Pantex Plant

2017 Annual Progress Report

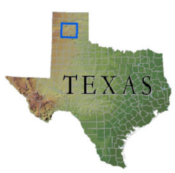
Remedial Action Progress

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

June 2018

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

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



Pantex Plant Remedial Action Systems

CERTIFICATION STATEMENT

2017 Annual Remedial Action Progress Report
Pantex Plant, June 2018

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 Date
Senior Director
Environmental and Safety Programs
Consolidated Nuclear Security, LLC

2017 Annual Remedial Action Progress Report
in Support of Hazardous Waste Permit #50284
and Pantex Plant Interagency Agreement
for the Pantex Plant, Amarillo, Texas
June 2018

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.

Tony Biggs Licensed Professional Geologist No. 2693 Environmental Projects Consolidated Nuclear Security, LLC	Date

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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 2017. 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 system, maintenance of the WWTF, and in response to the break at the filter bank at the irrigation system. The average operational rate across 2017 was 70% at P1PTS and 75% at SEPTS. The pump and treat system performance for 2017 is depicted in Figure E-1.

While treatment throughput was not a primary goal after June 2014, 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 can be made. SEPTS was also impacted by the break at the irrigation system and while it remained operational most of the time, flows were reduced as injection into the perched groundwater was required. SEPTS operation focused on removal of water in high priority well locations to control plume movement to the southeast.

