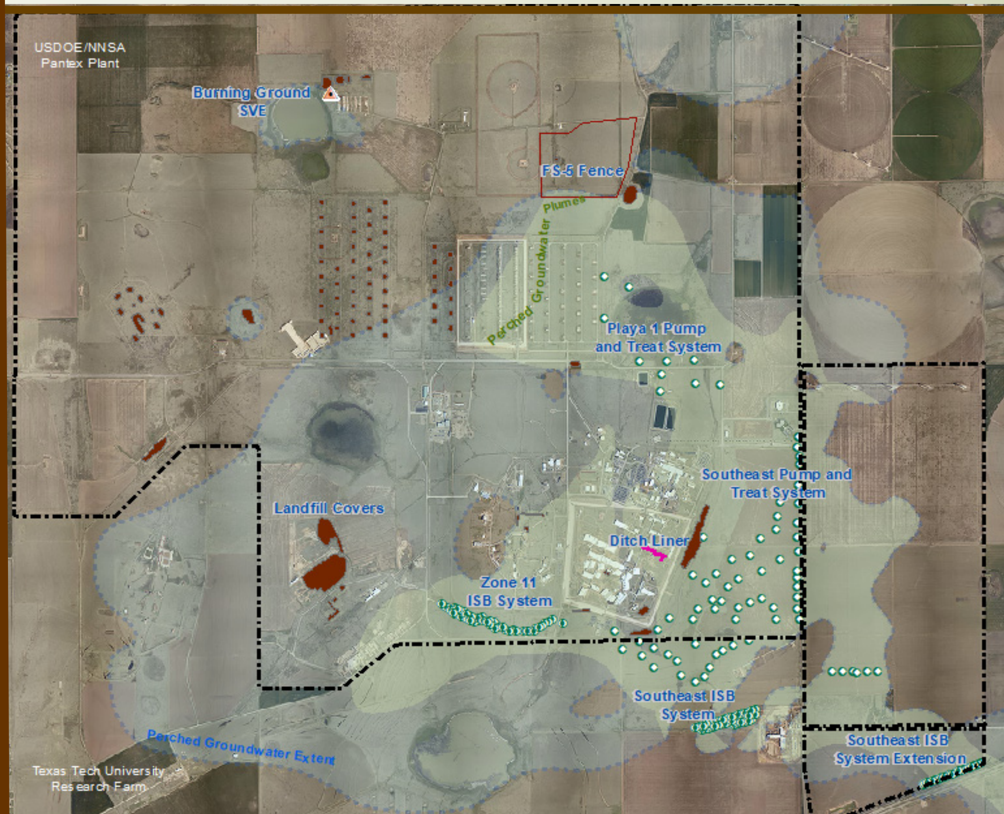
Remedial Action Progress

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

June 2020

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

Pantex Plant Remedial Action Systems



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CERTIFICATION STATEMENT

2019 Annual Remedial Action Progress Report
Pantex Plant, June 2020

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.

James C. Cantwell 06/23/2020
James C. Cantwell Date
Director, Environment, Safety and Health
Consolidated Nuclear Security, LLC

2019 Annual Remedial Action Progress Report
in Support of Hazardous Waste Permit #50284
and Pantex Plant Interagency Agreement
for the Pantex Plant, Amarillo, Texas
June 2020

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

> ***Annual Progress Report Outline***
>
> - Background Information
> - O&M of Remedial Actions
> - Groundwater Remedial Action Effectiveness
> - Soil Remedial Action Effectiveness
> - Recommendations and Conclusions

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 three areas. A soil vapor extraction (SVE) system has been installed to remediate volatile organic compounds (VOCs) in soils at the Burning Ground area. Other soil remedies (fencing, soil covers, and ditch liner) and institutional controls are also maintained as part of the soil remedy for Pantex. This annual report satisfies requirements in the Pantex Interagency Agreement (IAG) and Hazardous Waste Permit (HW) 50284 to provide information on the remedial action system performance and components. The focus for this report is the data and information collected for the soil and groundwater remedies during 2018. Data are evaluated according to criteria outlined in the *Long-Term Monitoring System Design Report* (Pantex, 2009a), HW-50284, the IAG, Land and Groundwater Use Control Implementation Plan, and various Operation and Maintenance (O&M) Plans for the remediation systems.

E.1 Remedial Actions

Pantex has implemented soil and groundwater remedial actions. Those actions and their objectives are described in the highlight box below.

Groundwater Remedial Actions

Two Pump & Treat Systems

- Reduce saturated thickness
- Reduce contaminant mass
- Plume stabilization

Three In Situ Bioremediation Systems

- Reduce contaminant concentrations as groundwater migrates through the treatment zone

Institutional Controls

- Control perched groundwater usage 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

Soil Vapor Extraction System

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

Fencing

- Prevent traffic and control access

E.2 O&M of Remedial Actions

E.2.1 Pump and Treat Systems

Operational goals have been developed to promote mass removal and continued removal of perched groundwater to reduce saturated thickness of the perched aquifer. The first goal of 90% system operation was not applicable at all times during the year due to shutdowns for maintenance of the systems, maintenance of the wastewater treatment facility (WWTF), and in response to the break at the filter bank at the irrigation system. Additionally, P1PTS only operated one week per month to allow the SEPTS to fully operate and improve removal of water and capture of the plume moving to the southeast. The average operational rate across 2019 was 35% at the Playa 1 Pump and Treat System

(P1PTS) and 97% at the Southeast Pump and Treat System (SEPTS). The pump and treat system performance for 2019 is depicted in Figure E-1.

While treatment throughput was not a primary goal after June 2017 due to the break at the irrigation system filter bank, the 90% goal is still depicted in the graphs and throughput is evaluated. When the systems operated, daily treatment throughput varied due to reduced flow to the WWTF and irrigation system. P1PTS was heavily impacted by the shutdown of the irrigation system after the filter bank break at the end of June 2017. Treated water from P1PTS can only be released to the WWTF, so flows are impacted when the WWTF cannot receive the water. Treated water from the WWTF are now routed to Playa 1 until repairs are complete at the irrigation system. SEPTS remained operational with higher flow throughout most of 2019 due to the shutdown of P1PTS 3 weeks of each month. SEPTS operation focused on removal of water in high priority well locations to control plume movement to the southeast.

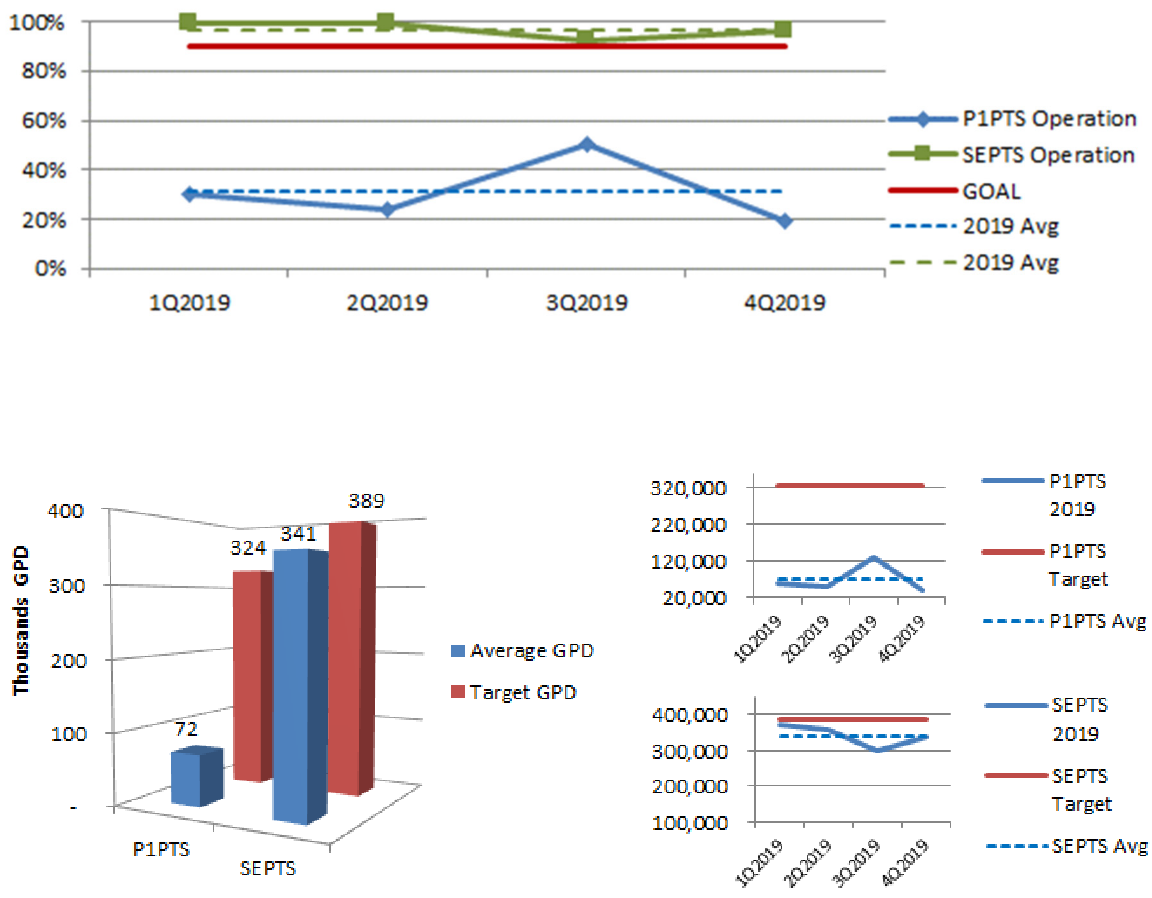

Figure E-1. Pump and Treat System Performance

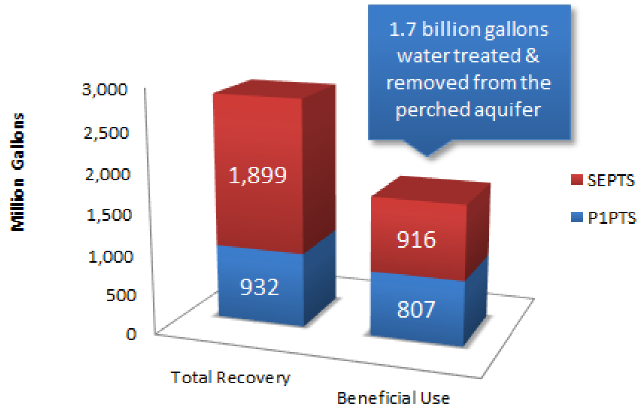

Figure E-2. Pump and Treat Recovery

Overall, the systems have operated efficiently to treat contamination and reduce saturated thickness. As depicted in Figure E-2, Pantex has treated over 2.7 billion gallons since the startup of the systems, with more than 1.7 billion gallons removed and beneficially used. Pantex continues to reduce reliance on injection of treated water as possible, and as recommended in the Five-Year Review, Pantex has implemented new throughput goals to align operations with the goal of reducing saturated thickness. During 2019, only 4% of the treated water was beneficially used. Beneficial use of the treated water was heavily impacted by the break at the irrigation system.

In addition to removing impacted water from the perched aquifer, the pump and treat systems remove contaminant mass from the groundwater that is extracted from the aquifer. The P1PTS primarily removes the high explosive RDX and the SEPTS primarily removes RDX and hexavalent chromium (CR(VI) in Figure E-3). The figures below provide the mass removal for high explosives (HEs) and chromium for 2019, 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 2019, SEPTS removed about 625 lbs of contaminants and P1PTS removed about 8 lbs of contaminants.

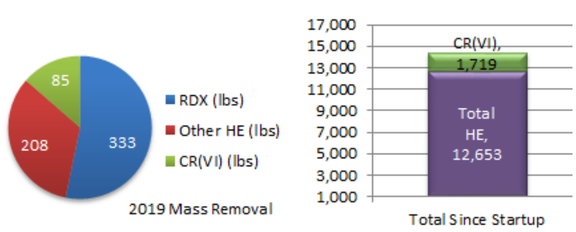

Figure E-3. SEPTS Mass Removal

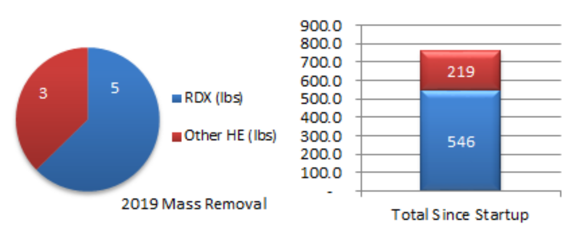

Figure E-4. P1PTS Mass Removal

E.2.2 In Situ Bioremediation Systems

There are three ISB systems installed at Pantex: the Zone 11 ISB, Southeast ISB, and Southeast ISB Extension. All systems were maintained and injected during 2019. The new Southeast ISB Extension began injection during 2019, with two injection events completed at the system. Treatment zone results indicate that the HEs are completely treated, but it will take up to two years to see effects at the downgradient wells.

The entire Zone 11 ISB system was injected in 2019. Pantex continued with molasses injection and results from the treatment zone indicate that conditions between wells has improved. It will take at least two years to see the effects of the molasses injection at downgradient wells. Pantex has experienced issues with injection at a portion of the wells so conditions between wells have not improved at those locations. Well replacement may be required to improve injection.

Pantex also injected the Southeast ISB during 2019. Molasses was used to improve distribution and possibly affect the downgradient well PTX06-1153. Several dry wells upgradient of PTX06-1153 were injected in an attempt to influence that downgradient well. Pantex also installed a pump in PTX06-1153 to induce flow to the well while injection was occurring. Results indicated that the well was influenced by the injection but it will take time to evaluate the impact of the influence. Water has heavily declined in this system and only one more injection may be required for treatment.

E.2.3 Soil Remedial Actions

A small-scale Catalytic Oxidation SVE system was installed at the Burning Ground in early 2012. 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 consistently operated until October with occasional shutdowns for maintenance, repairs, extreme temperatures, and power outages. The system shutdown in late October required use of contractors for repair. The system remained down until March 2020 when contracting and repairs were complete. Overall, the system operated about 60% of the year. Mass removal calculated for 2019 for VOCs contributing

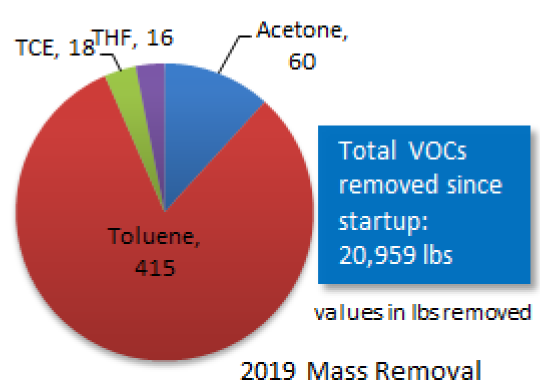

Figure E-5. Burning Ground SVE Mass Removal

the majority of the total VOC concentration is presented in Figure E-5 along with total mass removed since the SVE was installed as an interim action in 2002. The system removed about 508 lbs of VOCs during 2019.

In addition to the active soil remediation at the Burning Grounds, 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 to prevent spread of contaminated soils. SWMU interference was approved for five new projects that required work in a SWMU in 2019 and three older projects were completed. Pantex also regularly inspects and maintains all soil covers, fences, signs, postings, and ditch liners. Pantex will continue to evaluate the landfills annually and report the findings of the review and any plans that are developed to address holes, depressions, or bare areas. Problems identified will be addressed annually through the landfill cover maintenance contract and larger issues, such as erosion, will be addressed through separate contracts. Pantex has completed maintenance of the cover at four landfills in 2019. Remaining maintenance at other landfills will be completed by contract or onsite support, based on available funding or availability of maintenance personnel. An inspection of the ditch liner conducted in 2019 indicated no issues with the liner. Sedimentation and erosion of the anchor trench were observed as well as some blockage of the culverts from debris. Pantex Maintenance Department has been requested to assist with removing debris from the culverts and sedimentation during 2020.

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. The concentration data 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 (Pantex, 2014a) was conducted as part of the evaluation process.

Overall, calculated concentration and groundwater level trends were consistent with expected conditions defined in the Long-Term Monitoring (LTM) Design Report. Figure E-6 depicts recent water level trends in the perched aquifer LTM wells. Of the 48 monitor wells with expected decreasing water level trends, limited water, or dry conditions defined in the LTM Design Report, 21 wells exhibited conditions inconsistent with the current expected conditions or trends. Most of these wells exhibited recently increasing trends in response to increased precipitation and resulting recharge through unlined ditches and playas along with decreased extraction of perched groundwater. The long-term water level trend is decreasing or not trending for 19 of these wells, and it is expected that water levels will continue to decline. The remaining two wells with increasing water level trends are both historically dry wells that are now showing fluctuating water levels. The appearance of water in these wells does not represent movement of impacted perched groundwater into these areas. One well is near the Southeast ISB and had a maximum of 0.15 ft of water measured in 2017; the water level was below the bottom of the screen in 2019. The other well is located southeast of the Southeast ISB system near the Pantex Administrative Site Complex 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. The increasing water levels in these wells is believed to be related to recharge of stormwater runoff from this facility.

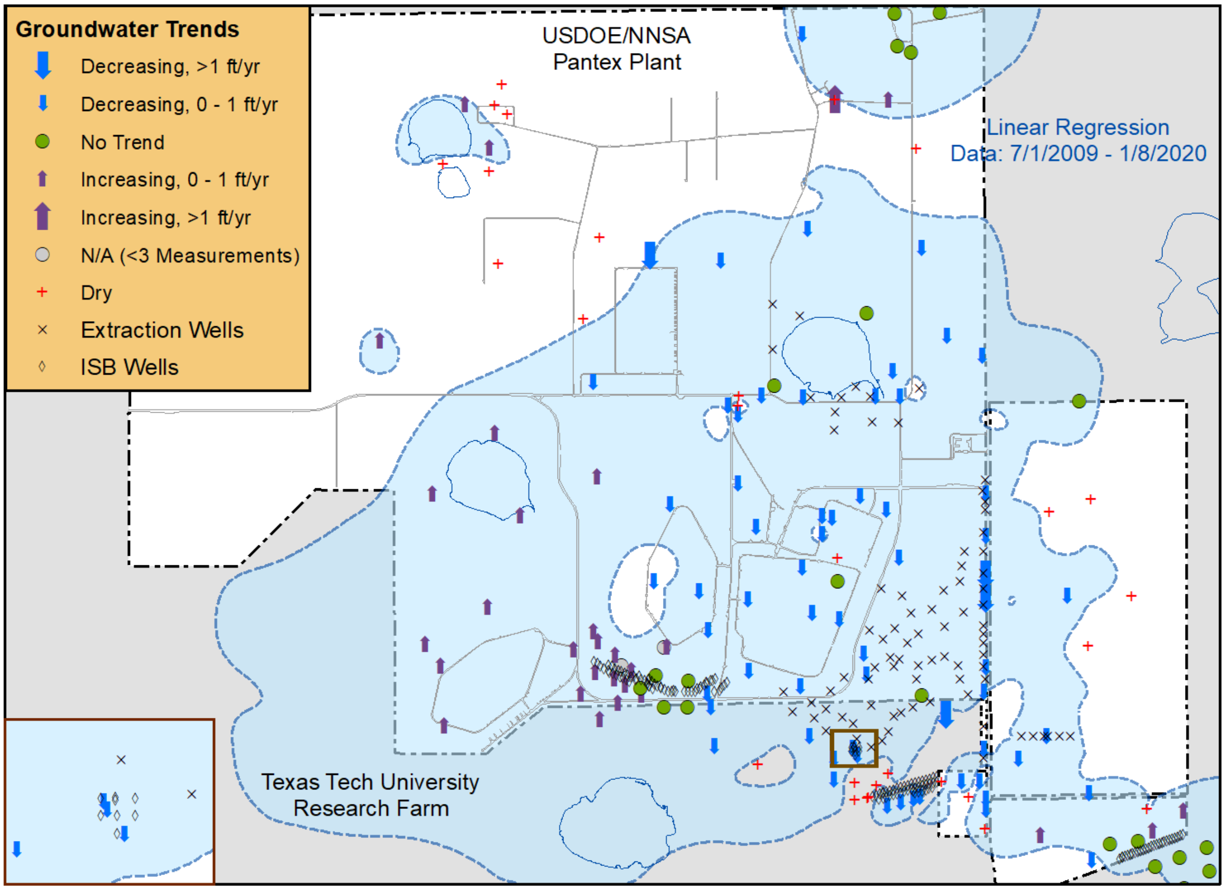

Figure E-6. Perched Aquifer Water Level Trends

Of the 103 monitor wells with expected COC concentration conditions defined in the LTM Design Report, 37 wells did not exhibit trends consistent with the expected conditions for the four major COCs (RDX, hexavalent chromium, TCE, and perchlorate). It is anticipated these trends will meet expected conditions as the corrective actions continue to operate in the perched aquifer. Figure E-7 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 under the influence of a remedial action.

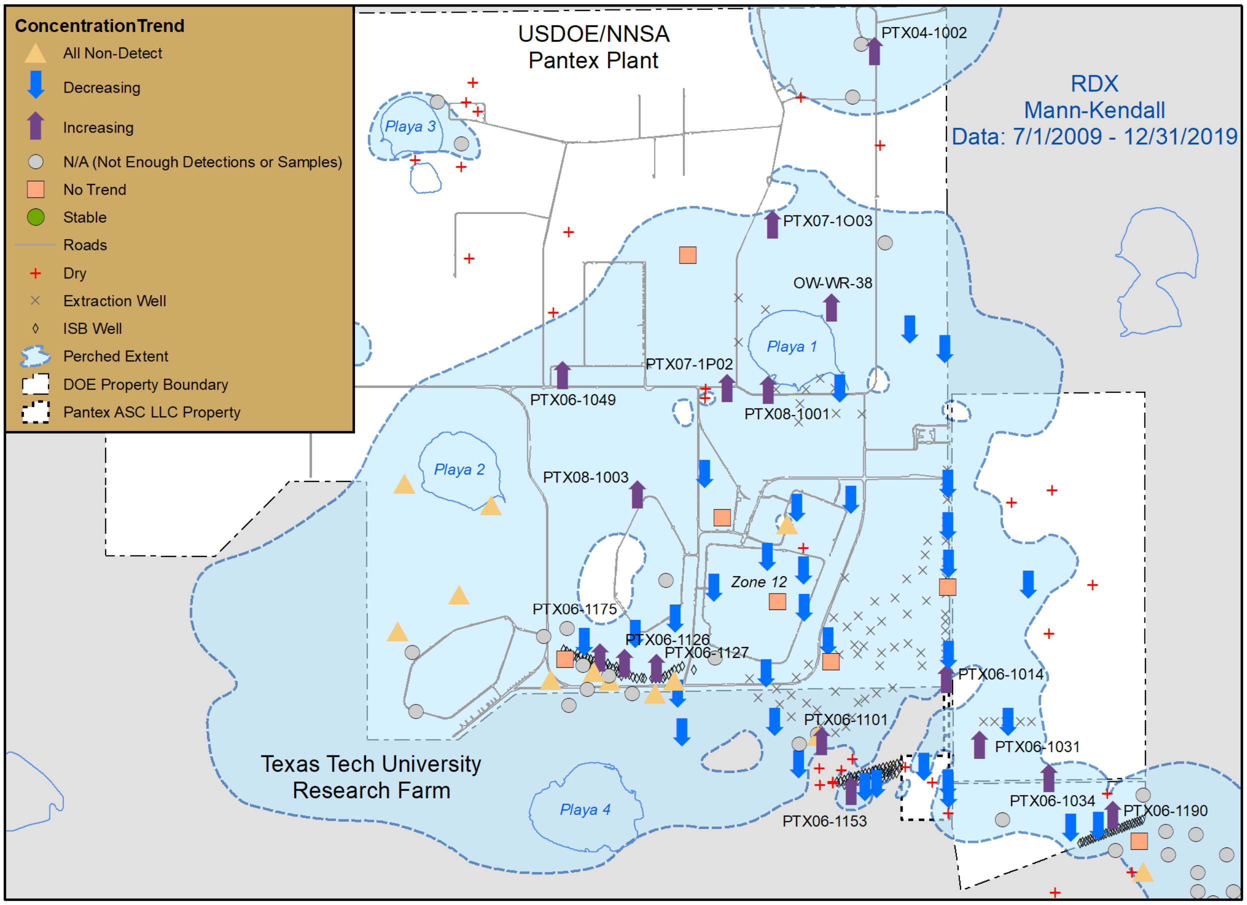

Figure E-7. RDX Trends in the Perched Aquifer

Generally, 2019 plume shapes are similar to the 2009 COC plumes with the greatest difference being the change in the extent of perched saturation in the extreme southeast lobe of perched groundwater and HE plumes in that area because of the new information collected from PTX06-1182 and other recently drilled wells. A shift in the hydraulic gradient eastward in the area between the southern parts of Zones 11 and 12 has allowed perchlorate to migrate east and southeast into the SEPTS well field; this portion of the perchlorate plume is being actively remediated by SEPTS at this time. Other changes in plume size and shape were due to 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. The major COC plumes of interest are depicted in Figure E-8.

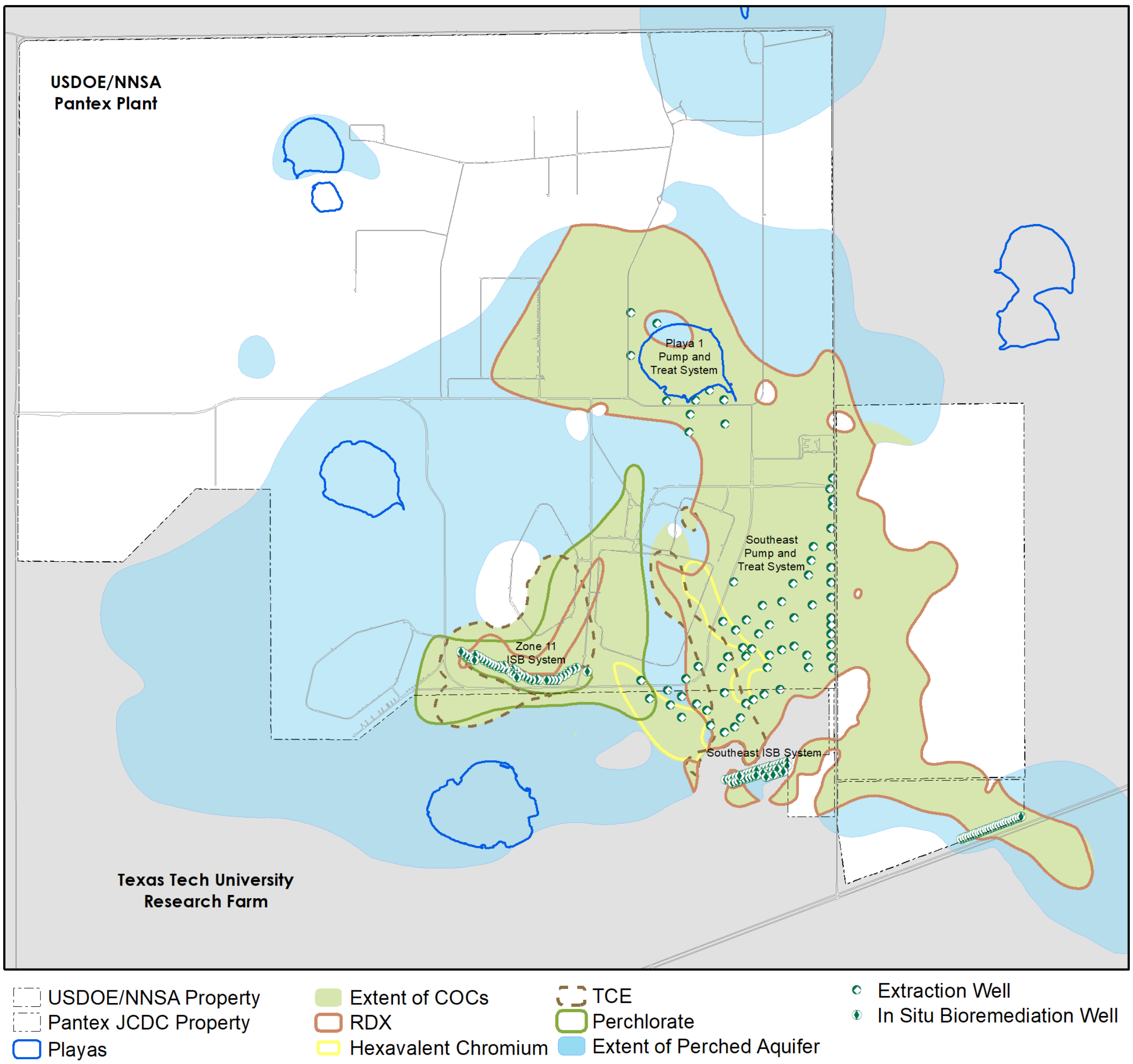

Figure E-8. Major COC Plumes in the Perched Aquifer

E.3.2 Remedial Action Effectiveness

Considering that one goal of both pump and treat systems is to affect plume movement, the plume stability evaluation can be used to determine the effectiveness of these systems.

To this end, the pump and treat systems have continued to be effective in 2019. The SEPTS has altered the groundwater flow direction and gradient at localized areas near the extraction wells in the perched aquifer. The P1PTS appears to be influencing local water levels and hydraulic gradient in the area near Playa 1 although impacts from the irrigation system break have affected operations. When comparing the 2019 conditions to LTM Design expected conditions, the majority are meeting expected conditions. Most wells not yet meeting expected conditions are in locations that have not yet been affected by the systems.

The Southeast ISB system data collected in 2019 indicates that it is effective in meeting the 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. Three of the closest downgradient monitoring wells for the Southeast ISB (PTX06-1037, -1123, and -1154) demonstrate that reduction of RDX, HE degradation products, and hexavalent chromium has occurred resulting in concentrations below the GWPS, with most not detected. PTX06-1153 continues to exhibit RDX concentrations above the GWPS, but hexavalent chromium concentrations continue to demonstrate a decreasing trend and have remained below the GWPS since 2016. During 2019, this well demonstrated signs of partial treatment. Breakdown products of RDX were detected at concentrations above the GWPS. Upgradient dry wells were injected in 2013 and 2015 in an attempt to affect this well. It is possible that those injections were slow to respond at this location and may only be partially affecting the water that continues to move into PTX06-1153. Pantex injected only molasses at the injection event in 2019 to attempt better distribution of amendment and possibly affect PTX06-1153. As with other locations, water levels at this well continue to decline.

The Zone 11 ISB system data collected in 2019 indicate 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, and deeper reducing conditions have been established at injection wells within the expansion area that has now received three injections. Evaluation of data in the treatment zone wells indicates very mild to strong reducing conditions across the Zone 11 ISB. Deep reducing conditions have been more difficult to establish at treatment zone monitor wells located between the injection wells in the expansion area. The molasses injection has improved conditions between injection wells in 2019. Improved conditions have been noted across the western side of the Zone 11 ISB after moving to the use of molasses. However, some wells have limited ability to accept injection and those areas will likely continue to demonstrate milder reducing conditions until wells can be replaced. All wells downgradient of the system have indicated arrival of treated water.

Pantex evaluates performance for the Zone 11 ISB at nine downgradient ISPM wells and two former ISB injection. All of these wells exhibited perchlorate concentrations below the GWPS in 2019. TCE concentrations are below the GWPS in five of nine ISPM wells plus the two former injection wells. The first breakdown product of TCE, *cis*-1,2-dichloroethene, was detected above the GWPS in three downgradient wells; the presence of cis-1,2-dichloroethene was also detected in PTX06-1156. These data indicate that because of treatment, concentrations of TCE and its breakdown products are very close to meeting the GWPS in treated water from the original portion of the system. The only downgradient well not demonstrating strong treatment is PTX06-1173. Wells upgradient of PTX06-1173 were difficult to inject into during the 2018 and 2019 injection events. Even with limited detections of vinyl chloride indicating limited areas of complete degradation, TCE and cis-1,2-dichloroethene is near or below GWPS in most downgradient wells indicating that the treatment zone is adequately reducing TCE and risk.

E.3.3 Uncertainty Management/Early detection

The purpose of uncertainty management wells in the High Plains Aquifer (commonly and hereafter referred to as the Ogallala Aquifer) and perched aquifer is to confirm expected conditions identified in the Resource Conservation and Recovery Act (RCRA) Facility Investigations and ensure there are not any deviations, fill potential data gaps, and fulfill long-term monitoring 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 potential source areas in the unsaturated zone before potential points of exposure have been impacted. These wells were proposed in the LTM Design Report for purposes of evaluating 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 the quarterly reports. No Group 1 perched aquifer wells had unexpected conditions in 2019.

In 2019, detection of organic constituents or metals above background (for those metals with site-specific background concentrations) occurred in three Ogallala wells. All metal and organic detections were less than GWPS. The detections are summarized below.

Hexavalent chromium was detected above background in one well, PTX06-1157, in 2019; this detection was below the GWPS of 100 ug/L. This detection likely represents background variability. Hexavalent chromium was detected below background in the subsequent sample from this well in 2019.

One Ogallala Aquifer well, PTX06-1056, had continued detections of 4-amino-2,6-DNT and 1,2-dichloroethane slightly above the laboratory PQL, but below the GWPS in 2019, indicating possible migration of perched groundwater to the Ogallala Aquifer. In response to these detections, Pantex has fully implemented the conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d) and will continue quarterly sampling for HEs and VOCs at this well. Pantex has proactively evaluated potential sources for the contamination. A nearby perched well (PTX06-1108) that was drilled deeply into the FGZ was plugged to address that potential source. An external independent review indicated that the perched well was the most likely source of the contamination, based on fate and transport modeling. A cement bond log was used to evaluate the competency of the concrete seal at the FGZ and indicated that the seal is competent. Therefore, PTX06-1056 is not likely acting as a preferential pathway for contamination to reach the Ogallala Aquifer.

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 to source contaminants to the perched aquifer for a long period of time (20 years or more), but at much lower concentrations than in the past (Pantex 2006).

Most of the Group 2 wells that have detections of COCs already meet expected conditions at the well. There are 13 wells that do not yet meet expected conditions, i.e., 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 while some could be 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, it is expected that concentrations will 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 were below GWPS. These metals detections are likely due to either well screen corrosion or variation in background.

Other Unexpected Conditions

As discussed in the 2016 Annual Report, Pantex drilled PTX06-1182 in 2016 to evaluate water conditions in the southeastern lobe of perched groundwater based on the continued evaluation that indicates that some portions of the southeast perched groundwater are not under the influence of the pump and treat systems. Water containing HEs at concentrations above the GWPS was discovered in PTX06-1182. In response to that information, Pantex installed additional wells to define the extent of the plume to the southeast. Water was discovered in two of the wells, and data confirmed the presence of two HEs, RDX and DNT4A. Pantex subsequently drilled a line of wells to extend the Southeast ISB along the southeast boundary of the site; as discussed previously, injection of these wells started in February 2019 to establish a treatment zone to prevent further migration of HEs across the site boundary.

The contaminant distribution indicates flow primarily through an old subsurface paleochannel with the main RDX plume only 500 to 700 ft wide at the property boundary. The main paleochannel where the highest concentrations occur is narrower, likely only about 250 ft wide. In an attempt to identify the boundaries of the paleochannel, Pantex conducted an electromagnetic study in 2018 using Willowstick Technologies, LLC. The objective of this study was to identify the area with faster flow paths in the groundwater so that the extent of contamination could be positively identified. The results of the investigation indicated the possibility of channels extending through the ISB, with one primary channel leading offsite to the south and southwest. The results of the study were less certain at the offsite property because of interferences from utilities along the northern fence line, signal homogeneity across portions of the area, and lack of downgradient wells that might help with resolution of signal. These issues resulted in the inability to identify any channels to the southeast of Pantex.

Pantex installed 14 additional monitoring wells in 2018 and early 2019 to define the extent of the plume to the southeast; 13 of these wells were installed offsite on adjacent properties to the south and southeast. With the latest round of sampling in early 2019, it appears that the extent of contamination to the southeast has been defined with HE not detected in three of the offsite wells. Sample results at the newly completed wells have been included in the data used for plume mapping in this report. Refer to Section 2 for well locations and plume extent.

To determine the best path forward for cleanup of the offsite southeast plume that is beyond the influence of the new Southeast ISB Extension, Pantex contracted to have the conceptual site model and perched fate and transport model updated in early 2019. The updated fate and transport model was used to determine the best options for cleanup and to optimize the system for cost, schedule, and completeness of cleanup. The results indicate that the best path forward for cleanup of the offsite plume is a combination of ISB and pump and treat. This recommendation is consistent with the chosen remedy for the Record of Decision (ROD) and the Compliance Plan. Pantex will plan to include this remedy expansion in the upcoming Explanation of Significant Difference for the ROD. System installation will occur across four phases, beginning in FY 2020 and ending in FY 2023, depending on available funding. Modeling indicates that injections will be required for approximately 10 years and pump and treat system operation for five years. The area is expected to be monitored for more than 20 years to verify predicted concentrations.

PTX06-1045, a point of compliance, downgradient performance monitoring well at the Southeast ISB, was reported dry from July of 2011 to September 2018, but has recently reported water in the well. Sufficient water was available to collect samples during the third and fourth quarters of 2019 with sample results demonstrating detections of RDX and TNT exceeding GWPS. The water in PTX06-1045 does not appear to be hydraulically connected to the Southeast ISB system; rather the unexpected water flux and detections of RDX and TNT are considered to be a response to multiple, large rain events experienced during 2018 and 2019 that released RDX from the pore space in the perched zone. PTX06-1045 was not treated before the well went dry. Pantex will continue to sample PTX06-1045 to evaluate trends in these detections. Further actions will be determined based on results of sampling and in accordance with the Pantex Groundwater Contingency Plan.

Natural Attenuation

Natural attenuation is the result of processes that naturally lower concentrations of contaminants over time. Data are collected at Pantex to help determine where natural attenuation is occurring, under what conditions it is occurring, and to eventually estimate 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. Pantex has historically monitored for RDX (since 2009), 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 of TCE 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 breakdown products (MNX, DNX, and TNX) indicate that the breakdown products are present throughout most of the RDX plume, with TNX being the most widespread. If complete biodegradation of RDX is occurring, RDX and all breakdown products would be expected to decrease over time. A 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 (CSIA) approaches. These approaches, along with the ability to quantify NDAB, an aerobic degradation product, allows Pantex to better evaluate the degradation of RDX.

Pantex subsequently contracted with the leading researcher for the SERDP study, Dr. Mark Fuller with APTIM, for a project to evaluate lines of evidence for natural attenuation of RDX at the Pantex 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/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 study found several lines of evidence for natural attenuation of RDX as well as the potential to enhance aerobic biodegradation of RDX with introduction of low levels of labile organic carbon. Recommendations for further study were presented for additional treatability studies, bioaugmentation, and additional proteomics analyses for the degrading bacterial strains.

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 continues to focus on treating residual NAPL and soil gas at well SVE-S-20. The system continues to be effective at removing residual soil NAPL. Pantex plans to continue operating the system while evaluating removal rates and influent concentrations to determine when the system can no longer effectively remove VOCs using active remediation.

E.5 Recommendations and Conclusions

Pantex plans to continue the current approved remedial actions. The groundwater remedies are considered protective for the short-term as untreated perched groundwater use is controlled to prevent human contact and Ogallala Aquifer data continues to indicate COC concentrations either non-detect or below GWPS. The systems are proving to be effective in reaching long-term established objectives for cleanup. Soil remedies have been effective at Pantex as 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 is actively removing soil gas and residual NAPL in soils at the Burning Ground thereby mitigating vertical movement of VOCs to the Ogallala Aquifer.

Based on issues identified in the Five-Year Review and during completion of this report, several changes are recommended or have been implemented to enhance the effectiveness of the remedies in some areas and to better monitor the effectiveness of the actions. Those recommendations are provided in the following sections.

E.5.1 Recommended Changes to the Selected Remedies

Pantex plans to release an ESD describing changes to the southeast and Zone 11 remedies. The scheduled date for completion of this action, as provided in the 2nd FYR, is September 2022.

As recommended in the 2nd Quarter Progress Report (2019), Pantex plans to install an offsite remediation system to address contamination found beneath two offsite properties. The remediation system consists of a combination of ISB and pump and treat on one property that will effectively treat the entire plume within 25 years. Phase 1 installation of wells is underway.

E.5.2 Recommended changes to the Pump and Treat Systems

Pantex has implemented a previous recommended change to the operation of the SEPTS and P1PTS. P1PTS is now only operated once each quarter to allow SEPTS to fully operate and continue more effective capture of perched groundwater and contaminant plumes moving to the Southeast. Pantex expects to operate both systems later in 2020 as the irrigation system repairs are completed.

Pantex is planning to evaluate ways to optimize the pump and treat systems to allow better capture of the plumes and removal of water for protection of the underlying Ogallala Aquifer. Optimization of the systems to control the perchlorate plume was identified as an issue in the 2nd FYR. Pantex requested extra funding in FY21 to complete the optimization work. The work is scheduled to be complete by September 2022.

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 areas of the ISBs.

Based on the dose-response study completed at the Zone 11 ISB during the 2018 injection, Pantex recommends moving solely to the injection of a more soluble carbon (molasses) to improve distribution and enhance the treatment zones at all ISBs. Pantex has requested budget to inject the molasses more frequently at the ISBs as it is not as long-lived as the soybean oil that has been previously injected. Pantex may elect to inject soybean oil again in the future to ensure continued longevity of carbon source near the injected area of the treatment zones.

E.5.3.1 Southeast ISB

Pantex has injected a more soluble carbon (molasses) to improve distribution of amendment at the ISB, implemented pumping of PTX06-1153 during injection to induce flow to the well, and injected in dry upgradient wells. These changes will require evaluation over time to determine the full impact of the injection. Water levels will continue to be monitored as it is anticipated that only one more injection may be needed at this system.

E.5.3.2 Southeast ISB Extension

Pantex just completed injections into this new ISB in 2019. No changes are recommended at this time.

E.5.3.3 Zone 11 ISB

In 2019, Pantex expanded the Zone 11 ISB to fully encompass the TCE plume. Pantex plans to inject the wells in 2020. Further evaluation is required to determine if additional changes are required.

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E.5.4 Recommended Changes to the Monitoring Network

Pantex updated the *Long-Term Monitoring Design* and the *Sampling and Analysis Plan* in September 2019. Those changes in the documents were implemented beginning January 2020. No further changes are recommended at this time.

E.5.5 Recommended Changes to Soil Remedies

No changes to the landfill remedies are recommended. Pantex has requested additional funding, beginning in FY 21 to contract the cover maintenance and repair work. Onsite support is also being requested to help address holes and voids in the old construction debris landfills.

Pantex is continuing to evaluate SVE data after modifying the system in May 2017. Further recommendations for a path to closure will be made after implementation of shutdown and pulsing of the system begins in 2020.

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amsl	above mean sea level
AOC	Area of Concern
bgs	below ground surface
btoc	below top of casing
CatOx	Catalytic Oxidation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
CP-50284	Compliance Plan 50284
CR(VI)	hexavalent chromium
CSIA	compound specific isotope analysis
DCE	dichloroethene
DHC	*Dehalococcoides sp.*
DNT	dinitrotoluene
DNT4A	4-amino-2,6-dinitrotoluene
DNX	hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine
DO	dissolved oxygen
EPA	Environmental Protection Agency
FM	Farm-to-Market Road
FS	Firing Site
ft	feet
FGZ	fine-grained zone
FY	fiscal year
GAC	granular activated carbon
gpm	gallons per minute
gpd	gallons per day
GWPS	groundwater protection standard
HE	high explosive
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
in	inches
IAG	Interagency Agreement
IRAR	Interim Remedial Action Report
IRPIM	Installation Restoration Program Information Management System
ISB	in situ bioremediation
ISM	interim stabilization measure
ISPM	in situ performance monitoring

LTM	long-term monitoring
Mgal	million gallons
MAROS	Monitoring and Remediation Optimization System
MCL	Maximum Contaminant 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
O&M	operation and maintenance
ORP	oxidation reduction potential
OSTP	Old Sewage Treatment Plant
P&A	plugging and abandonment
P1PTS	Playa 1 Pump and Treat System
PCA	1,1,2,2 – tetrachloroethane
PCE	perchloroethene
PID	photoionization detector
POC	point of compliance
POE	point of exposure
ppmv	parts per million by volume
PQL	practical quantitation limit
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
SEP/CBP	Solvent Evaporation Pit/Chemical Burn Pit
SEPTS	Southeast Pump and Treat System
SERDP	Strategic Environmental Research and Development Program
SVE	soil vapor extraction
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TLAP	Texas Land Application Permit
TNB	trinitrobenzene
TNX	hexahydro-1,3,5-trinitroso-1,3,5-triazine
TNT	trinitrotoluene
TOC	total organic carbon
TWDB	Texas Water Development Board
TTU	Texas Tech University

TZM	treatment zone monitoring
USDOE/NNSA	United States Department of Energy/National Nuclear Security Administration
VFA	volatile fatty acid
VOC	volatile organic compound
WMG	waste management group
WWTF	Wastewater Treatment Facility

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1.0 INTRODUCTION

The Pantex Plant, located in the Texas Panhandle approximately 17 miles northeast of Amarillo (see Figure 1-1), was established in 1942 to build conventional munitions in support of World War II. The Plant 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).

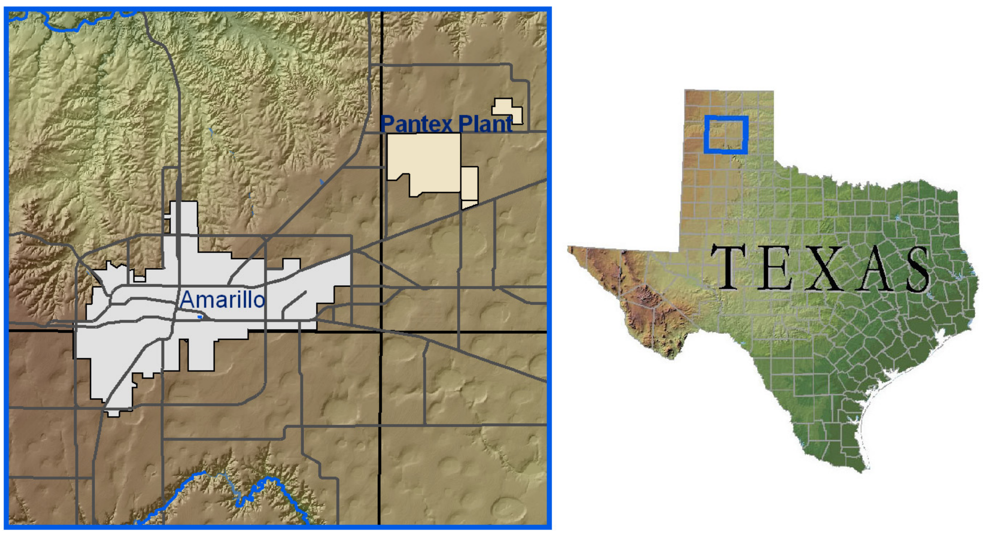

Figure 1-1. Location of Pantex Plant

The main Pantex 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. Remaining USDOE/NNSA-owned land serves safety and security purposes. Approximately 1,526 acres east of FM 2373 was purchased in 2008 to provide better access and control of perched groundwater areas included in the Remedial Action. 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, Texas Tech University property to the south, and property east of FM 2373. The extent of perched groundwater and the major contaminant plumes are depicted in Figure 1-2. Pantex has implemented remedial actions to mitigate perched groundwater contamination and to prevent contamination of the deeper drinking water aquifer.

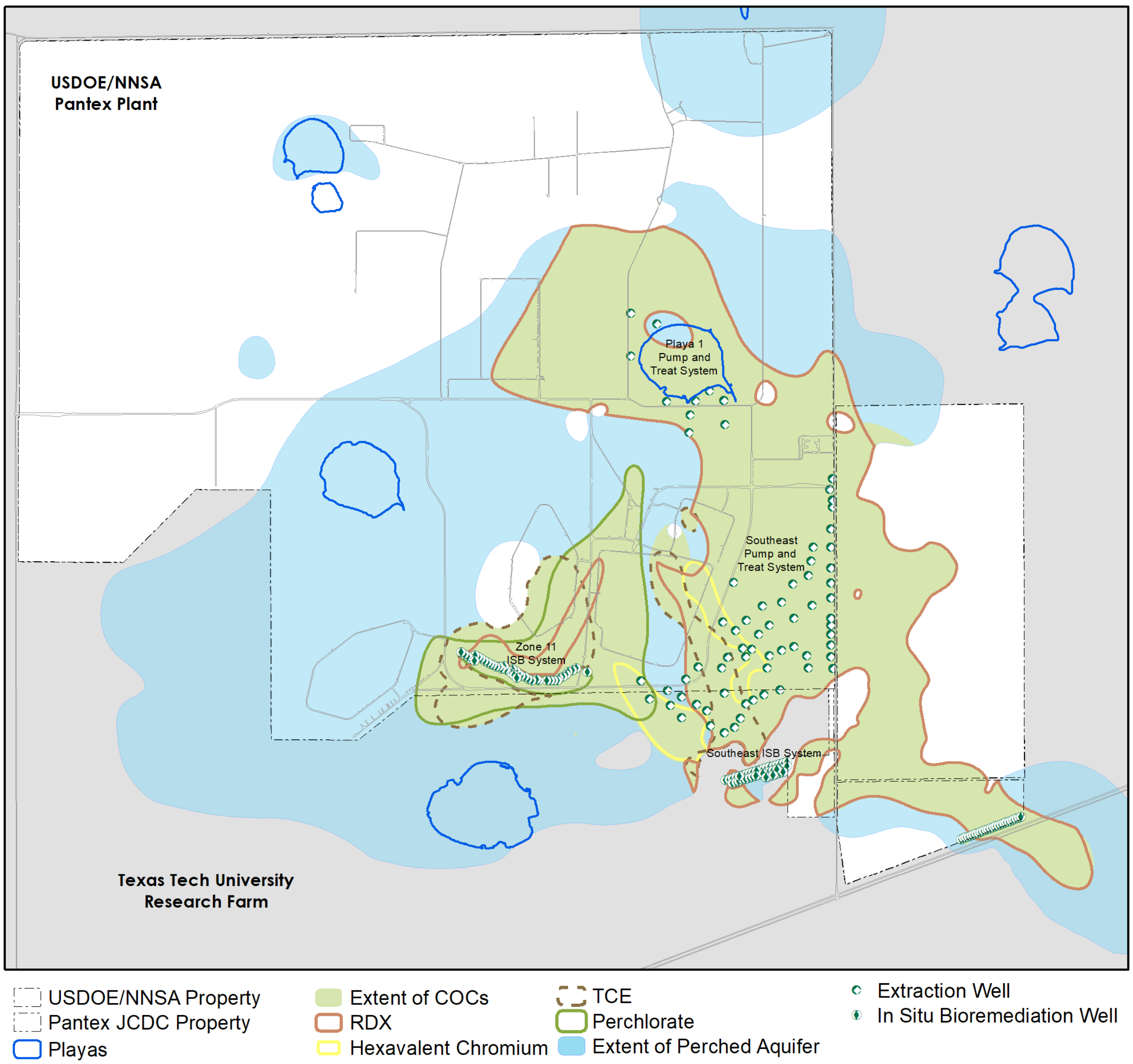

Figure 1-2. Extent of Perched Groundwater and Contaminant Plumes Exceeding GWPS

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 Pantex vicinity.

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 maintenance of soil covers and ditch liners to prevent infiltration of water and downward migration of contaminants to groundwater. Fencing and signs are also maintained to control worker use and traffic in the soil units.

1.1 Regulatory Background

Pantex implemented its remedial actions in accordance with the Compliance Plan for Industrial Solid Waste Management Sites, originally issued on October 21, 2003, and subsequently updated on September 16, 2010 to include final remedial actions, under the provisions of Texas Health and Safety Code Annotated, Chapter 361 and Chapter 26 of the Texas Water Code. The Compliance Plan is a Texas Commission on Environmental Quality (TCEQ) permit, which stipulates the requirements for conduct of corrective actions and groundwater monitoring programs according to Resource Conservation and Recovery Act (RCRA). The Hazardous Waste Permit was renewed in 2014 and the compliance plan requirements were incorporated into the permit.

Pantex was listed on the National Priorities List in 1994, requiring Pantex to also investigate and cleanup according to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Pantex meets the requirements of CERCLA through the Pantex Interagency Agreement (IAG), effective February 22, 2008. Table 1-1 lists the Compliance Plan and IAG, 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 for stabilization of groundwater plumes and monitoring of that action.
Interagency Agreement for the Pantex Superfund Site	2/22/2008	Established an agreement between the Environmental Protection Agency (EPA), TCEQ, and USDOE for the final remedial actions, framework for responding to and implementing CERCLA requirements, and framework for participation and exchange of information between parties.
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 into the permit. Minor changes include corrective action observation well changes and minor edits. Compliance plan requirements are included as Provision XI of HW-50284.

A Compliance Plan (CP-50284) was issued in 2003 that stipulated the requirements for conducting corrective actions and groundwater monitoring associated with the 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 Pantex Site-Wide Record of Decision (ROD) (Pantex and Sapere Consulting, 2008) and the final remedy was incorporated into CP-50284 effective September 16, 2010. The *Long-Term Monitoring System Design Report* (Pantex, 2009a) and *Sampling and Analysis Plan* (Pantex, 2009b) are approved through the Compliance Plan as the bases for monitoring and reporting of the remedies. The 2009 documents were updated in January 2014 (Pantex, 2014a and 2014b) 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 with minor changes.

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

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

1. Ensure that the environmental impacts associated with past and present activities at Pantex Plant have been analyzed, tested, and thoroughly evaluated, and appropriate remedial action 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 the Parties (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 chapters or section of the annual or quarterly report where the requirements are fulfilled. The requirements are from CP Table VII and VIII of HW-50284. The specific Articles in the IAG that contain reporting requirements are listed in the table. Although not included in the crosswalk, other requirements in the ROD and final documents supporting the design of the Remedial Actions were also considered in the development of 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 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 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, 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 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 POC/POE 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.
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: Section 2.1 and see 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. Quarterly Report: Pump and Treat Systems Section and Appendix B

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
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: Section 2.1. Quarterly Report: 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. Section 2.1 and see 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 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 second five-year review was started in 2017. The final approved report was completed in September 2018.
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 1.7 of the annual report contains the 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 Schedule Update Section.
IAG Progress Report Requirements:				
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: These data are summarized in Section 3.4 and 3.5. 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 1.5 provides a schedule of activities.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
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 1.7.

1.2 Remedial Action Background

Pantex has implemented soil and groundwater remedial actions to mitigate contamination that resulted from historical waste management practices. The remedial actions are described in detail in the ROD (found at: http://pantex.energy.gov/mission/environment/environmental-cleanup-documents). Soil and groundwater remedial actions 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 the Pantex Plant for further investigation and cleanup. Investigations that identified the nature and extent of contamination at solid waste management units and associated groundwater were submitted to the TCEQ and EPA in the form of RCRA Facility Investigation Reports. Those investigation reports closed many units through interim remedial actions and no further 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 remedial actions to protect human health and the environment. Figure 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, are determined to be of no further use, and 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).

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

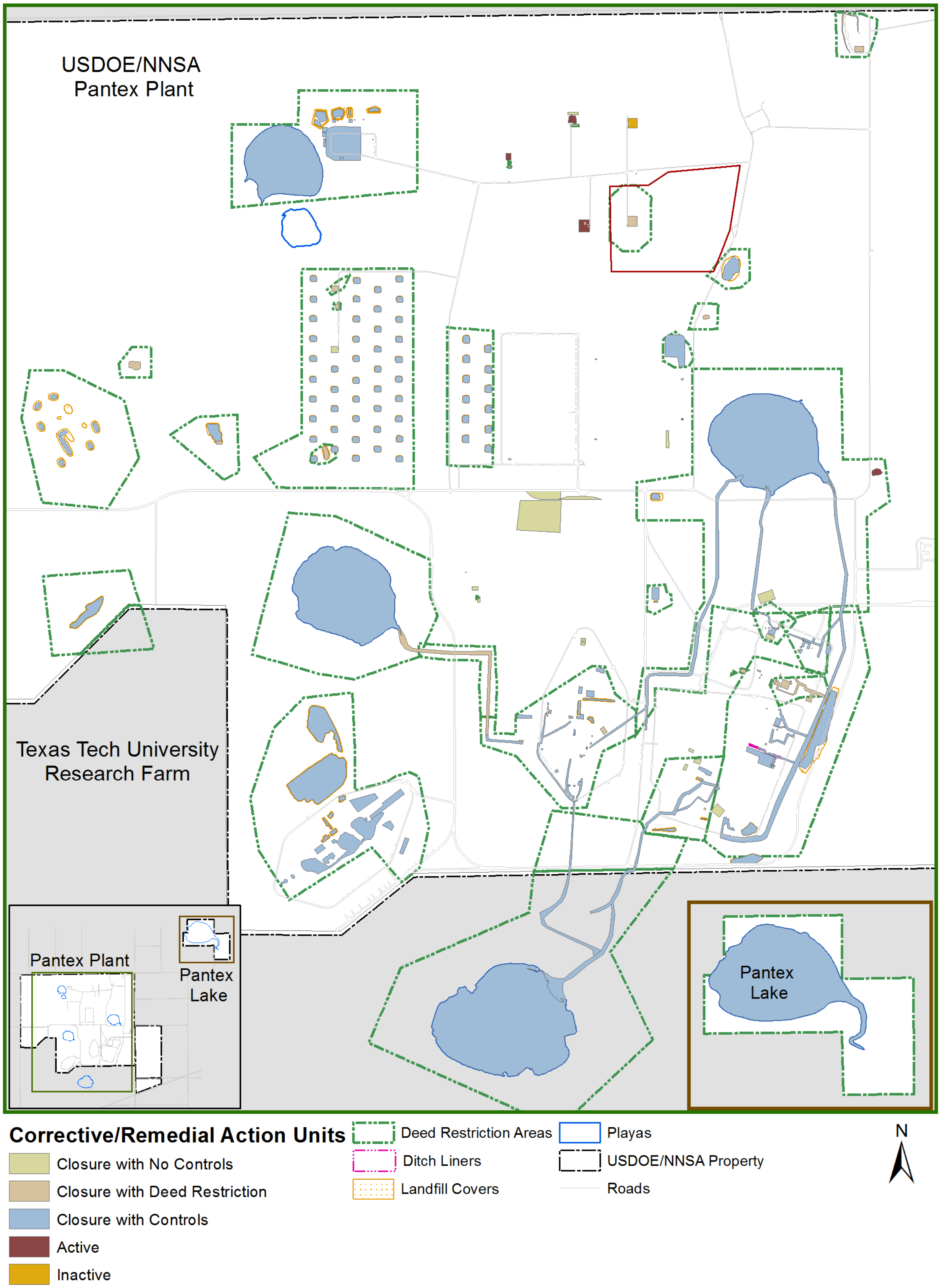

Figure 1-3. Status of Corrective/Remedial Action Units

Soil remedial actions focus on:

- Cleanup of soil gas and 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), and
- Maintenance of soil remedies (ditch liner and soil covers) for future protection of groundwater resources.

Soil Remedial Actions

Ditch Liner

Soil Covers on Landfills

Institutional Controls

Soil Vapor Extraction System

Fencing

In addition to the remedial actions, 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 SVE

The Burning Ground SVE system was installed in February 2002 as an interim remedial action and became the final remedial action with the issuance of the ROD and HW-50284. The SVE system was installed to address the remediation of VOCs present in the shallow and intermediate depth vadose zone at the Burning Ground (SWMUs 47 and 38). The system was designed to remediate soil gas in the areas beneath the solvent evaporation pit/chemical burn pit (SEP/CBP) and the Landfills north of the SEP/CBP. From the RCRA Facility Investigations, original VOC concentrations at the Burning Ground were as high as 962 parts per million by volume (ppmv) in the shallow zone (20-90 ft 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 (95-275 bgs) were as high as 1845 ppmv (Stoller, 2002). The remedial goal was to reduce the mass of VOC contaminants in soil gas significantly, thus mitigating impacts to the underlying groundwater. That goal has been 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 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 a single soil gas well (SVE-S-20), where soil gas concentrations continue to remain above 100 ppm, although 2019 data indicate a declining source near or below 100 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 allow installation of a small-scale CatOx system that continues to focus remediation on SVE-S-20. The new system is more cost efficient and will effectively treat all detected COCs at the Burning Ground. System construction and installation began in February 2012. System startup and testing began on April 5, 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 to promote increased volatilization and bioremediation of the remaining soil NAPL. Six wells surrounding SVE-S-20 were modified to include above-ground piping that would allow air flow through the wells while the system is operating and pulling air from SVE-S-20 (see Figure 1-4). Pantex increased influent flow to the SVE by 40% (from 32 scfm

Figure 1-4. Burning Ground SVE System Wells and Modifications

to about 45 scfm), close to the maximum design flow of 50 scfm. Pantex also increased monitoring and evaluation of influent air to the SVE system and evaluation of the individual wells that were modified to gain baseline information as well as continued monitoring of changes. The evaluations, presented in Section 4, will be used to help provide a path to closure of the Burning Ground SVE.

1.3.2 Protective Covers

The remedial action for landfills included installation and maintenance of protective covers for the Former Burning Ground Ash Disposal Trench and SWMUs 14 through 24, the former operational area of Firing Site (FS-5), and 27 landfill units depicted in Figure 1-3. These protective covers were either placed after landfilling operations ceased, or were installed as ICMs under State RCRA Authority to prevent worker contact and infiltration of water through the landfill materials that could lead to migration of contaminants to the underlying aquifer without mitigation. Construction of all the 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 SWMU 5-05, with a total length of approximately 832 feet, were lined as an ICM in 2004 to prevent migration of vadose zone soil contamination to the perched groundwater. 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 one foot deep to control against erosion and to 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 SWMU 2 and SWMU 5-05 Ditch Liner. Before installing the new liner, sediment, debris, and water were removed from the SWMU 2 and 5-05 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-foot 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 2 feet 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 interference 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. All liner welds were visually inspected and air lance tested.

1.4 Groundwater Remedial Actions

Groundwater Remedial Actions

Pump & Treat Systems

- Playa 1 Pump and Treat
- Southeast Pump and Treat

In situ Bioremediation Systems

- Zone 11 ISB
- Southeast ISB
- Southeast ISB Extension

In accordance with the IAG and HW-50284, Pantex has implemented remedial actions to remediate the contaminated perched groundwater. Two types of active remediation systems (see Figure 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 focus on the following:

- Cleanup of perched aquifer to the GWPS,
- Reduction of perched water levels to protect the underlying drinking water aquifer (Ogallala Aquifer) and to prevent growth of plumes; and
- Institutional controls to restrict perched groundwater use without treatment and to control drilling into and through the perched aquifer to prevent cross contamination.

The pump and treat systems were installed to address contamination in areas where there is generally greater than 15 ft of saturation in the perched aquifer. These systems are designed to remove and treat perched groundwater to reduce contaminant mass and saturated thickness of the perched aquifer. Reduction in saturated thickness should significantly reduce the migration of contaminants both vertically and horizontally so that natural breakdown processes can occur over time.

Pantex has installed in situ bioremediation systems to reduce the concentration of contaminants as they migrate through the remediation zone in targeted areas of the groundwater plumes.

Each of the remediation systems is detailed in the following sections.

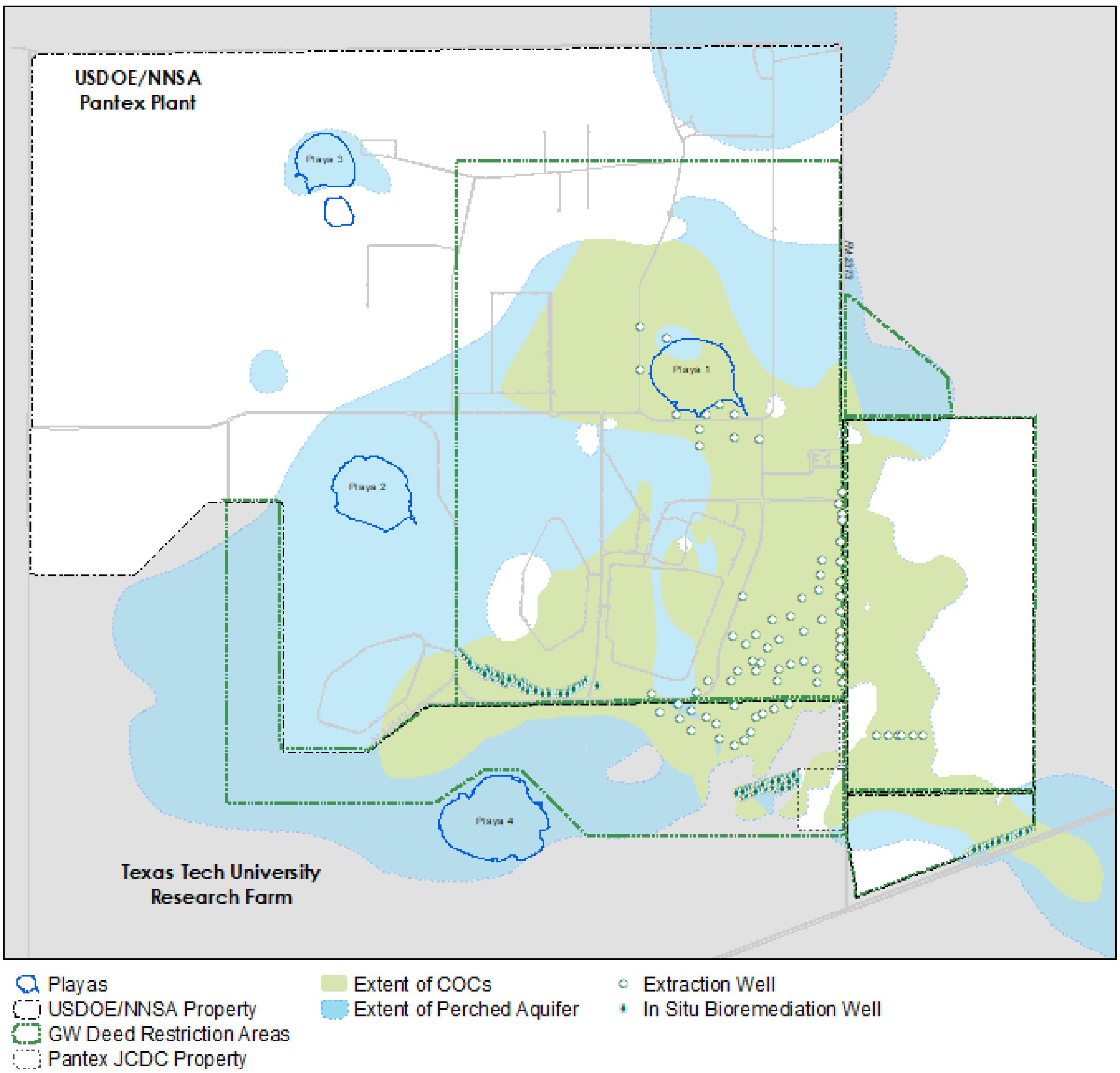

Figure 1-5. Groundwater Remedial Actions

1.4.1 Pump and Treat Systems

As part of the Remedial Action, Pantex installed two pump and treat systems, with 75 operating extraction wells and two injection wells that are currently treating up to a total of 550 gallons per minute (gpm) of contaminated perched groundwater. The systems address contamination in areas where there was generally greater than 15 ft of saturation in the perched aquifer at the time of installation. These systems were designed to remove and treat groundwater to achieve contaminant mass reduction and reduction in the saturated thickness of the perched aquifer. Reduction in saturated thickness will significantly reduce the migration of contaminants both vertically and horizontally so that natural attenuation processes can occur over time. To achieve mass reduction and reduction in saturated thickness, the pump and treat systems treat the extracted water to remove contaminants from the water before the effluent is sent to the WWTF and irrigation system for beneficial use. 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 during 2016 to allow beneficial use in accordance with the Texas Land Application Permit. While the primary use option is irrigation, the SEPTS retains the capability for injection back into the perched zone, as necessary.

PTS Operational Goals

1. 90% Operation Time with no injection when WWTF/Irrigation System can receive all treated water.
2. When the WWTF/Irrigation system is limiting flow, no injection at SEPTS with minimum flow rates (125 gpm) maintained at both systems. Injection is used at SEPTS to maintain minimum flow if flow is limited below 250 gpm for the two systems.
3. 90% of system treatment or well field capacity, whichever is lower.

The P1PTS began operating 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 been expanded with additional extraction wells and the capacity to treat boron and hexavalent chromium to become part of the final Remedial Action 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. Report Purpose and Objectives.

1.4.1.1 Playa 1 Pump and Treat System

The P1PTS extracts water from eleven wells near Playa 1 and treats the water through a series of granular activated carbon (GAC) beds and ion exchange process units to reduce HEs and metals below the GWPS established in the ROD and HW-50284. This system focuses on reducing the mound of perched groundwater associated with Playa 1, affecting the movement of the southeast plume by reducing the hydraulic head, as well as achieving mass removal. This system treats high explosives and volatile organics such as TCE. Boron is treated below the GWPS when the water will be used for irrigation purposes. Figure 1-11 depicts the P1PTS wells and conveyance.

P1PTS beneficially uses all treated water by sending it through the WWTF to the irrigation system. Because this system does not have the capability to 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 irrigation system so all irrigation usage was discontinued. Pantex, operating under permit by the State of Texas, can release treated waste water to Playa 1. Pantex continues to release to Playa 1 while engineering studies, designs, and repairs are made. Pantex is also pursuing other reuse methods for the treated perched groundwater.

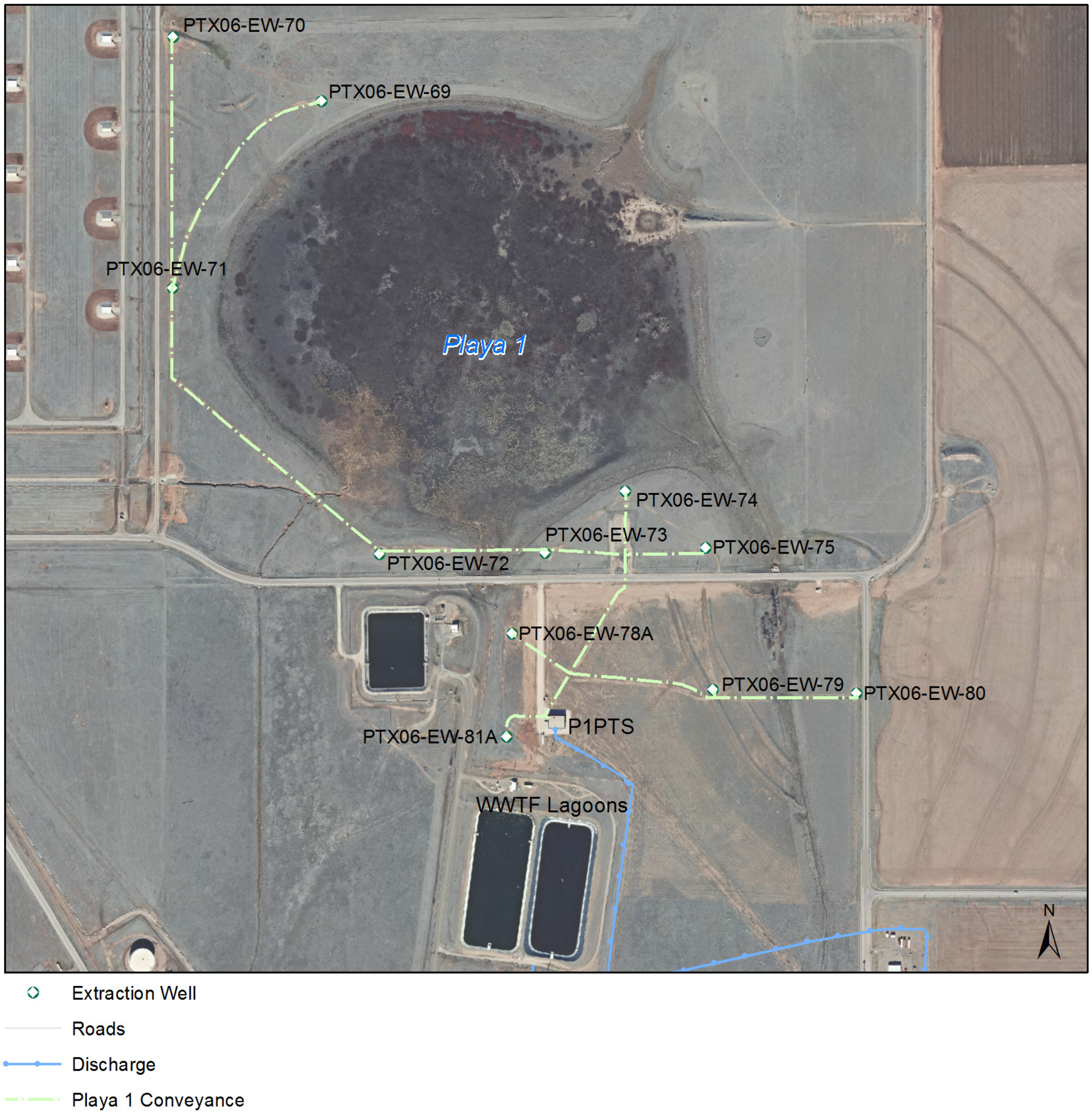

Figure 1-6. P1PTS Wells and Conveyance Lines

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 pump and treat system 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, 64 active extraction wells, 1 inactive extraction well, and 1 injection well (see Figure 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.

This system treats the recovered perched groundwater through a series of GAC vessels and ion exchange resin beds to reduce concentrations below the GWPS established in the ROD and HW-50284. Primary contaminants treated at this system includes high explosives and hexavalent chromium. There are other minor plumes in the area, including TCE, that are treated by the SEPTS. Boron is treated below the GWPS when the water will be used for irrigation purposes.

The objective of the SEPTS 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. This will achieve two important objectives:

1. Gradual reduction of the volume of perched groundwater (and contamination) moving downgradient toward the extent of the perched aquifer, and
2. A reduction in the head (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 for this system were established, as presented in the highlight box in Section 1.4.1. Goals are prioritized for system operation and will be met as conditions allow.

Figure 1-7. SEPTS Wells and Conveyance Lines

1.4.2 In Situ Bioremediation Systems

Pantex has installed and operates three ISB systems as part of the final Remedial Action for groundwater. One system is on the southeast side of Pantex Plant on TTU property, one is along the southeast property boundary east of FM 2373, and one is south of Zone 11. In 2019, the ISB systems consisted of 119 treatment zone injection wells, five treatment zone monitoring wells, and 18 in situ performance monitoring wells. Six new wells were added to the Zone 11 ISB in late 2019, but will not be injected until 2020.

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 Figure 1-8). The system, as operated in 2019, consists of 52 active and inactive injection wells, five treatment zone monitoring wells, and nine downgradient performance monitoring wells installed in a zone of saturated thickness of approximately 15-20 ft. Six new injection wells installed in late 2019 will begin operations in 2020.

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. One of the original wells was removed from active injection in 2013 (PTX06-ISB082), with three others on the eastern side (PTX06-ISB079 through PTX06-ISB081) also removed from active injection by 2015. Pantex expanded the system in late 2014 to include an additional 20 injection wells (18 new injection wells and 2 previously installed pump test wells), 3 new downgradient ISPM wells, and 3 treatment zone monitoring wells (TZM - 1 TZM well was previously installed as a pump test well) that will not receive injection. Two additional TZM wells were also installed in the original system on the TCE (western) side. The two additional TZM wells will replace monitoring of a portion of the injection wells on that side of the system. Pantex also designated three established downgradient monitoring wells as performance monitoring 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.

The 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 Texas Tech property near Playa 4. This system treats primarily TCE and perchlorate although minor plumes of high explosives 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 about every 12 to 24 months. Pantex has been scheduling rehabilitation and injection activities every 24 months based on data collected in the original treatment zone. Pantex has recently moved to the use of a more soluble amendment, molasses, for injection due to its ability to widely distribute during injection. However, the soluble molasses will require more frequent injection and has been scheduled for reinjection every nine months following the 2019 injection. Ten 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 (original 23 wells) November 2009 (9 new wells)
2	September 2010
3	October 2011
4	September 2012
5	July 2013 (31 wells)
6	July 2014 (31 wells + 2 converted pump test wells)
7	November 2015 (51 wells)
8	August 2016
9	October 2018 (20 wells)
10	January 2020

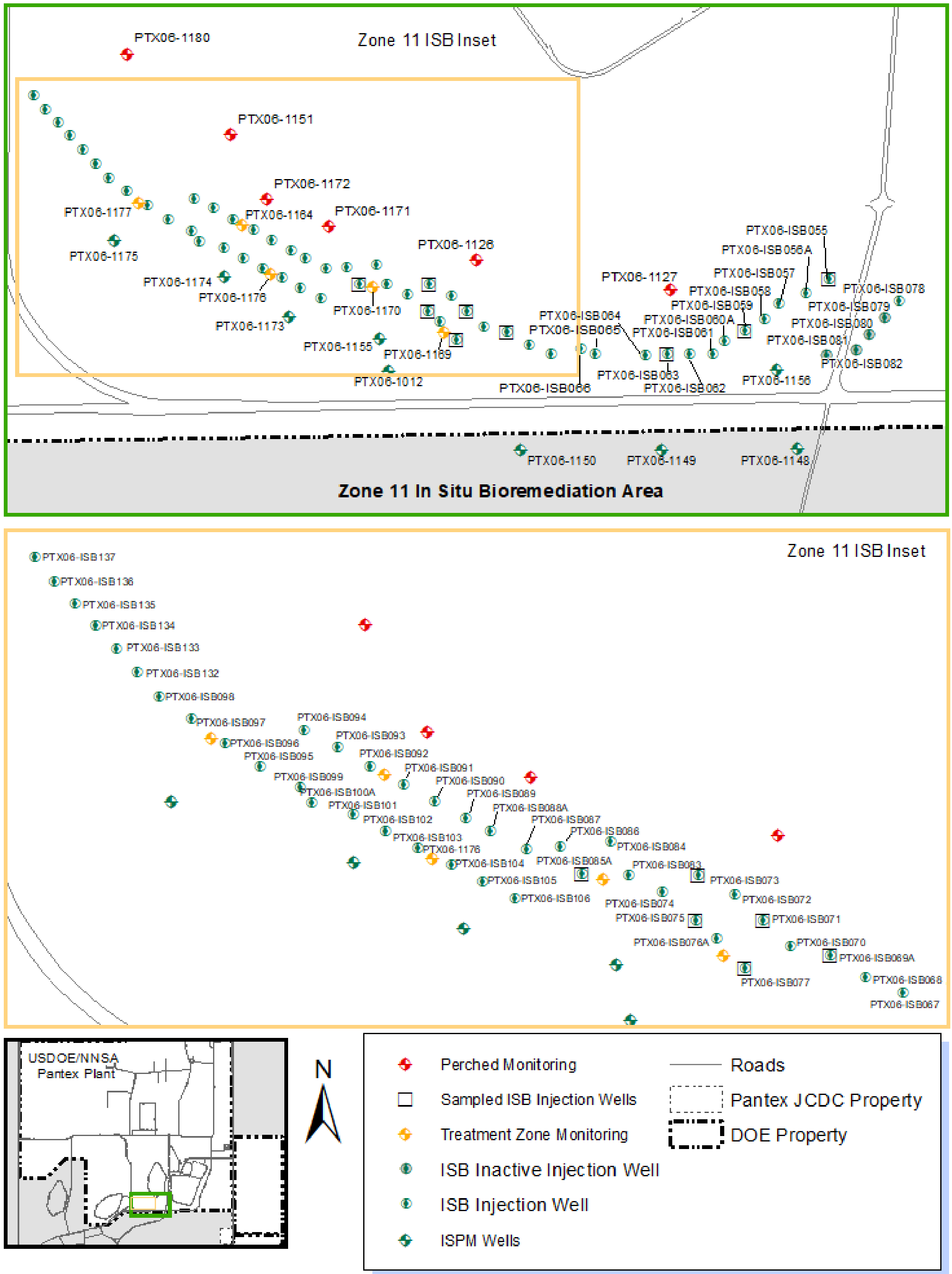

Figure 1-8. Zone 11 ISB Treatment Zone and Performance Monitoring Wells

The *In Situ Bioremediation Corrective Measures Construction Zone 11 South Implementation Report* (Aquifer Solutions, 2009a) documents the implementation of the Zone 11 ISB. That report was included with the *Final Pantex Interim Remedial Action Report* (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) that was 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). The well installations are documented in the *Well Drilling Implementation* Report (Trihydro, 2014) also included in the *2014 Annual Progress Report*. The *Bioaugmentation Implementation Plan* (Trihydro, 2015) provides the detailed plan for injection of DHC. The 2019 well installations follow the design of the original well installation. An implementation report will be developed in 2020 and provided in the 2020 Annual Progress Report. Well construction details are provided in Appendix G of this document.

1.4.2.2 Southeast ISB

The Southeast ISB System is on TTU property south of Pantex. The system was installed in 2007 as an early action and consists of 42 injection wells within the treatment zone and six performance monitoring wells (see Figure 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 Texas Tech property where the FGZ becomes less resistant to vertical migration.

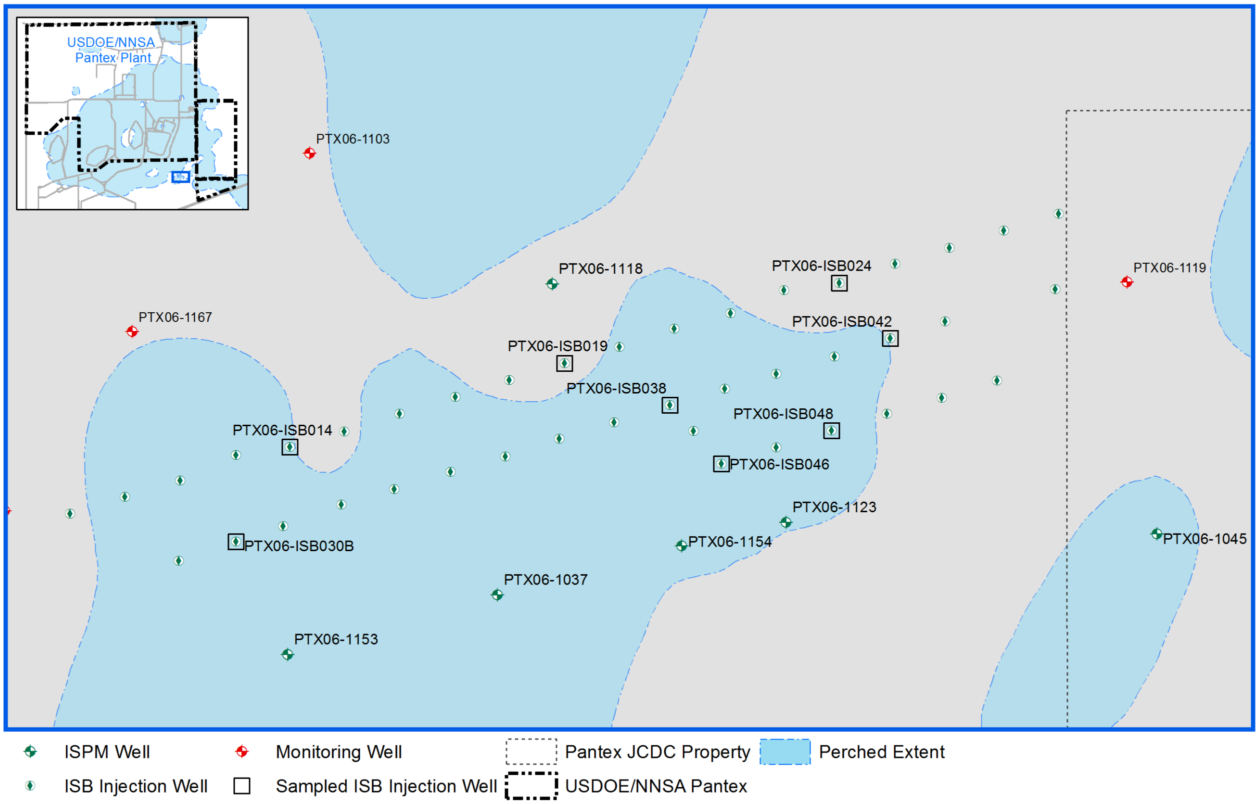

Figure 1-9. Southeast ISB Treatment Zone and Performance Monitoring Wells

Based on the rate of perched groundwater flow and estimated longevity of the Newman Zone® soybean oil, injections were estimated to be necessary about every 12 to 24 months. Pantex has reduced the frequency of injection to three years based on review of amendment longevity and performance of the pilot study ISB. In 2019 Pantex moved to injection of molasses in this system to increase amendment distribution. With the change in substrate, another injection is planned in two years. However, due to continued water level decline, it is not anticipated that further injections will be required after 2021. Seven injection events have been completed for the Southeast ISB as provided 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

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 *Final Pantex Interim Remedial Action Report* (IRAR) (Pantex, 2010a).

1.4.2.3 Southeast ISB Extension

Pantex installed a new system in 2018 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 Pantex ROD. The system consists of 25 injection wells and 3 downgradient monitoring wells. The new line of wells along the Pantex southeast boundary east of FM 2373, including 24 new wells completed in 2017 and one monitoring well that was converted for use as an injection well, was positioned to treat the contaminants in the southeast plume moving to offsite landowner property. The system will address the continued migration of the high explosive plume, particularly RDX. Due to the upgradient removal of water at new extraction wells, it is anticipated that water levels will decline in this system over time and future injections will be unnecessary. Figure 1-10 depicts the Southeast ISB Extension.

Based on the rate of perched groundwater flow and estimated amendment longevity, injections are estimated to be necessary every 6-9 months, based on the use of a more soluble amendment, such as molasses. As depicted in Table 1-5, two injection events have been completed at this system.

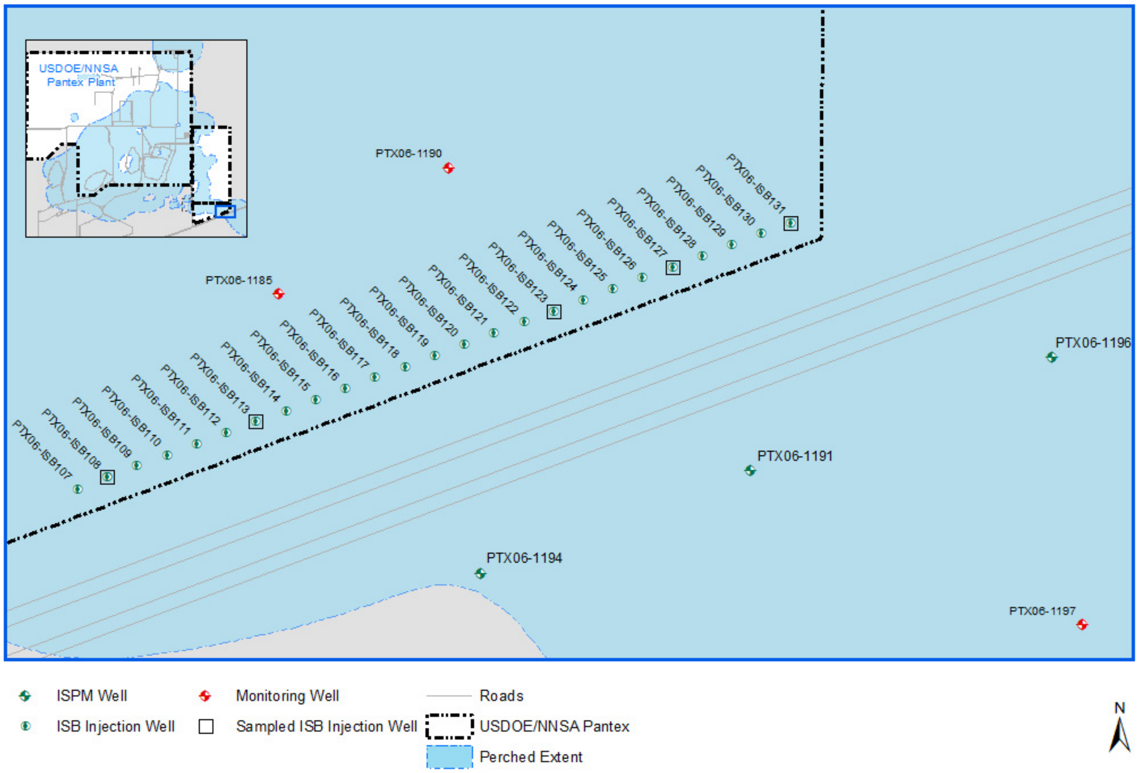

Figure 1-10. Southeast ISB Extension Treatment Zone and In Situ Performance Monitoring Wells

Table 1-5. Southeast ISB Extension Injection Events

Injection Event	Completion Date
1	February 2020
2	September 2020

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 for this report is the data and

> *Groundwater Remedial Action Evaluation Criteria*
> - Plume Stability
> - Remedial Action Effectiveness
> - Uncertainty Management
> - Early Detection
> - Natural Attenuation of COCs

information collected for the soil and groundwater remedies during the previous year. 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. This report provides information on its operation, mass removal, and effluent readings during 2019. This report also provides information on the inspection and maintenance of the ditch liner, soil covers, and fencing that are part of the remedial action. In addition, information on site control in accordance with institutional controls and deed restrictions is provided.

This progress report also provides information for the maintenance and operation of the groundwater remediation systems and components. Data are evaluated according to criteria outlined in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2014a). Those criteria are included in the highlight box 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 to provide an understanding of the conclusions of the report. 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, and SWMU status is included in the appendices. Contractor operational reports for the ISB, implementation reports, and well drilling reports are also included in the appendices, as applicable.

1.6 Long-Term Monitoring of Remedial Actions

Pantex has developed a long-term monitoring network to evaluate the effectiveness of the remedial actions, ensure that remedial action objectives (from the ROD) are achieved, and to confirm expected future conditions within the perched aquifer and the Ogallala Aquifer. The long-term monitoring design and evaluation criteria are provided in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2014a), in effect during 2019. 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 to include point of exposure and point of compliance wells where the GWPS is required to be met.

1.6.1 Perched Aquifer Long-Term Monitoring (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 2019, the network consisted of:

- 142 perched wells – 30 of those wells are monitored for continued dry or limited water conditions; 93 sampled for indicator COCs and other applicable analytes including natural attenuation products, corrosion indicators, and general water quality indicators; and 19 are monitored as in situ performance monitoring (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 142 perched LTM wells and 43 additional wells not included in the LTM network have water levels measured semi-annually.
- 65 wells are sampled semi-annually, 28 wells annually, 13 wells quarterly, and 6 wells are sampled every five years.
- 40 of the sampled wells (including 35 of the annual and semi-annual sampled wells) are sampled every five years using a modified 40 CFR Part 264 Appendix IX groundwater list to satisfy uncertainty management requirements. The next five-year sampling is scheduled for 2021 (Figure 1-11).
- Four indicator areas were defined for the perched groundwater. COCs to be monitored are defined for each of those areas.
- PTX06-1200, PTX06-1201, PTX06-1202, PTX06-1203, PTX06-1204, PTX06-1205, and PTX06-1207 were added to the network in 2019 and early 2020. All but PTX06-1205 and PTX06-1207 were monitored in 2019. PTX06-1205 was dry when drilled and remains dry. PTX06-1207 was drilled in early 2020 as part of the drilling contract that started in 2019, so will be sampled in 2020.

Table 1-6 lists all wells in the perched LTM network and HW-50284, their LTM objective, indicator monitoring area, Compliance Plan objective (point of compliance/point of exposure [POC/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 CP Table VII requirements. Figure 1-11 depicts the current active LTM wells listed in Table 1-6.

Table 1-6. Perched LTM Network and ISM 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	Inactive			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	Active	UM		3769596.99	628496.92
PTX06-1012	ISPM Zone 11	Y	Y	6/9/2003		Active	PS, RA		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		Active	UM		3772643.95	638901.00
PTX06-1081	Miscellaneous	Y	Y	6/9/2003		Active	UM		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, RA		3766957.63	642103.43
PTX06-1015	Southeast	Y	Y	6/9/2003		Active	RA		3753617.00	643765.00
PTX06-1023	Southeast	Y	Y	6/9/2003		Active	RA	POC	3764603.10	642773.84
PTX06-1030	Southeast	Y	Y	6/9/2003		Active	RA		3755008.03	644670.42
PTX06-1R01	Southeast	Y	Y	6/9/2003		Active	RA	POC	3753348.03	644674.92
PTX06-1034	Southeast	Y	Y	6/9/2003		Active	RA	POC	3752434.98	646555.62
PTX06-1036	Southeast	Y	Y	6/9/2003		Active	PS		3752455.56	638615.43
PTX06-1038	Southeast	Y	Y	6/9/2003		Active	RA		3760426.35	643802.04
PTX06-1040	Southeast	Y	Y	6/9/2003		Active	RA		3758262.93	643811.23
PTX06-1042	Southeast	Y	Y	6/9/2003		Active	RA	POC	3755779.88	643812.20
PTX06-1046	Southeast	Y	Y	6/9/2003		Active	RA	POC	3752292.55	643802.63
PTX06-1052	Southeast	Y	Y	6/9/2003		Active	RA	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, RA		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

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX01-1004	Burning Ground	N	Y	9/16/2010		Dry	PS		3770768.71	630729.82
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	RA		3752194.06	641549.25
PTX06-1045	ISPM Southeast	N	Y	9/16/2010		Dry	RA	POC	3752300.00	642697.65
PTX06-1118	ISPM Southeast	N	Y	9/16/2010		Dry	RA		3752736.07	641644.92
PTX06-1123	ISPM Southeast	N	Y	9/16/2010		Active	RA		3752319.94	642051.96
PTX06-1153	ISPM Southeast	N	Y	9/16/2010		Active	RA	POC	3752089.44	641184.13
PTX06-1154	ISPM Southeast	N	Y	9/16/2010		Active	RA	POC	3752278.90	641870.52
PTX06-1155	ISPM Zone 11	N	Y	9/16/2010		Active	RA	POC	3755215.62	634603.74
PTX06-1156	ISPM Zone 11	N	Y	9/16/2010		Active	RA	POC	3755076.47	636378.92
PTX04-1001	Miscellaneous	N	Y	9/16/2010		Active	UM		3772334.66	641458.10
PTX06-1049	Miscellaneous	N	Y	9/16/2010		Active	PS, UM		3763376.96	633343.53
PTX06-1055	Miscellaneous	N	Y	9/16/2010		Dry	PS		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		Dry	PS, UM		3766548.35	630823.57
PTX06-1097	Miscellaneous	N	Y	9/16/2010		Dry	PS, UM		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		Active	UM		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, RA		3765214.16	640649.01
PTX06-1050	North	N	Y	9/16/2010		Active	UM, RA	POC	3766622.06	636746.04
PTX06-1136	North	N	Y	9/16/2010		Active	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, RA		3767695.22	638532.53
PTX07-1O02	North	N	Y	9/16/2010		Active	PS, UM, RA	POC	3768117.46	639106.56
PTX07-1O03	North	N	Y	9/16/2010		Active	PS, UM, RA		3767462.56	639046.64
PTX07-1O06	North	N	Y	9/16/2010		Active	PS, UM, RA		3768536.81	638814.40
PTX06-1002A	Southeast	N	Y	9/16/2010		Active	UM, RA		3759984.00	641161.56
PTX06-1003	Southeast	N	Y	9/16/2010		Active	UM, RA		3758711.05	641498.93
PTX06-1005	Southeast	N	Y	9/16/2010		Active	UM, RA		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	RA		3764075.09	643710.38
PTX06-1014	Southeast	Y	Y	9/16/2010		Active	RA		3755125.71	643758.88
PTX06-1031	Southeast	Y	Y	9/16/2010		Active	RA		3753348.03	644674.92
PTX06-1039A	Southeast	N	Y	9/16/2010		Active	RA		3759272.56	643807.47
PTX06-1041	Southeast	N	Y	9/16/2010		Active	RA		3757622.78	643803.61
PTX06-1047A	Southeast	N	Y	9/16/2010		Active	RA		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, RA		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		Dry	PS		3751494.55	643813.77
PTX06-1095A	Southeast	N	Y	9/16/2010		Active	UM, RA		3755598.65	640634.87
PTX06-1098	Southeast	N	Y	9/16/2010		Active	RA		3753628.43	640266.14
PTX06-1100	Southeast	N	Y	9/16/2010		Active	RA		3753579.52	640285.97
PTX06-1101	Southeast	N	Y	9/16/2010		Active	RA		3753437.09	640383.57
PTX06-1102	Southeast	N	Y	9/16/2010		Active	RA		3754532.94	642751.09
PTX06-1103	Southeast	N	Y	9/16/2010		Dry	RA	POC	3752963.37	641222.64
PTX06-1119	Southeast	N	Y	9/16/2010		Dry	PS		3752739.01	642646.10

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX06-1120	Southeast	N	Y	9/16/2010		Active	PS		3752735.03	643152.43
PTX06-1121	Southeast	N	Y	9/16/2010		Active	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	9/9/2016	Dry	PS		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	RA	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		Active	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, RA		3763003.22	640859.00
PTX08-1009	Southeast	N	Y	9/16/2010		Active	UM, RA		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, UM	POC	3755562.85	635034.72
PTX06-1127	Zone 11	N	Y	9/16/2010		Active	PS, UM	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, RA		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, RA		3754718.24	635233.98
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

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX07-1P05	Zone 11	N	Y	9/16/2010		Active	UM		3762886.83	637136.13
PTX08-1001	Zone 11	N	Y	9/16/2010		Active	UM, RA		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[3]	Southeast	N	Y	7/28/2013		Active	RA		3752653.00	640913.72
PTX06-1158	Zone 11	N	Y	5/30/2014		Active	PS		3752025.93	648137.99
PTX06-1159	Zone 11	N	Y	5/30/2014		Active	PS, RA		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[4]	Zone 11	N	Y	11/17/2015		Active	RA		3755312.40	634197.62
PTX06-1174[4]	Zone 11	N	Y	11/17/2015		Active	RA		3755489.15	633904.63
PTX06-1175[4]	Zone 11	N	Y	11/17/2015		Active	RA		3755651.06	633416.97
PTX06-1182[5]	Southeast	N	Y	7/11/2016		Active	PS		3751088.49	647140.17
PTX06-1183[5]	Southeast	N	Y	7/11/2016		Active	PS		3753350.43	639765.77
PTX06-1184	Southeast	N	Y	5/4/2017		Active	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		Active	PS		3752340.04	640691.28
PTX06-1189	Southeast	N	Y	5/19/2017		Active	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	RA		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		Active	PS		3749346.75	646719.13
PTX06-1194	Southeast	N	Y	1/27/2018		Active	RA		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	RA		3750989.94	649710.26
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

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
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		Active	PS		3749894.03	648801.56
PX06-1207	Zone 11	N	Y	1/21/2020		Active	PS		3754046.00	632911.00

POC – point of compliance POE – point of exposure
PS – plume stability RA – Remedial Action effectiveness UM – uncertainty management

Wells with no designation in the POC/POE column are considered as observation wells. These wells are not listed in HW-50284 Table V, so the corresponding date of HW-50284 approval 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 the well in the monitoring network, or the date the well was 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.

[3]Well was recommended for inclusion in the network in the *2012 Annual Progress Report* (Pantex, June 2013).

[4]These wells were recommended for inclusion in the network in the *2014 Annual Progress Report* (Pantex, 2015). Report approval letter from TCEQ was dated November 17, 2015.

[5]These wells were recommended for inclusion in the *2015 Annual Progress Report* (Pantex, 2016). Report approval letter from TCEQ was dated July 11, 2016.

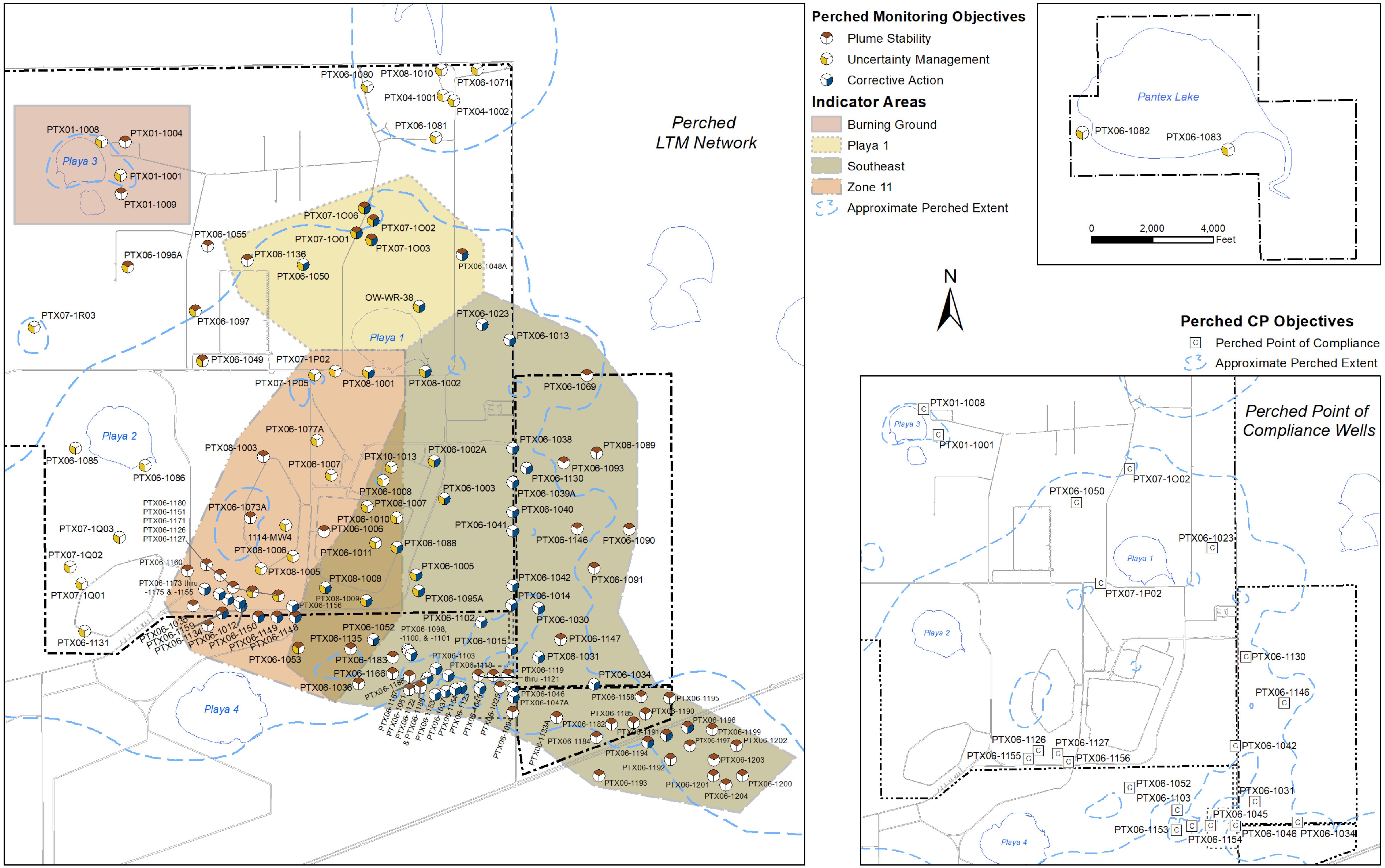

Figure 1-11. Perched LTM Network and Compliance Plan Wells

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1.6.2 Ogallala Aquifer Long-Term Monitoring Network

The final Ogallala Aquifer LTM network consists of the following.

- 24 LTM wells are monitored for indicator COCs and water levels. An additional well is used for monitoring water levels in the Ogallala Aquifer.
- 21 wells are sampled semi-annually and 3 are sampled annually. One well is being sampled quarterly for HEs and VOCs.
- 6 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. The next sampling event for the five-year sampling will be conducted in 2021. 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.
- 10 wells are sampled every five years using a modified 40 CFR Part 264 Appendix IX groundwater list to satisfy uncertainty management requirements. That sampling will be conducted again in 2021.
- Two indicator areas were defined for the Ogallala wells and indicator COC monitoring lists were developed for each of those areas.
- Four additional monitoring wells along the southern and western boundaries are monitored annually to evaluate the quality of groundwater upgradient of the Plant.

Table 1-7 lists all wells in the LTM network and HW-50284, with the corresponding LTM objective, indicator monitoring area, CP objective (POC/POE well), date of inclusion or removal from HW-50284, and coordinates. Figure 1-12 depicts the current active monitor wells listed in Table 1-7, as well as the additional four wells monitored along the southern and western boundaries. The wells are listed in chronological order according to the date of inclusion in HW-50284, in accordance with CP Table VII requirements.

Table 1-7. 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					
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[4]		Y	N	6/9/2003	9/16/2010	Active				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

POC – point of compliance
POE – point of exposure
ED – early detection
RA – 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 Data 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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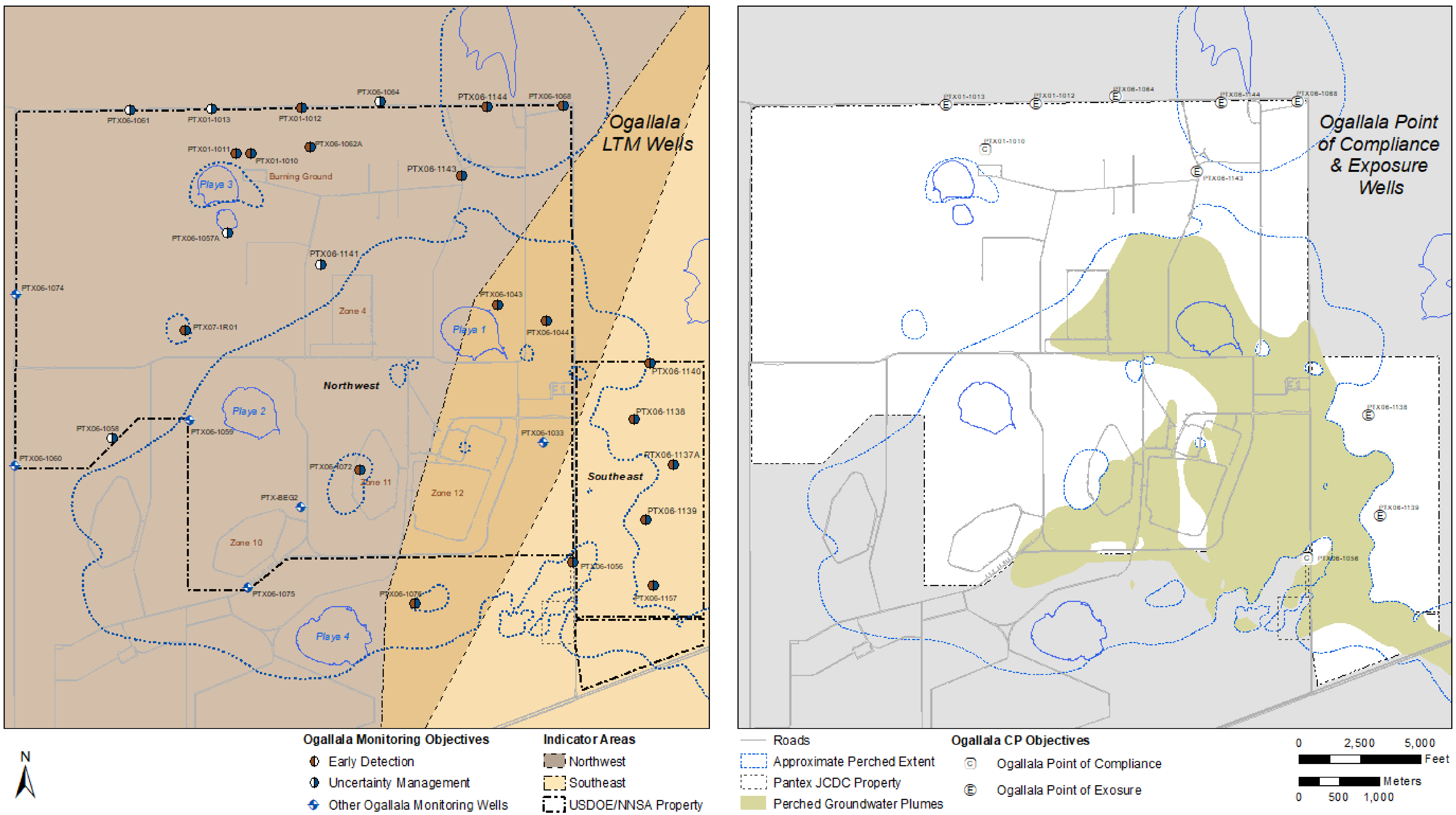

Figure 1-12. Ogallala Aquifer LTM and Compliance Plan Wells

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1.6.3 Remedial Action Wells

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

Table 1-8 details all installed wells for the pump and treat systems, as well as their current status, date of plugging and abandonment, and coordinates. Table 1-9 details all installed wells for the ISB systems, as well as their current status, date of plugging and abandonment, and coordinates. Table 1-10 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 network is used for remediation, but some wells are also sampled to provide information for the remedial action.

- 21 active ISB wells are used to monitor treatment zone conditions in the three established ISB systems.
- Two inactive ISB wells are monitored on the eastern side of the Zone 11 ISB. This monitoring evaluates the continued effectiveness of the system with using only one row of injection on the eastern side of the ISB.
- All available extraction wells (pumping at time of sampling) are generally monitored during June/July of each year. These data are used to support the plume mapping.
- Five wells in the SEPTS are monitored semi-annually to evaluate the movement of perchlorate into those wells.
- The SVE system is monitored to evaluate remedial action effectiveness and to provide information for the Air Quality Monitoring Report for the TCEQ.

The following changes to the Remedial Action Systems occurred during 2019:

- Six new ISB injection wells were added to the Zone 11 ISB.

Table 1-8. 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

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
PTX06-EW-42A	3/10/2000	Active		641052.06	3753818.72
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	Inactive		641005.96	3757505.73

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
PTX06-INJ-11	8/28/2004	Active		641752.09	3758137.05
PTX06-INJ-12A	1/24/2008	P&A	5/24/2017	640737.15	3756104.67
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

P&A = plugging and abandonment
[1]Due to low well yield and need for monitoring data, extraction well was converted to monitoring well rather than plugged and abandoned.
[2]Pantex completed connection to the system in June 2016, with well becoming operational by November 2016.
[3]Pantex was in process of connecting these wells to the system in late 2018.