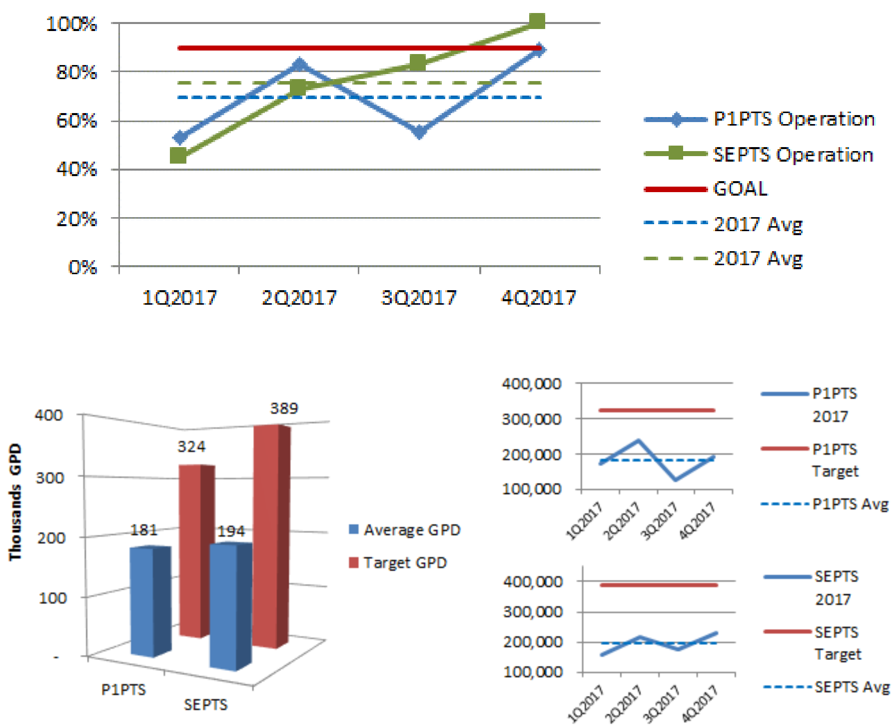

Figure E-1. Pump and Treat Systems Performance

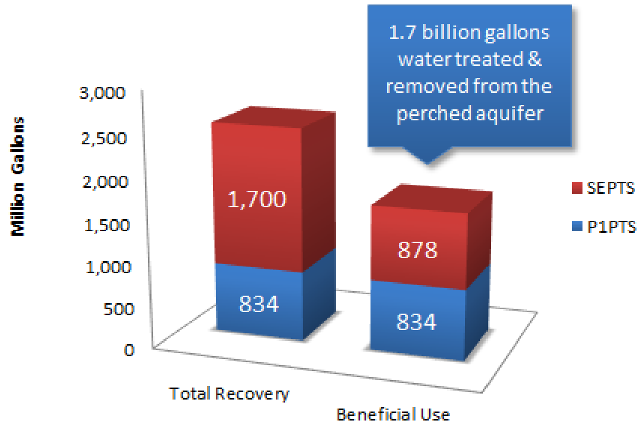

Figure E-2. Pump and Treat Recovery

Overall, the systems have operated efficiently to treat contamination and reduce saturated thickness. As depicted in Figure E-2, Pantex has treated approximately 2.5 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 2017, 52% 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 2017, 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 2017, SEPTS removed about 420 lbs of contaminants and P1PTS removed about 29 lbs of contaminants.

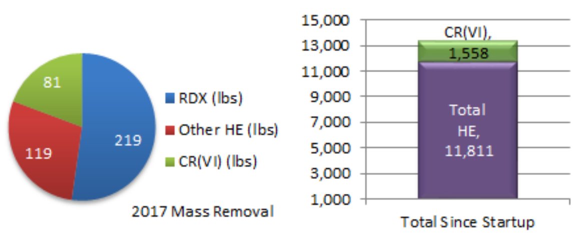

Figure E-3. SEPTS Mass Removal

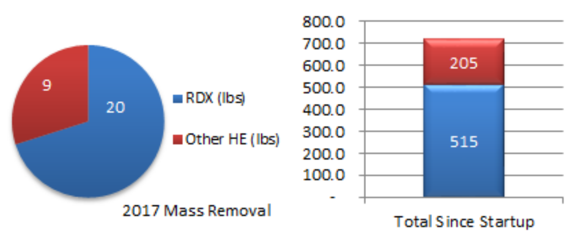

Figure E-4. P1PTS Mass Removal

E.2.2 *In Situ Bioremediation Systems*

For the treatment zone wells, this report evaluates whether the reducing conditions are present to degrade the contaminants of concern (COCs) in each area, as well as the presence of a continued food source for the bacterial reduction of COCs. Downgradient monitoring wells are evaluated to determine if COCs are being reduced to the GWPS and that complete degradation is occurring.

Installation of the Zone 11 ISB Remedial Action was completed in 2009, with initial amendment injection completed in 2009 and yearly injections thereafter. Data indicate that a reducing zone has been established and a fair to good food source is available for continued biologic growth. No injections occurred in the ISB systems during 2017.

Perchlorate concentrations were below GWPS in six of the nine downgradient ISPM wells during 2017. Perchlorate is exhibiting a decreasing trend in PTX06-1150 and PTX06-1175, and has been decreasing in PTX06-1148 although no trend is indicated for the last four samples in this well. TCE concentrations were non-detect or below GWPS in seven of the nine downgradient ISPM wells by late 2017. TCE concentrations in PTX06-1150 have been slightly increasing to concentrations slightly exceeding GWPS, but exhibited a decreasing trend for 2017. PTX06-1175 is beginning to demonstrate decreasing concentrations, but demonstrates no trend across all data.

Pantex previously recognized in the 2013 Annual Progress Report that complete TCE treatment may be constrained by a lack of DHC that are necessary for complete dechlorination of TCE and began working on a Bioaugmentation Plan in 2014. The seventh injection event, completed in 2015, included bioaugmentation of the western side of the original Zone 11 ISB where reducing conditions are established and where the heart of the TCE plume is treated.

Pantex is monitoring the impact of the bioaugmentation through the use of qPCR and compound specific isotope analysis (CSIA) sampling which began in February 2016. The qPCR and CSIA data, combined with other monitoring data from the Zone 11 ISB area, indicate that complete dechlorination is limited due to low counts of DHC and mild reducing conditions in many areas of the Zone 11 ISB where bioaugmentation has occurred. Additional sampling for CSIA and census DNA for DHC and 1,4-dioxane will be conducted at the Zone 11 ISB during 2018 after rehabilitation of the wells. These analyses will be used to determine the effectiveness of bioaugmentation and to evaluate other potential processes that may be helping degrade TCE and 1,4-dioxane through co-metabolic processes. Bioaugmentation in the expanded treatment zone described in Section 2.2.1 will not occur until the weight of evidence suggests the proper reducing conditions exist for DHC survival and growth.