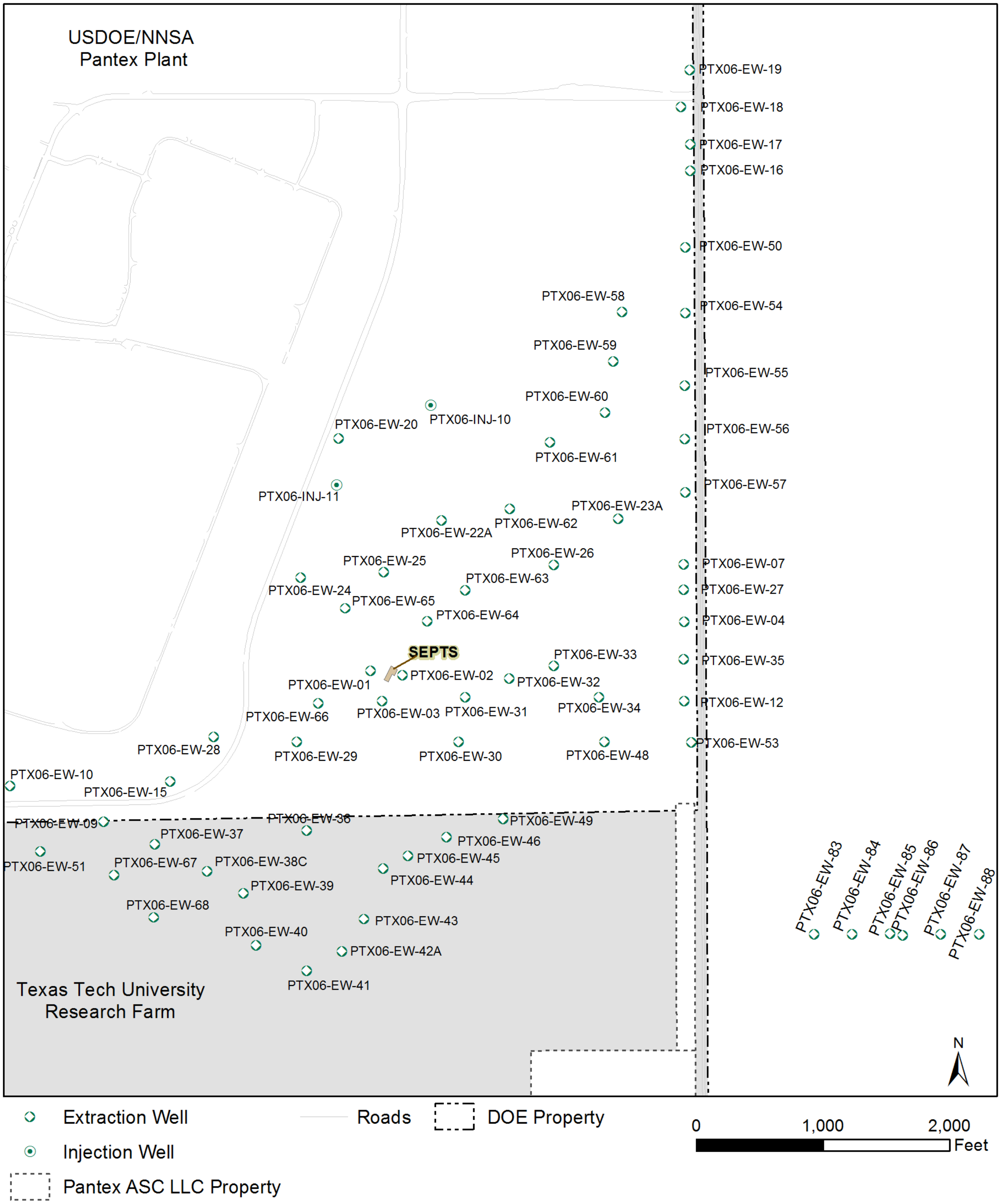


Figure 1-13. SEPTS Wells

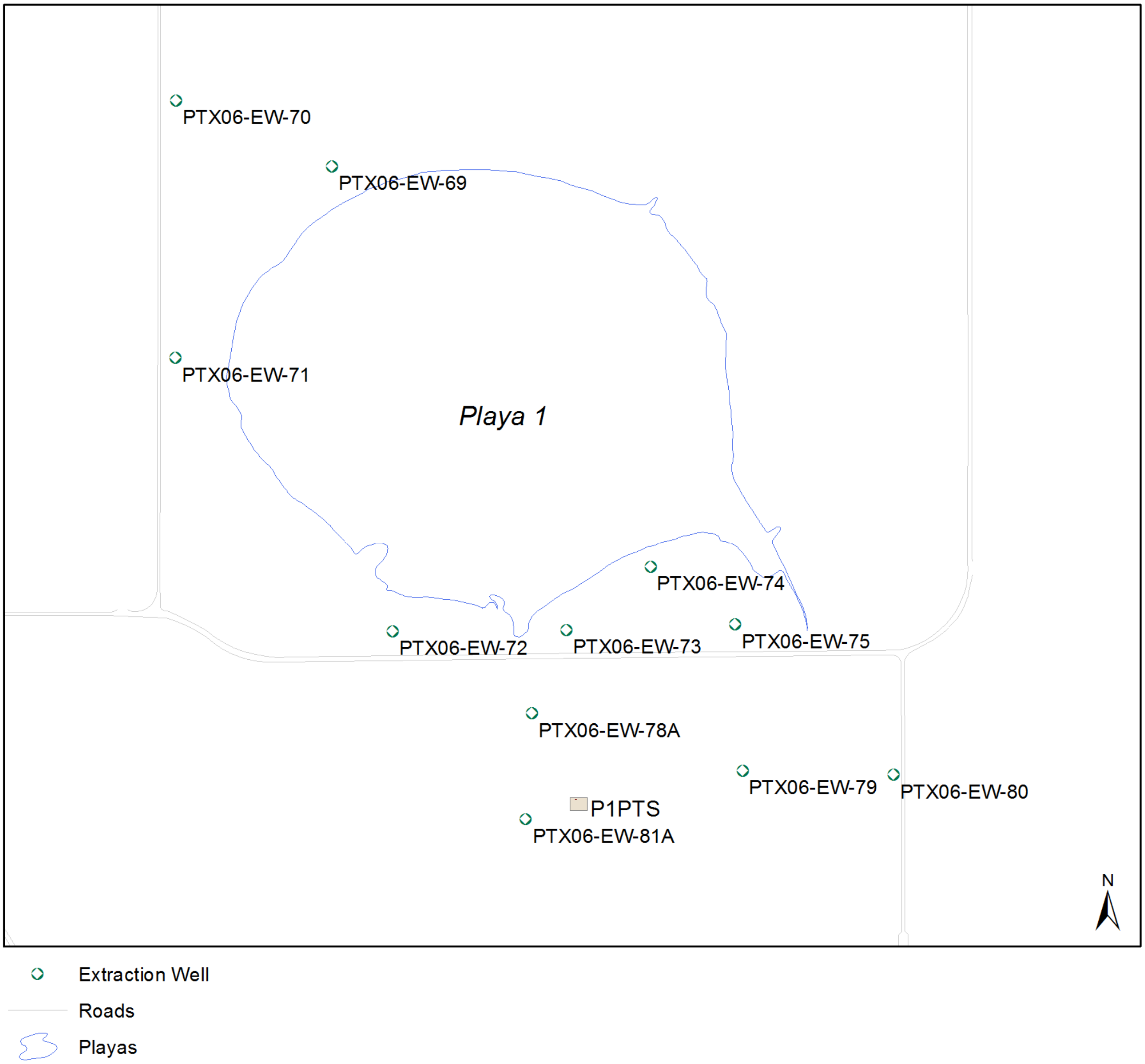


Figure 1-14. P1PTS Wells

Table 1-9. 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

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
PTX06-ISB101	08/07/2014	Active			633899.71	3755616.85
PTX06-ISB102	07/31/2014	Active			633985.55	3755572.69
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
			Southeast ISB Extension			
PTX06-ISB107	04/22/2017	Active			647400.94	3750677.17
PTX06-ISB108	12/13/2017	Active			647471.65	3750705.36
PTX06-ISB109	12/04/2017	Active			647541.96	3750731.23
PTX06-ISB110	12/02/2017	Active			647612.02	3750757.59
PTX06-ISB111	12/15/2017	Active			647682.57	3750783.88
PTX06-ISB112	12/13/2017	Active			647753.08	3750810.07
PTX06-ISB113	11/03/2017	Active			647823.09	3750836.66
PTX06-ISB114	11/07/2017	Active			647894.07	3750862.53
PTX06-ISB115	11/03/2017	Active			647964.07	3750888.51
PTX06-ISB116	11/05/2017	Active			648034.69	3750914.87
PTX06-ISB117	11/14/2017	Active			648105.30	3750940.93
PTX06-ISB118	11/15/2017	Active			648175.64	3750967.12
PTX06-ISB119	11/17/2017	Active			648245.97	3750993.50
PTX06-ISB120	11/30/2017	Active			648316.24	3751019.54
PTX06-ISB121	11/08/2017	Active			648386.52	3751045.71
PTX06-ISB122	11/06/2017	Active			648457.75	3751072.09
PTX06-ISB123	11/04/2017	Active			648527.50	3751098.16
PTX06-ISB124	12/03/2017	Active			648597.96	3751124.55
PTX06-ISB125	12/01/2017	Active			648668.62	3751150.76
PTX06-ISB126	11/17/2017	Active			648738.78	3751176.87
PTX06-ISB127	11/29/2017	Active			648809.07	3751203.15
PTX06-ISB128	10/24/2017	Active			648879.71	3751229.17
PTX06-ISB129	11/15/2017	Active			648950.08	3751255.41
PTX06-ISB130	11/14/2017	Active			649020.47	3751282.05
PTX06-ISB131	11/01/2017	Active			649090.64	3751308.18

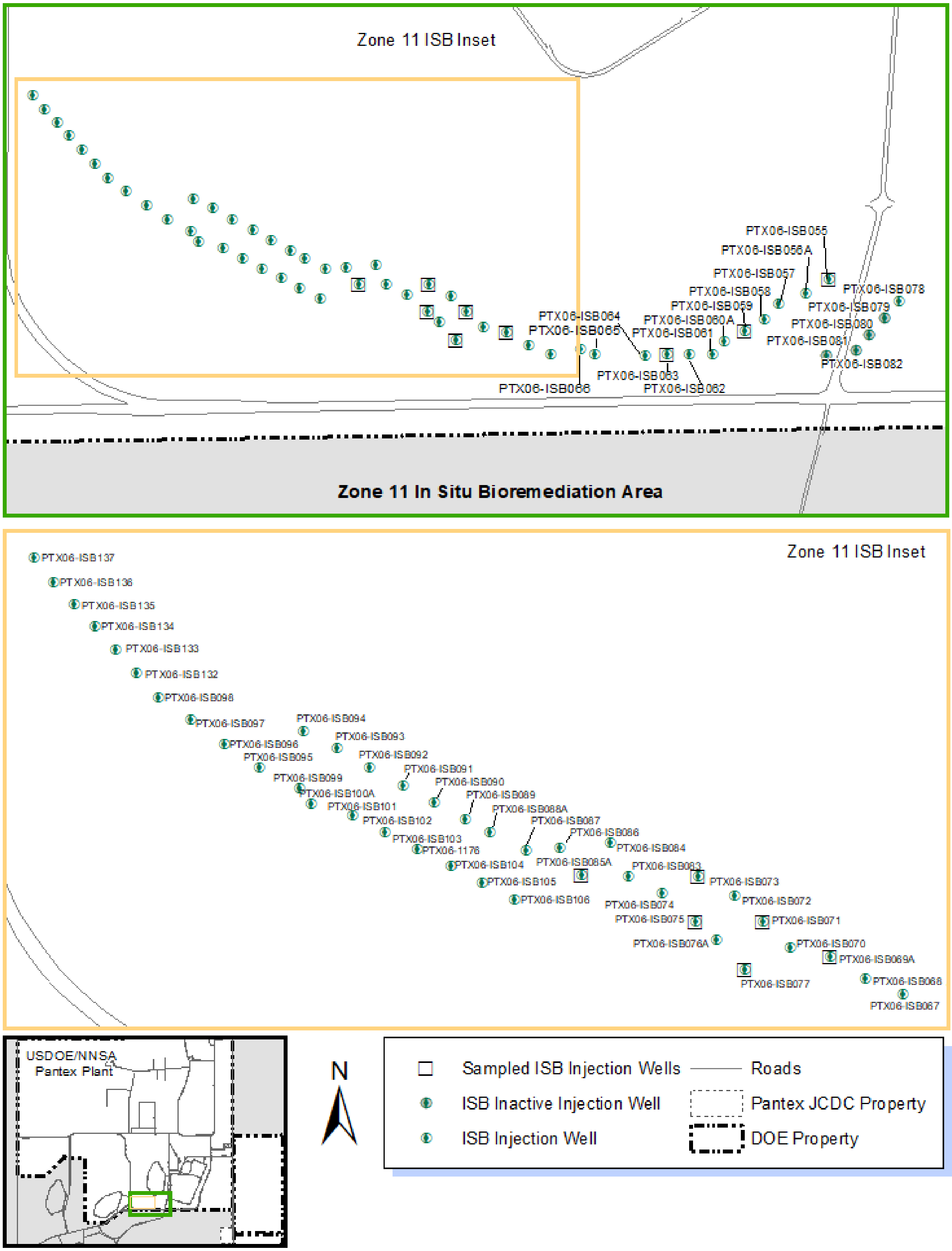


Figure 1-15. Zone 11 ISB System Wells

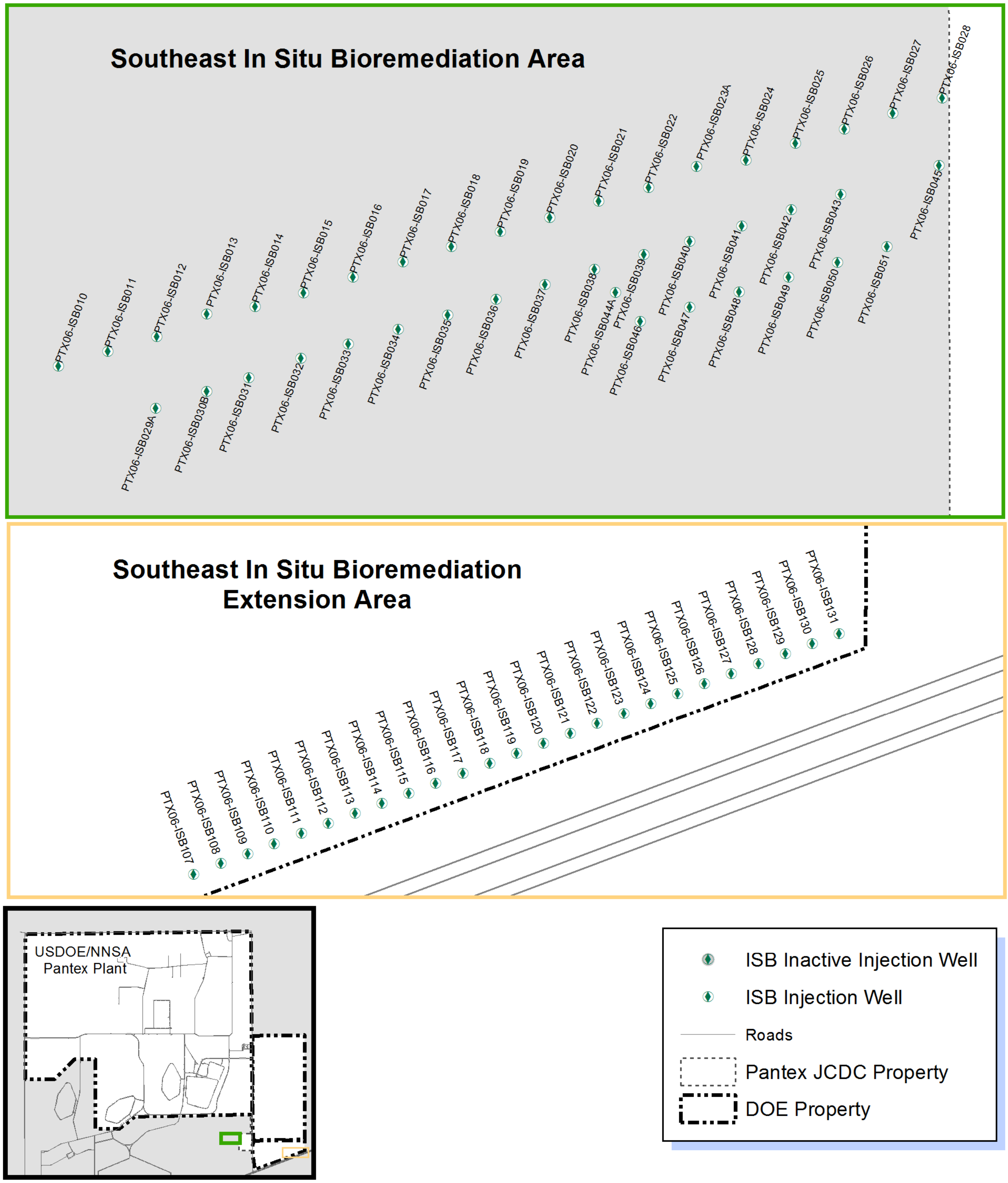


Figure 1-16. Southeast ISB System Wells

Table 1-10. 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

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

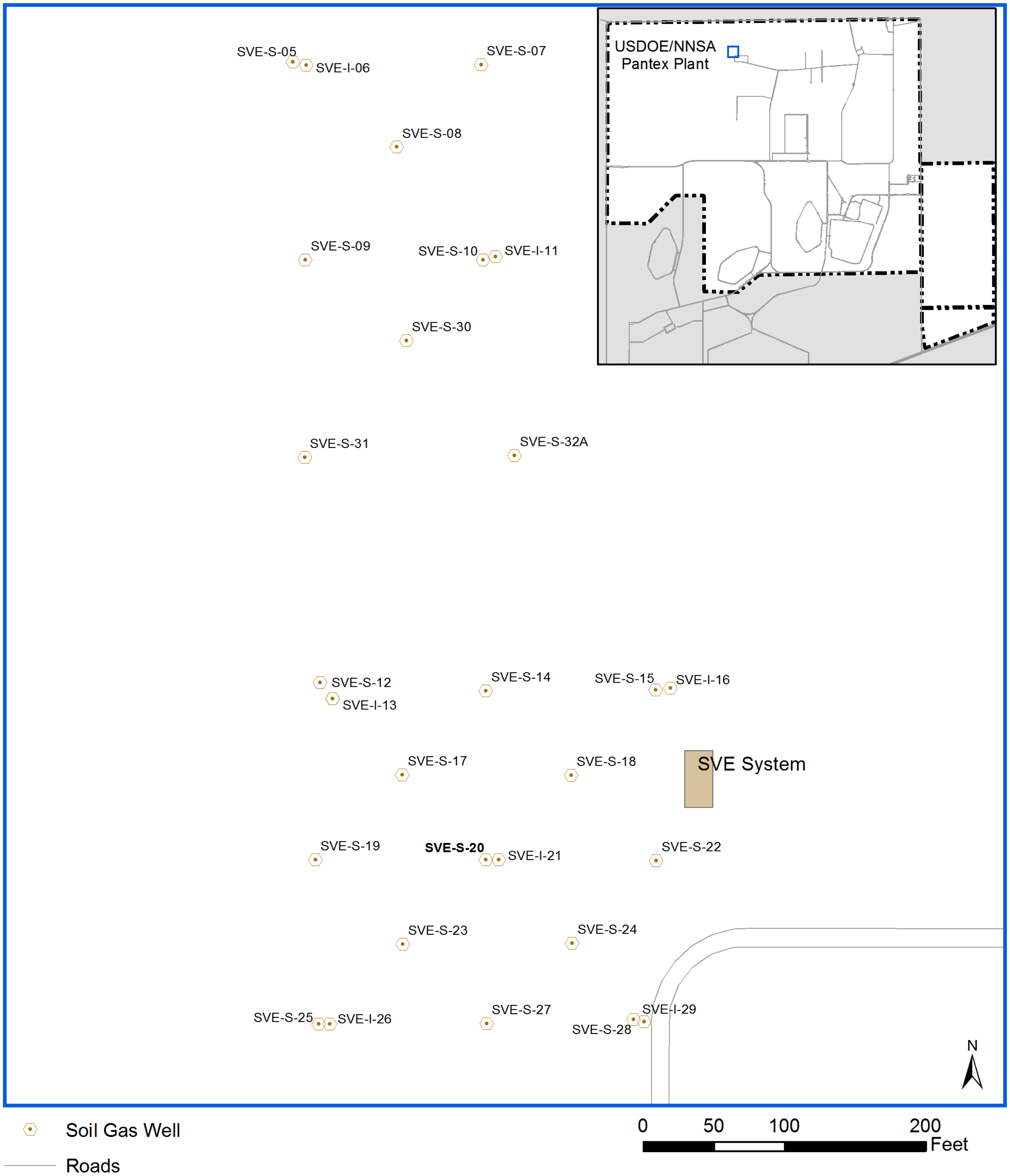


Figure 1-17. Burning Ground SVE Wells

1.6.4 Schedule of Activities

Pantex must meet requirements under CERCLA and RCRA, as detailed in HW-50284 and the IAG. Pantex has submitted a Site Management Plan (SMP) in accordance with the IAG that provides a list of required activities and planned dates of completion.

Activities completed in 2019 since the date of the last annual report, in 2020 prior to publication of this report, and projected start or completions for July 2020 - June 2021 are summarized in Table 1-11. The schedule of activities included in the 2019 annual report was the basis for this table. Revisions of that schedule are noted in Table 1-11 and are explained in the following text.

Pantex completed 2019 activities related to the Five-Year Review, recommendations from previous reports, as well as completing all normally scheduled monitoring and operation of remedial actions.

Pantex completed a FYR in 2013 and in 2018. 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. A table of action items has been developed from the second FYR. Those actions are included in the recommendations and conclusions section of this report and will be tracked to completion.

The significant actions completed in 2019 and early 2020 in relation to the second FYR include:

- Pantex committed to evaluating the expanding plumes of high explosives east of FM 2373 in the first and second FYR. To address the plume expansion, Pantex continues to evaluate and implement new actions to fully address the contamination. Pantex completed the following in 2019 and early 2020:
  - Six additional wells (PTX06-1200 through PTX06-1205) were drilled offsite in 2019 to address the expanding plume to the southeast. One offsite well was dry, all other wells had water, with some of the wells indicating the presence of HEs. These wells have helped define extent of the plume.
  - Pantex initiated onsite treatment of the expanding southeast plume in 2019, with the connection and operation of six new extraction wells to the SEPTS and two injections into the Southeast ISB Extension.

  - Pantex contracted Hydrogeologic (HGL) to update the Pantex conceptual site model and perched fate and transport model and evaluate options for treatment of the offsite plume. The evaluation included an optimization model that could identify options to achieve cleanup within a reasonable time period for the least cost. The least cost option that could mitigate the entire plume was chosen as the remedial action for the offsite plume that has migrated beyond the current pump and treat and ISB system. A combination of ISB and pump and treat will be installed at the offsite property over four phases, starting in fiscal year (FY) 20, to address the offsite plume.
  - Pantex negotiated a right-of-entry with an offsite neighbor so that remediation system installation can begin. Further works is required to obtain a long-term lease.
- Pantex completed the installation of six new ISB injection wells at the Zone 11 ISB. The wells encompass the entire extent of the TCE and perchlorate plumes. Pantex plans to inject the wells in 2020.
- Pantex injected molasses in the SE ISB to improve distribution of a carbon source in the treatment zone. Pantex also extracted water from PTX06-1153 to induce a gradient to the well while injecting to determine if the well may be connected to the system. Data were also collected at intervals to evaluate changes in RDX and carbon concentrations. Results of the study, as well as increased water levels, indicate the PTX06-1153 is connected to the system. Pantex will continue to evaluate PTX06-1153 for expected changes as treated groundwater moves downgradient.

Pantex has also implemented other recommendations made in the 2018 Annual Progress Report and 2019 Quarterly Progress Reports including:

- Pantex has modified the 2022-2026 budget requests to align funding with the need to fund projects identified by the FYR and recommendations from the modeling and treatment evaluation. Funding increases focused on the following: increased funding for landfill cover maintenance, installation of infrastructure and wells at the offsite property, landowner agreements for offsite treatment, and a communications upgrade for the pump and treat systems.

Pantex also completed studies on perchlorate last year due to the need to move to Method SW6850. Pantex has historically used Method E314 to evaluate perchlorate. However, the labs would no longer be able to be accredited for use of the E314 method after 2019. Therefore, Pantex completed several studies on perchlorate since the detection limits are so low and a previous study conducted by Texas Tech University indicated that perchlorate occurs naturally across the Texas Panhandle. For this reason, wells were tested for background after establishing the appropriate sampling methods. Pantex has completed that background study and has established a background of 0.96 ug/L in Ogallala groundwater for the Pantex region. Historically, Pantex has used the Ogallala backgrounds for perched groundwater as the past releases were from wastewater discharges whose source was Ogallala Aquifer groundwater. However, there is some uncertainty with applying the background in the perched groundwater as higher concentrations of perchlorate are expected in shallower groundwater. As long as there is no need to clean up to background in perched groundwater, the Ogallala background is appropriate for use.

In-progress and upcoming activities continue to focus on operation, maintenance, and monitoring of the remedial actions; operation and maintenance of soil actions; progress on the Second Five-Year Review issues and recommendations; and implementation of recommendations for treatment of the offsite plume. Some of the reporting and plans will require regulatory review and approval and are provided in bold in Table 1-11.

Pantex is currently behind on the first semi-annual sampling event for 2020 due to impacts from coronavirus. Pantex has sent home all workers that are non-essential, so completion of sampling has been delayed. Workers will return after cases have declined in the area and are expected to be back to work in early June. However, sampling for the first semi-annual event will likely continue into July.

The planned FY20 injection of the Southeast ISB Extension and Zone 11 ISB has also been impacted by the work stoppage. While the Southeast ISB Extension was originally planned for February/March time frame, it will be delayed. Data collected in early April indicate that a food source is still available for continued reduction of high explosives, so the delay is not expected to impact treatment. The system is expected to be injected in June. Other contract work has been delayed unless deemed high priority. In May, the only contractual work in progress in the field was the drilling of the first phase of the offsite remediation system.

Table 1-11. Complete, In-Progress and Upcoming Activities

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Completed Work					
Southeast ISB Extension Injection	Sep 2019	Sep 2019	Sep 2019	IAG Article 8 HW-50284 Provision XI.E.1	
Zone 11 ISB Rehabilitation and Injection	Feb 2019	Aug 2019	Jan 2020	IAG Article 8 HW-50284 Provision XI.E.1	
Southeast ISB Rehabilitation and Injection	Jun 2019	Nov 2019	Jan 2020	IAG Article 8 HW-50284 Provision XI.E.1	
FY19 Well Drilling - 6 new offsite wells	Dec 2018	Jun 2019	Mar 2019	HW-50284 XI.B.1 and XI.B.2	
FY20 Drilling – 6 Zone 11 ISB injection wells and 1 new monitoring well	Dec 2019	Jan 2020	Jan 2020	HW-50284 XI.B.1 and XI.B.2	3Q2018 2nd FYR
Sampling and Analysis Plan Update	Nov 2018	Sep 2019	Sep 2019	HW-50284 Provision XI.A.7 and XI.E.2	2nd FYR
LTM Design Update	Nov 2018	Sep 2019	Aug 2019	HW-50284 Provision XI.A.7 and XI.E.2	2nd FYR
Groundwater Contingency Plan Update	May 2019	Aug 2019	Sep 2019	IAG Article 8 and 9.5	
Fate and Transport Model/Conceptual Site Model Update and Evaluation of Treatment Options for the Offsite Southeast Plume	Feb 2019	Jul 2019	Sep 2019	HW-50284 Provision XI.E.1.d.	
Annual Landfill Cover Maintenance – 2019 (included 2018 maintenance)	Jan 2019	Jun 2019	Jun 2019	IAG Article 8.9 HW-50284 Provision XI.E	4Q2015, 2015A
Landowner Right-of-Entry for Remediation	Jun 2019	Dec 2019	Mar 2020	HW-50284 Provision XI.E.1	

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
2nd Quarter 2019 Progress Report	Aug 2019	Sep 2019	Sep 2019	HW-50284 Provision XI.G.3 and IAG Article 16.4	
3rd Quarter 2019 Progress Report	Nov 2019	Dec 2019	Dec 2019	HW-50284 Provision XI.G.3 and IAG Article 16.4	
4th Quarter 2019 Progress Report	Feb 20	Mar 2020	Mar 2020	HW-50284 Provision XI.G.3 and IAG Article 16.4	
1st Quarter 2020 Progress Report	Apr 2020	Jun 2020	Jun 2020	HW-50284 Provision XI.G.3 and IAG Article 16.4	
2019 Annual Progress Report	Mar 2020	Jun 2020	Jun 2020	HW-50284 Provision XI.G.3 and IAG Article 16.4	
2nd Semi-Annual 2019 Groundwater Sampling - Monitoring Wells	Jul 2019	Dec 2019	Dec 2019	HW-50284 Provision XI.F	
3Q2019 Groundwater Sampling - ISB System Wells	Jul 2019	Sep 2019	Sep 2019	HW-50284 Provision XI.F	
4Q2019 Groundwater Sampling - ISB System Wells	Oct 2019	Dec 2019	Dec 2019	HW-50284 Provision XI.F	
Work In-Progress					
Southeast ISB Extension Injection	Jun 2020*	Jul 2020		IAG Article 8 HW-50284 Provision XI.E.1	
1st Semi-Annual 2020 Groundwater and ISB Sampling	Jan 2020	Jun 2020		HW-50284 Provision XI.F	
FY20 Drilling – Offsite Remediation System wells – Phase 1	Apr 2020	Sep 2020		HW-50284 XI.B.1 and XI.B.2	2Q2019

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Annual Landfill Cover Maintenance – 2020	Jan 2020	Dec 2020		IAG Article 8.9 HW-50284 Provision XI.E	4Q2015, 2015A
Zone 11 ISB Rehabilitation and Injection	Feb 2020	Oct 2020*		IAG Article 8 HW-50284 Provision XI.E.1	
Playa 2 injection wells – Design and construction of wells and infrastructure	Nov 2019	Jun 2020		HW-50284 Provision XI.E.1	2Q2018
Landowner Agreements for Remediation and Deed Recordation	Apr 2020	Feb 2021		HW-50284 Provision XI.E.1	
Upcoming Work					
Southeast ISB Extension Injection	Feb 2021*	Mar 2021		IAG Article 8 HW-50284 Provision XI.E.1	
Offsite ISB Extension Injection	Oct 2020 Apr 2021	Oct 2020 Apr 2021		IAG Article 8 HW-50284 Provision XI.E.1	
Design/Construct Offsite Infrastructure – Phase 1	Jun 2020	Sep 2020		HW-50284 XI.B.1 and XI.B.2	2Q2019
Well Drilling – 2021 Offsite Remediation System Wells – Phase 2	Dec 2020	Jun 2021		HW-50284 XI.B.1 and XI.B.2	2Q2019
Design/Construct Offsite Infrastructure – Phase 2	Jan 2021	Sep 2021		HW-50284 XI.B.1 and XI.B.2	2Q2019
Design Irrigation System East of FM 2373	Jan 2021	Jul 2021		HW-50284 XI.B.1 and XI.B.2	4Q2018
Optimization Evaluation of Pump and Treat Systems	Jan 2021	Jul 2021		HW-50284 XI.B.1 and XI.B.2	2nd FYR
2nd Quarter 2020 Progress Report	Aug 2020	Sep 2020		HW-50284 Provision XI.G.3 and IAG Article 16.4	

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
3rd Quarter 2020 Progress Report	Nov 2020	Dec 2020		HW-50284 Provision XI.G.3 and IAG Article 16.4	
4th Quarter 2020 Progress Report	Feb 2021	Mar 2021		HW-50284 Provision XI.G.3 and IAG Article 16.4	
1st Quarter 2021 Progress Report	Apr 2021	Jun 2021		HW-50284 Provision XI.G.3 and IAG Article 16.4	
2020 Annual Progress Report	Mar 2021	Jun 2021		HW-50284 Provision XI.G.3 and IAG Article 16.4	
2nd Semi-Annual 2020 Groundwater and ISB Sampling	Jul 2020	Dec 2020		HW-50284 Provision XI.F	
1st Semi-Annual 2021 Groundwater and ISB Sampling	Jan 2021	Jun 2021		HW-50284 Provision XI.F	

*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, while the quarter and year refers to the specific quarterly progress report that presented the recommendation.

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. Maintenance activities (routine and unscheduled) ensure that the systems continue to operate optimally. A summary of the operation and maintenance (O&M) of the remedial action systems is provided to aid in understanding the effectiveness of the remedy.

2.1 Pump and Treat Systems

The pump and treat systems were described in Section 1.4. In 2019, the pump and treat systems continued to reduce saturated thickness and contaminant mass in the southeast perched groundwater, although the systems were impacted by reduced flow and shutdowns resulting from the subsurface irrigation breakdown. These data demonstrate the systems are effective at removing mass and water from the perched aquifer and system operation continues to move towards meeting remedial action objectives for Pantex.

Pump and Treat Systems Milestones

2019

- 147.7 million gallons treated
- 4% of treated water beneficially used
- 633 lbs of contaminants removed

Since Startup

- 2.8 billion gallons treated
- 1.7 billion gallons beneficially used
- 15,137 lbs contaminants removed

Appendix B contains the monthly flow calculations for each active well and detailed operation and maintenance information.

2.1.1 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. Goals are prioritized and will be met as conditions allow. The P1PTS was designed with a treatment capacity of 250 gpm or 360,000 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 in late June 2017 that required an engineering evaluation and complex repairs. WWTF treated water is now being routed to Playa 1 until repairs are completed at the irrigation system. Pantex has also decreased operation of P1PTS to allow higher recovery at SEPTS. Increased recovery at SEPTS provides better control of the RDX plume movement to the southeast. This reduction in operation is reflected in the reduced number of operational days and throughput for the system.

The P1PTS operated 127 days during 2019 with an average annual operational rate of 35%, based on total hours operated versus total possible operation time. The actual percentage monthly system operational time versus target is depicted in Figure 2-1.

Figure 2-2 depicts the average gpm extracted from all wells by month, the percentage of design capacity achieved, and goals for the system as a measure of well operation efficiency. While operational throughput of the system was reduced in 2019 to allow better capture of the RDX plume through higher operation of SEPTS, the 90% throughput goal is still depicted in the graphs and throughput is evaluated to identify potential issues with well operation.

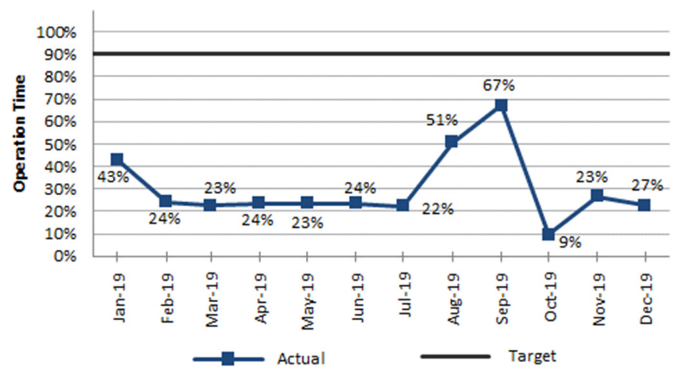


Figure 2-1. P1PTS Operation Time vs Target

The monthly system operation was primarily affected by the WWTF due to a break at the irrigation system lines that occurred in late June 2017 and the need to control plumes by operating SEPTS at a higher rate. The system was only operated once week per month to ensure continued operation of the

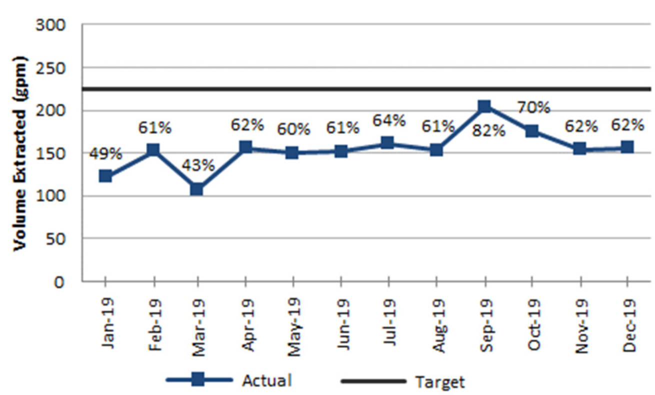


Figure 2-2. P1PTS Average GPM and % Capacity

system. When operated, it was operated at a lower throughput as flow to Playa 1 is restricted by permit.

The P1PTS system extracted an average of 154 gpm (about 62% of design throughput) from the well field while operating during 2019. The calculated gpm accounts for water extracted from the well field during the time the system operates and is affected by the yield from each well, well downtime, or reduced flow required by the WWTF/irrigation system.

Figure 2-3 reflects the operation time by well. The average annual well field operation was about 32%. The well operation was affected by reduced flows due to the irrigation break and shutdown of the irrigation system. P1PTS was only operated once per month after January 14, 2019.

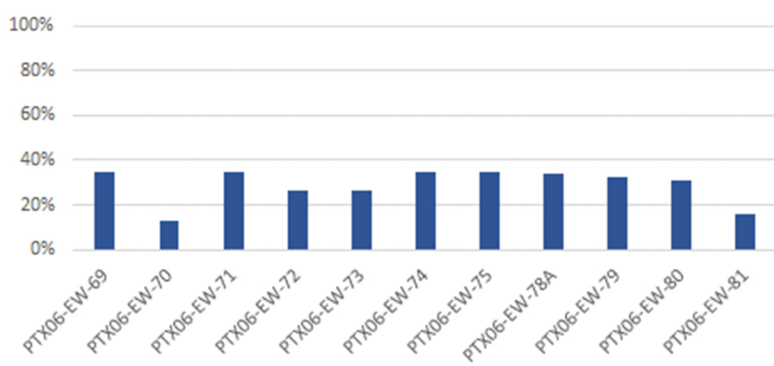


Figure 2-3. P1PTS Well Operation Time

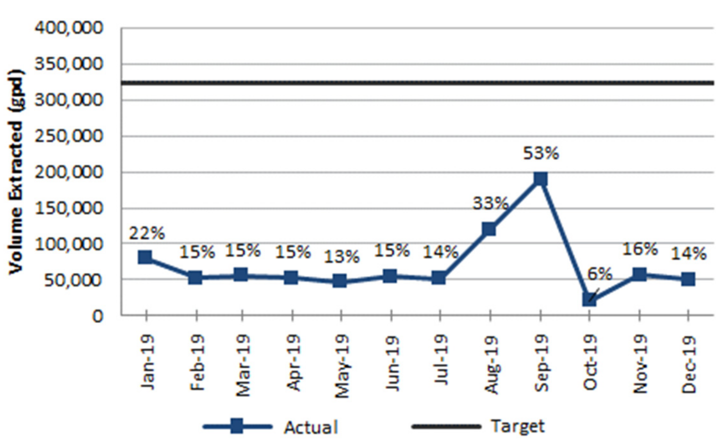


Figure 2-4. P1PTS Average GPD and % Capacity

Figure 2-4 reflects the overall system efficiency considering system and well operation. The figure depicts the average gallons per day (gpd) by month, the percentage of design capacity achieved, and a 90% goal for the system. While treatment throughput was not a primary goal in 2019, the 90% goal is still depicted in the graphs and throughput is evaluated to identify potential issues with well operation.

The system treated an average of about 69,700 gpd during 2019, about 19% 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. As discussed above, the overall operation and throughput was affected by the irrigation filter bank break and shutdown to allow increased operation of SEPTS. Loss of operation occurred due primarily to shutdown to allow higher throughput at the SEPTS.

The system treated approximately 25.3 million gallons during 2019, with an average treatment volume of about 2.1 million gallons per month. The monthly treatment flow volumes are depicted in Figure 2-5.

During 2019, the system removed approximately 5 lbs of RDX and 3 lbs of all other HEs (see Figure 2-6). The average removal rate of HEs was about 0.3 lbs per million gallons (lbs/Mgal) of treated water. The system has removed a total of 546 lbs of RDX and 219 lbs of all other HEs since startup in September 2008. HE mass removal is dependent on the wells operated within the system which affects the influent concentrations and throughput. Source concentrations from Playa 1 are rapidly declining. Therefore, there are no longer any wells in the higher concentration HE plume; thus, mass removal is low at P1PTS.

Influent concentrations at P1PTS are also declining over time. The average influent concentration of RDX was 148 ug/L in 2009, while the average influent concentration in 2019 was 17 ug/L. The maximum influent RDX concentration in 2009 was 200 ug/L and 44.7 ug/L in 2019. This system primarily reduces saturated thickness and head on the southeast perched groundwater, although mass removal is also achieved.

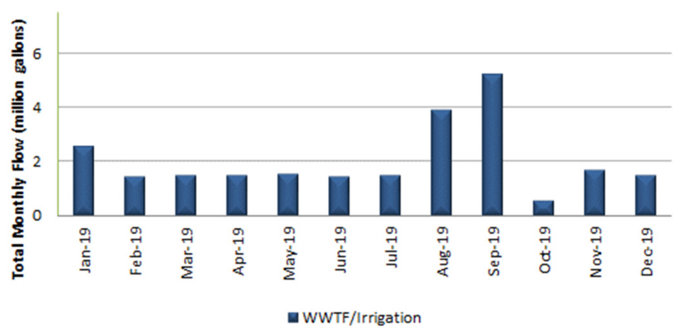


Figure 2-5. P1PTS System Monthly Total Flow

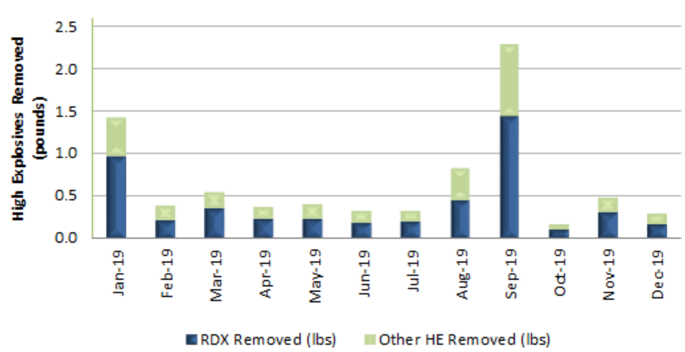


Figure 2-6. P1PTS Mass Removal by Month

Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below the

GWPS. The complete set of effluent data collected during 2019 is included in Appendix D electronic data tables.

Pantex also evaluates extraction wells near the SWMU 5-12 ditch for evidence of contamination that could impact P1PTS. In the past, wells in that area indicated the presence of perchlorate and 1,4-dioxane, which are not treatable by GAC. The plumes have shrunk back toward the source areas and are no longer expected to reach P1PTS.

During 2019, the P1PTS was in its eleventh year of operation. Operational performance was low for most of the year. Performance was affected by the break at the irrigation system filter bank, reduced operation to allow higher operation at SEPTS, carbon change-outs, and replacement of P1PTS filter banks. Pantex reevaluated goals for the pump and treat systems to emphasize beneficial use of treated water while continuing to meet remedial action goals. These goals first emphasize meeting the 90% operational goal. However, when flow is restricted to the WWTF system, P1PTS is shut down or flow is restricted at both systems to avoid injection, if possible. During 2019 the filter bank break at the irrigation system heavily impacted P1PTS throughput, goals to remove water from Playa 1, and avoidance of injection of treated water into the contaminated portion of the perched aquifer. Pantex has evaluated other methods to manage treated water and recommended in 2018 to extend the line going to the Zone 11 ISB to an area east of Playa 2 and inject treated water. Contracting is underway for that project. Pantex is also requesting funding to extend surface (center pivot) irrigation east of FM 2373. If funding is approved, the project will begin in 2021.

2.1.2 Southeast Pump and Treat System

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

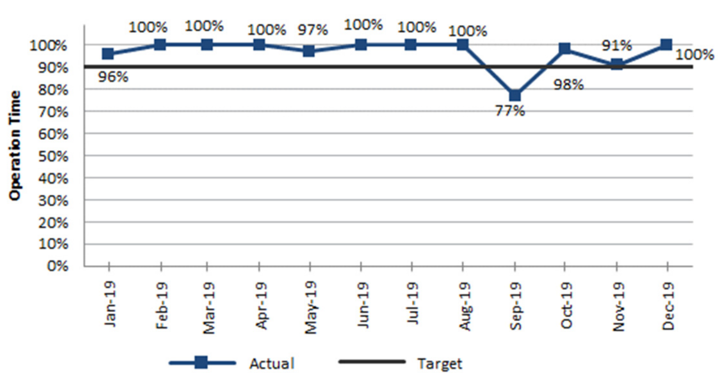


Figure 2-7. SEPTS Operation Time vs Target

The SEPTS operated all or part of 358 days during 2019 with an average operational rate of 97% based on total hours operated versus total possible operation time. The percent operation time (hours/day) versus target is depicted in Figure 2-7. The system operation was affected by shutdown for tie-in of new wells, power outages, high pressure alarm, chromium vessel repairs, SCADA communication issues and carbon change in May and September. Operation was consistent at SEPTS due to the shutdown of P1PTS. When P1PTS is operating, flow is reduced at SEPTS to meet permit limits on the discharge rate to Playa 1 and the need to minimize injection into the perched aquifer.

Figure 2-8 depicts the average gpm extracted from all wells by month, the percentage of design capacity achieved, and goals for the system as a measure of well operation efficiency. The operational rate of the system was the prioritized goal after June 2014 unless flow is affected by the WWTF or other issues. Even though the 90% throughput goal was not applicable during portions of 2019, is still depicted in the graphs and well throughput is evaluated to identify potential issues.

The system extracted an annual average of 240 gpm (about 80% 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 from each well, well downtime, or reduced flow required by the WWTF/irrigation system. When the WWTF/irrigation system was unable to receive full flow from the pump and treat systems, flow was reduced to avoid injection into the perched aquifer and to meet permit limits for release to Playa 1.

The well operation was not heavily affected in 2019 due to the shutdown of P1PTS; however flow was reduced when P1PTS was operated at the first of each month. Flow was limited to Playa 1 when both systems were operating to reduce injection into the perched groundwater.

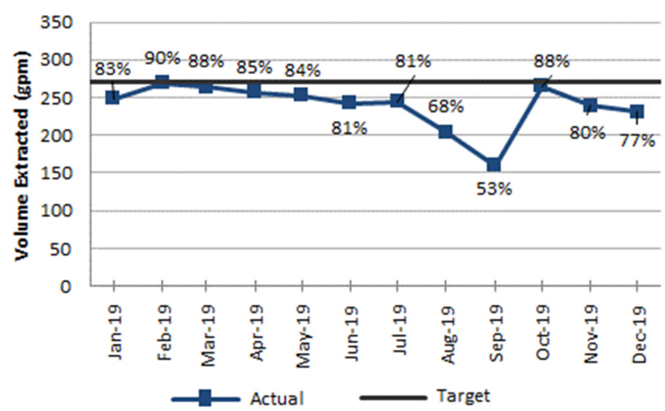


Figure 2-8. SEPTS Average GPM and % Capacity

Because the SEPTS has 59 operating wells, it is currently capable of extracting more water than the maximum treatment capacity of the system. 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 EWs installed in 2016, EW-83 through EW-88, were connected and began consistent operation in May 2019.

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 depicted in Figure 2-9. Seven priorities were set:

- Priority 1 Wells: Wells along the eastern edge of the well field (along the eastern fence line) and a line of wells east of FM 2373 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 these priority wells.
- Priority 2 Wells: Wells along the southern edge of the system that were installed to capture the highest concentrations of hexavalent chromium and to prevent further migration of the plume into areas where the FGZ is more permeable or to thinner saturated zones.
- Priority 3 Wells: Wells along the southeastern edge of the system that capture the highest concentrations of RDX and prevent further migration of the plume into areas where the FGZ is more permeable or to thinner saturated zones.
- 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 movement of the RDX plume 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 will help reduce saturated thickness in the perched aquifer and removing 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 so is a very low-producing well. For this reason, it was not placed in a high priority for pumping.

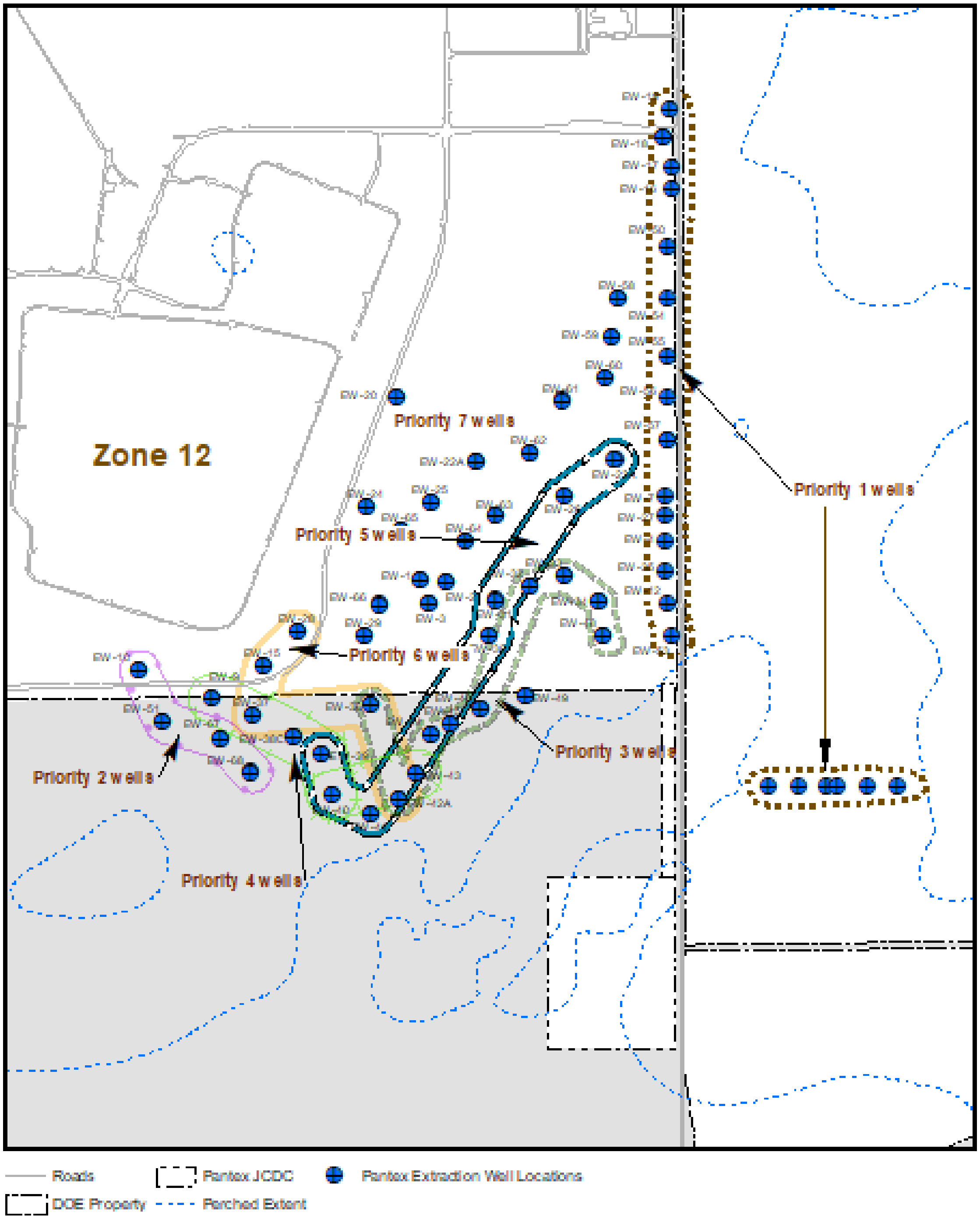
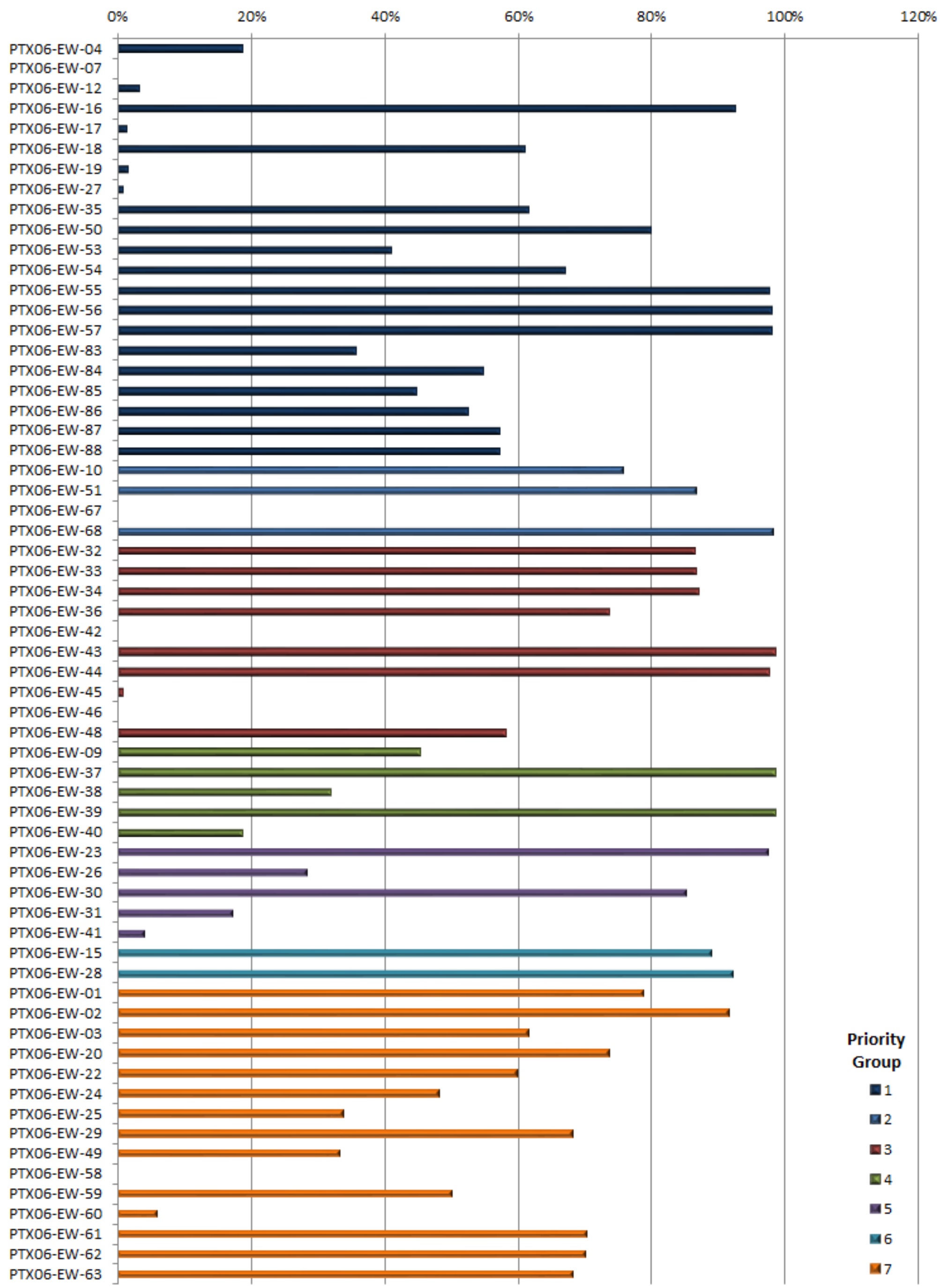


Figure 2-9. Extraction Well Prioritization

During 2019, the highest priority wells were operated to meet the lower extraction rates, unless issues were encountered at the wells. Lower priority wells were only operated to make-up additional flow that was needed.

This prioritization was implemented in 2009 after newly installed extraction wells were placed into operation. Figure 2-10 provides the percentage of days wells were operated in the SEPTS. Priority 1-5 wells are operated at a higher frequency with the exception of a few wells that had repair issues or were locked out due to repair issues with wells on the same line. Priority 6 and 7 extraction wells were operated periodically to ensure that wells remain operational or to make up flow. 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 so



pumps are cycling on and off causing the well to be operated intermittently. This effect is becoming more prominent in many of the wells in thin saturated portions of the perched aquifer as the system continues to remove water from the perched aquifer. Many wells along the eastern fence line and to the south on Texas Tech property are frequently cycling off due to the limited saturation in some areas. Several wells have gone dry and have been removed from the pumping network. The prioritization of the well pumping is expected to change based on results of optimization or be discontinued in the future as the capacity of the pump and treat system will exceed extraction rates. A few wells went down during the last quarter of 2019, requiring contract support for repairs. Pantex has contracted for support and is currently repairing wells, with the goal to have all well repairs complete by June.

As noted in the 4th Quarter 2017 Progress Report, a well video at PTX06-EW-58 indicated multiple stress fractures in the casing. Because the fractures occur only in the casing, Pantex has evaluated options and identified funding for the repair of this well. Pantex plans to line this well with a smaller casing and return the well to service until it fails. This repair is scheduled for completion in summer 2020.

Figure 2-11 reflects the overall system efficiency considering system and well operation. The figure depicts the average daily treatment rate (gpd) by month, target, and percentage of total capacity achieved at the SEPTS. The SEPTS treated an annual average of about 335,014 gpd (about 78% of design capacity) for 2019 based on total possible hours of operation and total inflow from the well field.

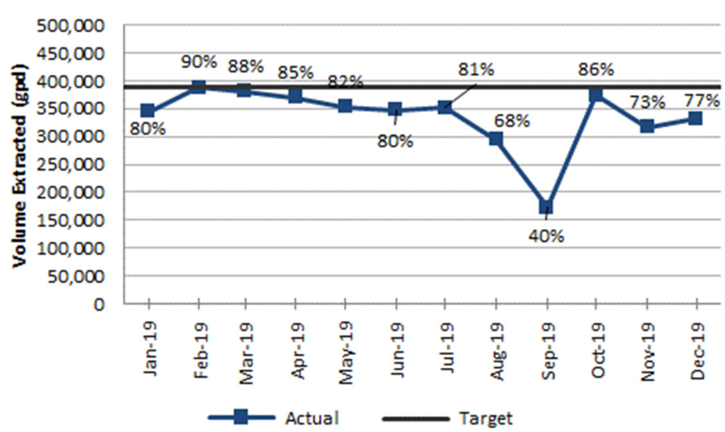


Figure 2-11. SEPTS Average GPD and % Capacity

The gpd is affected by system operational time, ability to extract water from the wells, and reduced flow to the WWTF and irrigation system. As discussed above, the system was primarily affected by loss of throughput to the WWTF/irrigation system after the break at the irrigation filter bank which was reduced when both

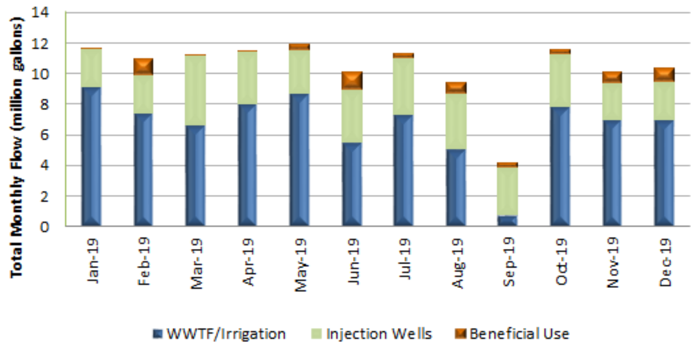


Figure 2-12. SEPTS Total Flow Volume and Disposition of Effluent

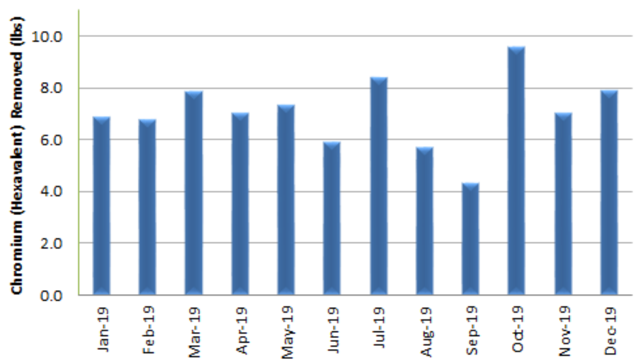


Figure 2-13. SEPTS Chromium Mass Removed by Month

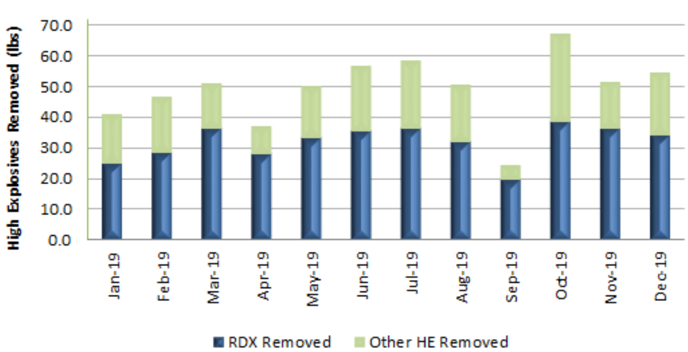


Figure 2-14. SEPTS High Explosive Mass Removed by Month

systems were operating. Operational time was affected by carbon change-out, shut down for tie-in of new wells, power outages, and communication issues.

The system treated over 122 million gallons of extracted water during 2019. The total volume treated by month and the final disposition of the treated water is depicted in Figure 2-12. About 31% of the treated water was injected into the perched aquifer, 5% was used beneficially for ISB injection, and the remaining released to Playa 1 via the WWTF.

The SEPTS primarily removes RDX and hexavalent chromium from the perched groundwater. The system removed about 85 lbs of hexavalent chromium, 382 lbs of RDX, and 208 lbs of all other HEs during 2019. The total mass removed by month is depicted in Figure 2-13 and Figure 2-14. The average removal rate of hexavalent chromium was 0.7 lbs/million gallons (Mgal) of water, and the average removal rate for HEs was 4.7

lbs/Mgal of water. Hexavalent chromium mass removal is declining because concentrations in PTX06-EW-51 and nearby extraction wells continue to decline. This well 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 hexavalent chromium plume has moved downgradient, and other extraction wells now capture portions of the plume although concentrations are much lower at these wells. HE mass removal is affected by the wells that operate in the higher concentration portions of the RDX plume. Overall, the average concentrations of RDX in the SEPTS influent has declined with average concentrations about 570 ug/L in 2009, the first year of the full remedial action, to about 382 ug/L in 2019. Hexavalent chromium average influent concentrations in 2009 were about 214 ug/L while concentrations were about 104 ug/L in 2019.

This system has treated approximately 12,653 lbs of HEs and 1,719 lbs of hexavalent chromium since it started operating. Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below GWPS.

The summary of COC effluent detections at the SEPTS is included in Table 2-1, with the exception of boron. Boron is detected in all samples and continues to remain below the GWPS. The complete set of effluent data collected during 2019 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?
2/21/2019	Perchlorate	0.48J	0.96	No	0.1	Yes	26	No
3/6/2019	Chloroform	0.74J	NA	NA	3	No	80	No
4/3/2019	Chromium, Total	5.1J	31.8	No	10	No	100	No
6/5/2019	1,2-Dichloroethane	0.23J	NA	NA	2.5	No	5	No
7/10/2019	Chromium, Total	4.2J	31.8	No	10	No	100	No
8/7/2019	Perchlorate	4.5J	0.96	Yes	12	No	26	No
8/7/2019	Perchlorate	5.1J	0.96	Yes	1	Yes	26	No
9/5/2019	Perchlorate	4.2J	0.96	Yes	12	No	26	No
9/11/2019	RDX	0.149J	NA	NA	0.266	No	2	No
11/6/2019	RDX	0.109J	NA	NA	0.255	No	2	No
11/6/2019	Chromium, Total	9.1J	31.8	No	10	No	100	No

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

In accordance with the *Contingency Plan*, Pantex also evaluated eight extraction wells (five included in the SAP: EW-9, EW-10, EW-51, EW-67, and EW-68) to evaluate perchlorate, and three more added in 2018 to evaluate 1,4-dioxane (EW-1, EW-65, and EW-66). Due to removal of perched water, flow directions are changing along the eastern side of Zone 11; therefore, perchlorate and 1,4-dioxane, which are not treatable by GAC, could move into the southwestern portion of the SEPTS extraction well field. Perchlorate was detected in the two closest downgradient extraction wells starting in 2017. Perchlorate was detected in those same two wells in 2018 and 2019, although concentrations have increased. 1,4-Dioxane was not detected in any extraction wells.

Pantex has evaluated options for the treatment of perchlorate through the SEPTS as it is expected to move through the same area as the hexavalent chromium plume. Pantex will continue to operate the extraction wells until concentrations at the influent of the system increases near the current GWPS of 26 ug/L. The maximum influent concentration of perchlorate was 15 ug/L during 2019. Pantex will shut down wells as needed to decrease influent perchlorate concentrations until the system is modified to include perchlorate resin vessels.

Pantex has confirmed that the chromium resin at SEPTS will also treat perchlorate at low levels. Sampling has been increased at the chromium vessel effluent and the system effluent to ensure that concentrations are not detected or are well below 15 ug/L, the value under review for inclusion as a new GWPS in the Explanation of Significant Difference for the Pantex ROD. Pantex has also increased sampling to semi-annually at applicable extraction wells to evaluate the movement of perchlorate into the SEPTS well field to the southwest of the system.

1,4-Dioxane was detected in extraction wells on the southeast side of Zone 12 in 2016 and 2017. 1,4-Dioxane was not detected in any extraction wells in 2018 or 2019. Pantex will continue to sample for 1,4-dioxane to evaluate potential plume movement into the well field.

Overall the SEPTS continues to remove and treat water from the well field. The system was primarily affected by the break at the irrigation system filter bank and restrictions from the WWTF required by the permit for release to Playa 1. Pantex has evaluated options to better manage the treated water. As discussed in the 2nd Quarter 2018 Progress Report, Pantex has contracted for the design and construction of a line to extend from the current Zone 11 ISB system to an area east of Playa 2 for injection of the treated water when the

ISB system is not using the water for injection. The project is currently underway and is expected to be complete by September 2019. Since the injection line will only allow 150-180 gpm, Pantex is also planning to design and construct three small center pivot irrigation systems in fields east of FM 2373. This project will only receive treated water from the pump and treat systems and will provide a consistent, long-term, high-volume option for management of treated water. Pantex has requested budget for the center pivot irrigation project starting in 2021, but is awaiting approval.

2.2 ISB Systems

Pantex has installed and operates three ISB systems as part of the final Remedial Action for groundwater. One system is southeast of Pantex Plant on TTU property, one is south of Zone 11, and one is southeast of the main Plant (east of FM 2373), at the extreme southeast boundary of USDOE owned property. System information and maps are provided in Section 1.4.2. In 2019, the ISB systems consisted of 125 treatment zone injection wells, 5 treatment zone monitoring wells, and 18 in situ performance wells. 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. 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 solely to the use of a more soluble carbon source such as molasses in the systems. This change has also required more frequent injection of amendment to ensure continued treatment of COCs. Each system frequency of injection is determined by amount of saturated thickness and water movement through the system.

Injection volumes and amendment concentrations are planned based the Zone 11 ISB study that indicated a higher volume of amended water was needed to affect areas between wells. The dose response study was conducted early in the 2018 injection event to determine if a solution of molasses mixed with Newman Zone® would reach the areas between wells at an appreciable concentration. Pantex studied three treatment zone monitoring wells between 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 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 analytical 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 fluorescein dye arrival was confirmed or a volume equivalent to 20% mobile porosity was reached. The study indicated that only the more soluble carbon (molasses) reached the monitoring points between injection wells. Calculations using dye and TOC concentration results indicate that injection volumes would need to 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 all ISBs is focusing on use of a more soluble carbon (e.g., molasses) to achieve the distribution needed at the ISB Systems. This is important since the Zone 11 ISB and Southeast ISB Systems are configured with a 100 ft spacing between injection wells. The Southeast ISB Extension was configured with at 75 ft spacing to overcome known problems with distribution. This approach will be evaluated through continued monitoring and results and recommendations from the monitoring will be provided in future reporting.

2.2.1 Zone 11 ISB

2.2.1.1 History of Zone 11 ISB

The Zone 11 ISB system is on Pantex Property, south of Zone 11. The system, as operated in 2019, consists of 48 injection wells, five treatment zone monitoring wells, and nine downgradient performance monitoring wells installed in a zone of saturated thickness of approximately 15-20 ft. The system is detailed in Section 1.4.2.

Based on recommendations made in the 2016 Annual Progress Report, injections have been lengthened to approximately 2 years in the original portion of the ISB where reducing conditions are established. This is based on evaluation of two factors: (1) PTX06-ISB082, and (2) evaluation of pilot study data. Pantex had decreased injection at a second row well, PTX06-ISB082, in the past to determine if pausing injection would be effective in reducing biomass and provide more effective sampling. This well had viscous white mass in the well when injection was discontinued. Rehabilitation was performed at the well for two years following the last injection to remove mass in the well. Within two years the well had improved. Data at the monitoring wells installed at 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 downgradient wells, the results indicate that the ISB is continuing to treat RDX and hexavalent chromium into 2019 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 continued for at least 10 years after the final injection. While conditions at the Pilot Study differ from the Zone 11 ISB, it does indicate that longer wait times for injection are appropriate when an emulsified vegetable oil such as Newman Zone® has been used.

Pantex has also considered the move to a more soluble carbon source in the Zone 11 ISB and has modified injection frequencies to nine months in portions of the system where very little Newman Zone® has been used.

Based on a previous recommendation in the *4th Quarter 2015 Progress Report,* Pantex discontinued injection into the second row of wells on the perchlorate side in 2016. This decision was based on information collected at PTX06-ISB082 and PTX06-1156. Pantex discontinued injection into PTX06-ISB082 after the fifth injection event in 2013 to evaluate the need for continued injection into the second row wells. Data collected since 2014 indicate that PTX06-ISB082 maintains deep reducing conditions and has 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 ISB and data through 2019 indicate that treatment is continuing and that ample food source remains to continue treatment. 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 will continue to watch these wells as TCE is moving towards the southeast in portions of the Zone 11 ISB due to the change in flow direction caused by removal of water by SEPTS.

2.2.1.2 Operation of Zone 11 ISB

During 2019, injection occurred throughout the Zone 11 ISB, with 48 wells rehabilitated and injected. The rehabilitation and post-injection report is included in Appendix H.

Wells were first maintained to improve injection well 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 to July 2019. 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.

2. Chemical rehabilitation involved the application of Cotey Chemical Corporation's 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 24 hours, the solution was purged from the well.
3. A second round of mechanical rehabilitation was conducted using a combination of jetting, surging, bailing, and airlifting. Development was considered complete when extracted water was clear and free of suspended solids. Consistent readings for indicator parameters (i.e., pH, specific conductivity, and temperature) in grab samples were used as an additional line of evidence that effective communication between the well and the surrounding formation had been restored.

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 effectively increased well performance prior to implementation of injection operations; however, overall transmissivity has decreased across the well field based on results of injection testing and actual injection rates achieved. Flowrates also decreased with continued injection into the wells.

Injection occurred across two phases, Phase 1 occurred from May 21 through July 16 with the expansion area wells to the northwest injected. Phase 2 injection occurred from September 30 through January 17, 2020, at the main system.

For injection, Pantex used molasses (70 or 80% strength of 79.5 BRIX molasses) to increase distribution of amendment across the treatment zone. Due to viscosity limitation of the current ISB configuration, the molasses was diluted with at least 20% water. A 70% strength was used during colder months to decrease the viscosity even further. Injection activities consisted of the injection of makeup water mixed with amendment followed by a clean water flush. A total of 2,808,625 gallons were injected into 48 injection wells, including 67,036 gallons of pure amendment, makeup water, and flush water injected after the target injection volume was reached. Target volumes were amended at 28 wells due to decreased injection performance. Revisions were made to injection volumes at wells PTX06-ISB055 through PTX06-ISB064, PTX06-ISB068 through PTX06-ISB077, PTX06-ISB087, PTX06-ISB088A, PTX06-SB092, PTX06-ISB097, PTX06-ISB101, PTX06-ISB102, PTX06-

ISB105, and PTX06-ISB106. The average flow rate at these locations was 2.9 gpm. The average flow rate at the 20 other locations was 10 gpm.

Well dosing with molasses at the wells varied from 1.4% to 7.7%, with an average dosing of 2.0% of 70% molasses and 2.5% of 80% molasses. Target dosing was achieved in 100% of the wells.

2.2.2 Southeast ISB

2.2.2.1 History of Southeast ISB

The Southeast ISB system is on Texas Tech Property, southeast of the main Plant. The system consists of 42 injection wells, five downgradient performance monitoring wells, and one upgradient performance monitoring well installed in a zone of saturated thickness of less than four feet 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 that water conditions are declining. Upgradient ISPM well PTX06-1118 has not been sampled since 2010. Three of the five downgradient ISPM wells south of the system went dry in 2009, 2015, and 2018. PTX06-1167, 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. Water level trends indicate that water is declining at a rate of 0.1 to 0.3 ft/yr in most of the ISB injection wells, with a few having much higher rates of decline. The system overall has very little saturated thickness, i.e. <10 ft of water, with water levels continuing to decrease yearly (see Figure 2-15). Only a small number 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 decreased since the start of remedial action. Some wells have dramatically decreased and have gone dry, with the 2019 water level mapping indicating that water in the Southeast ISB continues to be isolated from the southeast plume as water level elevations inside the system are lower than the FGZ elevations north of the system. The water remaining in the system will continue to move through the system and be treated.

Note that downgradient well PTX06-1045, that was previously dry, has demonstrated some recovery in water levels during 2018. This is believed to be related to the construction of the new Administrative Site Complex south of the main Pantex property. Management of 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 is believed to be a contributor to the increased water levels in that well. Sampling was conducted at this well in 2019.

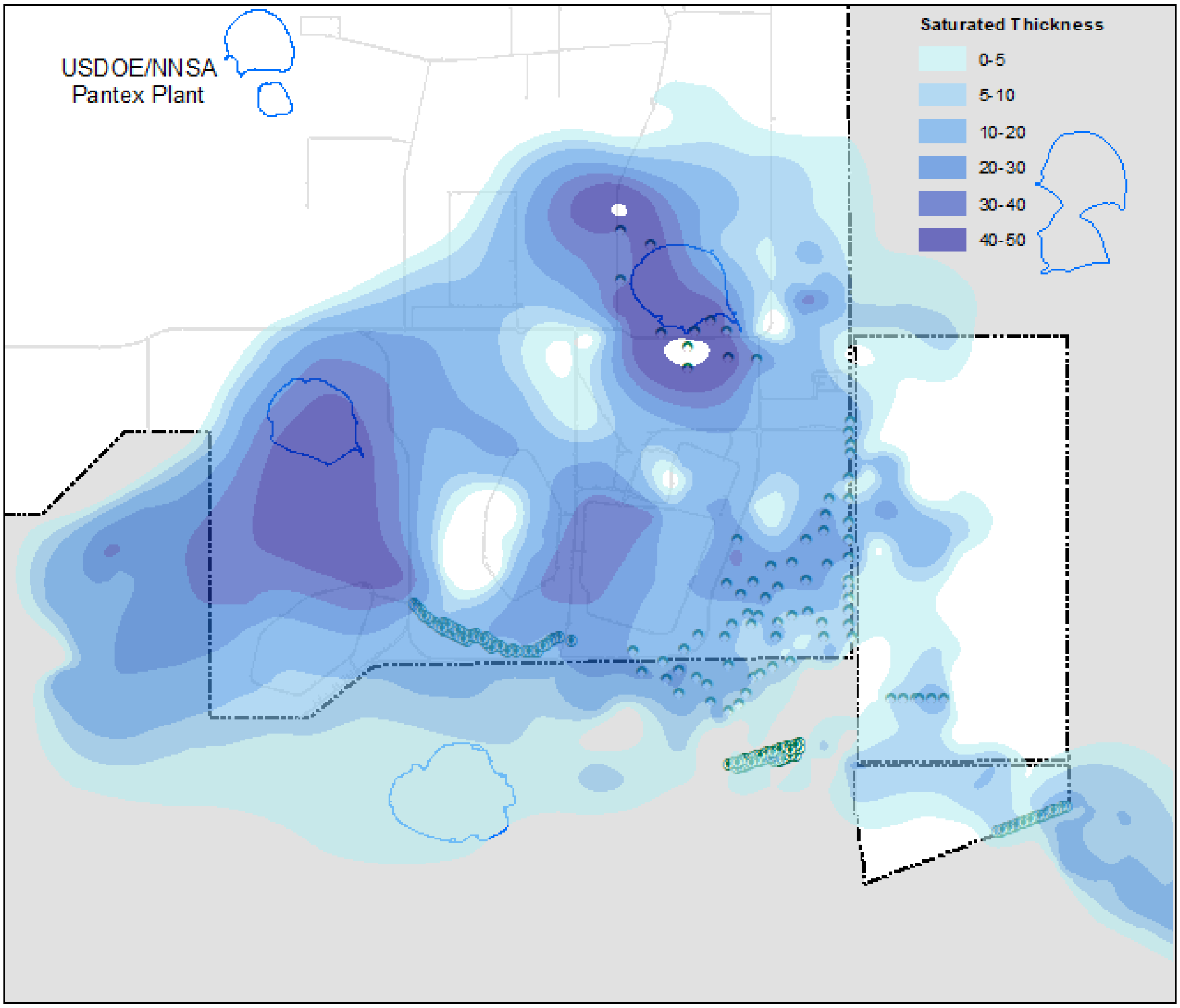


Figure 2-15. Perched Aquifer Saturated Thickness, 2019

Pantex recommended in the 2016 Annual Progress Report that injection at the Southeast ISB occur again in 2019 (3 years after last injection event) and be re-evaluated after the injection event. Pantex has planned for injections every two years at this system, based on the change to molasses. Due to declines in water levels, it is possible that this system will no longer require injection after the next injection event planned in late 2021. However, monitoring data will also be used to inform the timing and need for injection.

2.2.2.2 Operation of Southeast ISB

Injection and rehabilitation occurred at the Southeast ISB during 2019. Only 25 of 42 wells were maintained and injected during this injection event. Some dry wells were injected in an attempt to influence PTX06-1153.

Wells were first maintained to improve injection well 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 August to October 2019. At the Southeast ISB, 14 of 25 wells planned for maintenance were dry or nearly dry, requiring water to be added for the mechanical rehabilitation and the second step, chemical rehabilitation. 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. Water was added to the wells to the top of screen so that surging would impact all of the screened area. 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.
2. Chemical rehabilitation involved the application of Cotey Chemical Corporation's 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 24 hours, the solution was purged from the well.
3. A second round of mechanical rehabilitation was conducted using a combination of jetting, surging, bailing, and airlifting. Development was considered complete when extracted water was clear and free of suspended solids. Consistent readings for indicator parameters (i.e., pH, specific conductivity, and temperature) in grab samples were used as an additional line of evidence that effective communication between the well and the surrounding formation had been restored.

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 effectively increased well performance at 10 of the wells prior to implementation of injection operations; however, overall transmissivity has decreased across the well field based on results of injection testing and actual injection rates achieved.

Injection occurred from November 5 through January 13, 2020, with a total of 25 wells injected. For injection, Pantex used molasses (70% strength of 79.5 BRIX molasses) to increase distribution of amendment across the treatment zone. Due to viscosity limitation of the current ISB configuration and lower temperatures encountered during the winter, the molasses was diluted with 30% water. Injection activities consisted of the injection of makeup water mixed with amendment followed by a clean water flush. A total of 986,726 gallons was injected into 25 injection wells, which included water mixed with amendment and clean flush water. Target volumes were amended at 12 wells due to decreased injection performance. Revisions were made to injection volumes at wells PTX06-ISB010, PTX06-ISB012, PTX06-ISB015, PTX06-ISB029A, PTX06-ISB030B, PTX06-ISB035, PTX06-ISB037, PTX06-ISB039 through PTX06-ISB041, PTX06-ISB046, and PTX06-ISB048. The average flow rate at these 12 locations was 3.4 gpm. The average flow rate at the other locations was 5.2 gpm.

Well dosing with molasses at the wells varied from 3.2% to 6.3%, with an average dosing of 3.7%. Target dosing was achieved in 100% of the wells.

To determine if PTX06-1153 could be impacted by the upgradient injection of amended water, a study was performed with extraction occurring at PTX06-1153 during injection. Past efforts have resulted in partial effectiveness in demonstrating treatment to the well. An extraction pump was installed by CNS technicians and extraction occurred intermittently from November 20 to December 4. The technicians only operated the extraction pump during the day, during weekdays. The pump was only able to operate at 1 gpm consistently due to the limited saturated thickness at PTX06-1153. Samples were collected periodically to evaluate TOC/DOC, field parameters, and high explosives. Results indicate that RDX concentrations decreased throughout the study and pH Increased, possibly due to the use of Welgicide upgradient. Carbon slightly elevated, but remained low. An increase in water levels across PTX06-1153 and PTX06-1154 was also noted, likely due to the increased volume of water injected in upgradient wells. The results of the study indicated that there is some connection to the upgradient wells. However, it could take up to two years to see the results of injection.

2.2.3 Southeast ISB Extension

2.2.3.1 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 25 injection wells and three downgradient performance monitoring wells installed in a zone of saturated thickness of less than 12 feet 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. It is anticipated that water levels will decline in this system over time and future injections will be unnecessary. Currently, injections are budgeted semi-annually as this system has only been injected with a more soluble carbon source (molasses). Data are currently being collected to determine if a 9-month injection frequency is appropriate.

2.2.3.2 Operation of the Southeast ISB Extension

Injection and rehabilitation occurred at the Southeast ISB Extension twice during 2019. All 25 wells were maintained and injected during the 2019 injection events. Since the first injection event took place in early 2019, no well maintenance was required until the second injection event.

At the second injection event, wells were first maintained to improve injection well 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 prior to the September injection event. 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.
2. Chemical rehabilitation involved the application of Cotey Chemical Corporation's 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 24 hours, the solution was purged from the well.
3. A second round of mechanical rehabilitation was conducted using a combination of jetting, surging, bailing, and airlifting. Development was considered complete when extracted water was clear and free of suspended solids. Consistent readings for indicator parameters (i.e., pH, specific conductivity, and temperature) in grab

samples were used as an additional line of evidence that effective communication between the well and the surrounding formation had been restored.

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. These results will be used over time to determine continued injection performance at the system.

Injection occurred in two phases in 2019: from January 21 to March 1, 2019 and from August 8 through September 23, 2020, with a total of 25 wells injected. For injection, Pantex used molasses (70% or 80% strength of 79.5 BRIX molasses) to increase distribution of amendment across the treatment zone. Due to viscosity limitation of the current ISB configuration and lower temperatures encountered during the winter, the molasses was diluted with 20% or 30% water. Injection activities consisted of the injection of makeup water mixed with amendment followed by a clean water flush. A total of 995,000 gallons of amendment solution was injected into 25 injection wells during the first injection event. About 1900 gallons of flush water was then injected into each well. Target dosing was 1.6% by volume of 70% molasses. During the 2nd injection event, a total of about 1,050,000 gallons of amendment solution was injected into 25 injection wells. About 1000 gallons of flush water was then injected into each well. Target dosing was 2.7% by volume. Target injection volumes and dosing was met or exceeded at all wells for both events, with the exception of 6 wells during the 2nd event due to issues with flowmeters.

2.3 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.

2.3.1 Burning Ground SVE

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

Figure 2-16 depicts the SVE system operation for 2019. The system was consistently operated until October with occasional shutdowns for maintenance, repairs, extreme temperatures, and power outages. The system shutdown in late October required use of contractors for repair. The system remained down until March 2020 when contracting and repairs were complete. Overall, the system operated about 60% of the year.

Calculated mass removal for 2019 is presented in Figure 2-17. Mass removal was estimated based on concentrations reported from analytical sampling, system operation time, and system flow rates. VOC constituents contributing the majority of the total VOC concentration were included in the calculation.

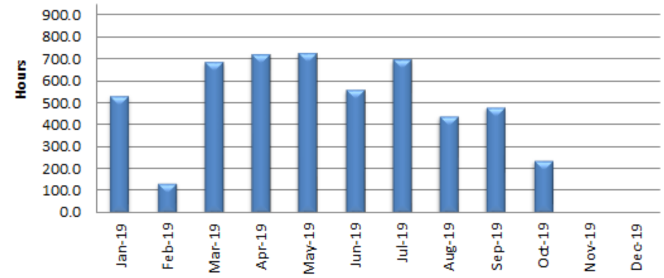


Figure 2-16. SVE System Operation

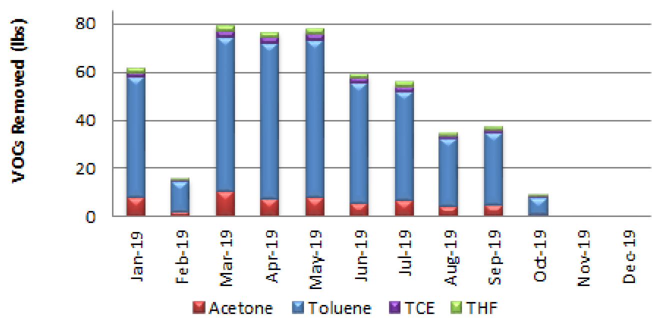


Figure 2-17. Burning Ground SVE Mass Removal

Since modifications were completed at the system in May 2017, the influent flow rate was increased from 32 scfm to about 44 scfm before the end of 2017. The 44 scfm flow rate was maintained consistently in 2019. Flow rates increased from 13% to 24% from 1st quarter 2017 baseline, causing a rise in mass removal as well. However, data collected during 2018 and 2019 indicate that although flow rate remained steady, mass removal rates declined due to lower influent concentrations.

The system removed about 508 lbs of VOCs during 2019. Since inception, the SVE system has removed over 20,950 lbs of VOCs. Trends of removal rates, concentrations and general effectiveness of the SVE are provided in Section 4.

As reported in the monthly Air Quality Monitoring Reports to the Regional TCEQ office, all 2019 effluent PID readings for the system indicate that destruction efficiency was greater than 96%.

2.3.2 Engineered and Institutional Controls

The soil remedial actions at Pantex are discussed in Chapter 1. The SVE system and containment of landfills and ditch soils is the only active soil remedy; however, other soil remedies require long-term stewardship to maintain controls. Pantex drafted all deed restrictions required as part of the final remedy during 2009 and submitted them to TCEQ and EPA as part of the draft final Interim Remedial Action Report (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. To support the deed restrictions, Pantex maintains long-term control of any type of soil disturbance in the SWMUs to protect human health and to prevent spread of contaminated soils. Pantex also regularly inspects and maintains soil covers on landfills to prevent infiltration of water into the landfill contents and migration of impacted water to groundwater. During 2019, Pantex conducted landfill inspections in accordance with the updated *Maintenance Plan for Landfill Covers* (Pantex, 2017a). Pantex installed, inspects, and maintains a fence around FS-5 to control access and use of an area that is impacted by depleted uranium. 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 will minimize migration of contaminants because it prevents rain water 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, 2017b). Inspections were also conducted for SWMU signs and postings at various times during 2019. Maintenance is either contracted, as necessary, or work orders are placed with the onsite Maintenance Department. Findings from the inspections of landfills and the ditch liners are provided below.

2.3.2.1 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 based on the evaluation. Larger issues (e.g., Landfill 3 erosion) are contracted separately for design and construction. Each contracting effort is followed-up with inspections to evaluate the effectiveness of the actions. The key findings and maintenance actions completed from past and 2019 soil inspections is included in Table 2-2. Additionally, the results of the site inspection of the landfills from the 2nd Five-Year Review (2018) are included in this table if no corrective action has occurred at the landfill.

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

Findings	Corrective Actions
Previous Findings	
SWMU 68b, Landfill 1 geomembrane and liner is damaged in four areas. Also identified in 2nd FYR.	Work was completed in September 2019.
SWMU 56, Landfill 5 depressions and re-seeding. Also identified in 2nd FYR.	This is a low priority landfill and will be addressed as funding and/or onsite maintenance allows. Have requested help from onsite maintenance group.
SVS 6 holes and voids to be filled and re-seeded. Also identified in the 2nd FYR.	Work was completed in June 2019.
Unassigned AOC Landfills near Zone 10 depressions and holes to be filled and re-seeded.	Work was completed in June 2019.
SVS 5 depressions to be filled and re-seeded.	Depressions were filled in 2018 and soil has naturally revegetated.
SWMU 66, Landfill 15 settlement and holes.	Work was completed in June 2019.
SWMU 43 and 44, Burning Ground Landfills have animal burrows in the middle of the cover.	This landfill is prioritized for FY 2020 maintenance with our onsite maintenance group.
SVS 7a/b, Igloo Demolition Debris Landfills have burrowing animal holes and voids.	Identified in 2nd FYR. These are low priority landfills and will be addressed as funding and/or onsite maintenance allows.
SVS 8, Zone 10 Abandoned Landfill has minor holes and depressions.	This landfill will be addressed through onsite Waste Operations Department.
SWMU 63, Landfill 12, Small depressions and animal burrowing holes observed. Erosion was noted on the south end of the landfill.	Will be prioritized for FY 2020 maintenance.
SWMU 68d settling and small holes	This landfill will be addressed through onsite Waste Operations Department.
SWMU 61 Landfill 10 holes and settling in small areas.	Work was completed in June 2019.
New 2019 Findings	
SWMU 68c, Landfill 2 prairie dog encroachment on perimeter of anchor trench, holes/subsidence near anchor trench, SWMU signs need repair	Will be addressed through onsite contract to control prairie dogs and onsite maintenance to fill holes, if needed. Onsite contractors will repair or replace signs.
SWMU 70, FS-5 needs SWMU signs posted on the fence	Will be addressed through onsite contractors.
SWMU 56, Landfill 5 has a few small holes that need to be filled	This is a low priority landfill that will be addressed through onsite maintenance group or as budget allows.
SWMU 64, Landfill 13 requires signs to be posted	Will be completed by onsite contracted labor as budget and time allows.

Based on the 2nd FYR findings and 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 priority than other landfills that had new additional cover placed at the end of investigations due to the content of the landfill. 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 that has occurred at some of these landfills resulting from burrowing animal activity, such as SVS 7a/b and SVS 6, it will take multiple years to completely restore all of the covers on the multiple individual landfills included in the SWMU. Pantex has requested an increase in budget in future years, but it is estimated that it will take up to five years to address SVS 7a/b and SVS 6 while continuing to prioritize other landfill cover maintenance.

Pantex will continue to evaluate the landfills annually and report the findings of the review and any plans that are developed to address holes, depressions, or bare areas. Problems identified will be addressed through the landfill cover maintenance contract or limited onsite maintenance. Larger identified issues, such as erosion or damage to the geomembranes, will be addressed through separate contracts. The active landfill area at Pantex is continually maintained by the Waste Operations Department and old landfills (SVS 8 and SWMU 68d) in that area continue to be addressed by onsite Waste Operations personnel.

Ditch Liner Inspection

Pantex installed a new liner over the old one, with construction complete in March 2017. As discussed above, a new maintenance plan was developed for the new liner. An inspection conducted in 2019 indicated no issues with the liner. Sedimentation and erosion of the anchor trench were observed as well as some blockage of the culverts from debris. Pantex Maintenance Department will assist with removing debris from the culverts and sedimentation during 2019.

2.3.2.2 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 execution of the work. Older listed projects from the completed project areas were verified after completion of work to ensure 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 the last annual report as well as new SWMU interference projects from 2019. Five new permits were issued in 2019 with those projects still active. Three older projects were completed in 2019.

Table 2-3. SWMU Interference Log

Log #	State Approval Date	SWMU #	Explanation of Work
Previous SWMU Interference Notifications			
SIN16-008	11/15.16	Multiple	Excavation for all utilities within SWMU's and SWMU extents for the new Administrative Support Complex. Status: Complete. Soils returned to SWMU.
SIN17-003	03.27.17	1 5/5 5/7 5/6 5/12a	Installation of outdoor floodlighting system. Installation will include new floodlights and poles, duct bank and concrete pole casings. Hydro excavation will be used as well as ditching equipment, auger, backhoes, directional bore and skid loader. Excavation depth is set at 30 ft and the width will be 15 ft. Status: Active.
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 & 12-62 Berm (Berm in 12/18). Status: Active.
SIN18-005	3/2/2018	WMG 12 & Playa 2; SWMU 7 & SVS 8	Water way improvement from Pantex landfill to Playa 2 and terrace erosion repair to the cultivated fields south and west of Playa 2. Status: Complete. Soils returned to SWMU.

Log #	State Approval Date	SWMU #	Explanation of Work
SIN18-007	9/6/2018	SWMUs 5-09 (WMG #4) 5-02 (WMG#9) 5-13c (WMG#11)	Demolition of four temporary buildings (09-130, 09-059, 09-060, 09-061). Status: Complete. Soils returned to SWMU.
SIN18-008	10/29/2018	SWMU 75 No WMG	Electrical mechanical upgrades at Firing Site 22. Status: Active.
SIN18-009	11/8/2018	WMG 12, SWMU 143 a&b	Electrical upgrades at Building 10-09 Status: Active.
SIN18-010	12/19/2018	WMG 10 SWMU 5-01 a & b	Water leak repair at Building 09-146. Status: Active.
2019 SWMU Interference Notifications			
SIN19-001	4/2/2019	WMG 13	Burning Ground Lightning Protection System Upgrades Status: Active.
SiIN19-002	4/2/2019	5/5	12-21 Chiller Upgrades Status: Active.
SIN19-003	6/20/2019	SVS 7b	Clearing ditches around 16-24 Range Complex Status: Active.
SIN19-004	8/6/2019	Extents	Demolition of 12-101 Status: Active.
SIN19-005	10/22/2019	WMG 5/ SWMU 68a	Zone 12 South Paving - South of 12-R-79 Status: Active.

2.4 Long-Term Monitoring Well Network

2.4.1 *Well Maintenance*

As recommended in the *First Five-Year Review* (Pantex, 2013d), the *Well Maintenance Plan* (Pantex, 2013b) was completed in October 2013 and was 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. Significant components of the plan include:

- Assigning 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).
- Assigning a maintenance frequency of two years for all wells with stainless steel screens that have documented well corrosion and elevated chromium concentrations.

- Assigning a default inspection frequency of five years for all perched aquifer LTM wells to comply with total depth measurement requirements 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 the field technicians. Water levels are measured at each sampling event and twice annually and total well depths are only measured when dedicated equipment is not present in the well.

The 2019 maintenance log for groundwater wells is included in Appendix C. This log 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. The disposition of the purge water from well activities is also provided.

Pantex has identified, through well videos, evidence of bacteria in many of the stainless steel wells. This condition is common in monitor wells, especially in wells 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 (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 the biofouling. Pantex developed plans to evaluate a chemical rehabilitation program in 2018 to address the perched wells as the growth has completely blocked portions of the screens in some wells. The study will continue into 2020 on two parked wells to evaluate the impacts to water quality as well as the ability to effectively manage the biofouling. New perched wells are now installed with PVC materials, rather than stainless steel, to avoid corrosion issues associated with well materials; however, pumps still consist of stainless steel that is subject to corrosion.

Pantex has redeveloped wells, including brushing, bailing, and pumping, as necessary, when screens were impacted by biofouling, calcium deposits, or sedimentation, or elevated chromium levels were observed. Based on well videos and total depth measurements, some wells were observed to have sediment in the sump, with a few wells having sediment built up into the bottom of the screen. However, no 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 2019:

- Performed 17 well videos to evaluate well installation or the condition of wells and determine if re-development or other maintenance was required and effectiveness of rehabilitation.
- Performed pump service (removal/installation of pump and tubing bundles) at 29 locations to prepare for well videos, re-development, special sampling, change-out of pump and tubing bundle, lengthen sampling depths due to declining water levels, and/or replace pumps.
- Redeveloped 13 wells to reduce silting, clean the well screens, and/or perform chemical rehabilitation.
- Miscellaneous maintenance including stencil replacement on wells, removal of injection tubing, installation of submersible pump for study, replacing/stamping brass tags, and collection of total depth, as requested.

Due to the increase in wells and related necessary inspections and maintenance, Pantex has requested extra resources in 2021 and later to provide continued well maintenance according to plan.

2.4.2 Well Casing Elevations

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

Pantex resurveyed all wells in 2010 using Pantex's real-time kinetic GPS system that is calibrated to the National Geodetic Survey. This system will be consistently used for surveying wells in the future. Those well elevations were included in the *2010 Annual Progress Report* (Pantex, 2011a). The next survey is due in 2020.

The surveyed well elevations for new wells and resurveyed wells are included in Table 2-4. During 2019 Pantex installed six monitoring wells. Two other wells were checked based on previous repairs conducted that affected the top of casing (TOC) elevation.

Table 2-4. Well Elevations Collected in 2019

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
Wells Installed in 2019				
PTX06-1191	3750720.88	648996.85	3513.02	3515.08
PTX06-1192	3749893.14	649119.32	3510.23	3512.32
PTX06-1193	3749346.75	646719.13	3508.28	3510.37
PTX06-1194	3750477.77	648355.41	3512.68	3514.75
PTX06-1195	3751968.74	649096.79	3516.83	3518.88
PTX06-1196	3750989.94	649710.26	3512.67	3514.95
Re-surveyed Wells				
PTX06-1061	3773185.72	625651.06	3589.81	3591.99
PTX06-1064	3773558.89	635900.14	3562.28	3564.91

Northings and Eastings are Texas State Plane
amsl – above mean sea level TOC - top of casing

2.4.3 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 is to 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 for mapping of the water table. Water level measurements are also taken during any well maintenance activities. The measurements and corresponding water elevations and total depth elevations are included in Appendix C.

2.5 Management of Recovered/Purged Groundwater

All 2019 purged contaminated groundwater exceeding GWPS from sampling events and maintenance activities was containerized, the volume of water was then logged and treated through SEPTS in accordance with Provision XI.B.8 of the HW-50284, with a few exceptions. Purge water from all ISB system wells was containerized and disposed of by the Pantex Plant Waste Operations Department due to the water being characteristically hazardous or the water contained contaminants that were not treatable by the pump and treat systems. Additionally, a chemical rehabilitation study was ongoing in 2019 and water from the chemical rehabilitation was also containerized and managed as Class 1 waste. Most Ogallala Aquifer wells are unaffected and are not required to be managed or volumes tabulated so the water is released to nearby ditches. Because Ogallala well PTX06-1056 had low-level detections of HEs (below GWPS) in 2019, Pantex containerized the purge water from sampling events, and then the water was logged and treated through SEPTS.

In accordance with Provision XI.B.8 of HW-50284, all recovered perched groundwater from extraction wells is treated through the P1PTS or SEPTS. All treated water from the P1PTS and the majority of the SEPTS treated water is sent through subsurface lines to the WWTF storage lagoon. The lagoon water is then sent through the WWTF filter building and subsequently released to the Plant's subsurface irrigation system, when operating. Pantex Plant has been authorized by permit (TLAP #04397, issued April 2012) to release treated wastewater for irrigation of crops. Provisions were added in the latest permit renewal allowing treated water obtained directly from SEPTS or P1PTS to be used in other ways, such as for construction projects, as long as the treated water meets GWPS and criteria specified by the State of Texas. Pantex has completed construction of a bulk water station at SEPTS for delivery of treated water for beneficial use at Pantex. Pantex has set up procedures and record keeping for the bulk water station. The station became operational in July 2016.

A break at the irrigation system 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. All treated water from 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. All of P1PTS water was released to Playa 1 via the WWTF.

As authorized by the Underground Injection Control, Authorization No. 5X2600215, Pantex injects treated water into select wells at Pantex. Portions of the SEPTS treated water is injected through injection wells PTX06-INJ-10 and PTX06-INJ-11 when needed. Some of the SEPTS treated water is also used for the Southeast ISB and Zone 11 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 is provided in Section 2.1.

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3.0 Groundwater Remedial Action Effectiveness

In this section, the groundwater remedial action is evaluated for overall effectiveness during 2019 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/early detection
4. Natural attenuation

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

3.1 Plume Stability

Plume stability is evaluated through examination of water level and concentration data. Water levels 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) also support this analysis.

Concentration data are used to perform concentration trend analysis. Concentration trend data are mapped for the four major COCs to identify trends in the spatial distribution of COCs. 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.

In order 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, 2014a). Therefore, a comparison of observed versus expected conditions was conducted as part of the evaluation process. Appendix E includes the LTM expected conditions as well as current conditions based on 2019 analytical and water level data.

3.1.1 Water Level Mapping

Groundwater beneath the Pantex 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 as perched groundwater overlying a fine-grained zone.

Presented in this section are water table maps of the Ogallala Aquifer and the primary perched aquifer underlying Pantex Plant. Water level measurements used to create these maps were collected primarily during December 2019 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. Figure 3-1 presents the Ogallala Aquifer water levels. Figure 3-2, Figure 3-3, and Figure 3-4 present perched aquifer water levels.

3.1.1.1 Ogallala Aquifer

As shown in Figure 3-1, flow in the Ogallala Aquifer underlying Pantex Plant is to the northeast. The northeast hydraulic gradient results from agricultural pumping as well as from the City of Amarillo 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 million gallons per day from the Ogallala Aquifer, based on 2018 City of Amarillo data. The hydraulic gradient in the Ogallala Aquifer underlying the northern part of Pantex Plant is approximately 0.006 ft/ft.

3.1.1.2 Perched Aquifer

As shown in Figure 3-2, Figure 3-3 and Figure 3-4, perched groundwater occurs as a number of separate flow systems beneath Pantex 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 about 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 0.0056 ft/ft near Playa 1, 0.0015 ft/ft near Playa 2, 0.0045 ft/ft downgradient of Zone 12, and 0.0013 ft/ft south of Zone 11.

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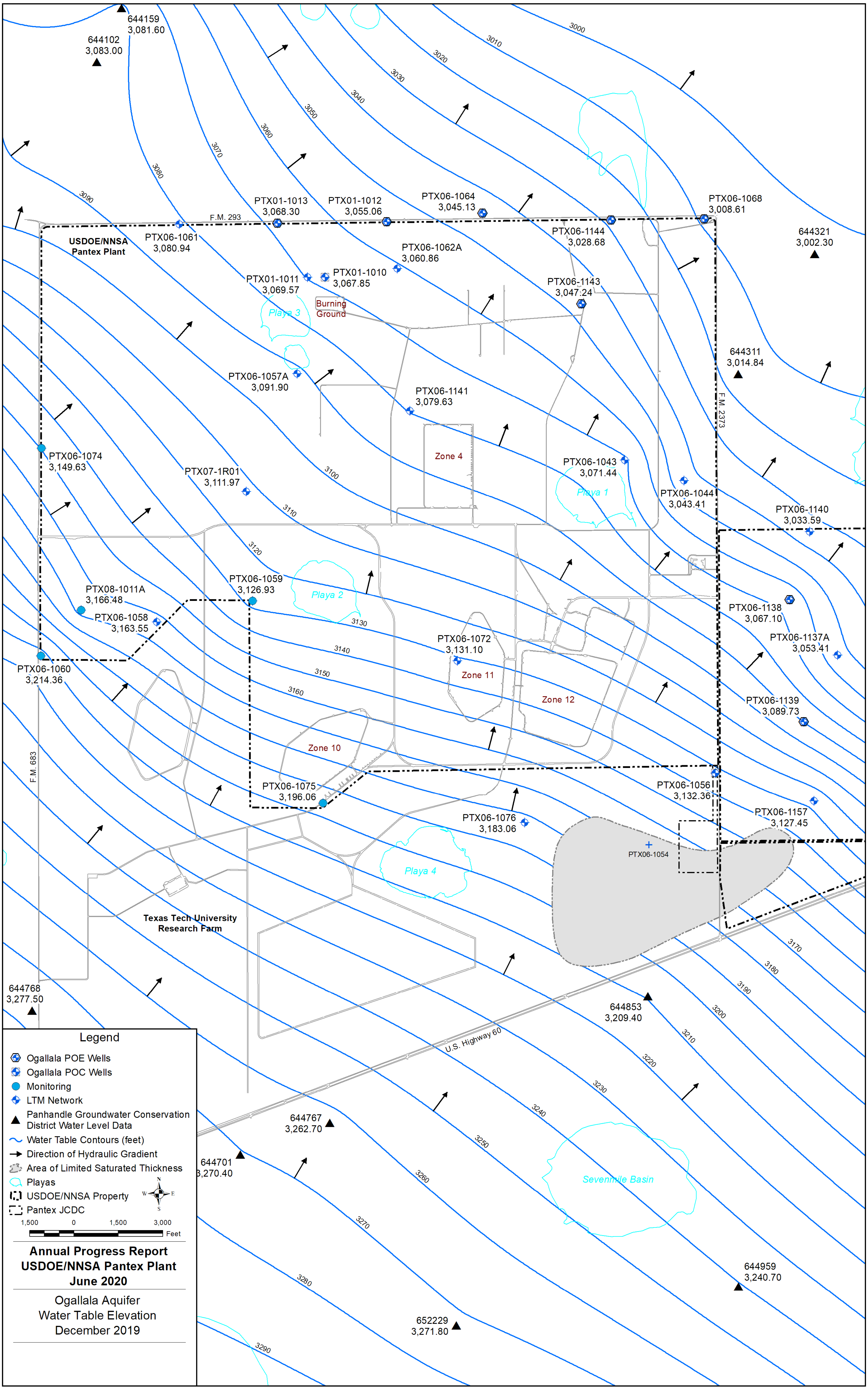

Figure 3-1. Ogallala Aquifer Water Levels

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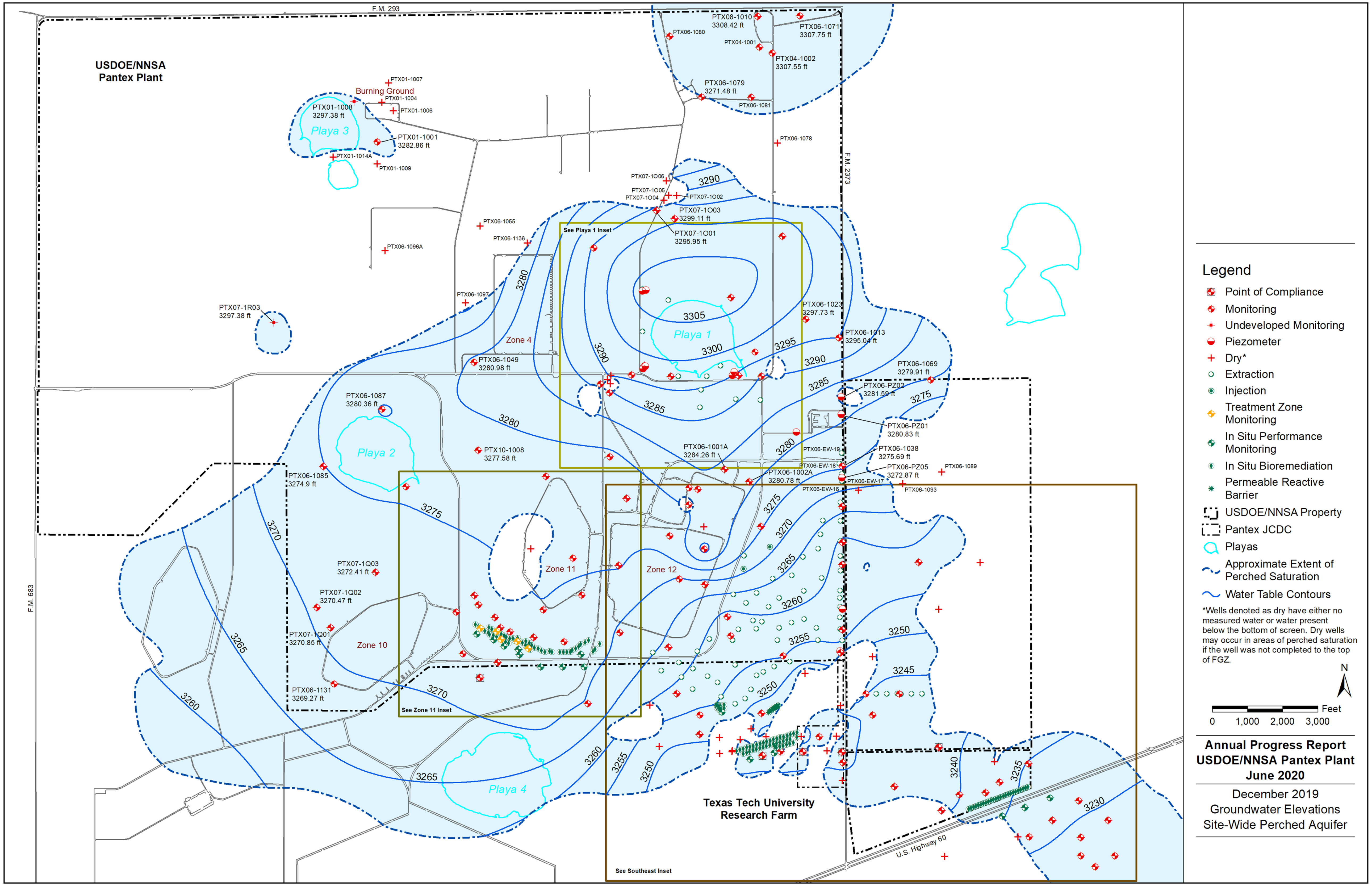

Figure 3-2. Perched Aquifer Water Levels

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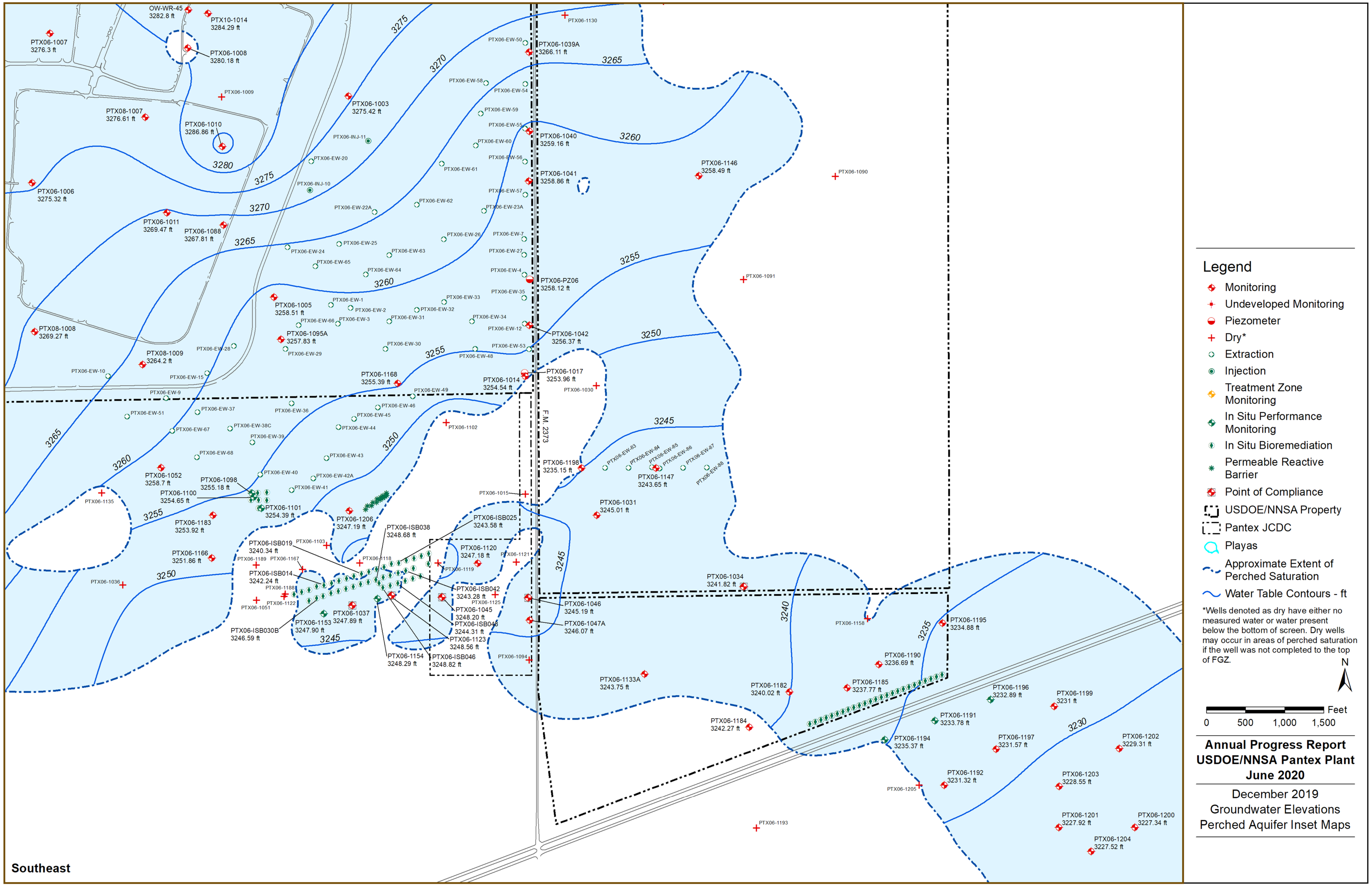

Figure 3-3. Perched Aquifer Water Levels, Southeast Inset Map

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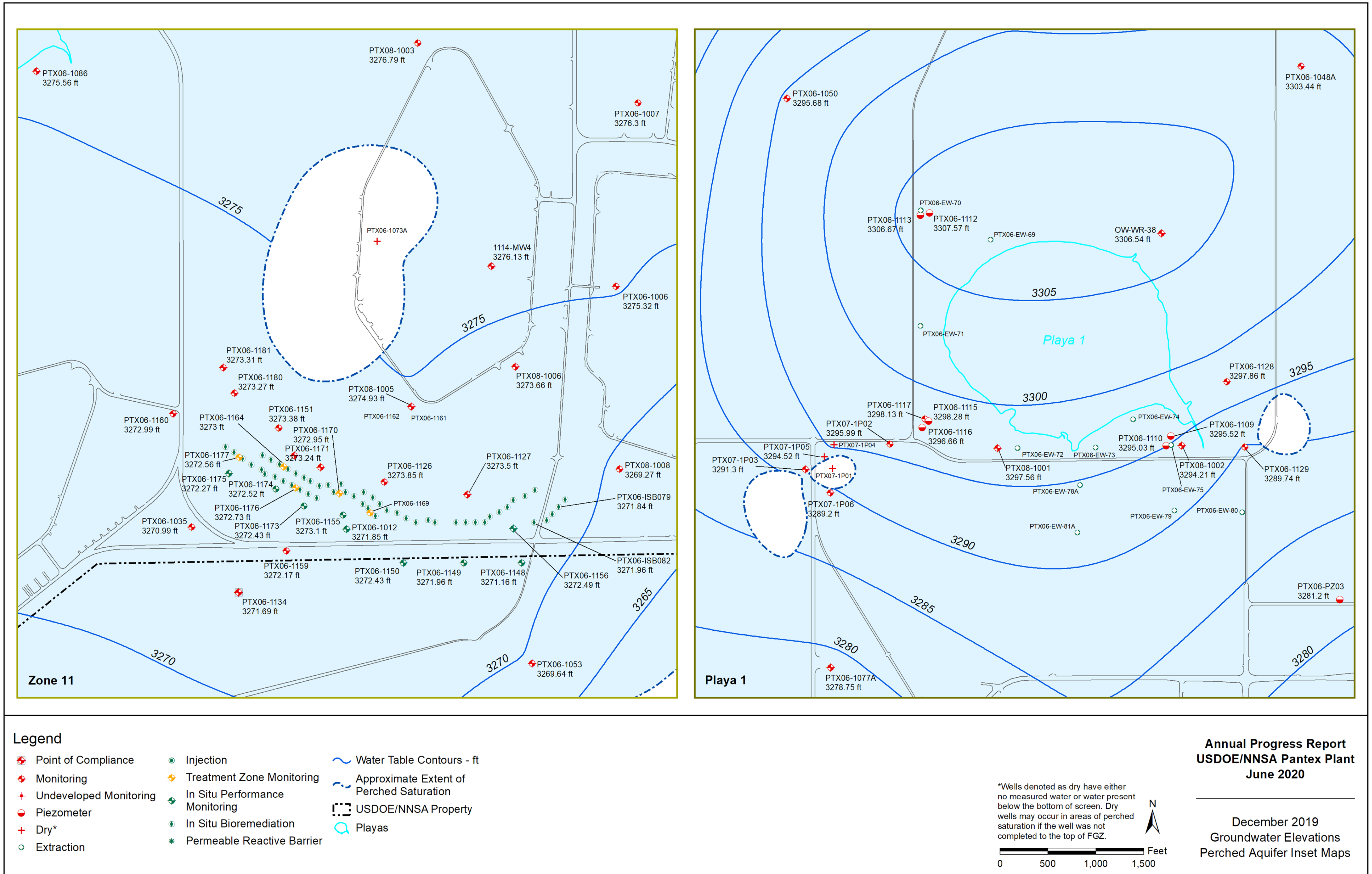

Figure 3-4. Perched Aquifer Water Levels, Zone 11 and Playa 1 Inset Maps

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3.1.2 WATER LEVEL TRENDING

MAROS linear regression methodology 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 a more accurate measurement of the effectiveness of the two pump and treat systems as the P1PTS began operating in late 2008 and the SEPTS began operating near full capacity by April 2009. Figure 3-5 depicts the water level trends in all LTM perched aquifer wells. Well hydrographs are included in Appendix F.