The Southeast ISB was installed in 2007, with injection completed by March 2008. This system has established an adequate reducing zone for HEs and chromium, based on geochemical conditions monitored at the treatment zone. No injection was completed at this system during 2017 and the next injection event is scheduled for 2019. The system has adequately treated the primary COCs (RDX and hexavalent chromium) at three downgradient monitoring wells to concentrations below their respective GWPS during 2017. HE breakdown products were also treated to levels below their respective GWPS in these three wells during 2017. Pantex continues to investigate why one downgradient well, PTX06-1153, has not responded as strongly to treatment of RDX and hexavalent chromium. Two other performance monitoring wells (one upgradient and one farther downgradient) were dry and could not be sampled during 2017. Other wells in the treatment zone, as well as one other downgradient well, showed dry or limited water conditions in 2017. This condition is expected to continue as the pump and treat systems continue to remove water upgradient.

Passive flux meters (PFMs) were deployed in fall 2016 to assess the impact of dewatering within and around the Southeast ISB on groundwater flow and to support long-term decisions regarding Southeast ISB injection. A primary objective of the PFM testing was to evaluate the hypothesis that contaminant concentrations have persisted in PTX06-1153 because groundwater in the vicinity of this well is stagnant. Results of the PFM testing show that measureable groundwater flux was observed in PTX06-1153, although flow to the well is limited. Given the location of PTX06-1153, apparent groundwater flux through the well may indicate a groundwater-flow pathway around the western end of the Southeast ISB. To evaluate the possibility of another flow path at the western end of the ISB, PTX06-1188 was installed in 2017. Data indicate the well was dry and has remained dry.

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 continuously operated except for testing, maintenance, repairs, or freezing weather that affects influent flow. Mass removal calculated for 2017 for VOCs contributing more than 2% 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 813 lbs of VOCs during 2017.

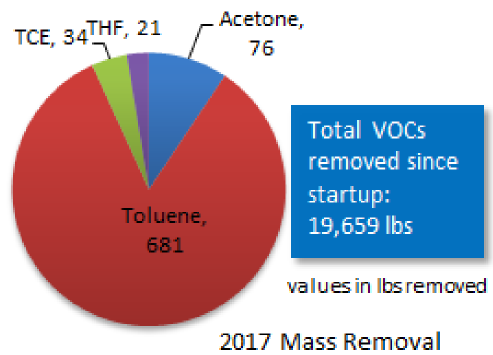

Figure E-5. Burning Ground SVE Mass Removal

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 eight new projects that required work in a SWMU in 2017. 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 maintenance contract and larger issues, such as erosion, will be addressed through separate contracts. Heavy rainfall in 2015 and 2016 caused problems with erosion at the landfills, with the largest problems identified at Landfill 3. Pantex contracted for design of improvements to address the erosion at Landfill 3. Construction of the upgrades is expected to occur by October 2018.

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, 2009a) was conducted as part of the evaluation process.

Overall, calculated concentration and groundwater level trends were consistent with expected conditions defined in the LTM Design Report. Figure E-6 depicts recent water level trends in the perched aquifer LTM wells. Of the 43 monitor wells with expected water level conditions defined in the LTM Design Report, only eight wells exhibited conditions inconsistent with the current expected conditions or trends. Most of these wells exhibited a short-term increasing trend in 2017 in response to above normal precipitation; no water was observed in one of these wells, PTX06-1003, in 2017. The long-term water level trend is decreasing for all of these wells, and it is expected that water levels will continue to decline.