Trending results are showing positive effects of the remedial actions as almost all wells currently recognized to be under the influence of the SEPTS and P1PTS have exhibited decreasing water level trends in recent years. Above normal precipitation during the spring and summer of 2016 and again in the summers of 2017, 2018, and 2019 filled the playas, and a resulting increase in water levels was observed in several wells near Playa 1 and some ditches. The apparent recharge through the playa was much greater than the volume extracted by the P1PTS causing short-term increasing trends to be observed in these wells.

In addition, SEPTS and P1PTS operation and throughput continued to be impacted in 2019 by a filter bank break at the irrigation system that occurred in late June 2017. Because of the severity of the break, engineering evaluation, contracting, and major repairs are required to restore the irrigation system. Meanwhile, Pantex continues to release all WWTF water to Playa 1. The flow to Playa 1 is restricted by permit, so flow from the systems must also be restricted until the irrigation system is repaired. Current and future operations will be impaired by the restricted flow to the WWTF. SEPTS has the capability to reinject, so the system has operated at a lower capacity, with the treated water injected into the two available injection wells for the system and/or released to the WWTF and Playa 1. Reduced extraction of perched groundwater by SEPTS and 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 a later section.

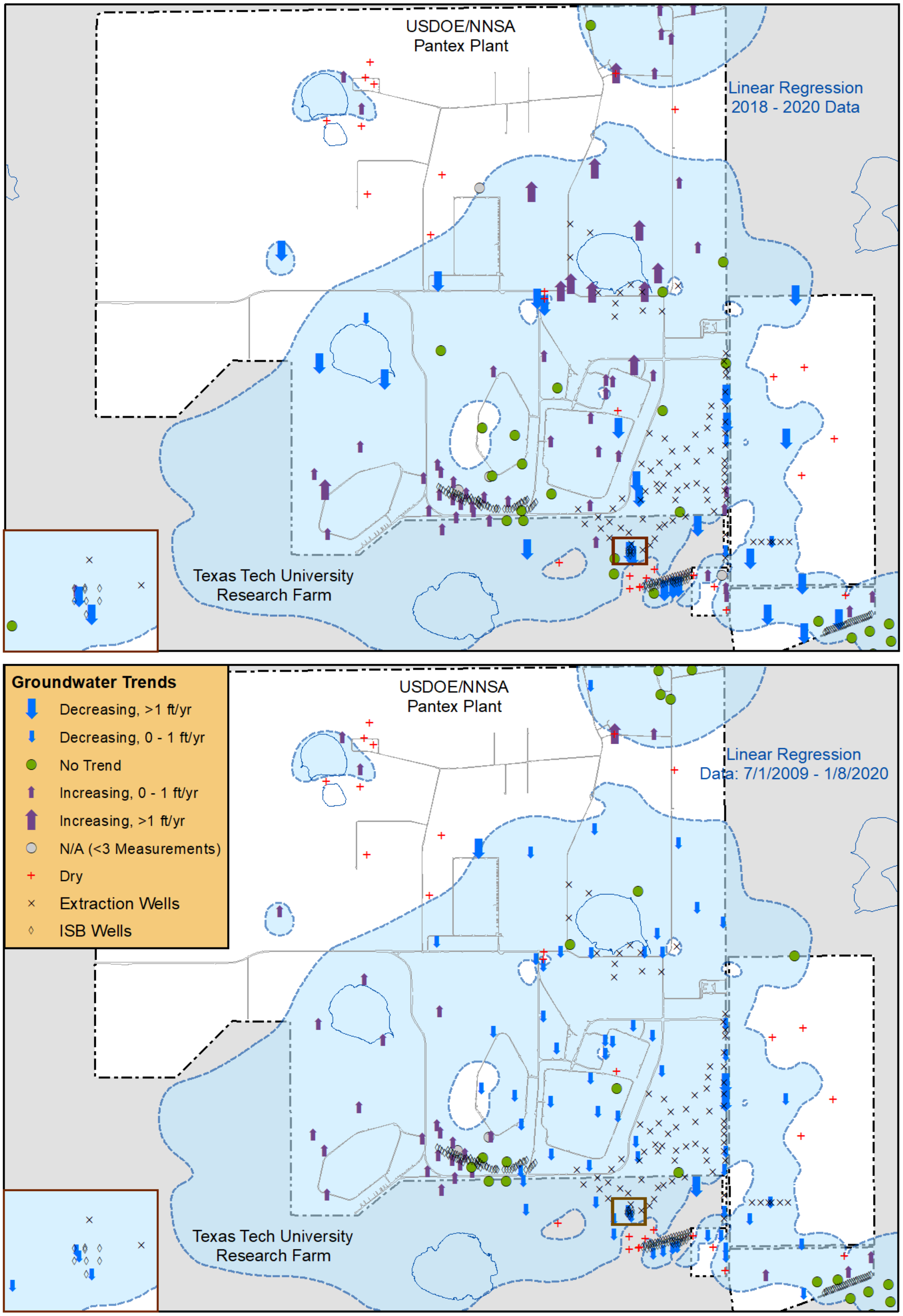

Figure 3-5. Water Level Trends in the Perched Aquifer

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 summarized in Appendix E. Of the 48 monitor wells with expected decreasing water level trends, limited water, or dry conditions defined in the *Update to the LTM System Design Report* (Pantex, 2014a) 21 wells (depicted in Figure 3-6) exhibited conditions inconsistent with the current expected conditions or trends. These include 15 wells with recent increasing trends and six wells with recent "No Trend" conditions. In addition, three wells are exhibiting apparent long-term increasing trends.

A recent increasing trend was observed at five wells near Playa 1 (OW-WR-38, PTX06-1023, PTX06-1050, PTX08-1001, and PTX08-1002), and a recent "No Trend" condition was observed at PTX06-1013 located east of Playa 1. These trends are associated with a combination of increased recharge through the playa resulting from discharge of treated wastewater effluent and reclaimed perched groundwater to the playa along with decreased extraction of perched groundwater from the P1PTS. The long-term water level trend is decreasing for all of these wells except OW-WR-38 which has no long-term trend.

A recent increasing trend was observed in several wells in the southeast area (PTX06-1002A, PTX06-1052, PTX06-1088, and PTX08-1009), and recent "No Trend" conditions were observed at PTX06-1003 and PTX08-1008. Most of these wells exhibited a marked increase in water levels in 2017 in response to above normal precipitation followed by more gentle increasing trends through 2019. The hydrographs for all of these wells shows that water levels have fluctuated in recent data, and the long-term water level trend is decreasing for all of these wells. The 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.

A recent "No Trend" condition or increasing trend was observed in three wells in the southeast area along FM 2373 (PTX06-1014, PTX06-1038, and PTX06-1042). The long-term water level trend is decreasing for all of these wells. 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.

Increasing trends have been observed at four wells (PTX06-1045, PTX06-1046, PTX06-1047A, and PTX06-1120) located southeast of the Southeast ISB system near the

Pantex Administrative Site Complex 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. The increasing water levels in these wells is believed to be related to recharge of stormwater runoff from this facility.

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 of the well 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 about ten feet 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 the water level.

Water levels in PTX06-1133A increased sharply in 2016 after declining in 2011 and 2012 then holding constant below the bottom of the well screen in 2013 through 2015. Although the long-term trend was identified as increasing, recent data indicate a decreasing trend. Inspection of the hydrograph shows that water levels peaked in May 2018 and have since declined by about 2 feet. This well is located near the southern extent of perched groundwater; the sudden appearance of water and subsequent stabilization of water levels may be associated with the above normal precipitation during recent years and increased recharge through a large borrow pit to the south.

In addition to the wells discussed above, appaerant increasing trends were identified for two wells that have historically been dry. At PTX01-1009 near Playa 3, water was measured just above the bottom of the well screen in June 2019. The well was dry at the subsequent measurement in December. At PTX06-1073A, an apparent increasing trend was identified based on historical observations of water in the well screen for short periods; however, water was last measured within the screen of this well in December 2014, and the well has been dry since 2018.

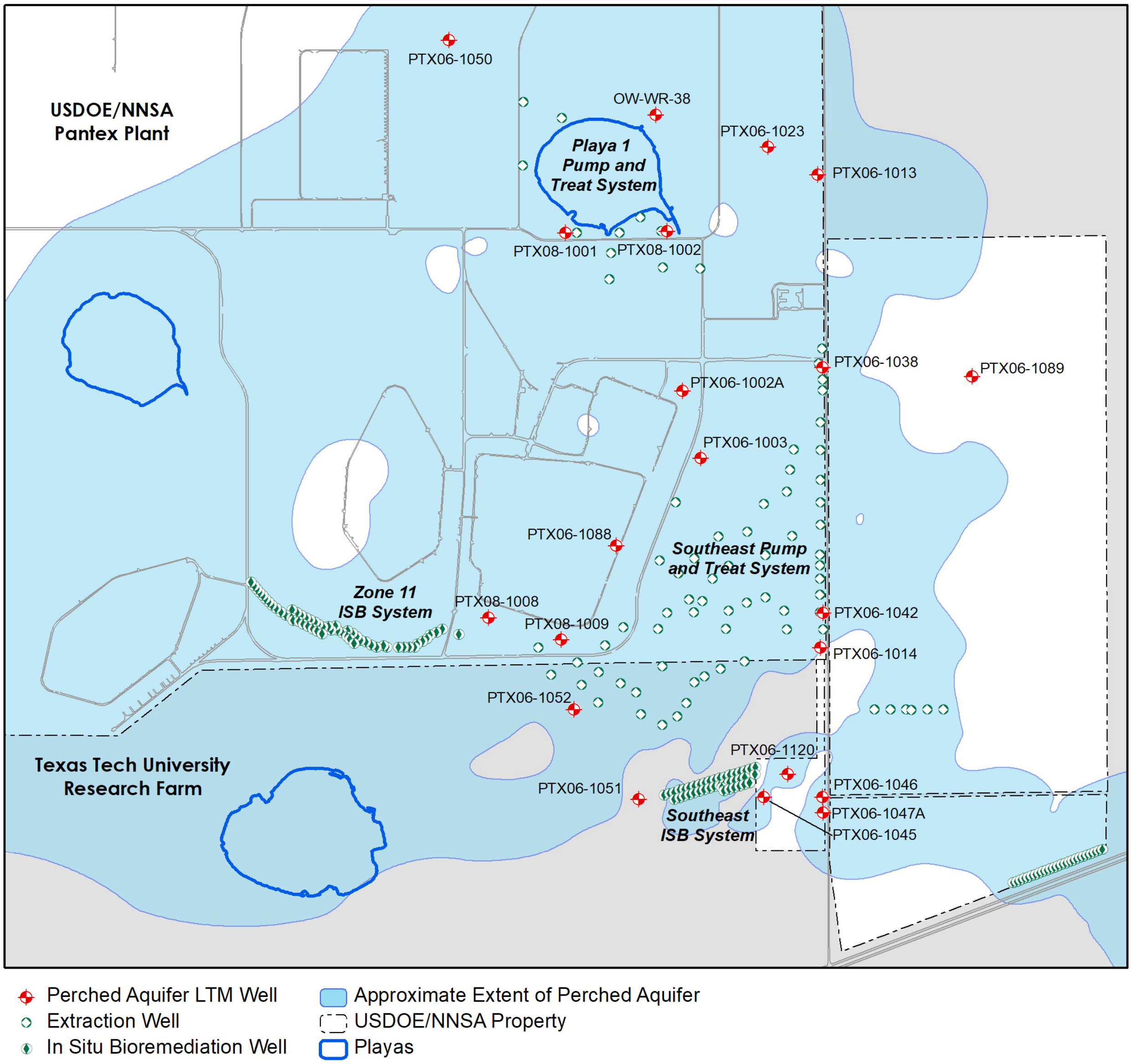

Figure 3-6. Perched Wells with Unexpected Water Level Trends

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 AFCEE Monitoring and Remediation Optimization System (MAROS) Software. Trends were calculated for the entire dataset for each LTM network well (long-term), data from the four most recent sampling events (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 remedial actions began for RDX, hexavalent chromium, perchlorate and TCE, and are depicted in Figure 3-7, Figure 3-8, Figure 3-9, and Figure 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, etc.) and can be used with data sets which 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 LTM System Design Report* (Pantex, 2014a).

3.1.4.1 RDX Trends

Evaluation of concentration trends for RDX 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 condition is expected as the source areas are predicted to continue contributing to the perched aquifer for up to 20 years, 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 as 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 as concentrations in downgradient wells are stable or declining, with the exception of 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 Figure 3-7.

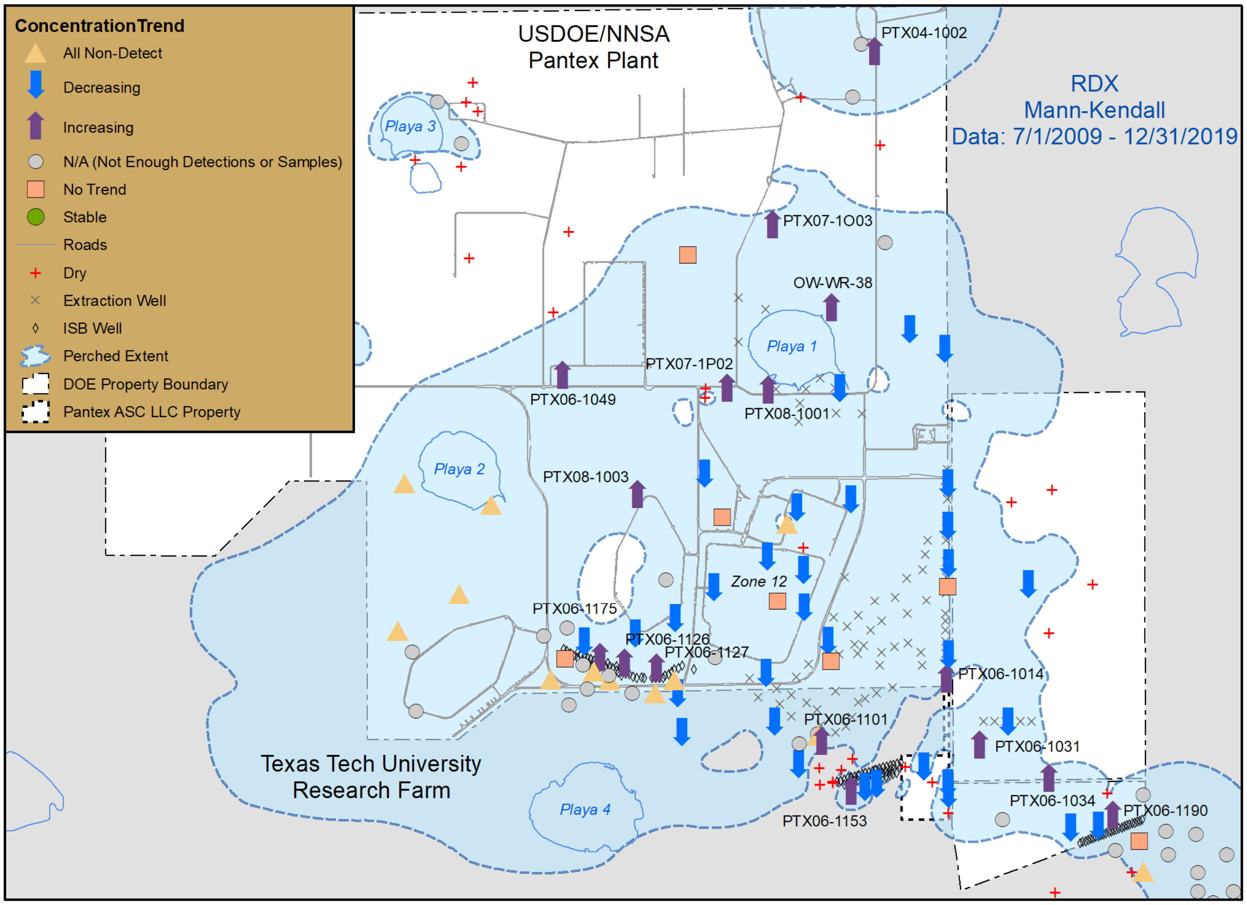

Figure 3-7. RDX Trends in the Perched Aquifer

Overall, 14 monitoring wells exhibited increasing trends in RDX using data since the start of remedial actions, as depicted in Figure 3-7. Two additional wells, PTX06-1175 and PTX06-1190, are shown on the map with increasing trends. These wells were installed after the 2014 *Update to the Long-Term Monitoring System Design Report* (Pantex, 2014a) and have been added to the approved LTM network effective on January 1, 2020. Trends for these wells will be evaluated relative to the monitoring objectives and expected conditions established for these wells as part of the 2019 *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a) and discussed in future Annual Progress Reports.

- OW-WR-38, located north of Playa 1, is exhibiting an increasing trend in RDX. However, concentrations have been fluctuating for the last five years and remain near the GWPS. The trend may be due to P1PTS effects as system operations have dramatically affected water levels and gradients in this region of perched groundwater.

- PTX04-1002, located in the OSTP area north of the main body of perched groundwater, is exhibiting an increasing trend, but all values are near the PQL and well below the GWPS.
- PTX06-1014 is exhibiting a probably 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.
- Two wells located in the far southeast lobe of perched groundwater (PTX06-1031 and PTX06-1034) are exhibiting increasing trends in RDX, likely due to plume movement into these wells, although recent data indicate decreasing or "No Trend" conditions, respectively.
- RDX was first observed at low concentrations in PTX06-1049 in 2011 and has since fluctuated at levels near the GWPS. This well is located in the far western side of the perched aquifer which is outside the influence of a remedial action and these trends are likely due to groundwater flow from the Playa 1 vicinity.
- PTX06-1101 is located immediately downgradient of the Southeast ISB pilot study well field. RDX was non-detect in this well from installation of the well in 2007 until 2014 and has been increasing since then. The increasing trend likely results from loss of treatment effectiveness in the ISB pilot area and concentrations returning to baseline conditions.
- PX06-1126 and PTX06-1127, located south of Zone 11 outside the effects of a remedial action, are exhibiting long-term increasing RDX trends. However, recent data indicates a decreasing trend in PTX06-1126 and stable conditions in PTX06-1127. Both 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 in the system.
- PTX06-1153, is a downgradient ISPM well for the Southeast ISB system, is exhibiting an increasing but highly variable trend in RDX. This well is discussed in detail in Section 3.2.3.2.

- PTX07-1O03, located north of Playa 1, is exhibiting an apparent increasing trend in RDX. However, this well exhibited higher historic RDX concentrations and exhibits a decreasing trend considering all data and for the last two years. The increasing trend may be due to P1PTS effects as system operations 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 P1PTS effects as system operations have dramatically affected water levels and gradients in this region of perched groundwater.
- PTX08-1001, located southwest of Playa 1, is exhibiting an increasing trend with fluctuating concentrations above GWPS. The apparent increasing trend may be due to P1PTS effects as system operations have dramatically affected water levels and gradients in this region of perched groundwater.
- PTX08-1003, is exhibiting an increasing trend, but all values are near the PQL and well below the GWPS.

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 Figure 3-8, five perched aquifer wells are exhibiting increasing trends in hexavalent chromium below the GWPS since remedial actions began. Two additional wells, PTX06-1185 and PTX06-1190, are shown on the map with increasing trends. These wells were installed after the 2014 *Update to the Long-Term Monitoring System Design Report* (Pantex, 2014a) and have been added to the approved LTM network effective on January 1, 2020. Trends for these wells will be evaluated relative to the monitoring objectives and expected conditions established for these wells as part of the 2019 *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a) and discussed in future Annual Progress Reports.

- An increasing trend was identified for PTX06-1011. This well is located within Zone 12, southwest of one of the hexavalent chromium source areas, at the former cooling tower. Historical concentrations in this well have fluctuated from slightly above the GWPS in the mid-1990s to less than the PQL. Concentrations in this well likely decreased after the SEPTS came online, and as flow conditions have changed with the decline in saturated thickness in the perched groundwater, concentrations have fluctuated. The long-term trend for this well is decreasing, and recent concentrations remain below the GWPS.

- PTX06-1095A is within the influence of the SEPTS well field, but is also located less than 50 feet downgradient of the PRB pilot study wells PTX06-PRB01A and PTX06-PRB02. Since 2013, detections have been highly variable. The increasing trend is likely due to the PRB losing treatment effectiveness and concentrations returning to baseline conditions. A decreasing trend was exhibited by the last four samples.
- 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.
- An increasing trend was identified for PTX06-1166. This well is located along the southern edge of the hexavalent chromium plume, so the observed increase is related to the movement of the plume to the southeast. Although concentrations remain below the GWPS through 2019, the recent trend is increasing.
- An apparent increasing trend was identified for PTX08-1009; however, a decreasing trend was identified for the last four samples and concentrations remain below the GWPS. This well is located along the northern edge of the hexavalent chromium plume and historically exhibited very high concentrations. The recent detections may indicate general plume movement to the southeast and the influence of the SEPTS well field.

In addition to the wells identified above, an apparent increasing trend was identified for PTX06-1015; however, the water level in this well has been below the bottom of the well screen since December 2018. The trend was stable for the last four samples collected before the water level dropped, and all concentrations were below the GWPS of 100 ug/L. Concentrations of total chromium in this well were also increasing for past several years; therefore, observed fluctuations in hexavalent chromium may have been due to corrosion of the stainless steel screen of the well.

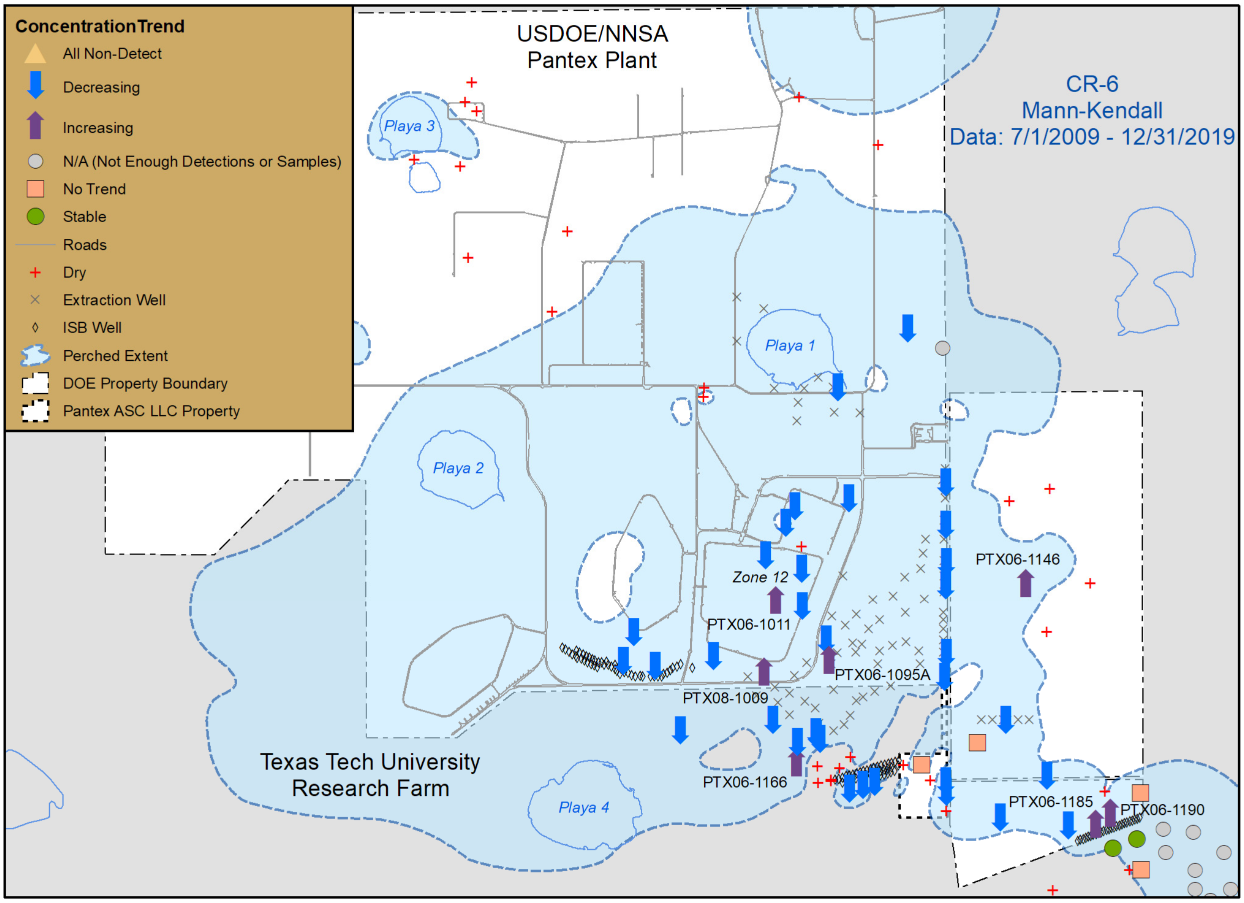

Figure 3-8. Hexavalent Chromium Trends in the Perched Aquifer

3.1.4.3 Perchlorate Trends

As depicted in Figure 3-9, eight monitoring wells are exhibiting increasing trends in perchlorate concentration:

- 1114-MW4 is exhibiting an increasing trend in perchlorate concentrations since the start of remedial actions in 2009. This well had concentrations in the range of 300 ug/L when installed in 2002, which steadily declined until 2010 then exhibited a slow increasing trend. Observed concentrations have been declining again since 2018. These shifting trends could be due to changes in gradients or general plume movement downgradient. Regardless, 1114-MW4 is installed upgradient of the Zone 11 ISB system and the SEPTS; the perchlorate will be treated as it flows through the ISB system or captured by the SEPTS.

- PTX06-1006 was exhibiting a decreasing trend in perchlorate from the time perchlorate was first detected in the well until 2014; Mann-Kendall analysis indicates an increasing trend based on data collected since the start of remedial actions in 2009. However, a decreasing 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 historic injection and the resulting return to unaffected perchlorate 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.

- PTX06-1035, PTX06-1134, and PTX06-1159, which are located southwest of the Zone 11 ISB system, are demonstrating increasing trends in perchlorate concentrations likely due to general plume movement downgradient. While these wells are located downgradient of the current Zone 11 ISB system, treated water is not expected to reach these wells for many years.

- An apparent increasing trend was identified for PTX06-1077A. However, all samples have been below the PQL or non-detect, and the apparent trend is caused by using one-half the sample detection limit in the trend analysis.

- Perchlorate increased in PTX08-1008 from 2014 into 2017, but a decreasing trend is indicated for the last four samples. 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 SEPTS operations.

- An apparent increasing trend was identified for PTX10-1014. However, all samples collected since 2003 have been below the PQL or non-detect, and the apparent trend is caused by using one-half the sample detection limit in the trend analysis.

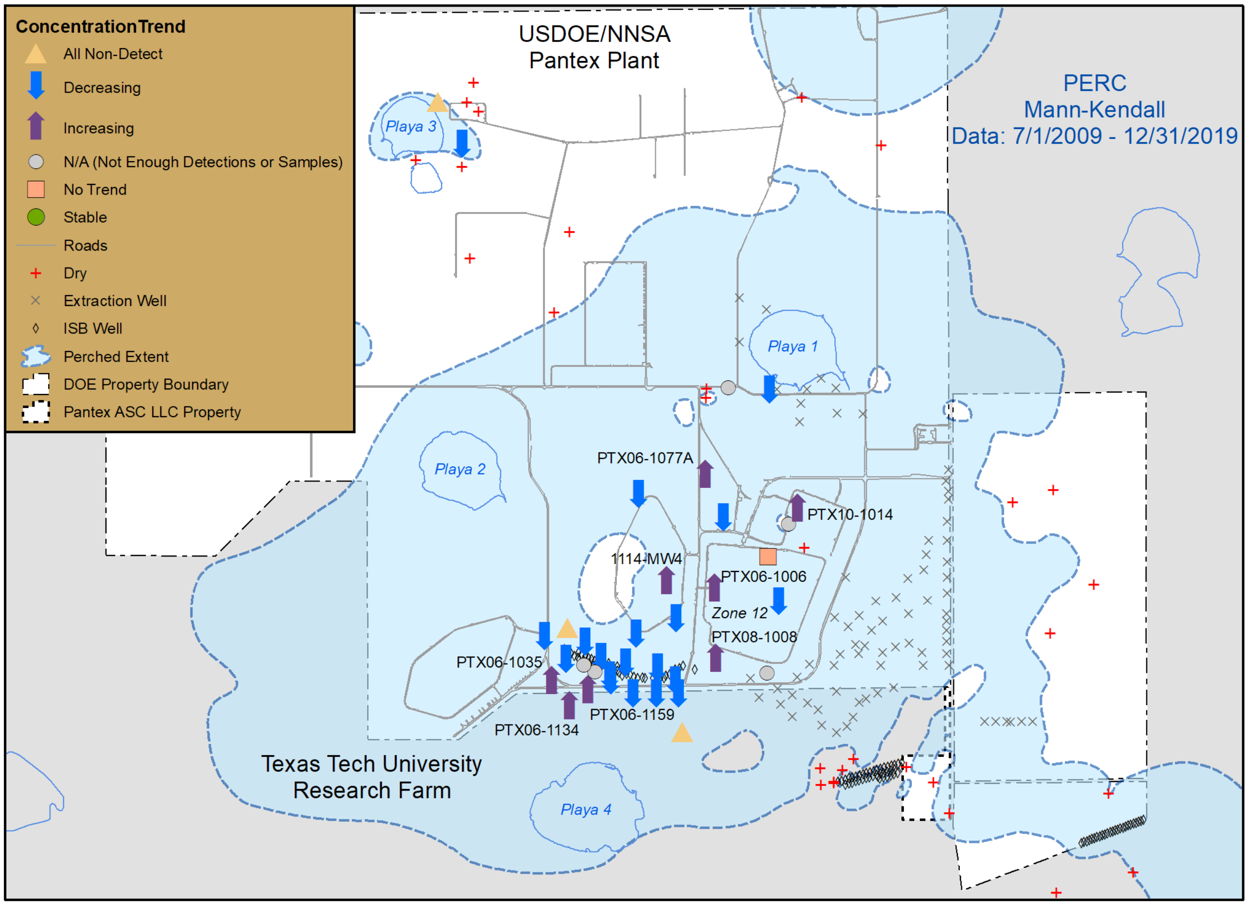

Figure 3-9. Perchlorate Trends in the Perched Aquifer

3.1.4.4 TCE Trends

As depicted in Figure 3-10, 18 monitoring wells are exhibiting increasing trends in TCE concentration since the start of remedial actions. One additional well, PTX06-1174, is shown on the map with an increasing trend. This well was installed after the 2014 *Update to the Long-Term Monitoring System Design Report* (Pantex, 2014a) and has been added to the approved LTM network effective on January 1, 2020. Trends for this well will be evaluated relative to the monitoring objectives and expected conditions established as part of the 2019 *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a) and discussed in future Annual Progress Reports.

- 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 below the sample PQLs. The identified increasing trend is the result of low-level detections and use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area.

- The apparent increasing TCE trend in PTX06-1005 is likely caused by the return of unaffected conditions in this area following the cessation of injection of treated water at SEPTS injection well PTX06-INJ-12A, which is located approximately 200-feet to the east. Almost 70 million gallons of treated water were injected into the perched aquifer at PTX06-INJ-12A from the time it was installed in 2008 through 2012 when injection into this well was ceased because of failure of the well. Over the last five years, concentrations have fluctuated between about 20 to 40 ug/L in this well, and the last four samples indicate "No Trend" for this well.

- An increasing trend was identified for PTX06-1006 where TCE had been consistently detected below the sample PQL since 2011 until the most recent sample with a detection slightly above the PQL. The increasing concentrations could be caused by changes in gradients and plume movement from the SWMU 5-13A ditch or by historic injection and the resulting 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.

- Increasing trends were observed for PTX06-1010 in the eastern part of Zone 12. TCE concentrations in PTX06-1010 have been below the GWPS since 2009. The trend for all data is decreasing, and the last four samples indicate "No Trend."

- 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 PTX06-1149 began increasing in 2018. Concentrations of TCE slightly exceed the GWPS in both wells. Because the concentrations detected at these wells are near the GWPS, these data indicate expected conditions are being met in this area.

- PTX06-1035, PTX06-1134, 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 slightly exceeded the GWPS for the first time in 2019.

- TCE is exhibiting a probably increasing trend in PTX06-1048A, located northeast of Playa 1, which is not historically nor expected to be under the effect of a remedial action. TCE was first detected in this well in 2000 and has generally been detected at levels near the PQL and below GWPS. The last four samples indicate a decreasing trend.

- An apparent increasing trend was identified for PTX06-1081 located south of the former OSTP area. However, TCE has been at or below the PQL or non-detect in all samples collected at this well since 2003, and the apparent trend is caused by using one-half the sample detection limit in the trend analysis.

- PTX06-1095A is within the influence of the SEPTS well field, but is also located less than 50 feet downgradient of the PRB pilot study wells PTX06-PRB01A and PTX06-PRB02. Since 2014, detections have been highly variable. The increasing trend is likely due to the PRB losing treatment effectiveness and concentrations returning to baseline conditions. A decreasing trend was exhibited by the last four samples.

- An apparent increasing trend below the GWPS was identified for PTX06-1098, located on the upgradient side of the ISB pilot system; however, the last four samples indicate "No Trend." These results correspond to a decrease in *cis*-1,2-DCE and may indicate a reduction in the treatment provided by the ISB pilot system along with movement of the plume out of this area.

- An apparent increasing trend was identified for PTX06-1101; however, the most recent sample was equal to 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 decreases in *cis*-1,2-DCE to below the PQL. Therefore, the increase in TCE may indicate a reduction in the treatment provided by the ISB pilot system along with movement of the plume out of this area.

- A probably increasing trend was identified for PTX06-1126 located upgradient of the Zone 11 ISB system. Concentrations began increasing in 2016, but the last four samples indicate a stable trend. This well is located downgradient from the identified sources in Zone 11, so the variations likely reflect general plume movement in the area.

- 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 general plume movement in the area.
- PTX07-1O03, located north of Playa 1, has exhibited increasing low-level TCE detections since 2014. However, concentrations remain at or below the PQL, and no detections have exceeded GWPS. The last four samples indicate a decreasing trend below the PQL. As discussed in Section 3.1.4.1, the area north of Playa 1 is affected by P1PTS operations.
- 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, which may also be influenced by SEPTS operations. Concentrations have been highly variable in this well, and the last four samples indicate a decreasing trend.
- TCE was detected near the PQL in 2019 at PTX08-1008, located southwest of Zone 12. The identified increasing trend is the result of recent low-level detections and use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area.

In addition to the wells identified above, an apparent increasing trend was identified for PTX07-1O02; however, the water level in this well has been below the bottom of the well screen since 2017. No trend was identified for the last four samples collected before the water level dropped, and all concentrations were below the GWPS of 5 ug/L.

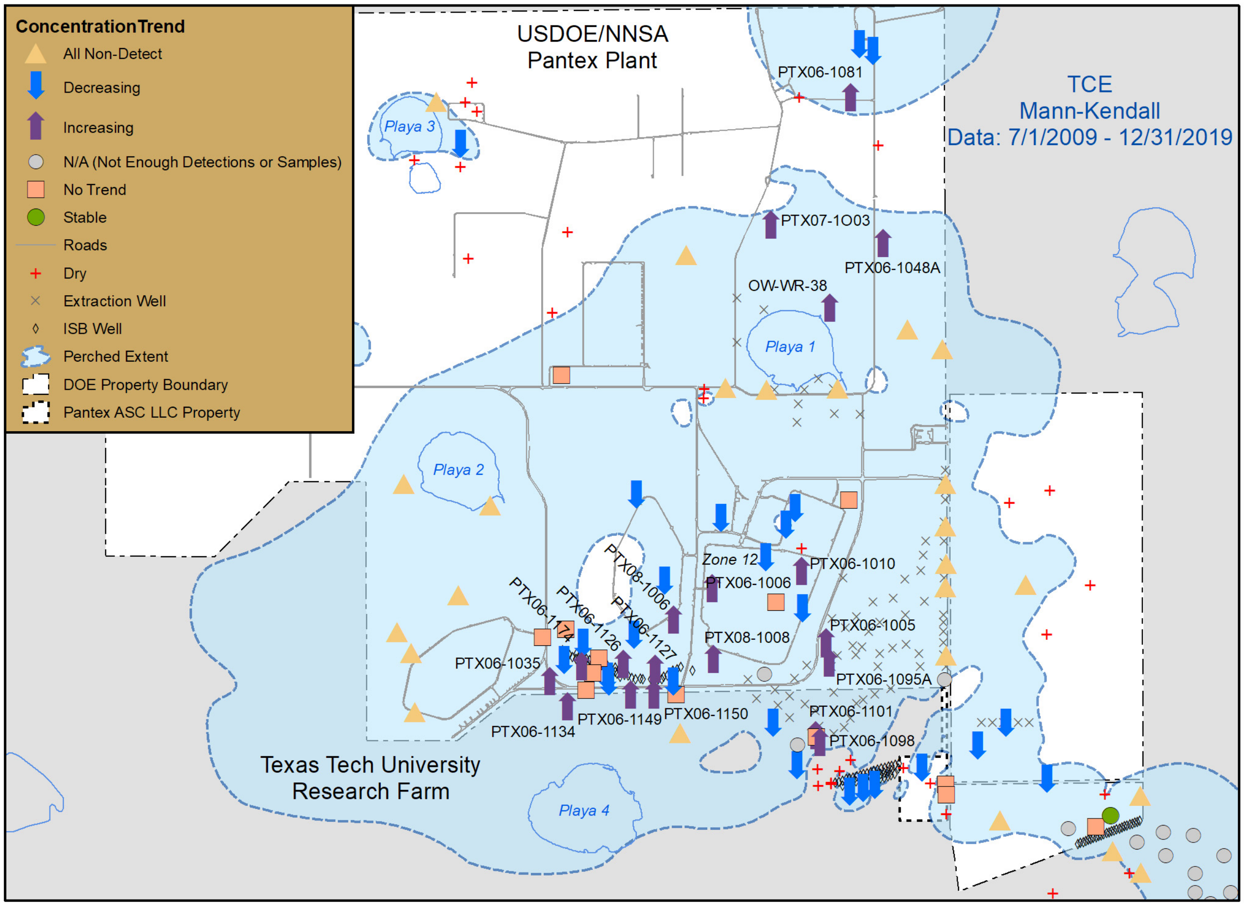

Figure 3-10. TCE Trends in the Perched Aquifer

3.1.5 CONCENTRATION TRENDS COMPARED TO EXPECTED CONDITIONS

Of the 103 monitor wells with expected COC concentration conditions defined in the LTM Design Report, 36 wells did not exhibit trends (since the start of remedial actions) consistent with the expected conditions. Fifteen wells (1114-MW4, OW-WR-38, PTX04-1002, PTX06-1010, PTX06-1011, PTX06-1014, PTX06-1048A, PTX06-1077A, PTX06-1081, PTX06-1098, PTX07-1O03, PTX07-1P02, PTX08-1003, PTX08-1009, and PTX10-1014) had expected conditions of long-term stable or decreasing trends in concentration, but indicated increasing trends since the start of remedial actions. However, their long-term trends were decreasing or stable, so the expected conditions are met and the trends in these wells are not discussed further. Currently, the smaller size of the comparative dataset (covering approximately 9 ½ years since remedial actions began) limits its effectiveness to represent long-term trends. It is expected that, as remedial actions continue to operate and the dataset continues to grow, these trends will become more representative of long-term conditions in the perched aquifer.

The following 21 monitoring wells (depicted in Figure 3-11), PTX06-1005, PTX06-1006, PTX06-1015, PTX06-1031, PTX06-1034, PTX06-1035, PTX06-1049, PTX06-1095A, PTX06-1101, PTX06-1126, PTX06-1127, PTX06-1134, PTX06-1146, PTX06-1149, PTX06-1150, PTX06-1153, PTX06-1159, PTX06-1166, PTX08-1001, PTX08-1006, and PTX08-1008, exhibited trends that were not consistent with the expected conditions and were previously discussed in Section 3.1.4. Additional detail on all LTM wells is located in Table E-1 in Appendix E.

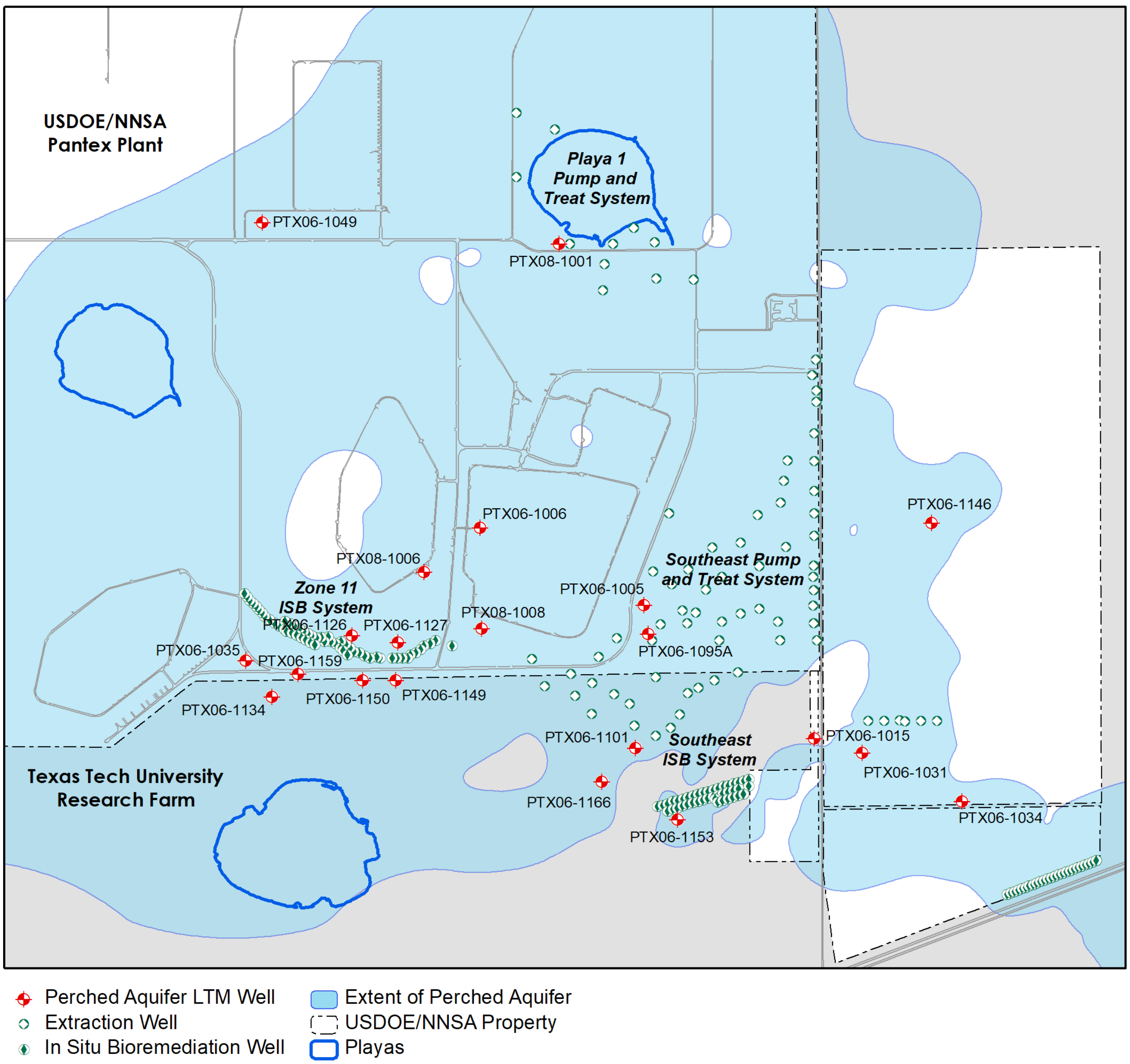

Figure 3-11. Perched Wells with Unexpected COC Trends

3.1.6 PLUME MAPPING

Isoconcentration maps of indicator constituents (COCs and breakdown products of RDX and TCE) in the perched aquifer are presented in this section. Perched aquifer indicator parameters were proposed in the SAP. Isoconcentration maps for this annual report were produced from groundwater data collected in 2019. Each isoconcentration map presents the highest detected concentration for each constituent using validated analytical data from January to December 2019. The COC plumes were delineated to the approved GWPS as was done for the 2014 Annual Progress Report. 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 in generating the isoconcentration contours, but the analytical concentration data from these wells may differ from 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 in generating 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 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, these results were not included in the contouring process. The estimated downgradient areas under the influence of the ISB systems are now 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 in generating 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. Figure 3-12 through Figure 3-26 are isoconcentration maps for RDX, 4-amino-2,6-dinitrotoluene, hexavalent chromium, perchlorate, and TCE. Maps for MNX, DNX, TNX, TNT, 2-amino-4,6-dinitrotoluene, 1,3,5-trinitrobenzene, 1,4-dioxane, 1,2-dichloroethane, *cis*-1,2-dichloroethene, PCE, and vinyl chloride are presented in Appendix F.

Table 3-1. Perched Aquifer Indicator Parameters

HEs	Metals	Inorganics	Volatile Organics
RDX	Boron	Perchlorate	1,2-Dichloroethane
HMX	Chromium		1,4-Dioxane
MNX	Hexavalent Chromium		*cis*-1,2-Dichloroethene
DNX			*trans*-1,2-Dichloroethene
TNX			PCE
TNT			TCE
1,3-Dinitrobenzene			Chloroform
2-Amino-4,6-dinitrotoluene			Vinyl Chloride
4-Amino-2,6-dinitrotoluene			
2,4-Dinitrotoluene			
2,6-Dinitrotoluene			
1,3,5-Trinitrobenzene			

Isoconcentration maps for the other indicator constituents (HMX, 1,3-dinitrobenzene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, boron, *trans*-1,2-dichloroethene, 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.

Boron

Boron did not exceed the GWPS of 7,300 ug/L in any perched aquifer well sampled in 2019. 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 2019. Historically, wells constructed with a stainless steel well screen 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 analysis of the concentrations of chromium and other components of stainless steel (manganese, molybdenum, and nickel) shows 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. Therefore, 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.

HMX

HMX was not detected above the GWPS of 360 ug/L in any perched aquifer well sampled in 2019. 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 2019. Therefore, an isoconcentration map was not prepared for this compound.

2,4-Dinitrotoluene

2,4-Dinitrotoluene was not detected above the GWPS of 1 ug/L in any perched aquifer well sampled in 2019. 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 two perched aquifer SEPTS extraction wells in 2019. These isolated exceedances 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.

Trans-1,2-Dichloroethene

Trans-1,2-dichloroethene was not detected above the PQL or GWPS in any perched aquifer well sampled in 2019. Therefore, an isoconcentration map was not prepared for this compound.

Chloroform

Chloroform did not exceed the GWPS of 80 ug/L in any perched aquifer well sampled in 2019. Therefore, an isoconcentration map was not prepared for this compound.

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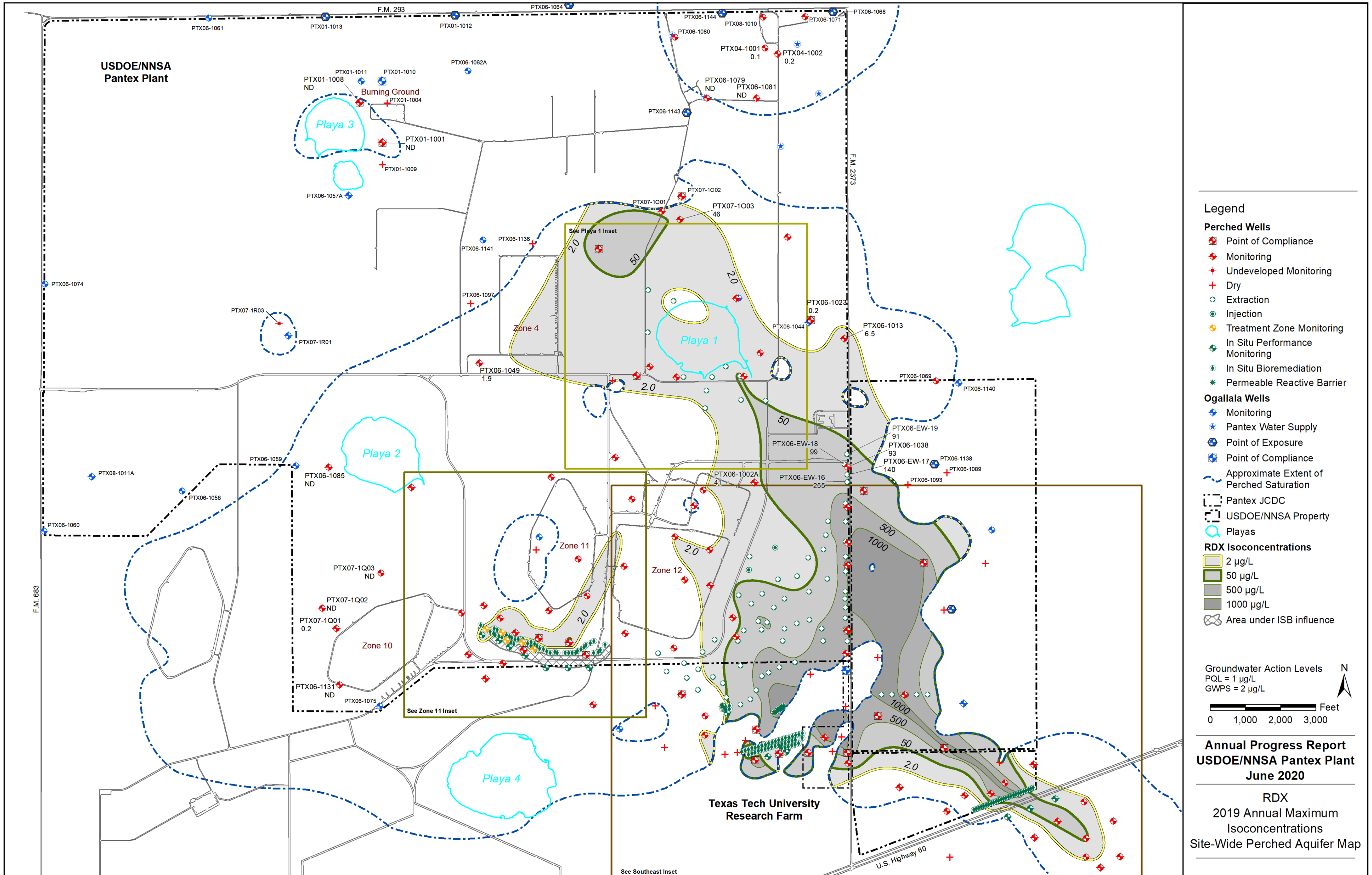

Figure 3-12. RDX Isoconcentration Map

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Figure 3-13. RDX Isoconcentration Southeast Inset Map

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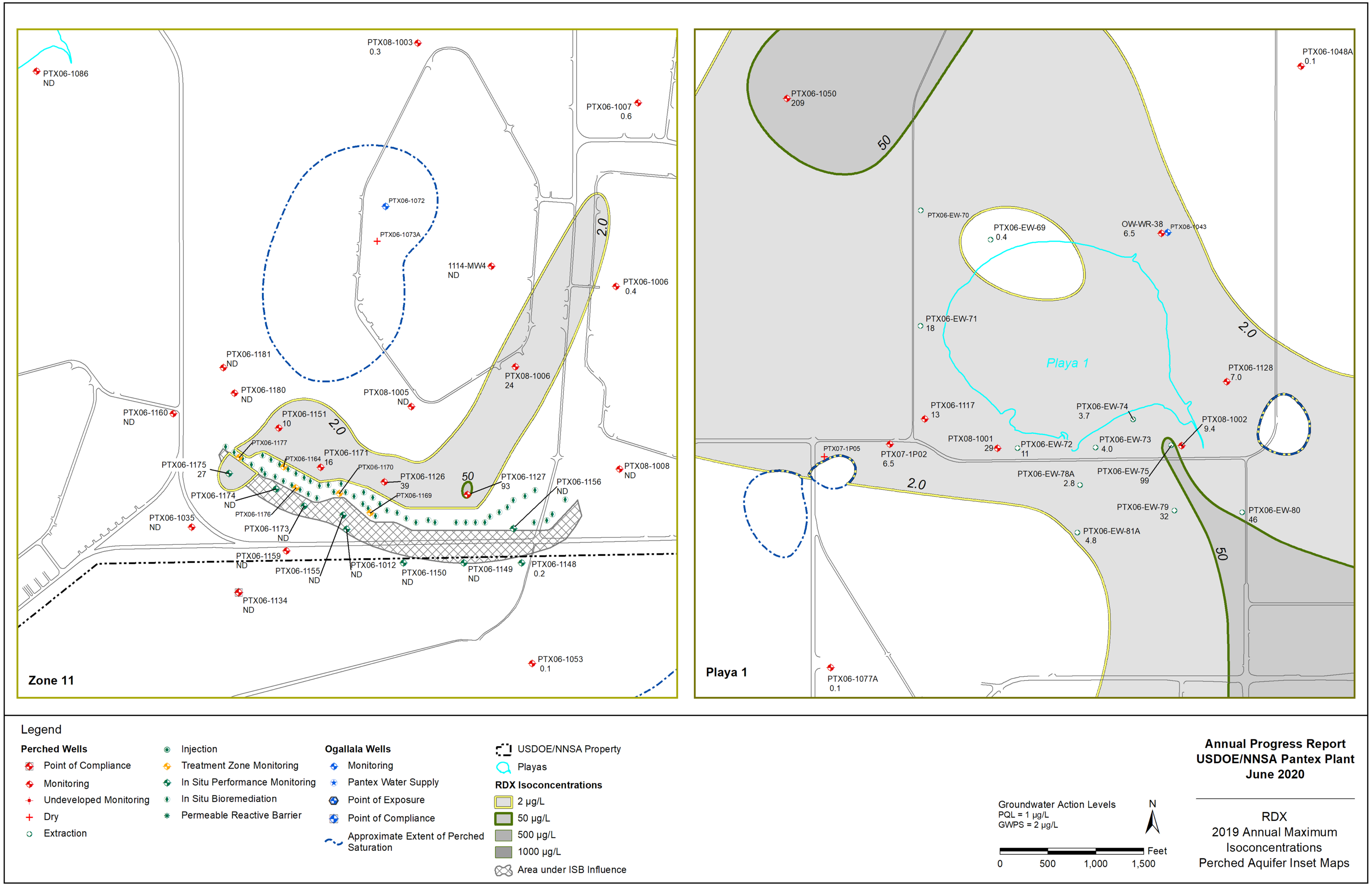

Figure 3-14. RDX Isoconcentration Zone 11 and Playa 1 Inset Maps

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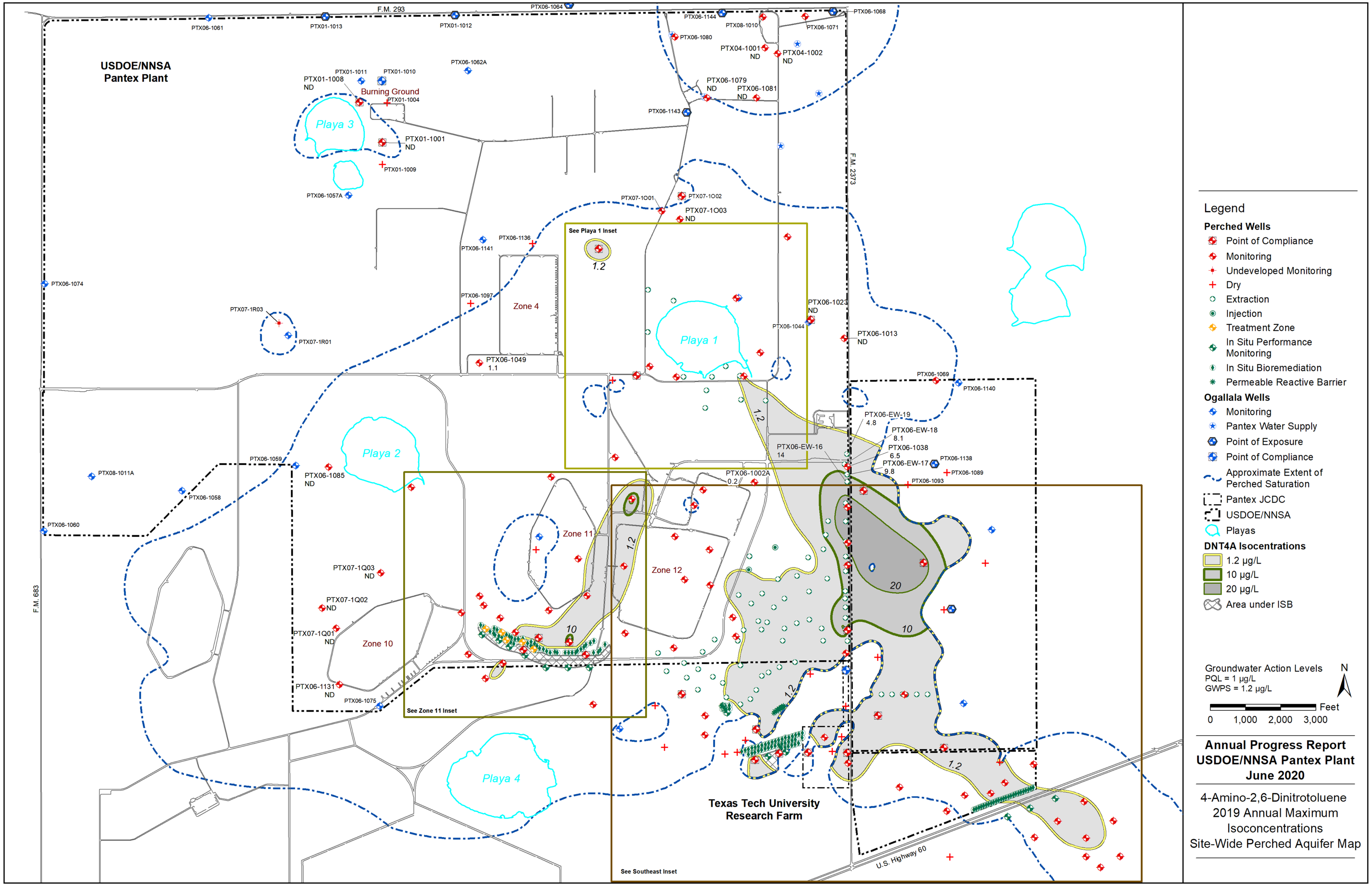