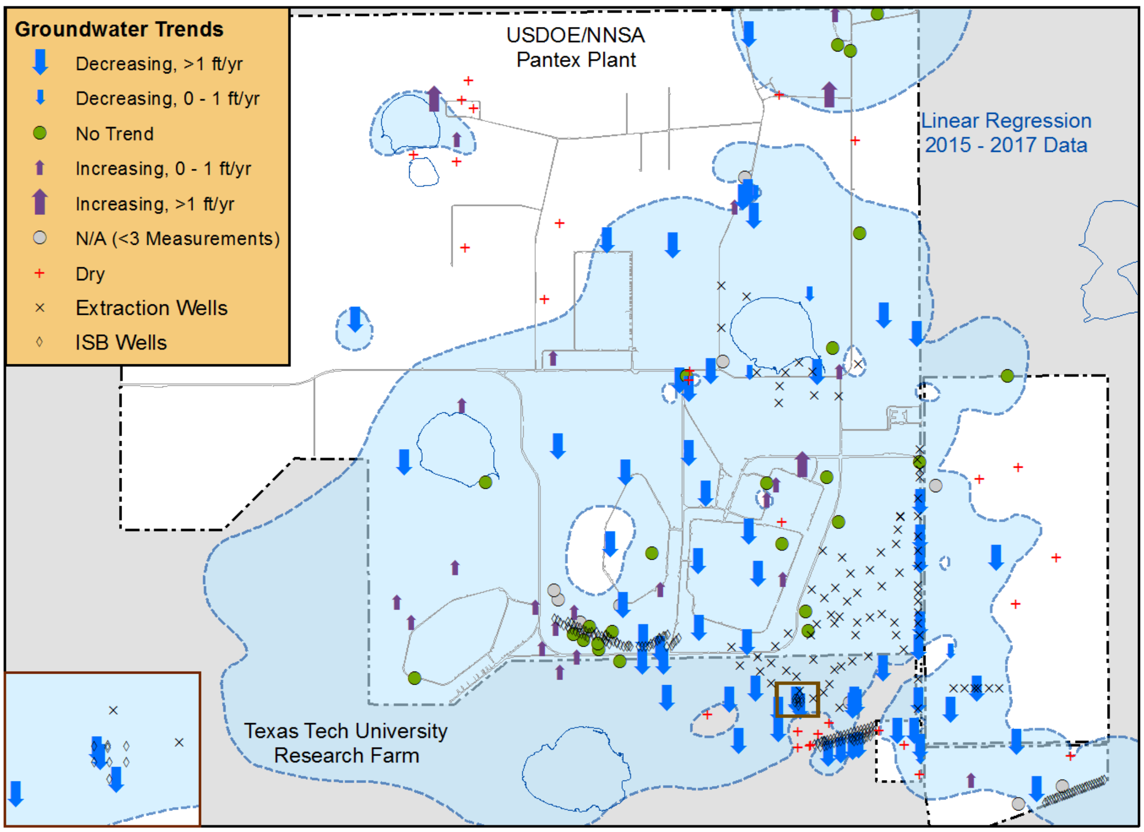

Figure E-6. Perched Aquifer Water Level Trends

Of the 103 monitor wells with expected COC concentration conditions defined in the LTM Design Report, 34 wells did not exhibit trends consistent with the expected conditions for the four major COCs (RDX, hexavalent chromium, TCE, and perchlorate). It is anticipated for these trends to 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.