Figure 3-15. DNT4A Isoconcentration Map

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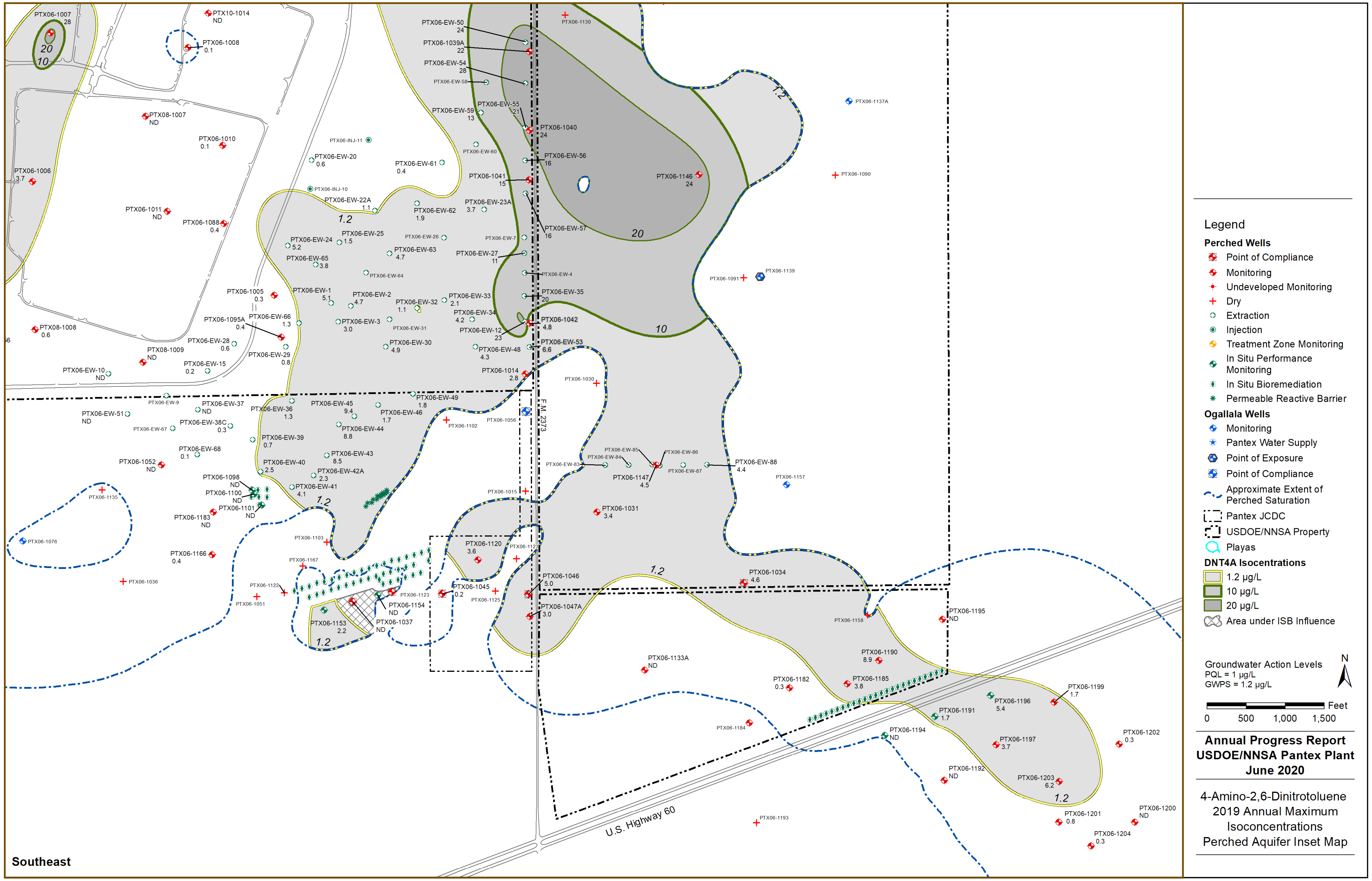

Figure 3-16. DNT4A Isoconcentration Southeast Inset Map

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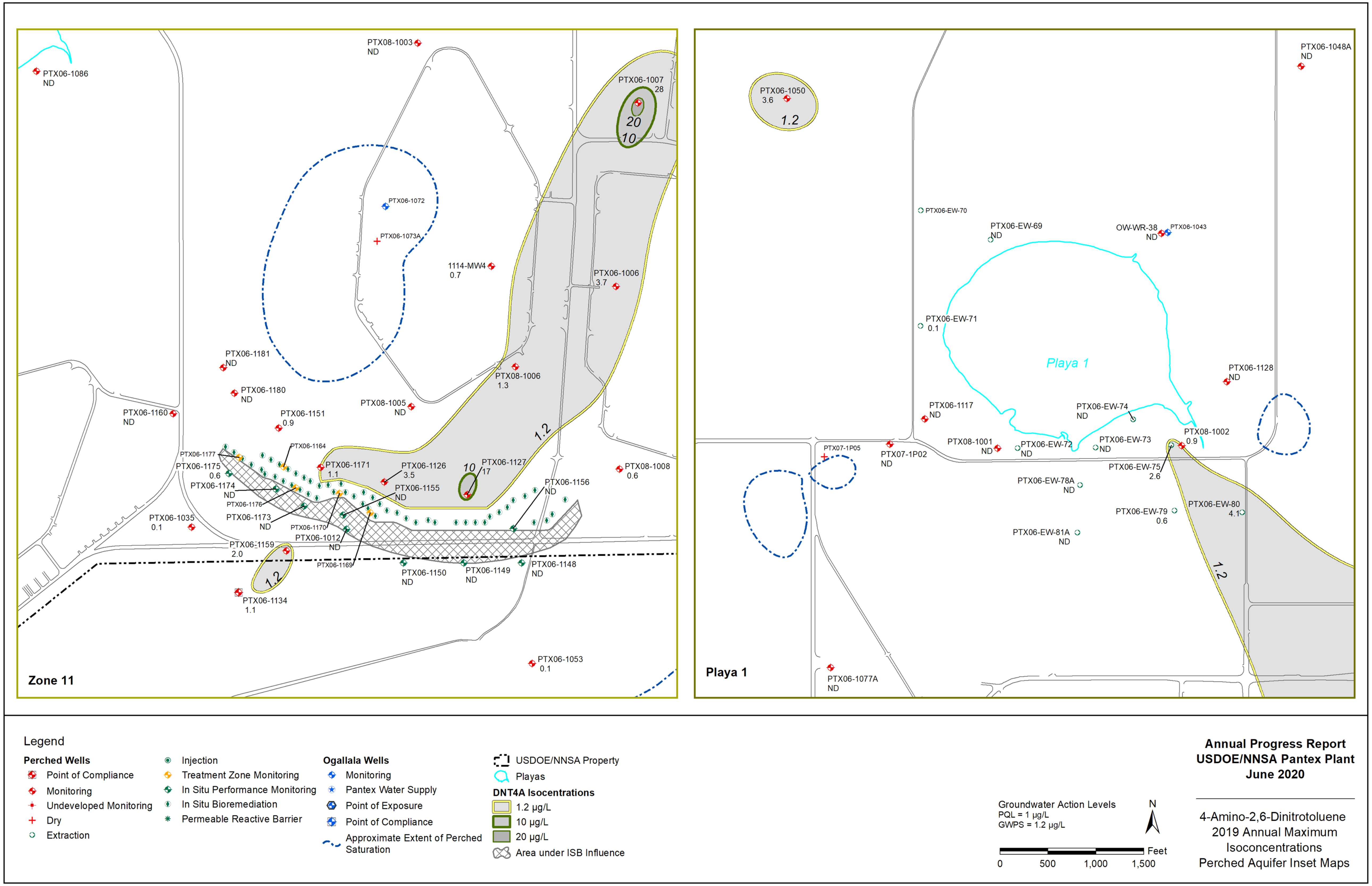

Figure 3-17. DNT4A Isoconcentration Zone 11 and Playa 1 Inset Maps

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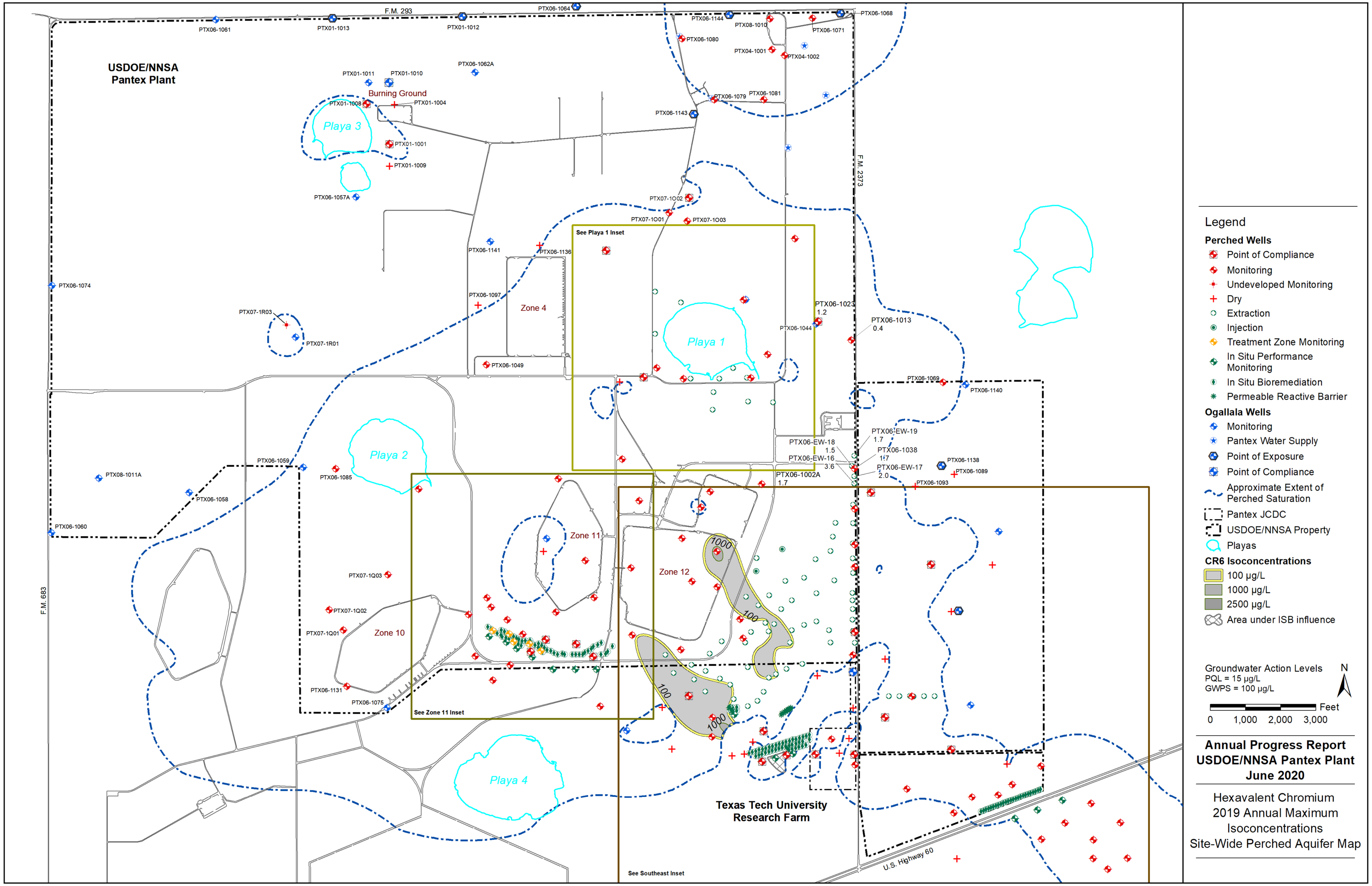

Figure 3-18. Hexavalent Chromium Isoconcentration Map

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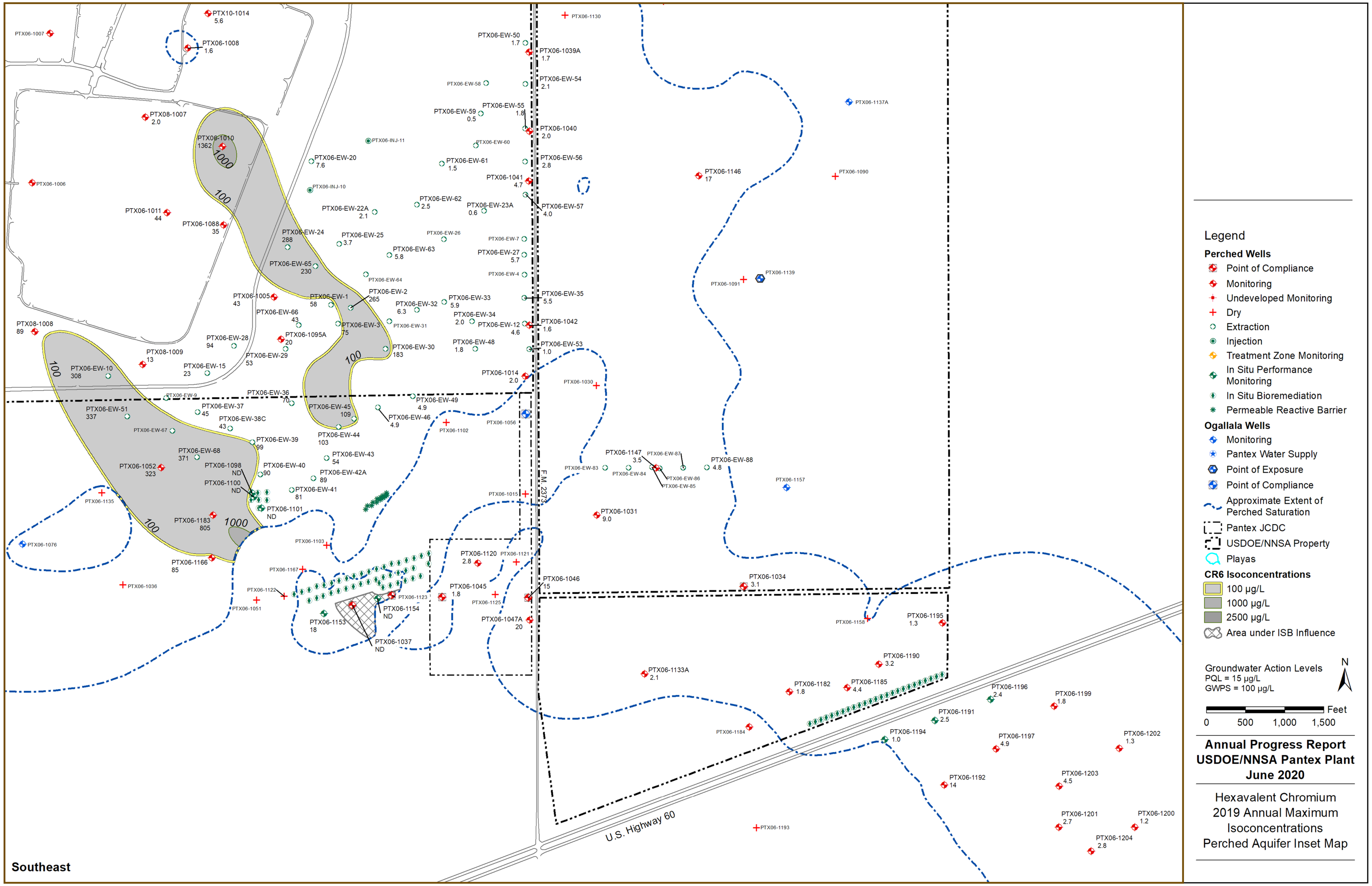

Figure 3-19. Hexavalent Chromium Isoconcentration Southeast Inset Map

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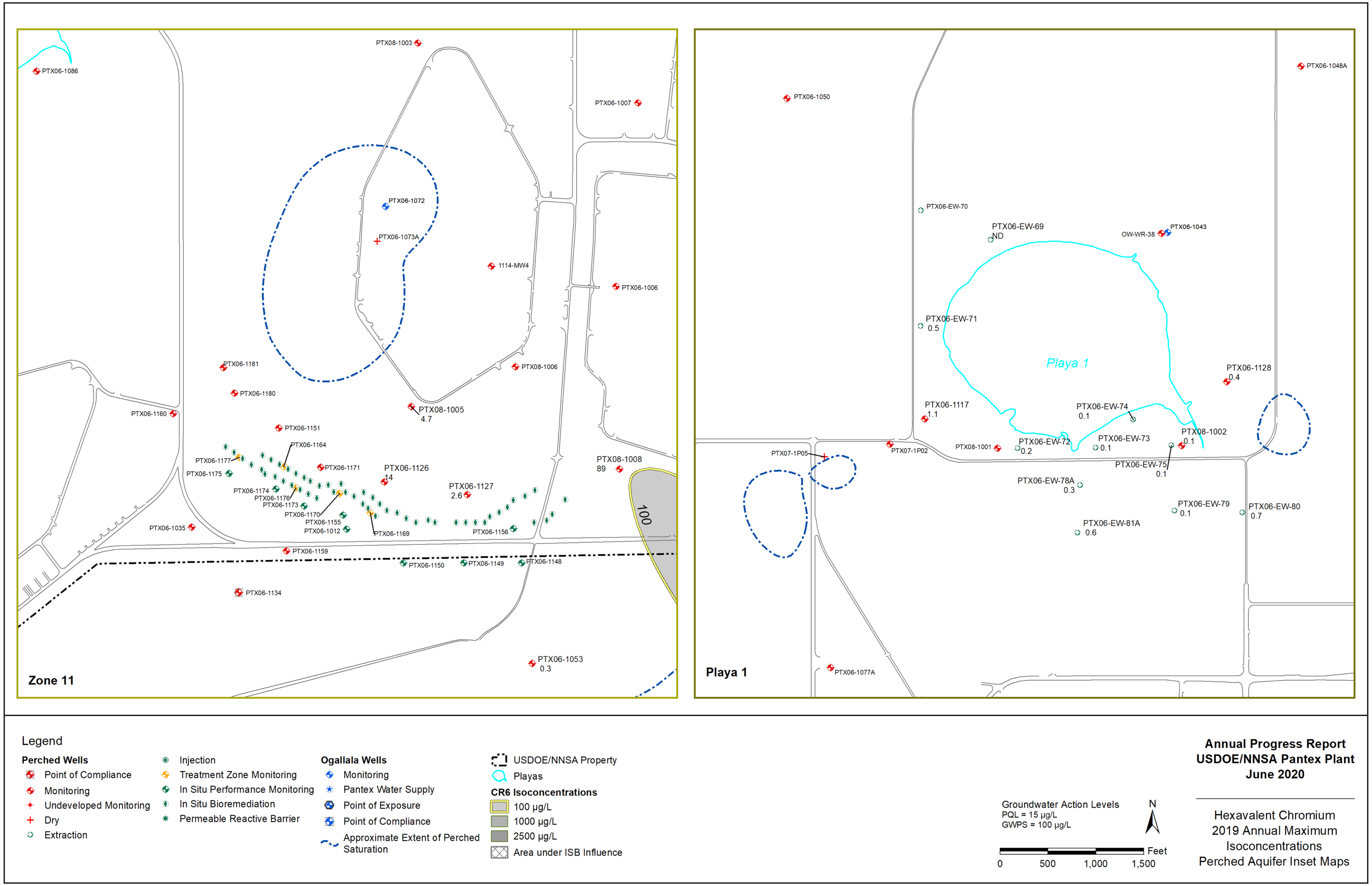

Figure 3-20. Hexavalent Chromium Isoconcentration Zone 11 and Playa 1 Inset Maps

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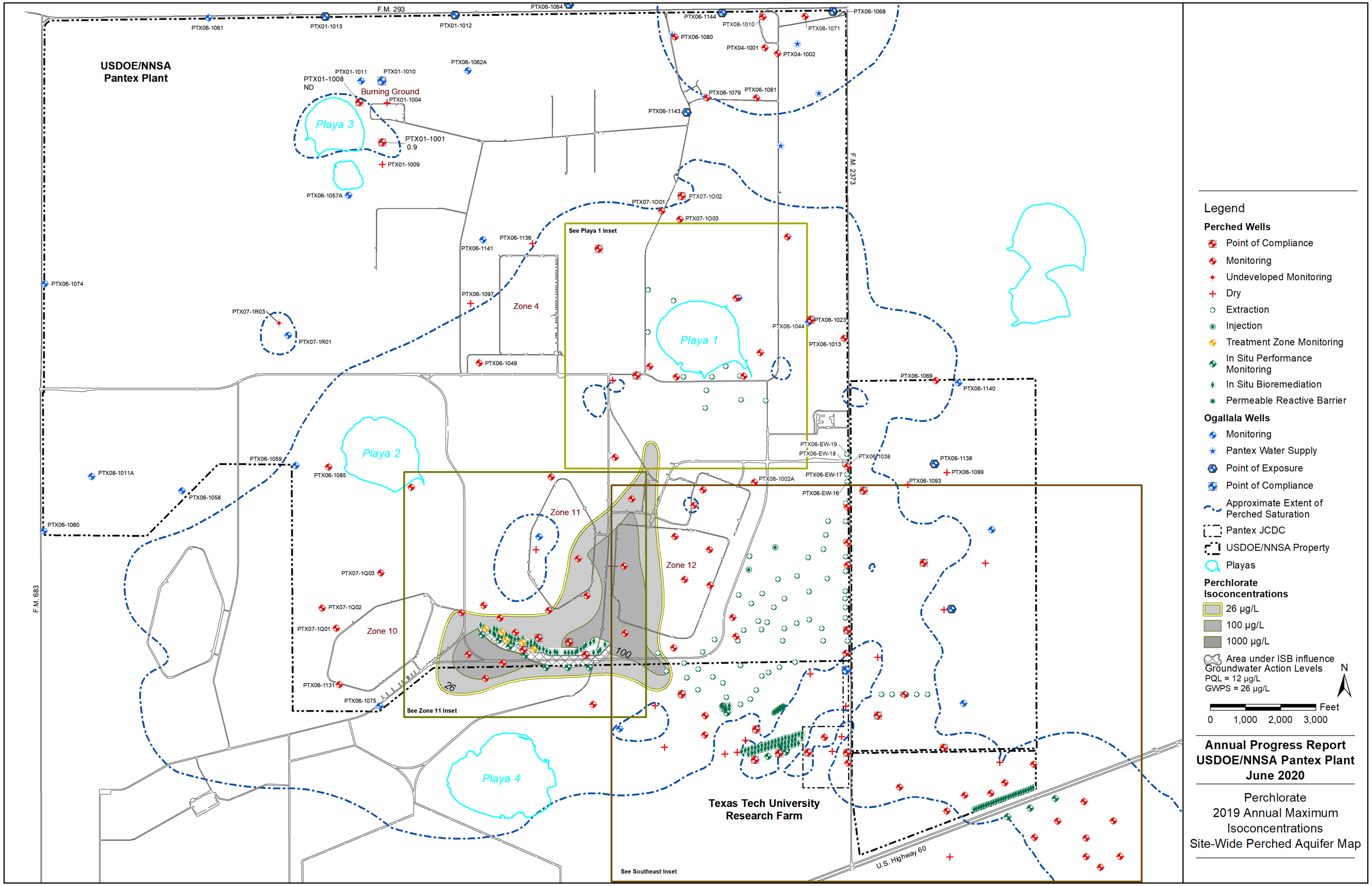

Figure 3-21. Perchlorate Isoconcentration Map

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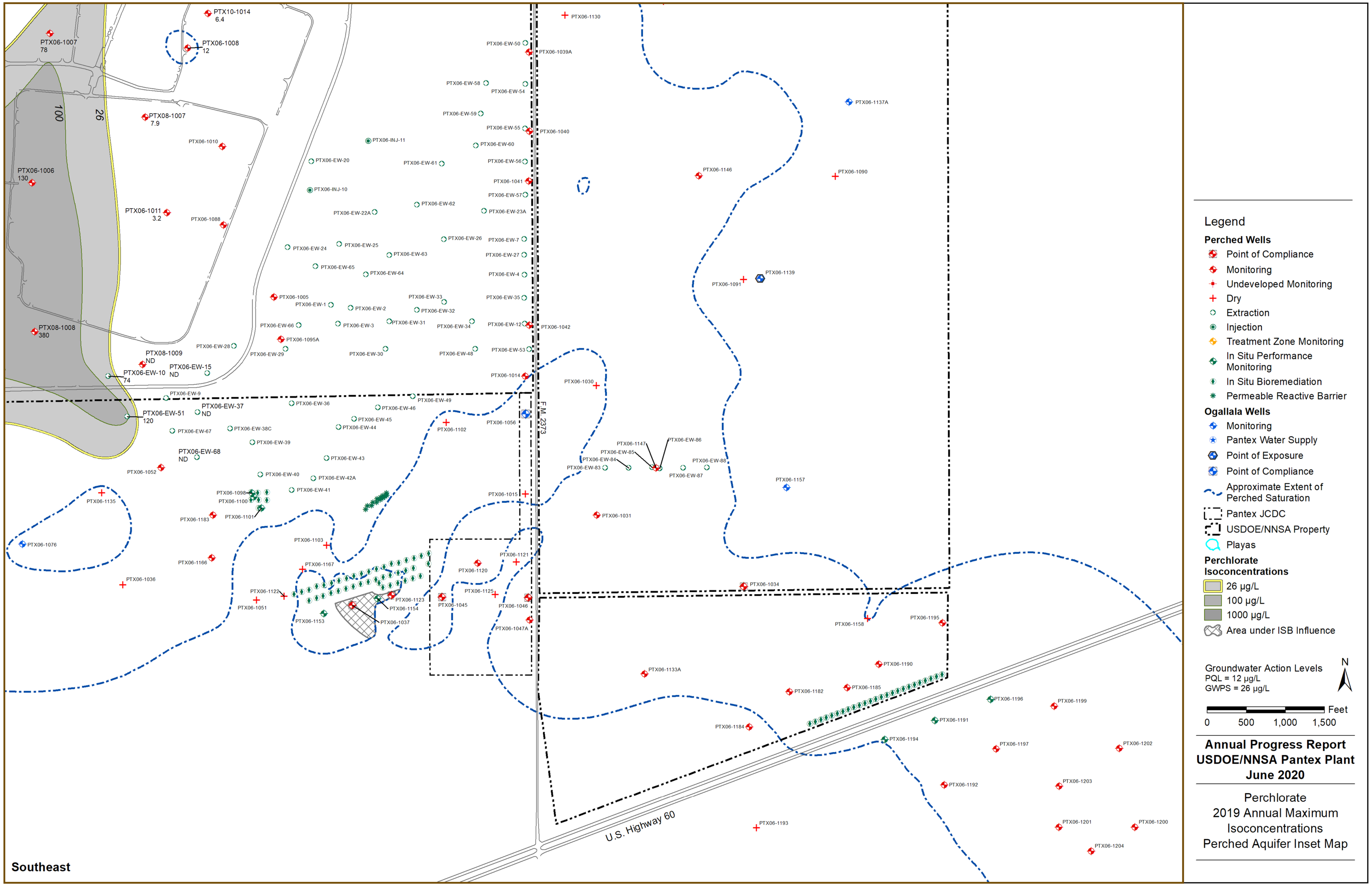

Figure 3-22. Perchlorate Isoconcentration Southeast Inset Map

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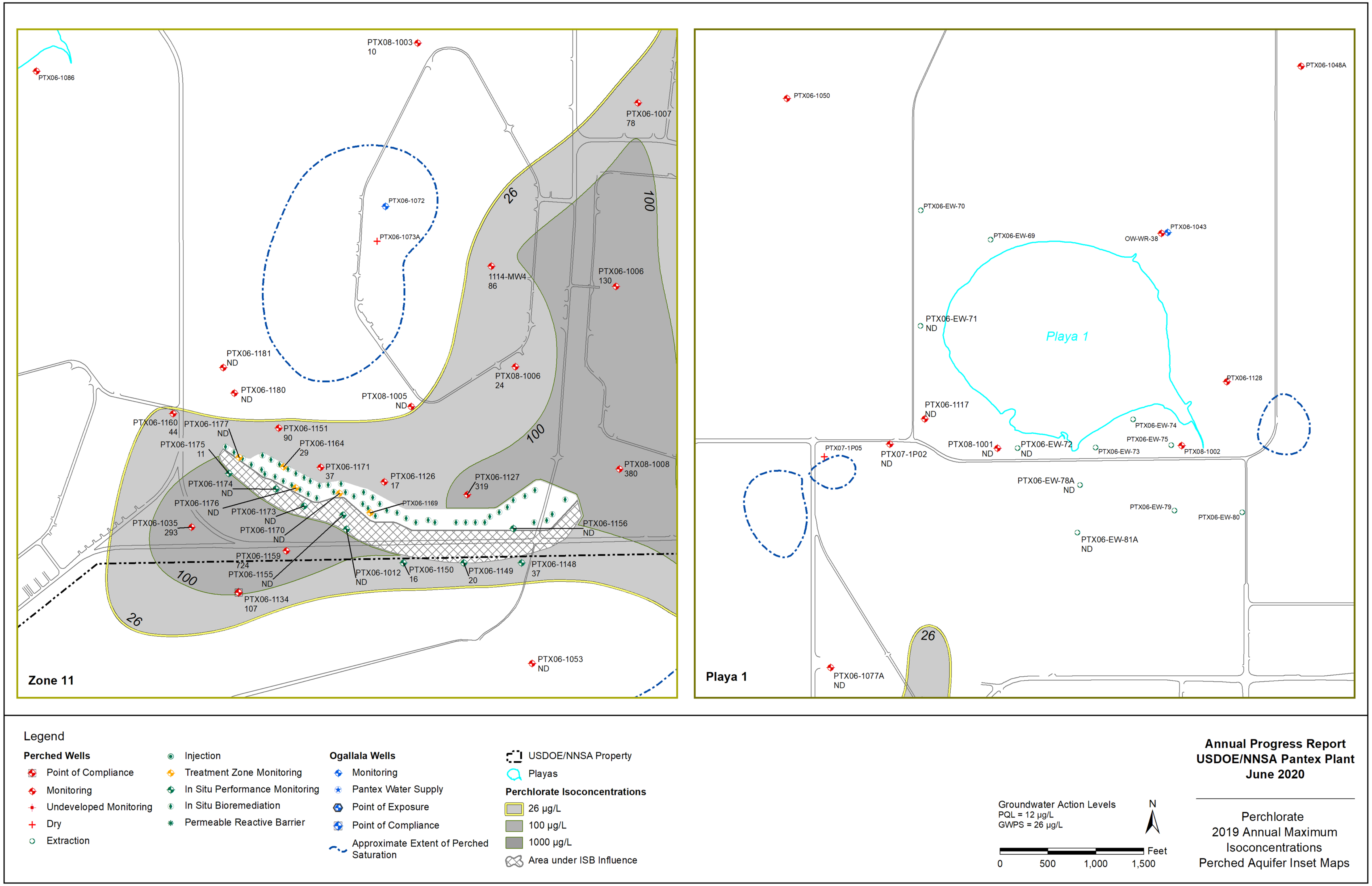

Figure 3-23. Perchlorate Isoconcentration Zone 11 and Playa 1 Inset Maps

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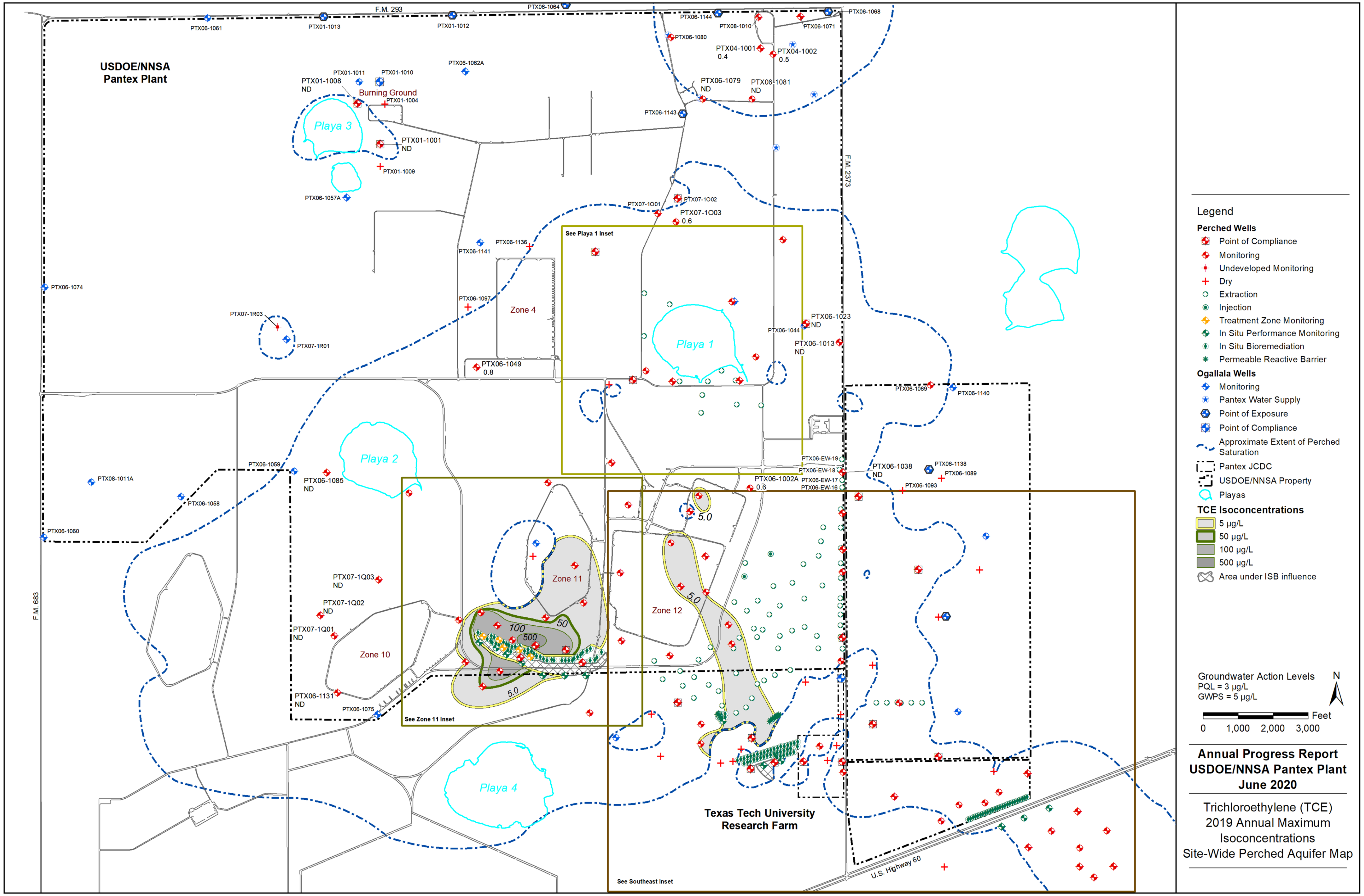

Figure 3-24. TCE Isoconcentration Map

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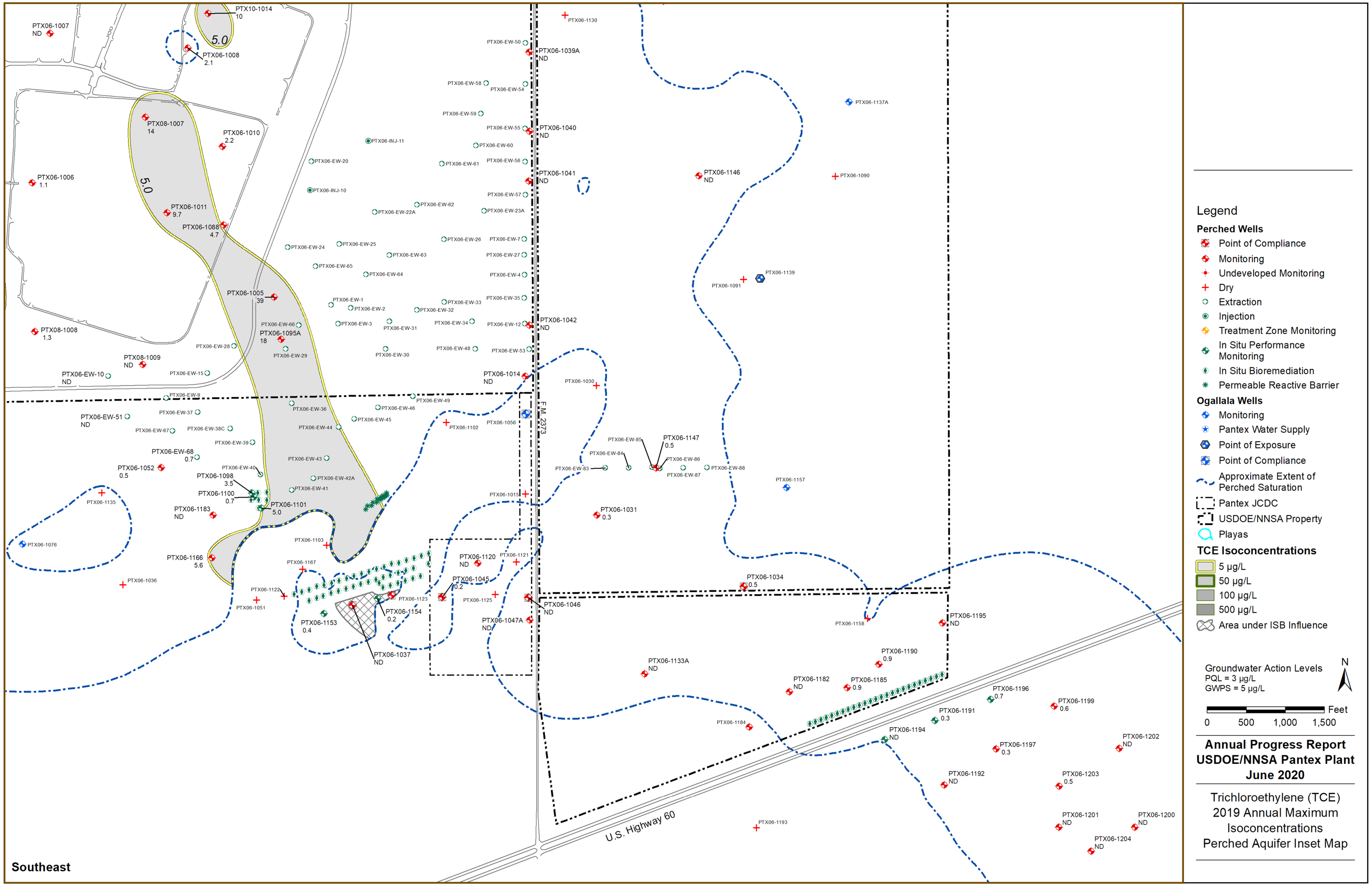

Figure 3-25. TCE Isoconcentration Southeast Inset Map

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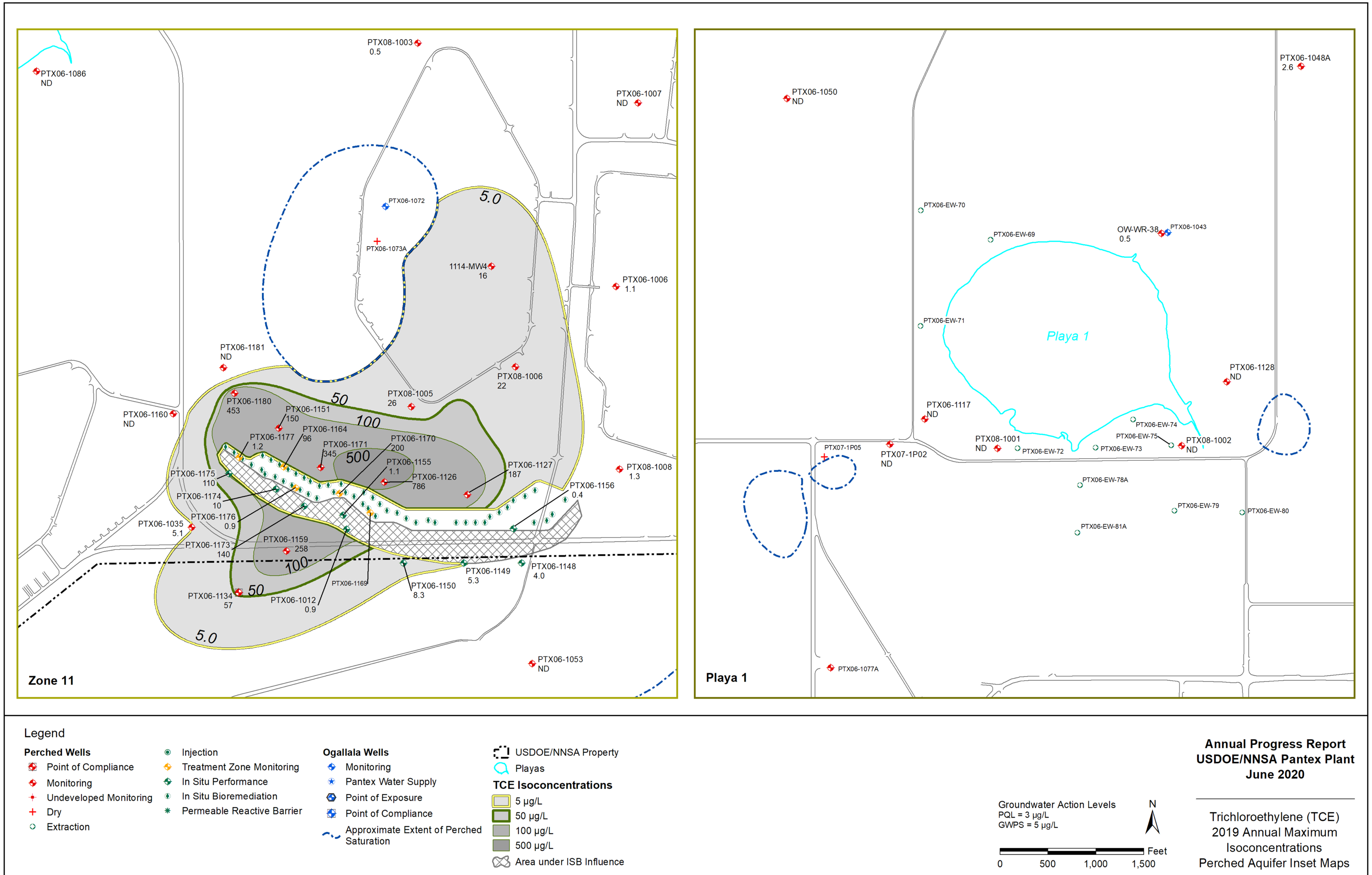

Figure 3-26. TCE Isoconcentration Zone 11 and Playa 1 Inset Map

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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 for estimating the rate of migration of groundwater contaminants. Unlike a typical contaminant plume in a regional aquifer, the HE plume associated with Pantex (Figure 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, 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 located 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 2009–2019 is included in the following sections. 2019 plume boundaries 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 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. Trending of historic analytical data for this plume indicates source areas along the ditches continue to leach HEs into perched groundwater, but at much lower concentrations than occurred historically. This plume is being actively remediated by the SEPTS that limits further migration of contaminants to the east. In addition, the P1PTS is actively treating the 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 and PTX06-1049 are exhibiting some increasing trends in HEs. However, these trends are believed to be due to the reduction of saturated thickness and shifting gradients in the northern perched groundwater due to P1PTS operations rather than sourcing from the landfills. Trends will continue to be monitored at these locations.

In order to attempt to evaluate HE plume movement from 2009–2019, 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 the plume 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 (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 Figure 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 SEPTS operations and general plume movement in areas that are not under the SEPTS influence. For 2019, the RDX contour has extended into the far southeastern lobe of perched groundwater. This shift is the result of increases in RDX to above 1,000 ug/L at PTX06-1034, PTX06-1147, and PTX06-ISB124 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 in the top of the FGZ.

Pantex determined the downgradient extent of the plume in early 2019 with the installation of 6 new wells to the southeast and has completed a line of injection wells as part of an extension to of the Southeast ISB remedy to intercept this plume as it migrates to the southeast.

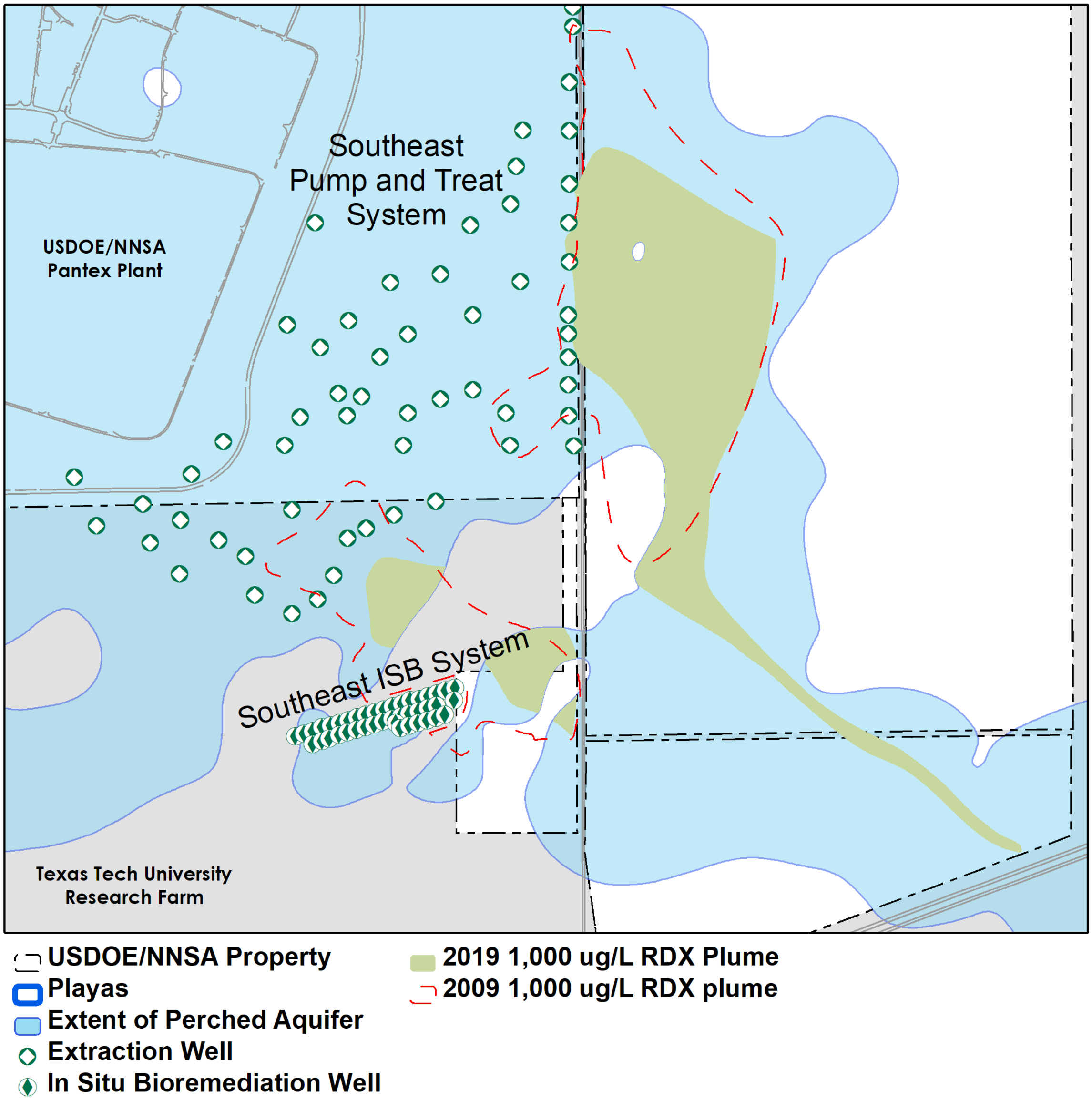

Figure 3-27. RDX Plume Movement, 2009-2019

3.1.7.2 Hexavalent Chromium Plumes

Hexavalent chromium is present in the perched aquifer in two commingled plumes originating in Zone 12 as shown in Figure 3-18 and Figure 3-19. Both of these plumes are being actively remediated by the SEPTS. The highest concentrations are associated with a source in WMG 5 outside the southwestern corner of Zone 12. Concentrations near the source area are decreasing indicating 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 and Southeast ISB system.

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 it is likely the source area continues to leach contamination to the perched groundwater.

When compared with the 2009 hexavalent chromium maps (Figure 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 SEPTS extraction well pumping and reduction of injection in the area.
- The southern portion of the plume has apparently shifted southwest because of downgradient movement of chromium beyond the influence of the SEPTS.

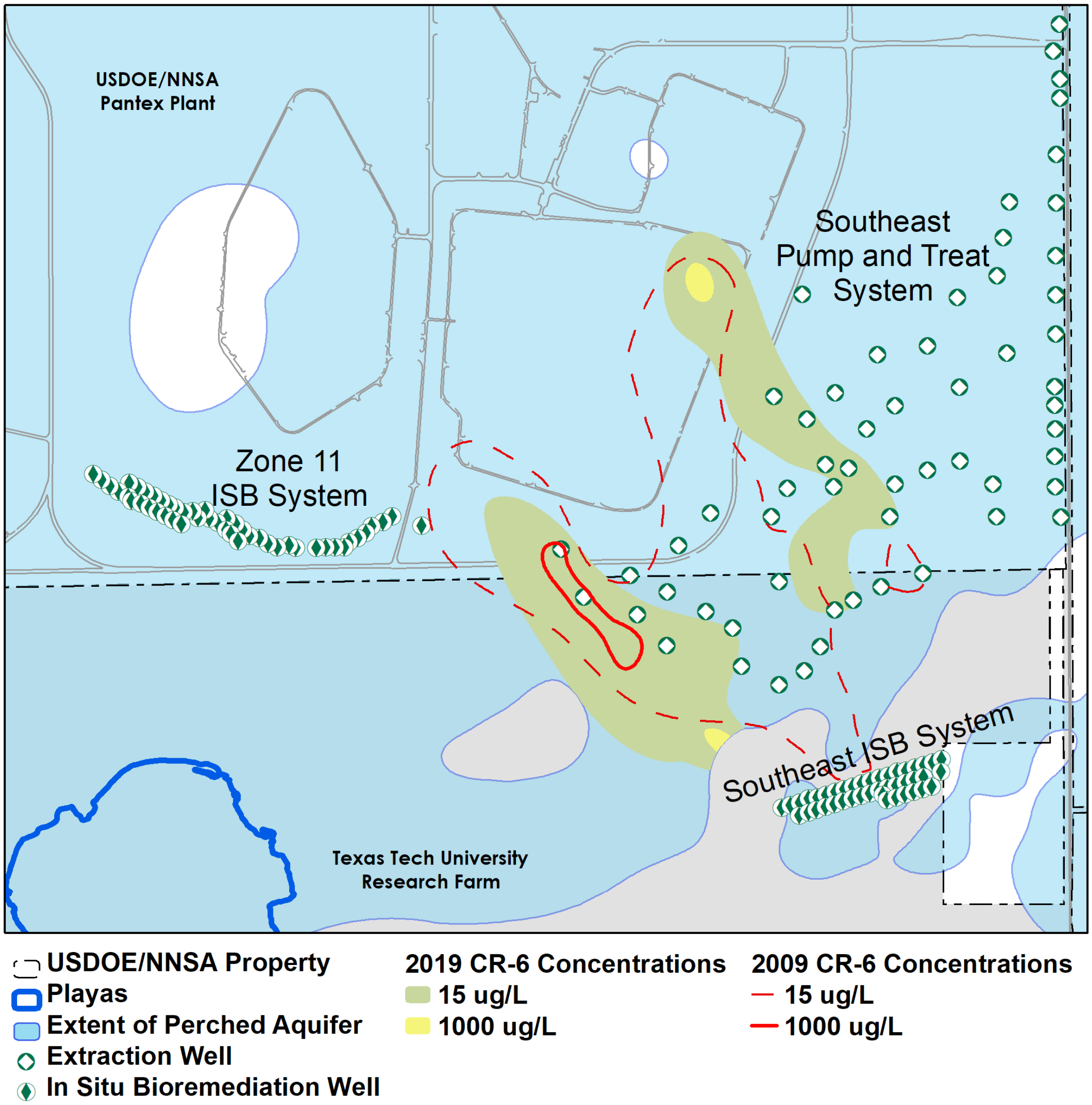

Figure 3-28. Hexavalent Chromium Plume Movement, 2009–2019

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 TTU property as shown in Figure 3-21, Figure 3-22, and Figure 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 Pantex

Plant continue to generally increase. This plume is being actively remediated by the Zone 11 ISB System.

As depicted in Figure 3-29, the perchlorate plume shape is similar to the 2009 plume map, with the following notable exceptions.

- The northern lobe of the plume has contracted due to the decreasing concentrations in wells that define the boundaries in the area. However, these concentrations and resulting plume shapes have been quite variable since remedial actions began in 2009.
- The southern lobe of the plume has shifted to the south and west, likely due to advection and dispersion, as well as data collected from newly installed monitor wells.
- 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 two westernmost SEPTS extraction wells.

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. This portion of the perchlorate plume is being actively remediated by SEPTS at this time. The ion exchange resin used in SEPTS for treatment of chromium can also treat perchlorate at lower concentrations. Pantex has plans to upgrade SEPTS with perchlorate resin vessels to treat the higher concentrations that are expected in the future.

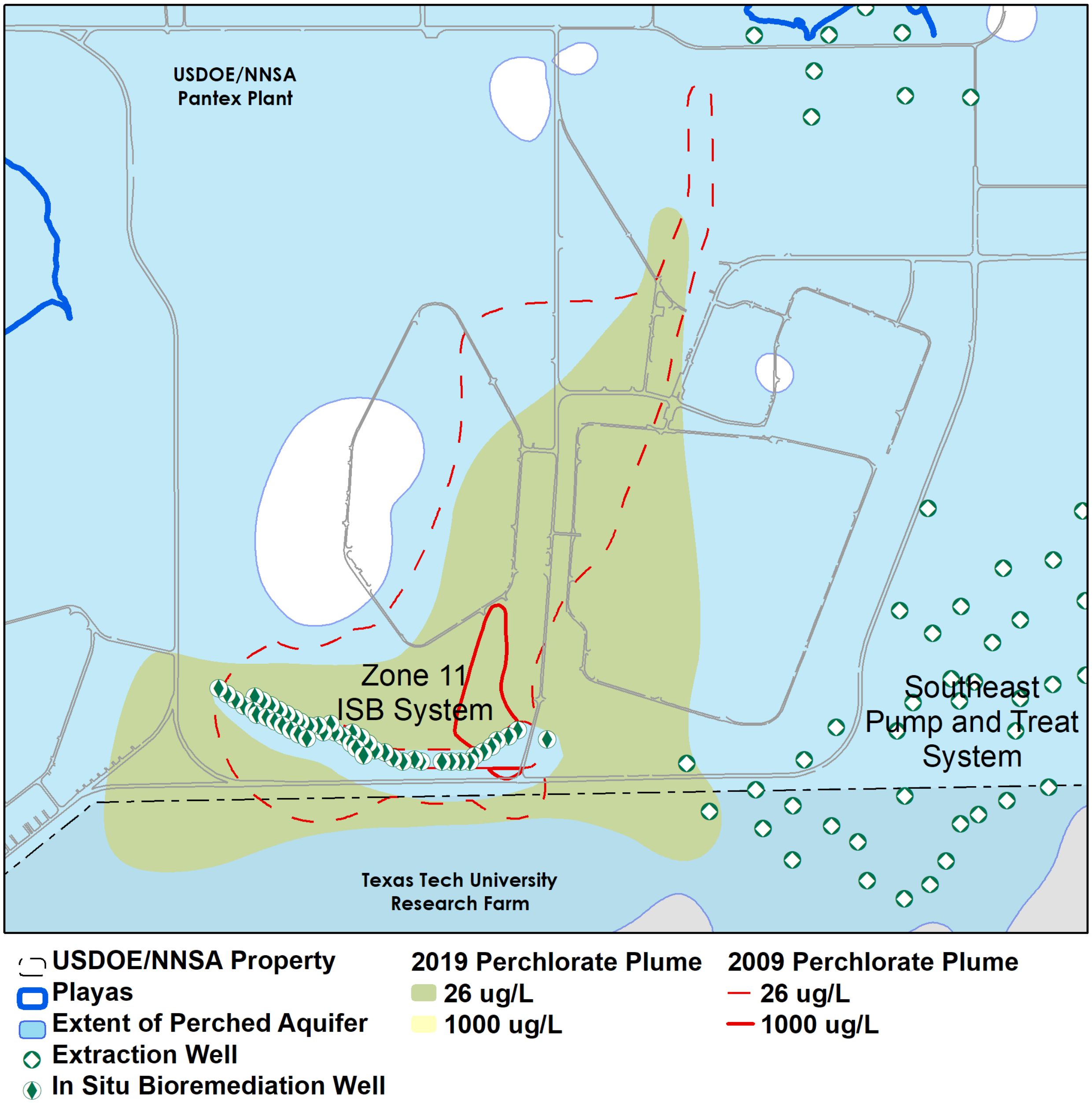

Figure 3-29. Perchlorate Plume Movement, 2009-2019

3.1.7.4 Trichloroethene Plumes

Several TCE plumes are present in the perched aquifer as shown in Figure 3-24, Figure 3-25, and Figure 3-26. One plume originates in the north (source area in Waste Management Group [WMG] 10) and east (source area in SWMU 122b) sides of Zone 12 and extends 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 leaching of TCE-contaminated process water associated with legacy discharges to 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 decreasing trend in TCE.