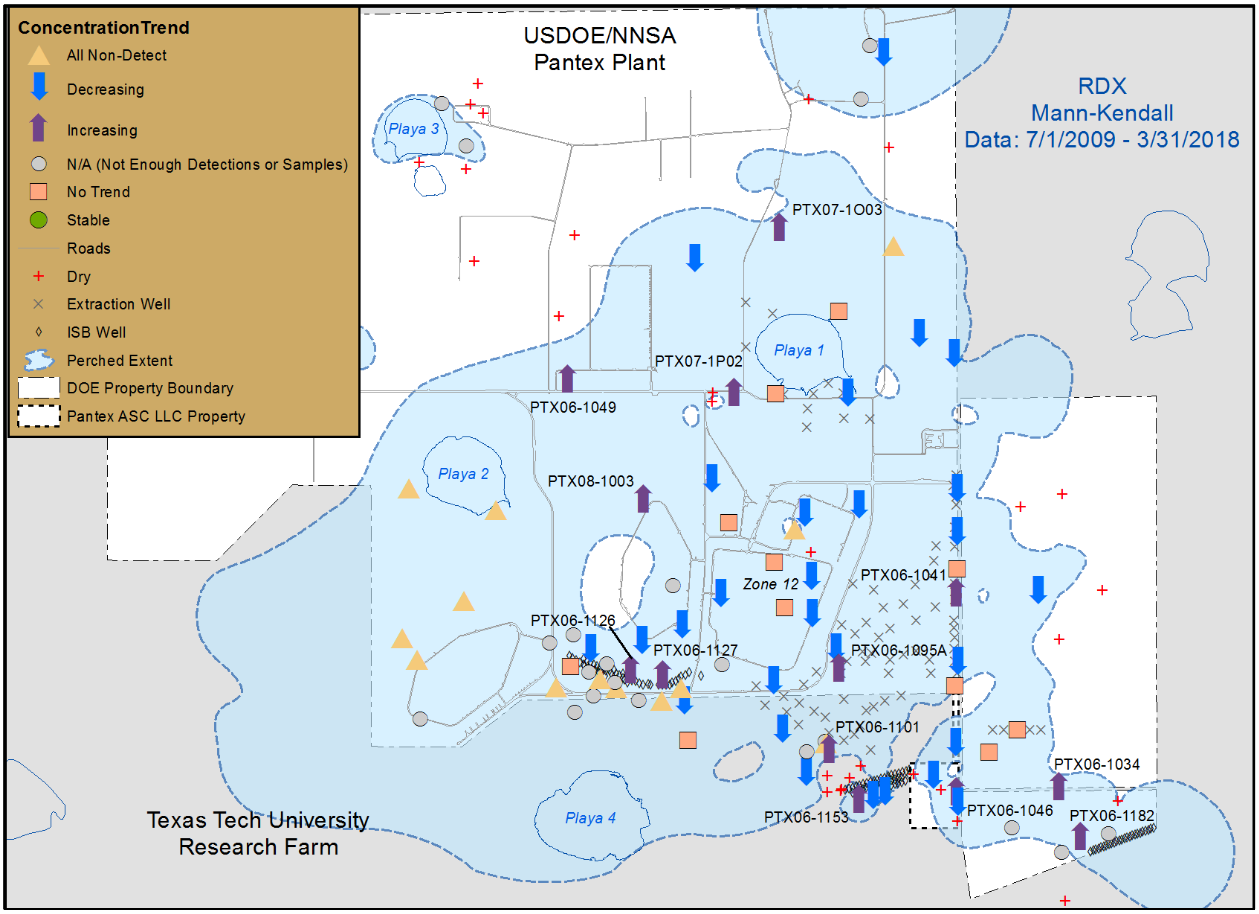

Figure E-7. RDX Trends in the Perched Aquifer

Generally, 2017 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. 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.