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

As depicted in Figure 3-30, the 2009 and 2019 TCE plume shapes are similar, with the following notable exceptions.

- The plume originating from Zone 12 has contracted near the Zone 12 source areas. However, the southern edge of the plume has shifted to the west due to data collected at monitoring well PTX06-1166 and decreasing TCE concentrations in Southeast ISB ISPM wells.
- The plume originating from Zone 11 has shifted to the south and west due to general gradient in the area and recently installed wells to the west. The TCE plume beneath Zone 11 has also expanded to the east as a result of the shifting flow gradients in perched groundwater.

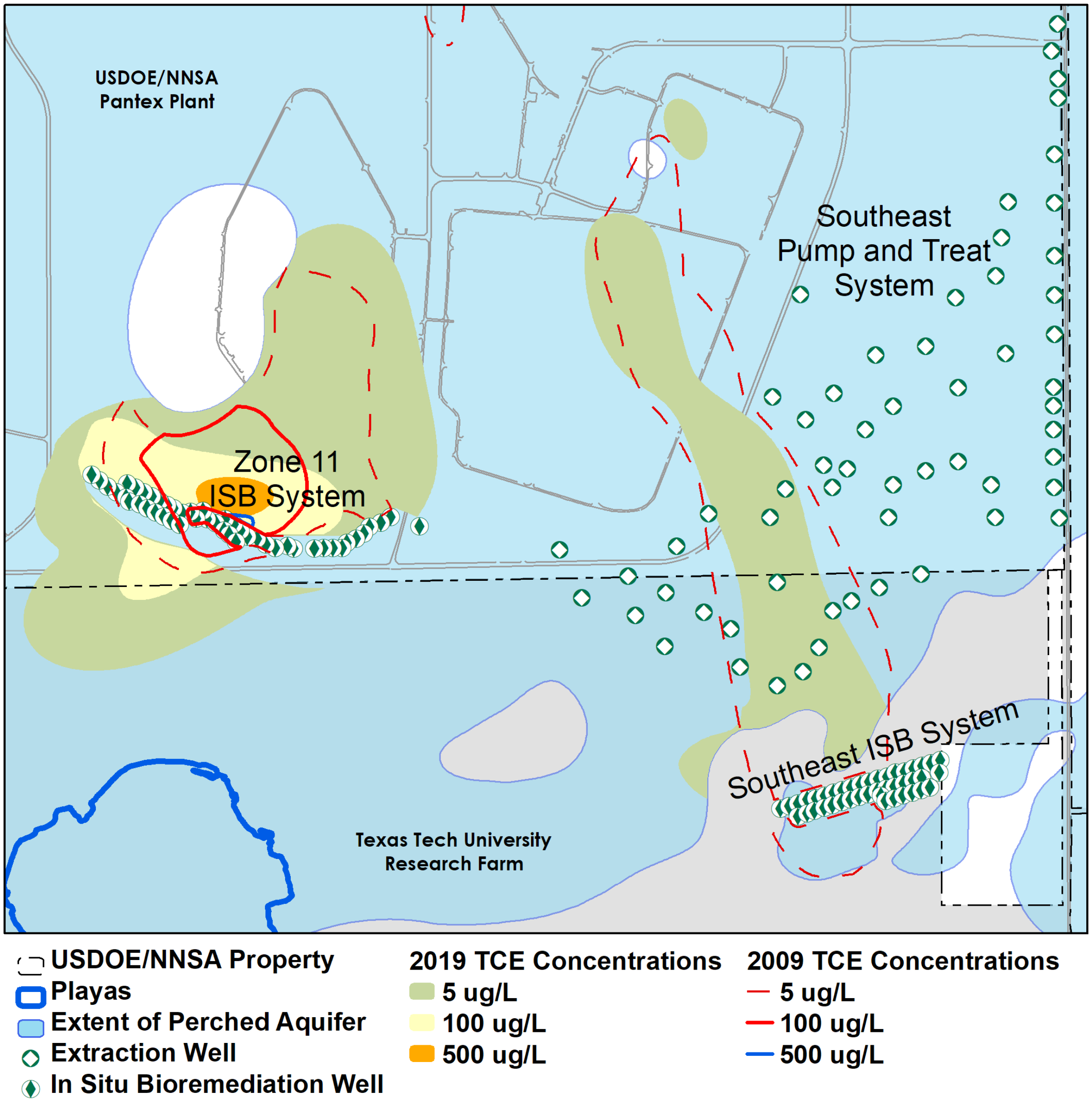

Figure 3-30. TCE Plume Movement, 2009-2019

3.2 Remedial Action Effectiveness

3.2.1 Southeast Pump and Treat System

The objective of the SEPTS (see Figure 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 in order to achieve two important goals:

- A gradual reduction of the volume of perched groundwater (and contamination) moving downgradient toward the extent of saturation, and

- A reduction in the head (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 both pump and treat systems. Water levels measured at 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 formation of an extensive cone of depression throughout the system is limited by the thin saturated thickness of the aquifer.

The water table map indicates groundwater is still flowing southward across the USDOE/NNSA property boundary onto TTU property. However, extraction wells located on 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

Hydrodynamic control limits the horizontal migration of contaminants by using extraction wells to alter the hydraulic gradient. Because of the limited saturated thickness of the perched aquifer, complete hydraulic containment of the contaminant plume is not possible. However, the SEPTS has been effective at altering 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, the removal of perched groundwater has resulted in significant retreat of the apparent extent of perched saturation on TTU property. The approximate radius of influence of the groundwater treatment systems and the directions of perched groundwater flow gradients outside the radius of influence are shown on Figure 3-31. Capture zones, shown in Figure 3-31 for the extraction wells, were calculated using a single-layer groundwater flow model of the perched aquifer. Average 2019 extraction flow rates for each well were used in the calculations.

Operation of the pump and treat systems was affected in 2019 by repairs at the WWTF and the break at the filter bank of the irrigation system. The break at the filter bank is expected to be a long-term impediment to operations because repairs will only focus on a portion of the irrigation system. Once repaired, the irrigation system is expected to support release of water from the WWTF as a priority, restricting flow from P1PTS more than experienced in the past. As a result, the capture zone is expected to be impacted until Pantex can put other systems in place for the management of the treated water. Operation of new wells east of FM 2373 that were tied in to the system in March 2019 has improved capture of water to the east of FM 2373, but other areas may continue to be impacted by the lower flow rates at the SEPTS as the new wells are prioritized for operation. To address the issues regarding release or use of treated water, Pantex has recommended design and construction of the following two options:

- Increasing irrigation to the land east of FM 2373 under the Texas Land Application Permit. Pantex submitted an application to amend the permit to include surface application of irrigation using treated perched groundwater (separately or with the WWTF effluent). Pantex has also requested funding to design and construct changes to the SEPTS and to build irrigation infrastructure to the east. Funding is not expected until Fiscal Year 2021 for this recommendation and construction is not expected to be complete until the end of 2022.
- Pantex previously recommended extending the treated water line from the Zone 11 ISB to an area east/southeast of Playa 2 to allow injection of treated water. Design and construction of that project is expected to be complete in 2020. Pantex expects to be able to inject about 150 gpm in this area when needed.

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.

3.2.1.2 System Effectiveness

Considering 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 included in Section 3.1 can be used to determine the effectiveness of these systems. To this end, the pump and treat systems continue to be effective in 2019. When comparing the 2019 conditions to LTM Design expected conditions, the majority of monitor wells are meeting expected conditions in the ninth year of the remedial action. The LTM wells not meeting expected conditions for water levels are summarized in Section 3.1.4.

As a part of the SEPTS secondary goal of mass removal, the system continued to remove both HEs and hexavalent chromium and treated over 122 million gallons of extracted water to concentrations below the PQL and the GWPS during 2019. As discussed in Section 2.1.2, the SEPTS was primarily affected by loss of throughput to the WWTF/irrigation system after the break at the irrigation filter bank. While the SEPTS did not consistently meet all throughput goals during 2019, Pantex continues to optimize the system operation.

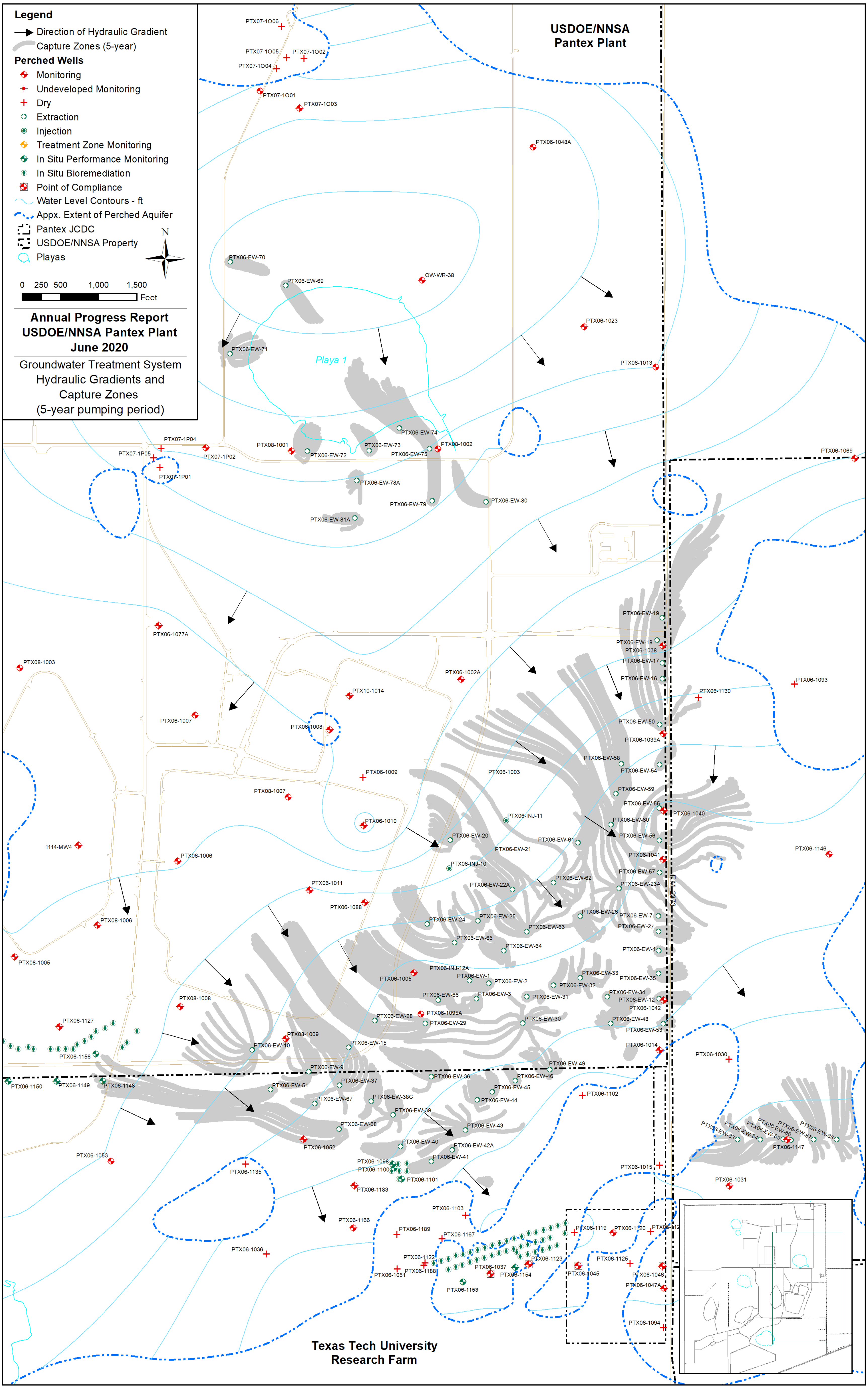

Figure 3-31. Pump and Treat System Capture Zones

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3.2.2 Playa 1 Pump and Treat System

The P1PTS was completed during 2008 with operations starting in September 2008. This system extracts water from 11 wells near Playa 1 (see Figure 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 reduce the mound of perched groundwater associated with Playa 1, affecting the movement of the southeast plume by reducing the hydraulic head, as well as achieving mass removal.

P1PTS appears to be influencing local water levels and hydraulic gradient in the Playa 1 area. Figure 3-31 illustrates the influence of both groundwater pump and treat systems. Water levels measured at 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 as the groundwater high in the perched aquifer is now to the north. Groundwater is still generally flowing away from the Playa 1 region, then to the south/southeast across the USDOE/NNSA property boundary onto TTU property. As the perched aquifer saturated thickness continues to be reduced in this region, this flow should decrease, and the driving head will be reduced. In addition, SEPTS extraction wells limit the 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.

3.2.2.1 System Effectiveness

Considering 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 included in Section 3.1 can be used to determine the effectiveness of these systems. To this end, the pump and treat systems continue to be effective in 2019. When comparing the 2019 conditions to LTM Design expected conditions, most wells are meeting expected conditions.

During 2019, the system treated approximately 25.3 million gallons of extracted water. As discussed in Section 2.1.1, total flow at P1PTS was limited to allow higher recovery at SEPTS because increased recovery at SEPTS provides better control of the RDX plume movement to the southeast. Impacts from the irrigation system break also affected operations at

P1PTS. Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below the PQL and the GWPS.

3.2.3 ISB Systems

Pantex has installed and operates three ISB systems (Zone 11 ISB, Southeast ISB, and Southeast ISB Extension). 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, indicators of geochemical conditions and amendment longevity are used to determine if conditions are within an acceptable range for oxidation-reduction (redox) potential, electron acceptor concentrations (i.e., dissolved oxygen [DO], nitrate, and sulfate), and nutrient supply (total organic carbon). These parameters are important because reducing conditions and adequate nutrients must be present to treat the COCs.

Because of problems with plugging of the wells, Pantex has moved to increasing the soluble carbon during injection events and reducing the EVO, as recommended in the 2017 Annual Progress Report. An amendment dose response study performed in 2018 found that the use of more soluble carbon source amendments, such as molasses, in combination with use of larger volumes of water and amendment, results in better distribution of amendment between injection wells and produces deeper reducing conditions within the treatment zone.

Based on the dose response study, future operation of all ISBs is focusing on use of a more soluble carbon (e.g., molasses) to achieve the distribution needed at the ISB Systems. Molasses was injected at the Zone 11 ISB in 2019 and was used at the Southeast ISB Extension. This measure is expected to help avoid issues with plugging of the wells or formation by the EVO and resulting biomass. Pantex will continue to evaluate the 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 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 the most widespread and that have the potential to affect human health if the water were to be used for residential purposes, even though 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.

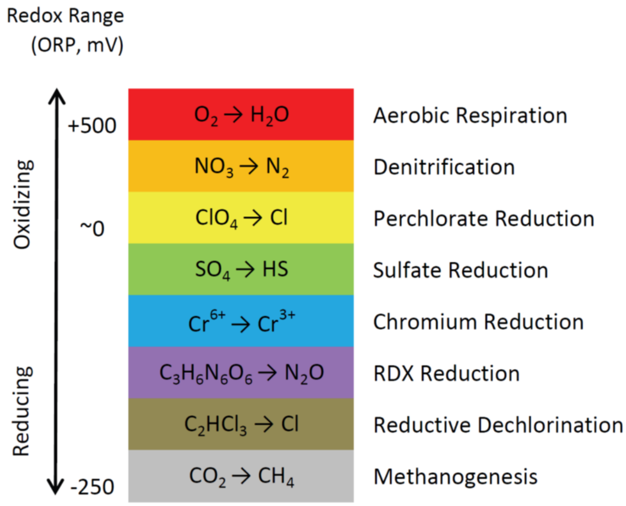


Figure 3-32. Typical Geochemical Redox Ranges

In addition to specific indicators to help determine if additional injections are required, Pantex monitors for TOC, metals, and general chemistry parameters. TOC was selected as an indicator that an adequate carbon source remains available for continued ISB treatment. Specific metals are monitored in downstream performance monitoring 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 the naturally occurring metals in the formation soils. However, as the water moves away from the 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 is on Pantex Property, south of Zone 11 (see Section 1.4.2 map). The system, as operated in 2019, consists of 48 injection wells, ten of which are used to monitor performance in the injection zone, five treatment zone performance monitoring wells, and nine downgradient ISPM wells. The injection wells are installed in a zone of saturated thickness of approximately 15–20 ft. The performance monitoring wells are used to monitor characteristics indicative of the health of the microorganisms and the overall performance of the remedial system.

The Zone 11 ISB system was installed in 2009 with injection completed in 32 wells. Pantex expanded the system to the west in late 2014 to include an additional 20 injection wells, along with treatment zone and performance monitoring wells, targeted at the TCE plume on the western side of the ISB system. Four second row wells on the perchlorate (eastern) side of the system were removed from active injection in 2016. Ten injection events have been completed at the system; the tenth injection event occurred in 2019 in two phases with the expansion area wells to the northwest injected in May, June, and July and the main system injected from September 2019 through January 2020. The expansion area has received three injections through the end of 2019, so deeper reducing conditions are likely established at the injection wells. Deep reducing conditions may not be fully demonstrated at all of the wells that are monitored in the expansion area due to their placement between injection wells. Pantex continues to evaluate the expansion area to determine if bioaugmentation with *Dehalococcoides spp*. (DHC) is needed to potentially boost the treatment efficiency for TCE. More frequent injections are anticipated for molasses and have been 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 with the molasses.

Pantex has also further expanded the Zone 11 ISB in late 2019 with six new injection wells to completely encompass the plume to the northwest. The final well was sampled to determine the concentration of TCE and ensure the plume would be completely treated. Pantex plans to inject the new wells at the next injection event scheduled later in 2020.

COCs targeted for treatment by this system are perchlorate and TCE. Indicator constituents evaluated for trends at downgradient performance monitoring wells include TCE and its degradation products (*cis*-1,2-DCE and vinyl chloride) along with perchlorate. Expected conditions are that the indicator constituent concentrations will decline at 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 total organic carbon are evaluated in the ISB treatment zone performance wells to determine if the treatment zone is rebounding to baseline conditions, thus requiring amendment injection. The expected conditions for the treatment zone wells are that redox potential and electron acceptor

(DO, nitrate, and sulfate) concentrations will decline after injection. As shown in Figure 3-32, strongly reducing conditions must be achieved for reductive dechlorination of TCE to occur. The redox potential should decline from baseline and be below –50 mV for the reduction of TCE and near 0 mV for the reduction of perchlorate. Concentrations of total organic carbon should increase after injection, but decline over time as the amendment is consumed.

During 2019, Pantex monitored four treatment zone monitoring (TZM) wells, eight injection wells, and nine downgradient performance monitoring wells in accordance with the SAP to evaluate the Zone 11 ISB (see Section 1.4.2 map). Pantex also monitors two treatment zone wells in the second row to better evaluate conditions on the east side of the system where injection was discontinued in the second row of wells. An additional treatment zone well (PTX06-1169) was installed to potentially replace nearby monitored injection wells PTX06-ISB071 and PTX06-ISB077. However, these two injection wells are defined as monitoring points in the SAP. This well is now included in the new SAP revision that was implemented at the beginning of 2020.

One of the monitored treatment zone wells (PTX06-ISB075) is a replacement of the original ISB injection well but is not currently used for injection. The original PTX06-ISB075 well continues to receive amendment and will be used until the well fails.

The system has a well-established treatment zone in the original portion of the system, where injection has occurred since 2009. The expansion area has received three injections, so deeper reducing conditions are likely established at the injection wells. Deep reducing conditions have been more difficult to establish at treatment zone monitor wells located between the injection wells in the expansion area. The molasses injection has improved conditions between injection wells in 2019. Improved conditions have been noted across the western side of the Zone 11 ISB after moving to the use of molasses. However, some wells have limited ability to accept injection and those areas will likely continue to demonstrate milder reducing conditions until wells can be replaced. All wells downgradient of the system have indicated arrival of treated water.

Evaluation of data in the treatment zone indicates very mild to strong reducing conditions (ORP ranging from -132 to 115 mV and sulfate from 0.2 to 25 µg/L) across the Zone 11 ISB. Monitored conditions inside the treatment zone indicate that sulfate was reduced in two of five non-injected wells and negative ORP in four of five wells, indicating deeper reducing conditions in those areas. Conditions improved at most of the non-injected wells in the expansion area following the molasses/EVO injection in 2018. TCE continues to be reduced to *cis*-1,2-dichloroethene (DCE), with TCE concentrations below GWPS in three monitor wells inside of the treatment zone and *cis*-1,2-DCE present at concentrations below the GWPS in three of the five monitor wells. The presence of TCE and *cis*-1,2-DCE continues to indicate partial treatment in the non-injected treatment zone wells, as concentrations tend to be higher in the non-injected 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 four wells inside the treatment zone and ethene detected at low concentration at two wells. The low vinyl chloride results, coupled with the minimal detection of ethene, indicates that some of the TCE is being completely degraded in some areas of the treatment zone. When TCE concentrations inside the treatment zone are low (< 300 µg/L), these low degradation rates may be enough to treat TCE and its breakdown products to GWPS. Upgradient data still indicate TCE concentrations periodically fluctuating above 300 µg/L, with a concentration of 1,500 µg/L indicated at an upgradient monitoring well in late 2018.

Table 3-2 summarizes the current and maximum COC concentrations in each ISB, TZM, and ISPM well. Perchlorate was not detected at any monitored injection well. TCE continues to be reduced to cis-1,2-dichloroethene (DCE), with TCE concentrations below GWPS in nine monitor wells inside of the treatment zone. Cis-1,2-DCE was detected in six monitor wells inside of the treatment zone in 2019 with concentrations below the GWPS in three of those wells. The presence of TCE and cis-1,2-DCE continues to indicate partial treatment in the non-injected treatment zone wells, as concentrations tend to be higher in the non-injected 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 above the GWPS at four wells inside the treatment zone, but was not detected at other wells. Ethene was detected in two wells, indicating that TCE is being completely degraded in some areas of the treatment zone. When TCE concentrations inside the treatment zone are low (< 300 µg/L), these low degradation rates may be enough to treat TCE and its breakdown products to GWPS. Upgradient data still indicate TCE concentrations periodically fluctuating above 300 µg/L. Data collected at treatment zone well PTX06-1170 during 2019 indicate TCE concentrations at 200 µg/L.

Pantex evaluates performance at nine downgradient ISPM wells for the Zone 11 ISB and two former ISB injection wells (PTX06-ISB079 and PTX06-ISB082). All of these wells exhibited perchlorate concentrations below the GWPS throughout 2019 except for the first quarter sample at PTX06-1148. TCE concentrations are below the GWPS in five of nine ISPM wells plus the two former injection wells. The first breakdown product of TCE, *cis*-1,2-DCE, was detected above the GWPS in three downgradient wells, PTX06-1155, PTX06-1173, and PTX06-1174; the presence of cis-1,2-DCE was also detected in PTX06-1156. These data indicate that because of treatment, concentrations of TCE and its breakdown products are very close to meeting the GWPS in treated water from the original portion of the system. The only downgradient well not demonstrating strong treatment is PTX06-1173. Wells upgradient of PTX06-1173 were difficult to inject into during the 2018 and 2019 injection events.

The results for upgradient well PTX06-1127 indicate that TCE is increasing above GWPS on the eastern side of the ISB. Neither TCE nor its degradation products were detected in PTX06-ISB079 and PTX06-ISB082 in 2019; TCE and cis-1,2-DCE were detected below GWPS at PTX06-1156. TCE was detected slightly above GWPS in two downgradient wells, PTX06-1149 and PTX06-1150, in 2019. Pantex will continue to evaluate treatment of TCE to determine if changes in the system operation will be required.

Metals concentrations have been increasing in all downgradient performance monitoring wells since the start of remedial actions and some are exceeding GWPS. For example, arsenic concentrations in PTX06-1012, PTX06-1149, PTX06-1155, PTX06-1156, PTX06-1173, and PTX06-1174 and barium concentrations in PTX06-1156 exceeded GWPS in 2019. However, metals concentrations in the downgradient performance monitoring wells are much 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. Several wells are already indicating a return to oxidized conditions with recent arsenic trends not increasing in 7 of the 9 ISPM wells and recent barium trends not increasing in all 9 wells.

Table 3-2. Summary of 2019 Zone 11 ISB Monitoring Well Data for TCE and Perchlorate

Well ID	Perchlorate					Trichloroethene				
	Max[a]	1Q	2Q	3Q	4Q	Max[a]	1Q	2Q	3Q	4Q
In Situ Bioremediation Wells										
PTX06-ISB055	3000	<12	<12	--	--	16	<2.5	<2.5	--	--
PTX06-ISB059	970	<12	<12	--	--	<3	<2.5	<2.5	--	--
PTX06-ISB063	39	<12	<12	--	--	0.75J	<2.5	<2.5	--	--
PTX06-ISB069A	880	<12	<12	--	--	62	<2.5	<2.5	--	--
PTX06-ISB071	400	<12	<12	--	--	1500	<2.5	<2.5	--	--
PTX06-ISB073	380	<12	<12	--	--	560	<2.5	<2.5	--	--
PTX06-ISB075[b]	97	<12	<12	<12	<12	440	17	20	13	4.3
PTX06-ISB077	840	<12	<12	--	--	310	<2.5	<2.5	--	--
PTX06-ISB079	<24	<12	<12	<12UJ	<12	<3	<2.5	<2.5	<2.5	<2.5
PTX06-ISB082	3090	<12	<12UJ	<12UJ	<12	9.6	<2.5	<2.5	<2.5	<2.5
In Situ Treatment Zone Monitoring Wells										
PTX06-1164	130	<12	<12	29	6.8	180	57J+	65	96	70J
PTX06-1169	<12	--	--	--	--	13	--	--	--	--
PTX06-1170	<120	<12	<12	<60	<12	500	200	110J+	110	140J+
PTX06-1176	240	<12	<12	<60	<12	220J	0.89	0.64J+	0.58	0.56J+
PTX06-1177	210	<12	<12	<60	<12	130	<2.5	<2.5	0.58	1.2J
In Situ Performance Monitoring Wells										
PTX06-1012	341	<12	<12	<12	<12UJ	580	0.9	0.8J-	0.88J	<0.84UJ
PTX06-1155	487	<12	<12	<12	<12UJ	660	<2.5	<5UJ	1.1J	<13
PTX06-1156	2140	<12	<12	<12	<12UJ	7.4	<2.5	<2.5UJ	0.23J	0.35
PTX06-1148	1290	37	14	11	<12	3.6	2.3	2.9J-	3.5	4
PTX06-1149	684	<12	5.4	8.4	20	5.3	3.2J	4.2J-	5.3	5.3
PTX06-1150	235	16	11	10	10	8.3	7.4	7J-	7.5	8.3
PTX06-1173	16J	<12	<12	<12	<12	140J	15	66	130	140J
PTX06-1174	170J	<12	<12	<12	<12	160J	0.69	10	4.8	1.0J
PTX06-1175	340J	11	<12	<12	<12	150	93	110J-	62	58J

Concentrations provided in ug/L.

Highlighted cells indicate concentrations less than the GWPS. GWPS: Perchlorate = 26 ug/L and TCE = 5 ug/L.

The "--" symbol indicates no samples were collected.

When COC was not detected, a "less than" 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 in which it was collected.

[b]Due to well damage, PTX06-ISB075 was replaced in September 2012, and the replacement well was first sampled during 2013.

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.

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. The system was installed in 2007 as an early action and consists of 43 injection wells, 8 of which are used to monitor performance in the treatment zone, and 6 performance monitoring wells (see Section 1.4.2 map). 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. With the injection event conducted in the 4th quarter of 2019, seven injection events have been completed at this system.

Decline in water levels in the Southeast ISB continues; only 50 percent of the system was injected during the last two injection events in 2016 and 2019 because of dry or low water (< 1 ft) conditions in the wells. The inability to sample or inject into these wells is expected to persist with continued upgradient removal of water by the SEPTS. Evaluation of data indicates that most wells in the Southeast ISB will not contain appreciable water by 2022.

Pantex previously recommended the Southeast ISB for injections approximately every three years (see Section 2.2.2.4) to avoid depletion of food source and possible loss of reducing conditions. With the change to the use of molasses as the carbon source, more frequent injections may be needed. Pantex therefore plans to inject the system again in 2021, but further injections may be limited or unnecessary. Pantex will evaluate the timing and need for further injections after the 2021 injection event.

Constituents targeted for treatment by this system are RDX, other HE COCs (e.g., DNTs and 1,3,5-TNB), 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. Expected conditions at downgradient performance monitoring wells are that concentrations of indicator constituents will decline over time and that all degradation products of RDX will not be detected or will be present in low concentrations indicating complete breakdown is occurring. Dissolved oxygen, redox potential, nitrate, sulfate, total organic carbon, and volatile fatty acids are also evaluated at the ISB treatment zone performance wells.

The expected conditions for the treatment zone wells are that redox potential and electron acceptor (dissolved oxygen, nitrate, and sulfate) concentrations will decline after injection. Redox potential should be less than 0 mV for reduction of RDX and hexavalent chromium.

As provided in the SAP, eight treatment zone wells, five downgradient performance monitoring wells, and one upgradient performance monitoring well are used to evaluate the Southeast ISB. Two performance monitoring wells (PTX06-1118 and PTX06-1123) for the Southeast ISB have gone dry and have not been monitored since 2010 and 2015, respectively. PTX06-1045 (a point of compliance well) was dry from 2011 until the 4th quarter of 2018 when water was reported in the well. Water levels were sufficient to collect samples in the 3rd and 4th quarters of 2019; further discussion of the results is provided in Section 3.4.3 Other Unexpected Conditions. In addition, limited sampling has occurred at PTX06-1037 since November 2017 because of declining water levels, and this well could not be sampled in the 1st quarter because of insufficient water. Only four of eight treatment zone wells were sampled in the 1st and 2nd quarters of 2019, and only three wells were sampled in the 3rd quarter because of low water levels or dry conditions. No treatment zone wells were sampled during the 4th quarter because of injection.

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 four ISB injection wells sampled, as well as concentrations for target indicators at the three sampled 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 mild to deep reducing conditions were present for treatment of HEs and hexavalent chromium prior to the 4th quarter injection event; conditions may have been turning less favorable before the injection. The ORP was between –98 mV and 100 mV at all four wells throughout the year but was generally increasing although the positive ORP value was anomalous based on observed sulfate and DO data that indicated deeper reducing conditions at the well (PTX06-ISB048). Sulfate was reduced to values less than 2 µg/L in all four wells in the first three quarters. Total organic carbon results indicated that a continued food source was available to maintain reducing conditions. All COCs were non-detect in the sampled treatment zone wells.

The ISB system has been effective in treating HEs and hexavalent chromium at three of the closest downgradient ISPM wells (PTX06-1037 and 1154, plus historically at PTX06-1123) for the SE 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 ORP is negative, nitrate and sulfate concentrations are reduced, and TOC is present in all three wells.

PTX06-1153 continues to exhibit RDX concentrations above the GWPS, but hexavalent chromium concentrations continue to demonstrate a decreasing trend and have remained below the GWPS since 2016. During 2019, this well demonstrated signs of partial treatment. Breakdown products of RDX were detected at concentrations above the GWPS. Upgradient dry wells were injected in 2013 and 2015 in an attempt to affect this well. It is possible that those injections were slow to respond at this location and may only be partially affecting the water that continues to move into PTX06-1153. As with other locations, water levels at this well continue to decline.

Table 3-3. Summary of 2019 Southeast ISB Monitoring Well Data for RDX and Hexavalent Chromium

	Hexavalent Chromium					RDX				
Well ID	**Max[a]**	**1Q**	**2Q**	**3Q**	**4Q**	**Max[a]**	**1Q**	**2Q**	**3Q**	**4Q**
In Situ Bioremediation Wells										
PTX06-ISB014[b]	NE	NE	NE	NE	NE	217	--	--	--	--
PTX06-ISB019[b]	NE	NE	NE	NE	NE	143	--	--	--	--
PTX06-ISB024[b]	NE	NE	NE	NE	NE	3860	--	--	--	--
PTX06-ISB030B[b]	NE	NE	NE	NE	NE	2.7	<0.26	<0.26	<0.26	--
PTX06-ISB038	NE	NE	NE	NE	NE	421	<0.27	<0.26	<0.26	--
PTX06-ISB042[b]	NE	NE	NE	NE	NE	2920	--	--	--	--
PTX06-ISB046	NE	NE	NE	NE	NE	4350	<0.26	<0.26	<0.26	--
PTX06-ISB048	NE	NE	NE	NE	NE	--	<0.26	<0.26	--	--
In Situ Performance Monitoring Wells										
PTX06-1037[b]	109	--	--	<0.02UJ	--	2800	--	<0.39UJ	<0.26UJ	0.12J
PTX06-1123[b]	10	--	--	--	--	4300	--	--	--	--
PTX06-1153	159	18J-	14	11	9	838	477J	559J	838J	751J
PTX06-1154	29.2	<0.02UJ	<0.02UJ	<0.02UJ	<0.02	630	<0.26UJ	<0.26UJ	0.11J	0.86J

Concentrations provided in ug/L.
Highlighted cells indicate non-detect or concentrations less than the GWPS. GWPS: Cr(VI) = 100ug/L and RDX = 2 ug/L.
NE – Hexavalent chromium was not evaluated in the ISB treatment zone due to interference from the amendment.
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-ISB014, PTX06-ISB019, PTX06-ISB024, PTX06-ISB42, PTX06-1037, and PTX06-1123 were either dry or had limited water and could not be sampled for all or part of 2019.
Data from ISPM Wells PTX06-1045 and PTX06-1118 were 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. PTX06-1118 is upgradient to the ISB system and was used to monitor the influent COC concentrations and has been dry since late 2009.
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.
UJ The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

Pantex is continuing to investigate the cause of the unexpected results in PTX06-1153. As discussed in the 2013 Annual Progress Report, the conditions could be due to any number of hydrologic issues and it may be difficult to prove (or disprove) if any of these are occurring. It is possible that this well may not be hydraulically connected to the Southeast ISB. Several confounding issues complicate the investigation efforts in the area, including significant heterogeneity in the fine-grained zone, potential changes in formation properties due to biologic growth or other injection effects, and potential reduction of saturated thickness upgradient due to pump and treat operations. Pantex injected this system with molasses, a more soluble carbon source, during the 2019 injection to attempt better distribution of the amendment. PTX06-1153 will be evaluated to determine if this effort will increase treatment at that location. Additionally, in an effort to effect treatment at the well, Pantex extracted water from the well at a flow rate of about 1.25 gpm for two weeks during the fourth quarter; it is unknown at this time how this extraction may affect treatment long term.

Metals concentrations have increased in all downgradient performance monitoring wells and some are exceeding GWPS. Arsenic and barium concentrations exceeded the GWPS in PTX06-1037 and PTX06-1154 during 2019. Total organic carbon data suggest the treatment zone has expanded into these wells and the reduced conditions continue to mobilize the 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 complete breakdown is occurring. Monitoring results for the system indicate that RDX and breakdown products (MNX, DNX, and TNX) are present in downgradient performance monitoring wells. TNX, the final degradation product, is the best indicator of degradation because the other intermediate products (MNX, DNX) degrade rapidly and do not accumulate in the environment. 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 non-detect or below PQL at both wells throughout 2019. These results indicate near complete treatment of RDX is occurring. High RDX concentrations and elevated MNX, DNX, and TNX concentrations at PTX06-1153 indicate partial treatment at this location.

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. The system consists of 25 injection wells. Two injection events have been completed for this system, with the latest injection completed in September 2019. Based on the success with distribution of a more soluble carbon source (molasses) and the long turnaround needed to order EVO, Pantex began injection at the Southeast ISB Extension using only soluble carbon (molasses), as recommended in the 3rd Quarter 2018 Progress Report. 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 six to nine months.

The first post-injection treatment zone data were collected in 2nd quarter 2019; four wells were subsequently sampled during the 4th quarter. Treatment zone data indicate that mild to deep reducing conditions are present for treatment of HEs. ORP is between −134 mV and −29 mV, nitrate is reduced in all wells, and sulfate is reduced to values less than 2 µg/L in all wells except PTX06-ISB108 which showed an increase in sulfate in the 4th quarter sample. Soluble metals, i.e., arsenic and manganese, increased, indicating that reducing conditions are being established. Only RDX degradation products were detected in the sampled injection wells. Total organic carbon results for the 4th quarter indicate that a sufficient food source is available to continue to establish reducing conditions at two of the sampled injection wells, indicating it may be appropriate to inject every 9 months. Downgradient wells did not demonstrate treatment during 2019 but are expected to demonstrate treatment within 1 to 2 years after the first injection.

Table 3-4. Summary of 2019 Southeast ISB Extension Monitoring Well Data for RDX

	RDX				
Well ID	**Max[a]**	**1Q**	**2Q**	**3Q**	**4Q**
In Situ Bioremediation Wells					
PTX06-ISB108[b]	<0.26	--	<2.5UJ	<0.26	--
PTX06-ISB113	12.3	--	<0.5UJ	<0.26	<0.26
PTX06-ISB123	718	--	<0.5UJ	<0.26	<0.26UJ
PTX06-ISB125	774	--	--	<1	--
PTX06-ISB127	279	--	<1UJ	--	<0.26UJ
PTX06-ISB131	21.8	--	<1UJ	--	<0.26UJ
In Situ Performance Monitoring Wells					
PTX06-1191	164	--	113	--	126
PTX06-1194	0.15	--	<0.26	--	<0.26
PTX06-1196	24.7	--	17.3	--	24.7

Concentrations provided in ug/L.
Highlighted cells indicate non-detect or concentrations less than the GWPS. RDX GWPS = 2 ug/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 in which it was collected.
[b]Data for the 4th quarter sample from PTX06-ISB108 were rejected based on laboratory quality control data.
UJ The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

3.3 Natural Attenuation

Natural attenuation is the result of processes that naturally lower concentrations of contaminants over time. This process is monitored at Pantex to help determine where natural attenuation is occurring, under what conditions it is occurring, and to possibly determine 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. Because the right microbes for biodegradation are present in the perched sediments, Pantex is interested in

Natural Attenuation Processes

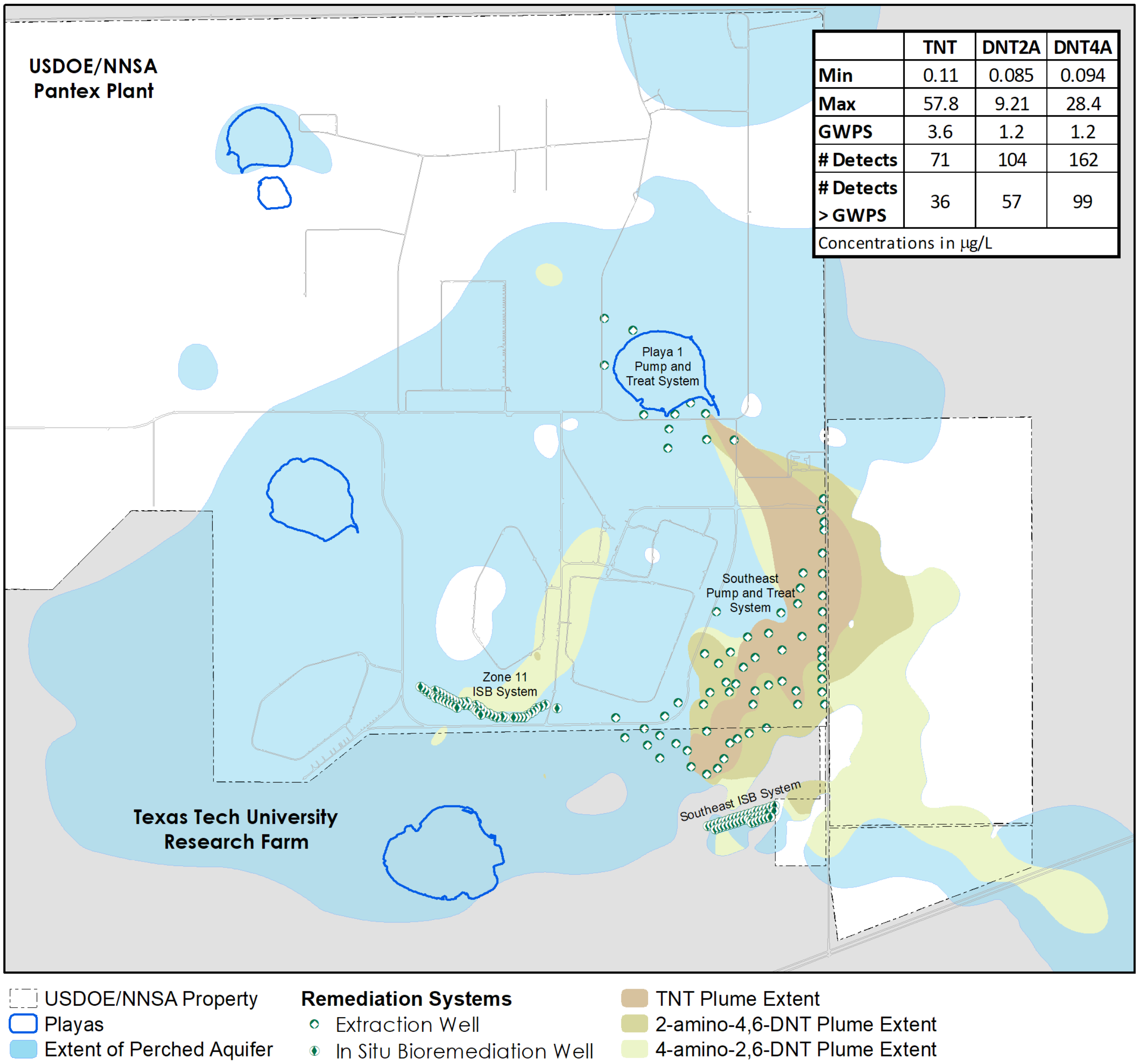
- Biodegradation – soil microbes can cause the contaminants to break down to less harmful products
- Sorption – the contaminants are bound to soil particles so that movement through groundwater is stopped or is slower allowing time for other processes to work
- Dispersion – the contaminants are dispersed through the groundwater as they move away from the source so that concentrations are diluted

monitoring for breakdown products of RDX. Pantex started monitoring for degradation products of RDX in all monitoring wells by July 2009, after testing analytical methods to ensure they can reliably detect and quantify those products. Since analytical methods are readily available, Pantex has monitored for degradation products of TNT and TCE in the past and continues to monitor for those in key areas.

Other groundwater conditions that may impact 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 best reduction under anaerobic conditions. As more data are collected, trending and statistical analysis 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 (2-amino-4,6-DNT and 4-amino-2,6-DNT), TNT has naturally attenuated over time (see Figure 3-33). TNT has been manufactured at Pantex since the 1950s yet is only present in the central portion of the overall southeastern plume - within the SEPTS well field and near Playa 1. Its first breakdown product, 2-amino-4,6-DNT, occurs near the TNT plume and extends slightly beyond. The final monitored breakdown product, 4-amino-2,6-DNT, 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 GWPS, but most wells with detections are recently showing a decreasing or stable trend. A table of natural concentration ranges for wells outside the influence of the ISB systems is included in Figure 3-33.



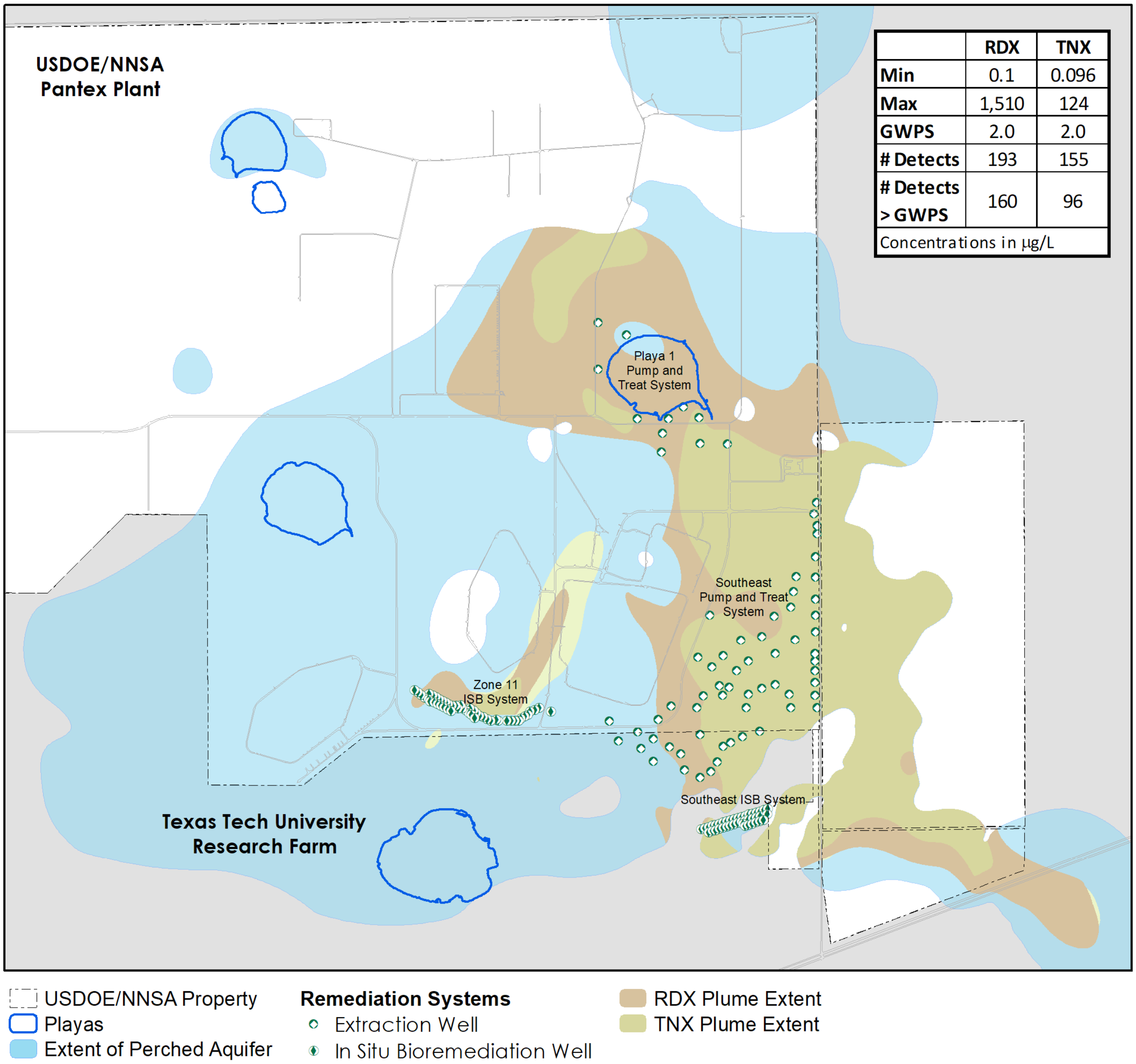
	TNT	DNT2A	DNT4A
Min	0.11	0.085	0.094
Max	57.8	9.21	28.4
GWPS	3.6	1.2	1.2
# Detects	71	104	162
# Detects > GWPS	36	57	99
Concentrations in µg/L			

Figure 3-33. TNT and Degradation Product Plumes

Perched aquifer sampling results for RDX and breakdown products (MNX, DNX, and TNX) indicate that the breakdown products are present throughout most of the RDX plume, with TNX being the most widespread. TNX, the final degradation product, is a better indicator of degradation because the other intermediate products (MNX, DNX) degrade rapidly and do not accumulate in the environment (SERDP, 2004). If complete biodegradation of RDX were occurring, RDX and all breakdown products would be expected to decrease over time. Figure 3-34 depicts the overall RDX and TNX plume. A table of concentration ranges for wells outside the influence of the ISB systems is included in the figure.

A 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 (CSIA) approaches. These approaches, along with the ability to quantify NDAB, an aerobic degradation product, allows Pantex to better evaluate the degradation of RDX.

Pantex subsequently contracted with the leading researcher for the SERDP study, Dr. Mark Fuller with APTIM, for a project to evaluate lines of evidence for natural attenuation of RDX at the Pantex 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/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 study found several lines of evidence for natural attenuation of RDX as well as the potential to enhance aerobic biodegradation of RDX with introduction of low levels of labile organic carbon. Recommendations for further study were presented for additional treatability studies, bioaugmentation, and additional proteomics analyses for the degrading bacterial strains.



	RDX	TNX
Min	0.1	0.096
Max	1,510	124
GWPS	2.0	2.0
# Detects	193	155
# Detects > GWPS	160	96
Concentrations in µg/L		

Figure 3-34. RDX and Degradation Product Plumes

Pantex has monitored for breakdown products of TCE for many years and a strong indication of natural attenuation of TCE has not been observed in the perched aquifer. 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 the ISB treatment zones.

3.4 Uncertainty Management/Early Detection

The purpose of uncertainty management wells in perched and Ogallala groundwater is to confirm expected conditions identified in the RCRA Facility Investigations and ensure there are not any deviations, fill potential data gaps, and fulfill long-term monitoring requirements for soil units evaluated in a baseline risk assessment. The purpose of early detection wells is to monitor for breakthrough of constituents to the Ogallala Aquifer from the overlying perched aquifer, if present, or from potential source areas in the unsaturated zone before potential points of exposure have been impacted. These wells were proposed in the LTM design for purposes of evaluating the effectiveness of the soil and groundwater remedial actions. Additionally, the perched aquifer data were evaluated with respect to field observations. In 2019, no evidence of NAPL was observed in sampled perched aquifer wells.

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

Group 1 — 47 locations (designated by boxes on Figure 3-35) where contamination has not been detected or confirmed, or in previous plume locations where concentrations have fallen below GWPS, background, or PQL (e.g., Burning Ground and Old Sewage Treatment Plant areas). These are typically Ogallala Aquifer wells, although some perched aquifer wells are located in areas where there are no active groundwater remedial actions. These wells were evaluated in the quarterly reports.

Group 2 — 30 uncertainty management wells (all other wells in Figure 3-35) near groundwater contamination source areas. This is 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 frequency of sampling, all available data for the UM/ED wells are used in this evaluation.

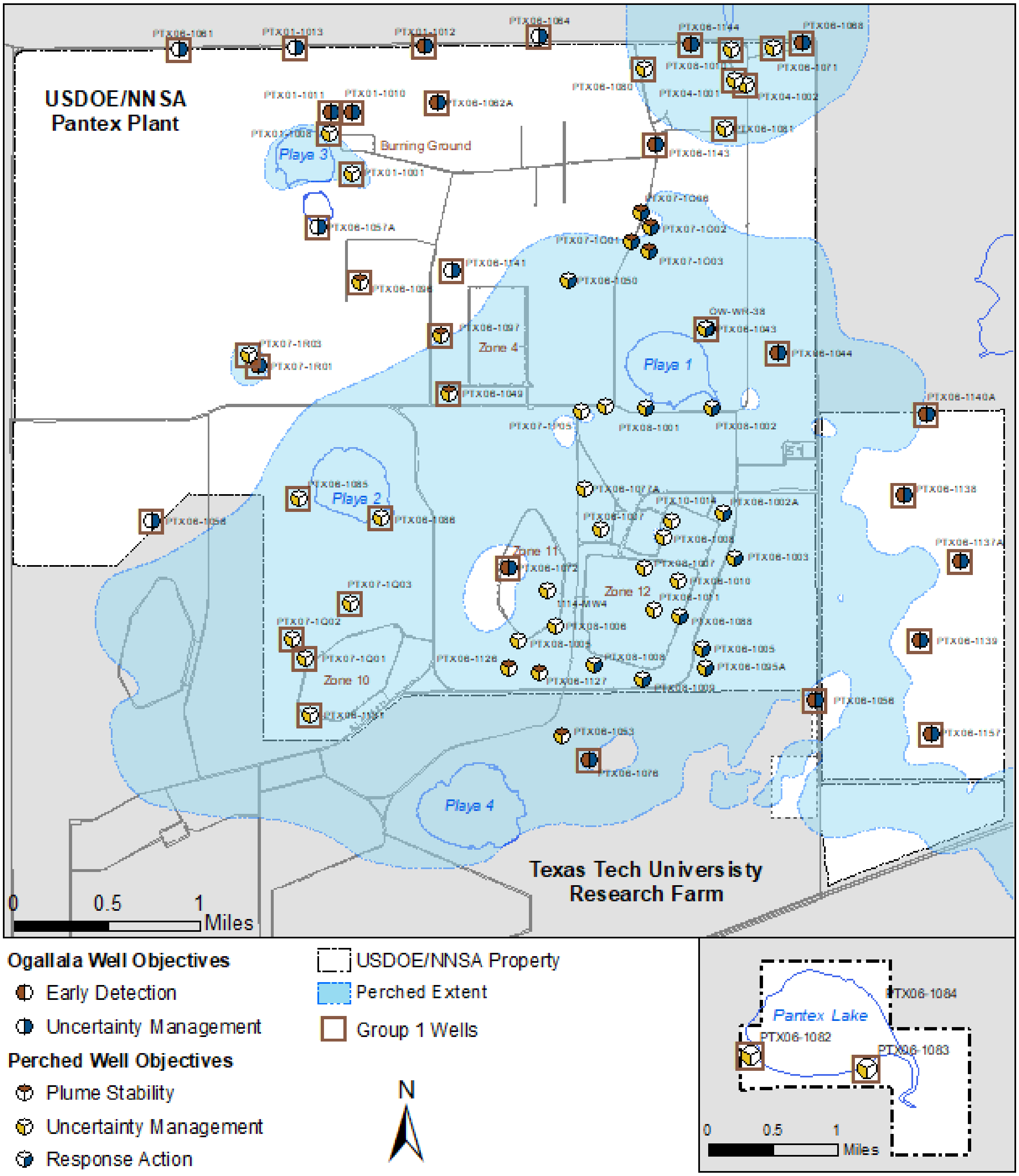


Figure 3-35. Uncertainty Management and Early Detection Wells

3.4.1 Group 1 Wells

No Group 1 perched aquifer wells had unexpected conditions in 2019. Detections of indicator COCs occurred in five Group 1 perched aquifer wells in 2019 (PTX01-1001, PTX04-1001, PTX04-1002, PTX06-1049, and PTX07-1Q01). All detections of indicator COCs at these wells were below GWPS.

3.4.1.1 Ogallala Aquifer Wells

In 2019, detection of organic constituents or metals above background (for those metals with site-specific background concentrations) occurred in three Ogallala wells. Metals (excluding boron) were detected above background but below GWPS in one well and organics were detected in one well with all detections less than GWPS. Data for these detections is provided in Appendix D, Table D-2. Iron was also detected at one well, but was not included in Table D-2 because no GWPS has been established. Boron was detected at levels slightly above background in 12 wells; these detections represent natural variability in background. Boron detections are summarized in Table D-3.

Hexavalent chromium was detected above background in one well, PTX06-1157, in 2019; this detection was below the GWPS of 100 ug/L. At PTX06-1157, hexavalent chromium was detected slightly above the background value of 3.2 ug/L (measured value of 3.31 ug/L using Method 218.7). This detection likely represents background variability. Hexavalent chromium was detected below background in the subsequent sample from this well in 2019.

PTX06-1056 continues to demonstrate detections of 4-amino-2,6-DNT, a breakdown product of the high explosive TNT, first detected in April 2014, and the VOC 1,2-dichloroethane, detected for the first time in August 2015. 4-amino-2,6-DNT was detected in all four quarterly samples in 2019 at values up to 0.48 ug/L, above the PQL of 0.26-0.27 ug/L, but below the GWPS of 1.2 ug/L. 1,2-Dichloroethane was detected in all four quarterly samples in 2019; all detections were below the PQL and GWPS.

Pantex has proactively evaluated potential sources for the contamination. A nearby perched well (PTX06-1108) that was drilled deeply into the FGZ was plugged to address that potential source. An external independent review indicated that the perched well was the most likely source of the contamination, based on fate and transport modeling. A cement bond log was used to evaluate the competency of the concrete seal at the FGZ and indicated that the seal is competent. Therefore, PTX06-1056 is not likely acting as a preferential pathway for contamination to reach the Ogallala Aquifer.

Based on all four quarters of data in 2019, the detections of 4-amino-2,6-DNT do not exhibit a trend, and detections of 1,2-dichloroethane are exhibiting a decreasing trend. Long-term trends continue to indicate a slight increasing trend. Pantex has fully implemented the conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d) and will continue quarterly sampling for HEs and VOCs at this well.

As presented in Table D-3, boron was detected at concentrations slightly above the background value of 194 ug/L in 12 Ogallala wells in 2019, including PTX01-1011, PTX06-1043, PTX06-1044, PTX06-1056, PTX06-1058, PTX06-1062A, PTX06-1064, PTX06-1137A, PTX06-1139, PTX06-1140, PTX06-1144, and PTX06-1157. Because the boron concentrations at these wells are very close to background and observed boron concentrations tend to vary considerably, it appears that these concentrations also represent background. Evaluation of historic boron data in these wells results in variable trends. The measured concentrations are well below the GWPS of 7,300 ug/L. Pantex will continue to monitor these wells according to the SAP.

In addition to comparison of measured concentrations to GWPS, all Ogallala Aquifer wells were evaluated to determine if specific constituents that are detected are trending upward (see Appendix E). For the trending analysis, chromium, hexavalent chromium, boron, and a small list of HEs (RDX and the DNTs) 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 3-5, indicate that across all data, 13 wells are indicating increasing or probably increasing trends.

Table 3-5. Increasing Trends in Group 1 Ogallala Aquifer Wells

Well	COC	Concentration Trend
PTX01-1012	CR	Probably Increasing
PTX06-1043	B	Increasing
PTX06-1043	CR	Increasing
PTX06-1056	DCA12	Increasing
PTX06-1056	DNT4A	Increasing
PTX06-1056	CR	Increasing
PTX06-1058	B	Probably Increasing
PTX06-1058	CR	Probably Increasing
PTX06-1062A	CR	Increasing
PTX06-1064	CR	Probably Increasing
PTX06-1068	CR	Increasing
PTX06-1072	B	Increasing
PTX06-1072	CR	Increasing
PTX06-1076	CR	Increasing
PTX06-1143	B	Increasing
PTX06-1144	B	Increasing
PTX06-1157	B	Increasing
PTX06-1157	MN	Increasing
PTX07-1R01	CR	Probably Increasing

Ten wells indicate increasing or probably 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 wells (perched and Ogallala aquifers) at Pantex. Typically, chromium levels drop in these wells after brushing and bailing of the well. Well 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 ten wells.

Mann-Kendall trending across all data also indicates that boron is increasing or probably increasing in six 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 4-amino-2,6-dinitrotoluene and 1,2-dichloroethane across all data, but detected concentrations remain below the GWPS, and recent data indicate no trend or a decreasing trend.

Mann-Kendall trending across all data indicates an increasing trend for manganese in PTX06-1157. However, manganese was not detected in the first sample collected in 2019 and was detected in the second 2019 sample with an estimated value that is the lowest across all data for this well. The apparent trend is caused by using one-half the sample detection limit in the trend analysis.

3.4.2 GROUP 2 WELLS

These wells are near source areas and generally have contamination at levels above the GWPS. The purpose of this evaluation is to determine if source strength is declining. It is an expected condition that the ditches and playas would continue to contribute contamination to the perched aquifer for a long period of time (20 years or more), but at much lower concentrations than in the past (Pantex, 2006). For many of these wells, it is expected that concentrations will stabilize with an eventual long-term decreasing trend below the GWPS. Table D-4 in Appendix D presents the evaluation of Group 2 wells 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-4:

- HE breakdown products (MNX; TNX; DNX; 1,3-DNB; 2-amino-4,6-DNT; and 4-amino-2,6-DNT) were not included since increasing trends are not an indicator of continued sourcing.
- TCE breakdown products (*cis*-1,2-DCE; trans-1,2-DCE; and vinyl chloride) were not included since increasing trends are not an indicator of continued sourcing.
- Total Chromium was not included in lieu of hexavalent chromium.

Five wells that have detections of COCs already meet expected conditions at the well. Several wells have increasing or probably increasing historical COC trends. PTX06-1095A, PTX06-1005, and PTX08-1002 are exhibiting increasing trends in multiple COCs, but these three 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. PTX06-1126, PTX06-1127, and PTX07-1O03, while classified as Group 2 wells, are far away from the identified source areas, so these trends are not representative of the current mass flux near the source areas.

One or more constituents in PTX06-1008 are not exhibiting a trend while the expected condition is long-term decreasing trends. However, statistical trend analysis does not indicate that trends are increasing. Water levels in PTX06-1003, PTX07-1O01, PTX07-1O02, PTX07-1O06, and PTX06-1P05 have declined since the start of remedial actions; all of these wells are dry, have water only in the well sump, or have insufficient water to sample.

Thirteen wells that are exhibiting increasing trends when the 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 decline in perched water levels. Thus, all of the increasing trends discussed below are associated with changes in plume movement rather than continued or increasing release of contaminants from source areas.

- 1114-MW4, located in central Zone 11, is exhibiting increasing trends for perchlorate and 1,4-dioxane, possibly due to changing flow gradients and plume movement away from the source (Hypalon pond and nearby ditches). Detections of 1,4-dioxane have fluctuated near the PQL since 2013.
- OW-WR-38, located northeast of Playa 1, is exhibiting increasing trends for RDX and TCE. RDX concentrations have been fluctuating for the last five years and remain near the GWPS. The trend may be due to P1PTS effects as system operations 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 use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area.
- PTX06-1010 is exhibiting increasing trends in TCE and chloroform while the expected condition is a long-term decreasing trend. Although the trend indicates increasing TCE, concentrations in this well have declined to below GWPS from historical levels above GWPS, have remained well below GWPS since 2009, and the last four samples indicate “No Trend.” Chloroform is fluctuating near the PQL with an overall increasing trend, but concentrations remain well below the GWPS.
- PTX06-1011 is exhibiting an increasing trend in hexavalent chromium and chloroform while the expected condition is a stable or decreasing trend below GWPS. Although increasing in recent data, chloroform concentrations in this well remain near the PQL. Hexavalent chromium has fluctuated in this well at levels

below the GWPS since 1998. The identified 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. Data for the last four samples indicate a decreasing trend.

- PTX06-1077A is exhibiting an apparent increasing trend for perchlorate. However, all samples have been below the PQL or non-detect, and the apparent trend is caused by using one-half the sample detection limit in the trend analysis.
- PTX06-1088 is exhibiting an increasing trend in PCE and chloroform since the start of remedial actions. PCE concentrations in PTX06-1088 are only slightly increasing, are highly variable and fluctuate near the GWPS, and reflect general movement of the plume in this area. Chloroform has been increasing since 2017, but concentrations remain well below the GWPS
- PTX07-1P02 is exhibiting an increasing but variable trend in RDX just above the GWPS, but fluctuating concentrations remain far below historical levels for this well. The apparent increasing trend may be due to P1PTS effects as system operations have dramatically affected water levels and gradients in this region of perched groundwater.
- PTX08-1001 is exhibiting an increasing trend in RDX with fluctuating concentrations above the GWPS while the expected condition is long-term stabilization of concentrations. The apparent increasing trend may be due to P1PTS effects as system operations have dramatically affected water levels and gradients in this region of perched groundwater.
- PTX08-1006 is exhibiting an increasing trend in TCE, while 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, which may also be influenced by SEPTS operations. Concentrations have been highly variable in this well, and the last four samples indicate a decreasing trend.
- PTX08-1007 is exhibiting an increasing trend in 1,4-dioxane and chloroform while the expected condition is a long-term decreasing trend. Chloroform concentrations have fluctuated at levels below the GWPS since the well was completed in 1996; however, concentrations have been increasing since 2012 but remain below the GWPS. Detections of 1,4-dioxane have fluctuated near the PQL since 2012. The

identified increasing trend is the result of low-level detections and use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area.

- PTX08-1008 is exhibiting increasing trends in perchlorate, TCE, and 1,4-dioxane, and a probably increasing trend in chloroform while 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 may also be influenced by SEPTS operations. 1,4-Dioxane has been detected at low levels near the PQL since 2016; concentrations are exhibiting a gradual increasing trend but remain below the GWPS. TCE has been detected near the PQL for a number of years, and recent data do not indicate a trend.

- PTX08-1009 is exhibiting a slight increasing trend in hexavalent chromium below the GWPS since the start of remedial actions while the expected condition is a long-term stabilization of concentrations. Although the trend was identified as increasing, a decreasing trend was identified for the last four samples and concentrations remain below the GWPS. This well is located along the northern edge of the hexavalent chromium plume and historically exhibited very high concentrations. The recent detections may indicate general plume movement to the southeast and the influence of the SEPTS well field.

- PTX10-1014 is exhibiting an apparent increasing trend for perchlorate. However, all samples collected since 2003 have been below the PQL or non-detect, and the apparent trend is caused by using one-half the sample detection limit in the trend analysis.

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

Table D-5 in Appendix D summarizes all detections of analytes above the laboratory PQL and site-specific background, if calculated, that are not considered to be indicator parameters. Nickel was the only constituent detected above background in 2019. Iron was also detected, but was not included in Table D-5 because no GWPS has been established. The detection of nickel occurred in a single well, PTX10-1014, slightly above the background value of 15 ug/L (measured value of 15.4 ug/L). Nickel is an indicator of corrosion of stainless steel screens, and this well has a stainless steel screen and was constructed in 1992.

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 to evaluate whether the well remains in contact with the formation.

A sudden drop in water level was observed in PTX06-1198 in December 2019. At the previous measurement in June 2019, the well had about 10 ft of water above the bottom of the screen. Observed water levels had been declining steadily at a rate of about 0.7 ft/year since the well was installed in July 2016. This well was originally installed as an extraction well but was not capable of yielding sufficient flow to be practical for use. Pumping at the nearby extraction wells have heavily affected PTX06-1198. In addition, this well is located near an expanding area of limited perched saturation near the northeast corner of the Texas Tech property, so it is believed that the drop in water level indicates the expansion of this dry zone further to the east past PTX06-1198.

As discussed in the 2016 Annual Report, Pantex drilled PTX06-1182 in 2016 to evaluate water conditions in the southeastern lobe of perched groundwater based on the continued evaluation that indicates that some portions of the southeast perched groundwater are not under the influence of the pump and treat systems. Water containing HEs at concentrations above the GWPS was discovered in PTX06-1182. In response to that information, Pantex installed additional wells to define the extent of the plume to the southeast and confirmed the presence of two HEs, RDX and DNT4A, in the southeastern lobe. Pantex subsequently drilled a line of wells to extend the Southeast ISB along the southeast boundary of the site; as discussed previously, injection of these wells started in February 2019 to establish a treatment zone to prevent further migration of HEs across the site boundary.

The contaminant distribution indicates flow primarily through an old subsurface paleochannel with the main RDX plume only 500 to 700 ft wide at the property boundary. The main paleochannel where the highest concentrations occur is narrower, likely only about 250 ft wide. In an attempt to identify the boundaries of the paleochannel, Pantex conducted an electromagnetic study in 2018 using Willowstick Technologies, LLC. The objective of this study was to identify the area with faster flow paths in the groundwater so that the extent of contamination could be positively identified. The results of the investigation indicated the possibility of channels extending through the ISB, with one primary channel leading offsite to the south and southwest. The results of the study were less certain at the offsite property because of interferences, homogeneity of the subsurface soils in the perched aquifer to the southeast, and lack of downgradient wells. These issues resulted in the inability to identify any channels to the southeast of Pantex.

Pantex installed 14 additional monitoring wells in 2018 and early 2019 to define the extent of the plume to the southeast; 13 of these wells were installed offsite on adjacent properties to the south and southeast. Based on data collected from these wells in 2019, it appears that the extent of contamination to the southeast has been defined with HE not detected in two of the offsite wells. Refer to Figure 3-13 for well locations and plume extent.

To determine the best path forward for cleanup of the offsite southeast plume that is beyond the influence of the new Southeast ISB Extension, Pantex contracted to have the conceptual site model and perched fate and transport model updated in early 2019. The updated fate and transport model was used to determine the best options for cleanup and to optimize the system for cost, schedule, and completeness of cleanup. The results indicate that the best path forward for cleanup of the offsite plume is a combination of ISB and pump and treat. This recommendation is consistent with the chosen remedy for the Record of Decision (ROD) and the Compliance Plan. Pantex will plan to include this remedy expansion in the upcoming Explanation of Significant Difference for the ROD.

Modeling predicted that the new system will cleanup to GWPS within 25 years. The new system will consist of 89 ISB system wells (51 injection and 38 extraction/recirculation wells) and 6 pump and treat system wells (3 extraction and 3 injection). The system will not be reliant on water sources from other areas; therefore, extraction/recirculation wells are a necessary component of the system. System installation will occur across four phases, beginning in FY 2020 and ending in FY 2023, depending on available funding. Modeling indicates that injections will be required for approximately 10 years and pump and treat system operation for five years. The area is expected to be monitored for more than 20 years to verify predicted concentrations. Pantex is planning to install all Phase 1 injection and extraction wells during 2020. Phase 1 focuses on controlling the leading edge of the plume to prevent further movement and control of the head of the plume where concentrations are highest. One injection event will be scheduled in late 2020 for the Phase 1 system installation. Phase 2 installation in 2021 involves installation of injection and extraction wells for ISB treatment and the beginning installation of extraction wells for pump and treat. Associated infrastructure needed for treatment will also be installed in 2021, based on available funding.

Pantex has worked with the offsite landowners to gain needed agreements (deed restrictions and lease or purchase of property). While a long-term lease and deed restrictions continue to be negotiated, a right-of-entry has been put in place to allow Pantex to begin the phased installation of the system and begin injections at the leading edge of the plume. Pantex has already updated the UIC authorization for installation and use of the offsite wells.

PTX06-1045, a point of compliance, downgradient performance monitoring well at the Southeast ISB, was reported dry from July of 2011 to September 2018, but has recently reported water in the well. The well did not have sufficient water to permit sampling from September 2018 to June 2019, but sufficient water was available to collect samples during the third and fourth quarters of 2019. Sample results from 2019 demonstrate detections of RDX and TNT exceeding GWPS. The water in PTX06-1045 does not appear to be hydraulically connected to the Southeast ISB system. During 2018 and 2019, Pantex experienced multiple, large rain events, and the unexpected water flux and detections of RDX and TNT are considered to be a response to these events. A sample collected in October 2019, demonstrates a reduction in RDX and TNT concentrations, but this decline appears to indicate dilution, rather than degradation, because no RDX degradation products were detected. Pantex will continue to sample PTX06-1045 to evaluate trends in these detections. Further actions will be determined based on results of sampling and in accordance with the Pantex Groundwater Contingency Plan.

3.5 POC/POE Well Evaluation

As part of the approved changes to HW-50284, Pantex has designated POC and POE wells. As defined by HW-50284, the purpose of these wells is:

1. POC wells demonstrate compliance with the GWPS.
2. POE wells demonstrate compliance with the GWPS and are used to

POC/POE Wells

- 21 perched aquifer POC wells, with 14 exceeding GWPS.
- 2 Ogallala Aquifer POC wells, with no GWPS exceedances.
- 8 Ogallala Aquifer POE wells, with no GWPS exceedances.

evaluate the effectiveness of the remediation program.

The remediation program must continue until the POC and POE wells are compliant with the GWPS. The POC/POE wells approved in HW-50284 are depicted in Figure 3-36. 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/POE wells were evaluated against the established GWPS. Evaluation of the data indicates that only three perched aquifer POC wells had concentrations below GWPS. This is an expected condition at these wells because the full remedial actions were started in 2009. The Ogallala Aquifer wells were evaluated in the uncertainty management/early detection section to determine if any COCs were detected above background or PQL. All well data, along with comparison to the laboratory PQL, background, and GWPS are provided in Appendix D.

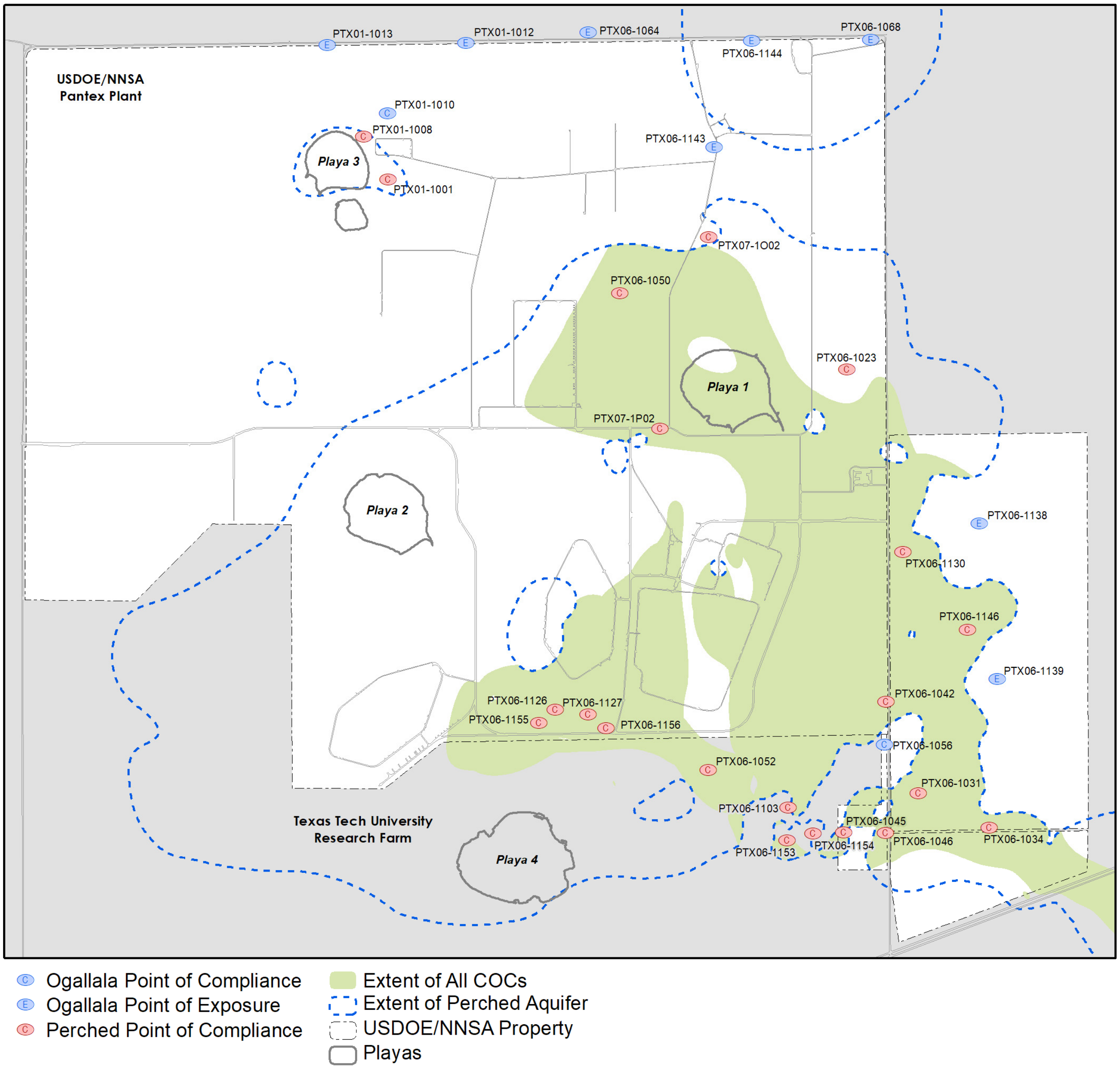


Figure 3-36. POC and POE Wells

4.0 Soil Remedial Action Effectiveness

Three soil remedial actions were implemented to prevent cross-contamination from soils to groundwater. Those actions include soil covers on landfills, a ditch liner in Zone 12, and 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 SVE Remedial Action Effectiveness

The Burning Ground SVE system consists of small catalytic oxidizer (CatOX) system that has been operating since April 2012, when it replaced a large-scale CatOX system. The small-scale system is used to treat residual non-aqueous phase liquid (NAPL) and soil gas at a single extraction well (SVE-S-20) near the source area.

The Burning Ground SVE system operated variably during 2019 with about 5,214 hours of operation during the year, or 60 percent operational. Operation of the system was negatively affected by several problems in 2019 including loss of power, failure to maintain temperature, pH issues, and repair of line and tank leaks. Figure 4-1 shows that the system was operated above 90 percent up to a maximum of 100 percent in March, April, May, and July, but operated less than 80 percent in all other months. The system was shut down on October 19th because of an issue with the heat controller and remained inoperable through the end of 2019.

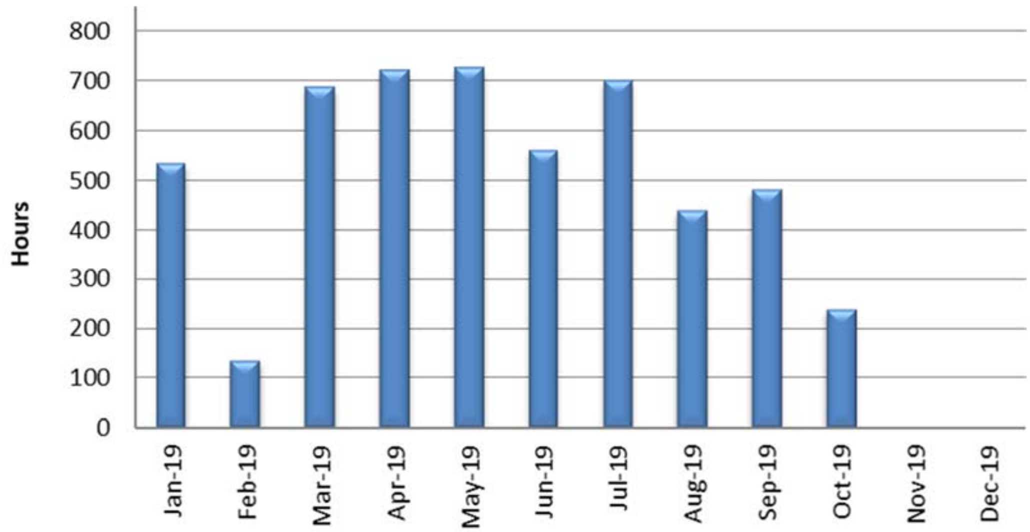


Figure 4-1 SVE system operational hours in 2019

The small catalytic oxidizer (CatOx)/wet scrubber system continues to focus on treating residual soil contamination and soil gas at a single soil gas well (SVE-S-20), where soil gas concentrations continue to remain relatively high. The system was modified in 2017 to increase air flow through the formation by opening pipes from wells surrounding SVE-S-20 to ambient air in order to enhance removal of the NAPL source through increased volatilization and stimulation of aerobic bioremediation. The system removed approximately 516 lbs of VOCs during 2019. PID data collected at the system effluent port compared to the PID data from the influent port suggests that the overall system destruction efficiency was at least 96% in 2019. Figure 4-2 shows the pounds of the four highest VOC compounds removed each month in 2019. The hourly VOC removal rate declined during 2018, but began to improve over the first two quarters of 2019. In the 3rd and 4th quarters of 2019, removal rates decreased significantly.

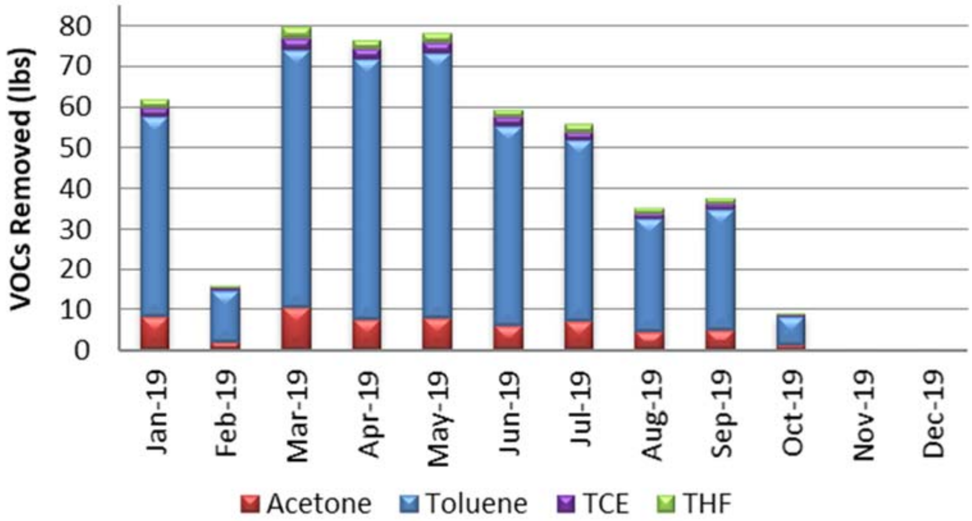


Figure 4-2 SVE System 2019 VOC Removal

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. The analytical samples are used to estimate the mass removal for the SVE system. In 2019, a total of 10 samples were collected for laboratory analysis from January through October.

Table 4-1 presents a summary of detected 2019 data in influent samples and the average concentrations from 2007-2008. The 2019 data were collected at the influent port of the current SVE system. The average of 2019 measured values are generally lower than the 2007-2008 data collected at the system, with the exception of methylene chloride (which was below the detection limit in 2007-2008) and PCA (concentration increased 50 percent since 2007-2008). The lower 2019 average concentrations likely reflect the increased air flow through the formation following completion of system modifications in 2017. Maximum and average values are lower than the baseline concentrations, with the majority of the COC maximum concentrations now an order of magnitude lower than baseline maximums. This change in concentration will continue to be analyzed to determine if a long-term trend emerges.

Methylene chloride was detected in four of the ten samples in 2019 and has been present since 2010 although it was not detected in baseline data. This COC had been detected prior to 2007 at low concentrations at the large-scale system or in individual soil gas wells.

Other COCs may be detected at low levels in the future because detection limits are expected to decrease as the major COC concentrations decrease and sample dilutions by the laboratory lessen.

Table 4-1. Burning Ground SVE Data Summary

Analyte	2019 Measured Value			2007-2008 Measured Value		
	Ave	Max	Min	Ave	Max	Min
Acetone	29,900	43,000	19,000	82,666	140,000	38,000
Toluene	128,300	170,000	76,000	477,307	990,000	45,000
Methylene chloride	4,600	7,900	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane (PCA)	5,000	5,700	3,500	3,356	6,300	760
Trichloroethene (TCE)	3,720	5,100	2,400	26,714	41,000	13,000
Tetrahydrofuran (THF)	6,330	8,400	4,000	20,107	26,000	9,500

Results for 2019 are based on laboratory analysis of samples of influent to the SVE system. Measured concentrations in parts per billion by volume (ppbv).

Indicates values greater than the baseline 2007-2008 concentration.

To verify whether concentrations of VOCs are decreasing, a nonparametric trend test, i.e., Mann-Kendall 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 since 2013 and recent data, i.e., last 4 measurements, collected at the influent port to the system. Since the analytical results can be affected by multiple factors, e.g., extraction equipment, sample port location, system conditions, etc., no effort was made to statistically trend the new results with analytical data associated with the old systems. Generally, concentrations appear to be lower than those collected in the previous large-scale CatOX or GAC system, but it is unknown whether these lower concentrations reflect a true source reduction or are caused by one of the system conditions enumerated above.

Table 4-2 provides a summary of the statistical trending. The results indicate that all four main COCs, i.e., acetone, toluene, TCE, and tetrahydrofuran [THF], exhibit decreasing trends considering all data collected since 2013. Similarly, the trends of the recent (last four) concentration measurements for the four main COCs are all decreasing.

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

COC	Trend-All Data	Recent Trend
Toluene	Decreasing	Decreasing
TCE	Decreasing	Decreasing
Tetrahydrofuran (THF)	Decreasing	Decreasing
Acetone	Decreasing	Decreasing

The average monthly PID measurements collected at the system influent, summarized in Figure 4-33, show some variability, but in 2019 monthly averages ranged between about 165 to 350 ppm. The orange circles on the chart show the 12-month rolling average which shows 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 not be representative were omitted from the 12-month averages. Through the 3rd quarter of 2019, average PID readings are lower than observed since the small-scale system began operating in 2012. Continued decreases in influent PID readings are expected as operations continue.

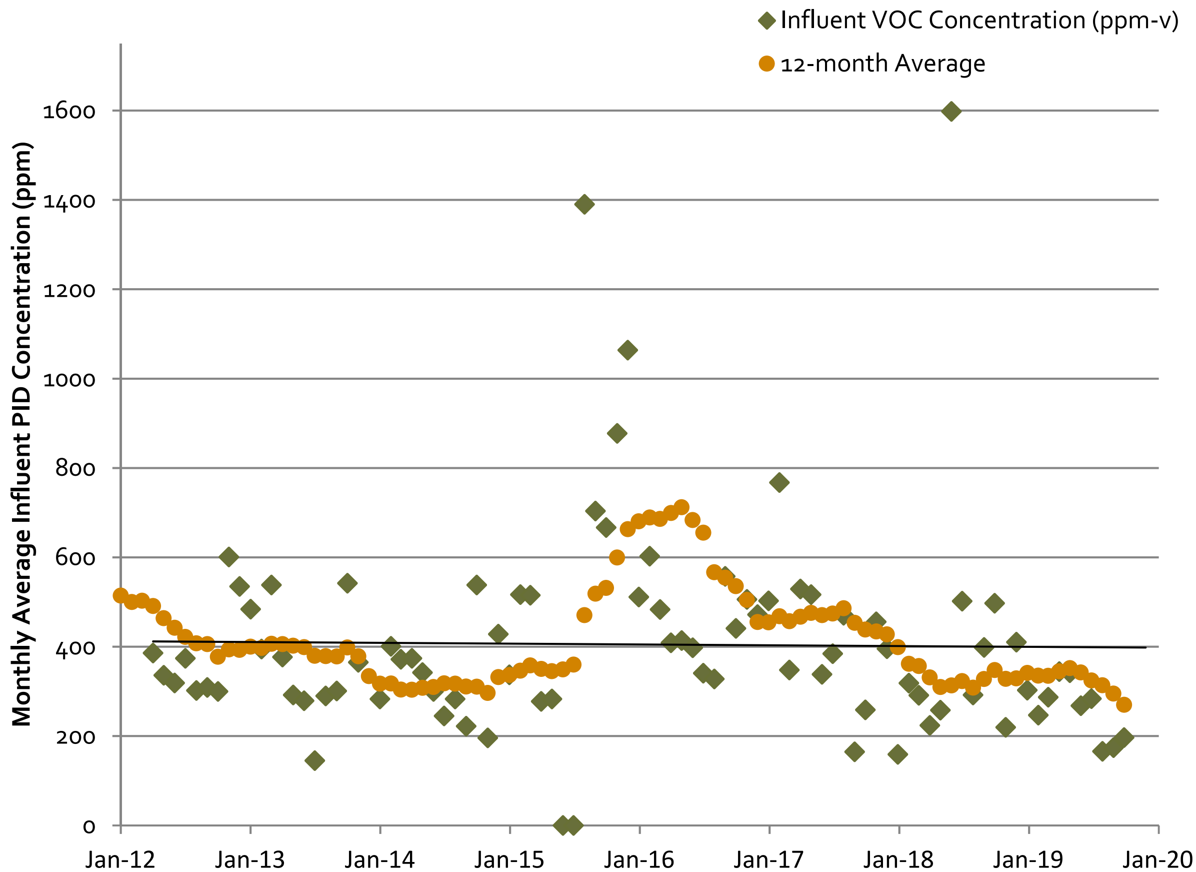


Figure 4-3. Influent Average PID VOC Concentrations vs. Time

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 path toward closure were defined for the SVE system, other than "significant reduction in soil gas VOCs."

Therefore, in the First FYR, Pantex recommended the development of a Burning Ground SVE Performance Monitoring Plan to define expected conditions of the system performance as well as a clear path toward an end point of active SVE operations. In anticipation of this plan, four rebound tests were attempted in 2014 and 2015 with the expectation of establishing baseline conditions to 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 four attempts at rebound testing over two years it does not appear the SVE performance-based approach will be technically practicable in attaining closure at the solvent evaporation pit/chemical burn pit area of the Burning Ground.

Pantex has evaluated other paths to an end point of active remediation for this system. After evaluation of the influent concentrations and system performance, Pantex recommended an approach to enhance bioremediation and volatilization and to eventually move to a passive remediation approach. Pantex recommended (Pantex 4th Quarter 2016 Progress Report) that up to seven inactive SVE extraction wells surrounding the active extraction well SVE-S-20 be modified with goose-neck pipes extending above ground with a screen and shut-off valves so that while the system is operating, air flow through the formation can be enhanced by opening the pipes to ambient air. This enhancement helps to stimulate naturally occurring aerobic bacteria that will degrade the NAPL source in addition to increasing 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 4th quarter of 2017. Hourly VOC removal rates increased with increased flow. The SVE system performance improvement in the fourth quarter of 2017 observed was an increase of 50 percent in the VOC mass removal rate over first quarter baseline values with an increase of 34 percent in the extraction air flow rate. The mass removal rate improvement lasted through the first quarter of 2018 and has since fluctuated. The hourly removal rate again declined during the third and fourth quarters of 2019. The drop in removal rates combined with declining influent PID measurements (Figure 4-3) may indicate that the system is nearing a point where the residual NAPL mass will not be effectively treated by the continued operation of the system. The SVE system has removed about 21,000 lbs of VOCs from soil gas and residual NAPL in the solvent evaporation pit/chemical burn pit area and successfully mitigating the potential vertical movement of VOCs to groundwater.

4.2 Uncertainty Management

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

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

Pantex analyzes for indicator constituents at all wells according to the SAP. This list of constituents helps determine possible impact at 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.

No Group 1 perched aquifer wells had unexpected conditions in 2019. As discussed in Section 3.4.2, 13 Group 2 perched aquifer wells exhibited increasing long-term trends in COC concentration while the expected condition was decreasing or stable trends below the GWPS. However, only one of these wells, 1114-MW4, exhibits trends that might indicate a new release related to a soil source. Apparent increasing trends for perchlorate and 1,4-dioxane were identified for this well; however, these trends likely result from changing flow gradients in perched groundwater that have been caused by the remedial actions. Historical perchlorate concentrations at 1114-MW4 were much higher than recent levels, and both the recent and long-term trends for this well are decreasing. Therefore, the observed perchlorate in this well does not indicate a new release to perched groundwater. Detections of 1,4-dioxane have fluctuated near the PQL since 2013. These COCs will continue to be monitored and evaluated over time to determine if the concentrations decline as expected.

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

5.0 Conclusions and Recommendations

5.1 Conclusions from the 2019 Annual Report

Overall, the groundwater remedial actions have been effective in 2019. The remedial actions continue to operate and meet short-term expectations for cleanup of the perched groundwater in areas under the influence of the remediation systems. Perched water levels are declining, COC mass is being removed or reduced, and institutional controls provide protection from use of impacted groundwater, while the remedial actions continue to operate to meet long-term goals. The influence of both pump and treat systems will continue to expand as the saturated thickness is reduced in the perched aquifer.

The groundwater remedies are considered to be protective for the short-term, as untreated perched groundwater use is controlled to prevent human contact and monitoring data continue to indicate that the remedial actions remain protective of the Ogallala Aquifer. One Ogallala Aquifer well, PTX06-1056, had continued detections of 4-amino-2,6-DNT and 1,2-dichloroethane slightly above the laboratory PQL, but below the GWPS in 2019, indicating possible migration of perched groundwater to the Ogallala Aquifer. In response to these detections, Pantex has fully implemented the conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2019c) and will continue sampling for HEs and VOCs in accordance with the SAP at this well. Pantex has proactively evaluated potential sources of the contaminants. A nearby perched well that was drilled deeply into the FGZ was plugged to address that potential source. An outside review indicated that the perched well was the most likely source of the contaminants based on fate and transport modeling. A cement bond log wasrun on PTX06-1056 in October 2016 to determine the competency of the concrete seal at the FGZ. The log indicates that the seal is competent and that PTX06-1056 is not likely acting as a preferential pathway for contaminants to reach the Ogallala Aquifer.

The pump and treat systems throughput performance was affected by shutdowns for repairs to the break at the filter bank at the irrigation system. In accordance with Permit #WQ0002296000, all treated wastewater effluent and treated P1PTS water is being routed to Playa 1. The SEPTS is injecting treated water into the perched aquifer and sending water to Playa 1 when P1PTS is not operating. P1PTS was only operated once per month to ensure continued functionality and to allow SEPTS to fully operate to capture water in high priority locations to control migration of plumes and minimize injection into the perched aquifer. Six new wells east of FM 2373 began operating in 2019 and are operated as high priority locations to control the continued movement of plumes to the southeast.

The Zone 11 ISB system has a well-established treatment zone in the original portion of the system, where injection has occurred since 2009. The expansion area has received three injections, so deeper reducing conditions are likely established at the injection wells. Evaluation of data in the treatment zone wells indicates mild to strong reducing conditions on the eastern side of the Zone 11 ISB where perchlorate is the primary COC. Reducing conditions across the western side ranged from very mild to strong with data indicating that deeper reducing conditions are present at injected wells for the reduction of TCE. Deep reducing conditions have not been fully demonstrated at all of the treatment zone monitor wells located between the injection wells in the expansion area. All wells downgradient of the system have indicated arrival of treated water. The ISPM wells downgradient of the original treatment zone are exhibiting effects of treatment with perchlorate not detected and TCE greatly reduced in all three original downgradient wells. At the wells downgradient of the expansion zone, perchlorate has declined to below the GWPS in all wells while TCE has declined at three of the wells. The only downgradient well not demonstrating strong treatment is PTX06-1173. Wells upgradient of PTX06-1173 were difficult to inject into during the 2018 and 2019 injection events.

To address the incomplete treatment of TCE, Pantex has moved to the use of molasses for injection. A study conducted in 2018 indicated that the molasses distributes widely between wells. Improved conditions have been noted on the western side of the Zone 11 ISB after moving to the use of molasses. However, some wells have limited ability to accept injection and those areas will likely continue to demonstrate milder reducing conditions until wells can be replaced.

Pantex has also further expanded the Zone 11 ISB in late 2019 with six new injection wells to completely encompass the plume to the northwest. The final well was sampled to determine the concentration of TCE and ensure the plume would be completely treated. Pantex plans to inject the new wells at the next injection event scheduled later in 2020.

The Southeast ISB system has been effective in treating HEs and hexavalent chromium at three of the closest downgradient ISPM wells (PTX06-1037 and 1154, plus historically at PTX06-1123). 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, but hexavalent chromium concentrations continue to demonstrate a decreasing trend and have remained below the GWPS since 2016. During 2019, this well demonstrated signs of partial treatment. Breakdown products of RDX were detected at concentrations above the GWPS. Upgradient dry wells were injected in the previous 2015 and 2019/2020 injection event in an attempt to affect this well. Pantex also moved to the use of molasses at this system to attempt better distribution of a carbon source across the treatment zone. Pantex also installed a pump at PTX06-1153 during injection to try to induce flow to the well. Data indicates the well was impacted by the injection, but it will take time to determine the extent of impact. As with other locations, water levels at this well continue to decline.

The new Southeast ISB Extension was injected for the first time in 2019. Two injection events were completed at the system, using molasses. Monitoring of treatment zone wells indicates complete treatment of the HE plume that is extending offsite. However, due to the distance to the downgradient wells offsite, treatment results are not expected to be observed in those wells for up to two years following the first injection.

Soil remedies have been effective at Pantex because 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 are operating as designed and recent rainfall continued to improve vegetative cover on the landfills. Yearly inspections and the Five-Year Review indicated several landfills require maintenance of the soil covers. Pantex is planning repair/maintenance of the landfill soil covers using a combination of on-site and contract resources. Pantex has also addressed, through contracting, a portion of the landfills that required maintenance. Pantex will continue to address the needed landfill maintenance as budget and availability of onsite resources allows. The ditch liner prevents the infiltration of water that would cause migration of HEs in soils to the perched aquifer. Maintenance of the ditch liner is required in 2020 to ensure continued conveyance of runoff through the ditch system. The SVE system is actively removing soil gas and residual NAPL in soils at the Burning Ground thereby mitigating vertical movement of VOCs to the Ogallala Aquifer. The system was shut down for more than 90 days due to repairs that required contracting. Pantex completed those repairs in 2020 and resumed operation.

The 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 the active remedies to determine if additional actions are needed to provide permanent long-term protection.

In order to address the identified issue of HE plumes expanding east of FM 2373 and in the southeast lobe of the perched aquifer to offsite properties, Pantex completed an update of the perched groundwater fate and transport model to assist with evaluation of treatment options for the off-site plume. Once the model was updated and calibrated, the model was used for optimization of a treatment system for the offsite plume. The results indicated that a combination of ISB and pump and treat on one property would effectively remediate the offsite plume within 25 years. Pantex has already begun the installation of the first phase of installation and plans to inject the ISB later in 2020. The system is planned to be installed across four phases, based on availability of annual funding.

To evaluate natural attenuation at Pantex, a leading researcher for a SERDP study of natural attenuation of RDX, Dr. Mark Fuller with APTIM, was contracted for a project to evaluate lines of evidence for natural attenuation at the Pantex 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/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 study found several lines of evidence for natural attenuation of RDX as well as the potential to enhance aerobic biodegradation of RDX with introduction of low levels of labile organic carbon.

5.2 Conclusions from the Five-Year Reviews

The first FYR Report for the Pantex Remedial Action was submitted in December 2012 and final approval was received in August 2013. The second FYR Report was submitted in May 2018 and final approval was received in September 2018. 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 or environmental receptors for soil or perched groundwater. In order to achieve long-term protectiveness of human health and the environment, operation and maintenance of the remedial action systems must continue and enhancements to existing systems and institutional controls need to be evaluated, planned, and implemented.

This section is provided to track the recommendations and actions from the FYRs to completion. There are three remaining recommendations/issues from the first FYR that were carried into the second FYR and will be addressed through that FYR. Those issues or recommendation are as follows:

1. The issue of expanding plumes to the southeast.
2. The issue of incomplete treatment at the Southeast ISB at well PTX06-1153.
3. The recommendation to develop criteria for ceasing active SVE system operations.

The table below details the issues and recommendations contained in the 2nd FYR. Items that have been addressed have been greyed out. Plans for completion or summary of work completed is provide for each item.

Table 5-1. 2nd FYR (2018) Issues and Recommendations

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Issues				
Soil Remedies				
Minor deficiencies in protective soil covers including erosion, slope instability, animal burrows and settling	Prepare and implement work plan to restore slopes and fill holes on soil cover surfaces.	Dec-2022		Pantex has prepared a plan to address the issues identified in the FYR as well as those identified through continuing annual landfill inspections. See Section 2 for a discussion of the plan. Pantex is planning to use onsite and contract work to fulfill these requirements. New funding has been requested for FY21-25 to address landfill issues.
New EPA protective dose calculations for radionuclides	Meet with EPA to discuss risk assessment process and data for radionuclides	Dec-2019	Dec-2019	Discussed at regulatory meeting on November 14, 2018. EPA requested a letter to close out the radionuclide issue. The letter closing out the issue was sent December 11, 2019.
Groundwater Remedies				
Plumes of high explosives (primarily RDX) are expanding in the southeast lobe of the perched groundwater unit in areas of low saturated thickness.	Continue to characterize the conceptual site model for the southeast lobe of the perched unit, including the extent of contamination, saturated thickness, groundwater flow direction and topography of the FGZ.	Phased approach through 2020	Sep-2019	Pantex has updated the fate and transport model and conceptual site model based on the latest data collected to the southeast of the Plant property. The model was used for optimization of an offsite remedy. The new offsite system was discussed in the 2019 2nd Quarter Progress Report.
	Connect six new extraction wells east of FM 2373 to the SEPTS.		Mar-2019	Wells were drilled and connected to SEPTS in March 2019.
	Design and implement an ISB system along Highway 60 southeast of the Pantex Plant.		Feb-2019	ISB injection wells installed in 2018 and first injection event completed in February 2019.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
	Confirm deed restrictions encompass property affected by migration of the HE plume.			Pantex has confirmed the extent of contamination for the deed restriction. The remediation system is designed to keep concentrations below GWPS at the boundary of the deed restriction area. Pantex is continuing to work with the DOE, U.S. Army Corp of Engineers, and offsite landowners to put restrictions in place. Completion is expected by the end of 2020.
The Zone 11 TCE plume extends west and outside of the Zone 11 ISB system.	Continue evaluating alternatives for treatment of the TCE plume. Remedial systems to be considered include expanding and/or updating the ISB system or implementing a pump & treat system.	Sep-2020	Jun-2018	Pantex completed an evaluation of remedial options. The final recommendation was to extend ISB to the untreated area and add recirculation to optimize treatment. Pantex has installed six new injection wells to the northwest of the ISB to expand injection to the edge of the plume. Injections are scheduled to begin in 2020.
Incomplete treatment of HE and Cr(VI) downgradient of the west end of the SEISB at PTX06-1153. Other ISB performance wells show results below remedial goals.	Continue to collect and evaluate data from the SEISB area, consider targeted injections in the area of PTX06-1153. Evaluate options for optimized injection of amendments to address contamination in this area.	Sep-2019	Jun-2019	Pantex continues to evaluate data and optimize the ISB systems. A study conducted in 2018, using a soluble carbon (molasses), indicates improved distribution of amendment between wells. As recommended in the 2018 Annual Progress Report, Pantex injected molasses during the 2019/2020 injection event as part of an optimized strategy to impact PTX06-1153. Additionally, a pump was installed in PTX06-1153 to induce flow to the well while injection occurred upgradient. Results of the study will be evaluated over time.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Perchlorate plume potential migration to SEPTS	Continue monitoring the perchlorate plume southeast of Zone 11. Modify the SEPTS extraction to limit mobilization in the short-term as needed. Addition of a perchlorate treatment unit to the SEPTS would be warranted if perchlorate is detected in SEPTS influent at concentrations near the GWPS of 26 ppb.	Sep-2019	Jan- 2019	Pantex has increased sampling at the SEPTS to semi-monthly and semi-annually at the affected wells. Pantex has included modification of the SEPTS to include perchlorate resins in our 2021 budget and scope for extending irrigation to the east of FM 2373. Current concentrations are low at SEPTS and the chromium resin can treat the perchlorate. Wells will be turned off in response to higher concentrations that cannot be treated until Pantex can modify SEPTS to include treatment vessels for perchlorate.
GWPS for perchlorate is 26 mg/L, the TRRP PCL is 17 mg/L, and the EPA LHA is 15 mg/L.	Include perchlorate as part of the risk assessment meeting and discussion with EPA described under Issue 2 (Soil radionuclides risk assessment). Update GWPS as needed in potential ESD.	Sep-2022		The perchlorate issue was discussed at a meeting held in November 2018. Pantex plans to implement a change in the perchlorate GWPS when the ESD is completed (see issue below). Pantex is already working towards implementing a lower GWPS at the pump and treat systems as part of the upgrade to the system to include resin treatment of perchlorate. No further meetings are required to address the perchlorate GWPS issue.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Significant updates to the selected remedy are currently underway or being considered	Issue an ESD before the 2023 FYR to document expansion and updates to the remedies selected in the ROD	Sep-2022		Pantex plans to include the offsite treatment system into a single ESD that covers expansion of the Zone 11 ISB and new treatment systems for the expanded southeast plume, as well as implementing a change to the perchlorate GWPS. Any other changes made to the system to expand treatment at Zone 11 ISB or possible changes at the Southeast ISB will also be included, if needed.
Additional Perched Groundwater COCs and COPCs				
Cadmium concentrations exceeded the MCL in 2011 beneath Zone 12 South (WMG 6/7) at PTX06-1010, recent data indicate concentrations below GWPS	Concentrations of cadmium should be monitored at PTX06-1010 and down-gradient well PTX06-1088 during the next five-year period to confirm concentrations below GWPS of 5 mg/L.	Annually through Progress Reports	Ongoing	Cadmium sampling at PTX06-1010 and one downgradient well has been included in the yearly data quality objectives and schedule for sampling.
Detections of Cr(VI) in Zone 11 (PTX08-1005)	While Cr(VI) concentrations are still slightly below the GWPS, the area will need to be evaluated and concentrations trended in the future to determine if the Cr(VI) persists.	Annually through Progress Reports	Ongoing	Cr(VI) sampling at PTX08-1005 and two downgradient wells has been included in the yearly data quality objectives and schedule for sampling.
1.4-Dioxane in Zone 11 plumes	Continue monitoring for 1,4-dioxane in the Zone 11 plume and downgradient from the ZN11ISB system to evaluate potential expansion of the plume.	Annually through Progress Reports	Ongoing	1,4-Dioxane sampling is conducted at all upgradient and downgradient wells for the Zone 11 ISB, as well as Zone 11 areas where a release could have occurred. This sampling has been included in the yearly data quality objectives and schedule for sampling.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Recommendations				
Soil Remedies				
Establish criteria for ceasing SVE system operations.	Develop a trial shutdown plan and monitoring program to evaluate potential rebound in concentrations during the shut-down period. Establish termination criteria.	As needed after review of influence of recent upgrades to system	Ongoing – trial shutdown to begin in 2020	Modified the SVE system in 2017 to pull in ambient air to increase volatilization and bioremediation. Continuing to monitor for drop in concentrations and removal rates that indicate that the system has effectively removed NAPL in intermediate soils. Trial shutdown and pulsing plan is anticipated to begin in 2020.
Groundwater Remedies				
Repair/enhance irrigation system and/or develop new options to reduce reliance on injection of treated water back into the perched zone.	Develop a work plan to optimize the irrigation system for disposing of treated groundwater and/or develop new options for beneficial reuse to increase extraction and treatment throughput volumes.	Jul-2019	New options identified Jun-2019	See Section 2 of this report for discussion of operation and maintenance of the system and recommendations to increase extraction and throughput. Plans include: -Playa 2 injection contract started in 2019. Construction is expected to be complete by the end of FY20. -Design of changes to SEPTS and new irrigation system east of FM 2373 design has been requested for 2021 budget/scope. –The filter bank at the existing system has been repaired. After repairs to the filter bank, the system will have to be tested and repaired in the field. Testing of irrigation tapes and necessary repairs is underway. The existing system is expected to be running by the end of FY20.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Consider optimization of the pumping network in the SEPTS.	Computational or qualitative optimization of extraction could improve: ·Control of migration of perchlorate plume. ·Continued reduction of saturation in the SEISB. ·Control of the plume migrating in the southeast lobe of the perched unit.	Sep-2021		Pantex has initiated a long-term contract for fate and transport modeling and evaluation of treatment. Additional funding has been requested for the 2021-2025 budget years to address these recommendations.
Consider optimization of the SEISB injection effort may be reduced in areas where groundwater COC concentrations have dropped below GWPS.	·Consider amendment injections in wells around PTX06-1153 (even if they appear dry) to target one area where COC concentrations are not responding.	Sep-2020	Jun 2019	See actions in Issues section above.
	·Schedule a reduced amendment injection frequency at the SEISB in areas where groundwater concentrations have dropped below GWPS.		Jun 2019	Pantex has reduced soybean oil injection events for the SEISB. One more injection event is planned in 2022. No further injections may be required due to declining water levels.
	Evaluate data annually and during the next FYR period to determine effects of the optimized strategy.		Ongoing	Pantex will include evaluation of evolving strategies in each annual progress report.
LTM Network				
Evaluate current conditions in Ogallala Aquifer monitoring wells to determine if changes are needed to implement improvement plan (2014).	Check current configuration of Ogallala Aquifer monitoring wells to decide if diverters need to be installed to improve early detection as recommended in the sampling improvement plan.	Sep-2019	Nov 2018	All Ogallala wells were evaluated with respect to screens with blanks and current water levels. A diverter was added to one Ogallala well, PTX01-1011. Sampling will continue at the current upper screened section of this well.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Update LTM Network design and SAP documents to capture changes and recommendations from the Second FYR, after regulatory approval.	LTM Network and SAP documents need to be updated to reflect recommendations from the 2017 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.	Sep-2019	Sep-2019	Pantex has updated the LTM Design and SAP and sent to TCEQ and EPA. Those documents have been approved. Pantex implemented changes to the network in accordance with the updated LTM Design and SAP beginning January 2020.
ICs				
Use data collected from the southeast lobe of the perched groundwater unit to determine if additional deed restrictions are required to restrict access to affected perched groundwater.	Implement additional deed restrictions as needed.	Phased approach through 2020		Pantex and the DOE Albuquerque Real Estate Office started working with neighbors to address treatment and deed restrictions in 2019. Well drilling in 2019 and new installations in 2020 indicate the plume is well defined and no further restrictions are required to address the plume. The previously identified deed restrictions are being pursued by Pantex, DOE, and the U.S. Army Corp of Engineers and is expected by be complete in 2020.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
Community Involvement				
Implement measures to better inform neighbors of the RA.	Update Community Involvement Plan, neighbor mailing lists, and distribute the annual newsletter and public meeting invitations accordingly to improve communication with Pantex neighbors/ local officials.	Dec-2019	May 2019	The Community Involvement Plan was fully updated to reflect new community information and updated contract information. Neighbor mailing lists are updated annually. Public meeting invitations are sent based on those updates, as well as expressed interest from stakeholders. The annual newsletter is sent to the full list of neighbors by October of each year, in advance of the public meeting that is held in November.
Improve communication of RA efforts with the Local Groundwater District	Provide copies of quarterly and annual progress reports to the Panhandle Ground Water District (PGWD) as part of distribution when submitted to TCEQ and EPA. This will ensure that RA progress and the new information on wells installed and water quality encountered is available to PGWD staff for use in protecting and conserving ground water resources critical to the future of the Panhandle region.	Annually	Jun-2018	The PGWD is now included in the distribution list for delivery of all quarterly and annual progress reports.

5.3 Recommendations

Pantex plans to continue the current approved remedial actions. The groundwater remedies are considered protective for the short-term as untreated perched groundwater use is controlled to prevent human contact and Ogallala Aquifer data continues to indicate COC concentrations either non-detect or below GWPS. The systems are proving to be effective in reaching long-term established objectives for cleanup. Soil remedies have been effective at Pantex as 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 is actively removing soil gas and residual NAPL in soils at the Burning Ground thereby mitigating vertical movement of VOCs to the Ogallala Aquifer.

Based on issues identified in the Five-Year Review and during completion of this report, several changes are recommended or have been implemented to enhance the effectiveness of the remedies in some areas and to better monitor the effectiveness of the actions. Those recommendations are provided in the following sections.

5.3.1 Recommended Changes to the Selected Remedies

Pantex plans to release an ESD describing changes to the southeast and Zone 11 remedies. The scheduled date for completion of this action, as provided in the 2nd FYR, is September 2022.

As recommended in the 2nd Quarter Progress Report (2019), Pantex plans to install an offsite remediation system to address contamination found beneath two offsite properties. The remediation system consists of a combination of ISB and pump and treat on one property that will effectively treat the entire plume within 25 years. Phase 1 installation of wells is underway.

5.3.2 Recommended Changes to the Pump and Treat Systems

Pantex has implemented a previous recommended change to the operation of the SEPTS and P1PTS. P1PTS is now only operated once each quarter to allow SEPTS to fully operate and continue more effective capture of perched groundwater and contaminant plumes moving to the Southeast. Pantex expects to operate both systems later in 2020 as the irrigation system repairs are completed.

Pantex is planning to evaluate ways to optimize the pump and treat systems to allow better capture of the plumes and removal of water for protection of the underlying

Ogallala Aquifer. Optimization of the systems to control the perchlorate plume was identified as an issue in the 2nd FYR. Pantex requested extra funding in FY21 to complete the optimization work. The work is scheduled to be complete by September 2022.

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 areas of the ISBs. Further evaluation of the changes implemented in 2019 is required to determine if further changes are required.

5.3.3.1 Southeast ISB

Pantex has injected a more soluble carbon (molasses) to improve distribution of amendment at the ISB, implemented pumping of PTX06-1153 during injection to induce flow to the well, and injected in dry upgradient wells. These changes will require evaluation over time to determine the full impact of the injection. Water levels will continue to be monitored as it is anticipated that only one more injection may be needed at this system.

5.3.3.2 Southeast ISB Extension

Pantex just completed injections into this new ISB in 2019. No changes are recommended at this time.

5.3.3.3 Zone 11 ISB

In 2019, Pantex expanded the Zone 11 ISB to fully encompass the TCE plume. Pantex plans to inject the wells in 2020. Further evaluation is required to determine if additional changes are required.

5.3.4 Recommended Changes to the Monitoring Network

Pantex updated the *Long-Term Monitoring Design* and the *Sampling and Analysis Plan* in September 2019. Those changes in the documents were implemented beginning January 2020. No further changes are recommended at this time.

5.3.5 Recommended Changes to Soil Remedies

No changes to the landfill remedies are recommended. Pantex has requested additional funding, beginning in FY 21 to contract the cover maintenance and repair work. Onsite support is also being requested to help address holes and voids in the old construction debris landfills.

Pantex is continuing to evaluate SVE data after modifying the system in May 2017. Further recommendations for a path to closure will be made after implementation of shutdown and pulsing of the system begins in 2020.

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