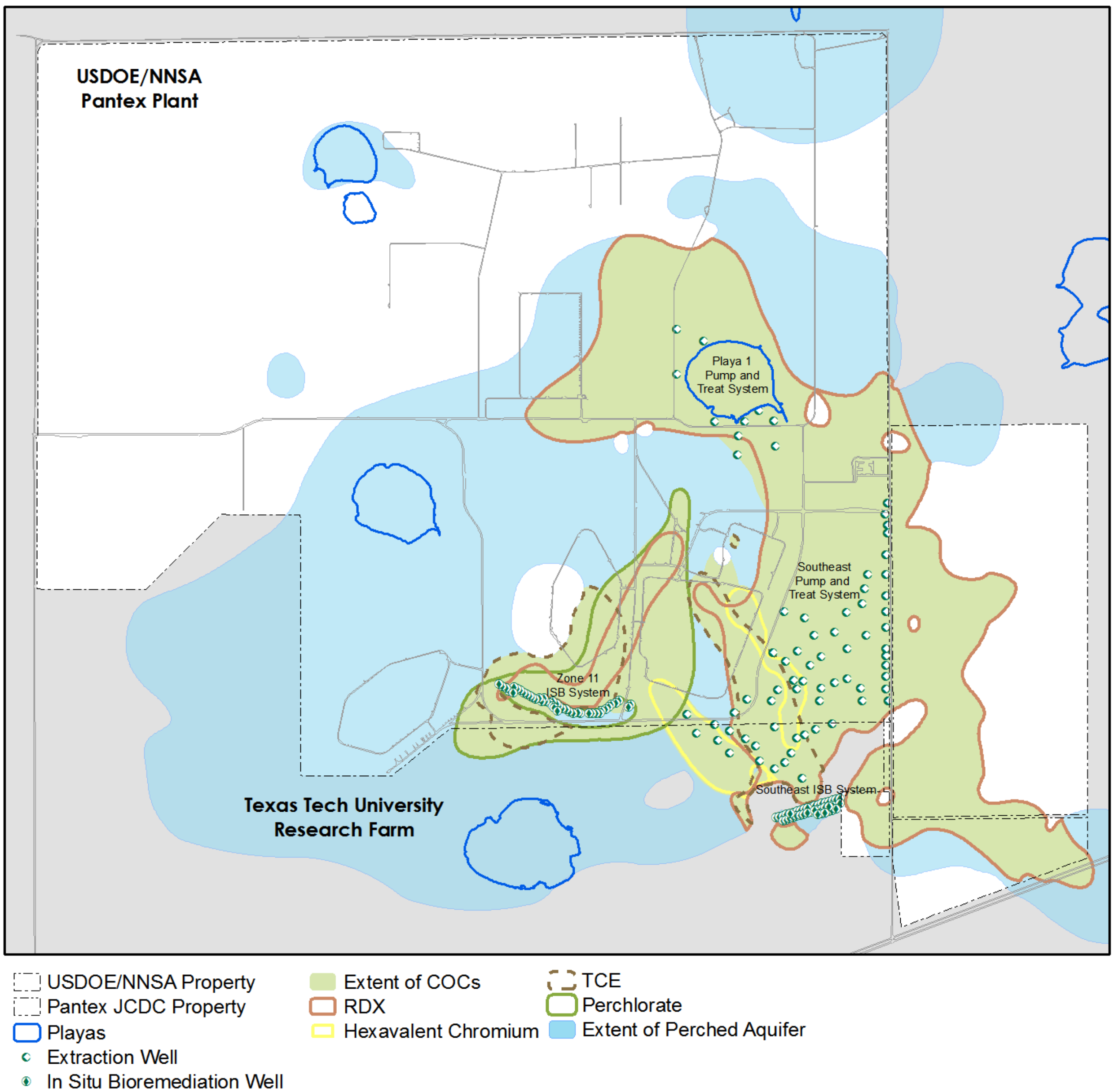

Figure E-8. Major COC Plumes in the Perched Aquifer

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 2017. 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. When comparing the 2017 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 2017 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. The fourth downgradient well (PTX06-1153) exhibits RDX concentrations above 200 ug/L and variable hexavalent chromium concentrations below the GWPS. Pantex has continued to evaluate the reason for incomplete treatment at PTX06-1153. In 2017, a new well was installed west of the Southeast ISB. This new well continues to indicate dry conditions in the area. Meanwhile, data collected in 2017 indicate that partially treated water is reaching PTX06-1153 again. It is possible that bioamendment injection into upgradient dry wells may be have a delayed effect on conditions at PTX06-1153. Pantex will continue to monitor the wells for water levels and the presence of COCs. Water levels at this well continue to decline with the current saturated thickness less than 6 ft at this location.

Monitoring data collected in 2017 also indicate the Zone 11 ISB system has been effective in its ninth year of operation. Data indicate that an adequate reducing zone has been established for perchlorate and conditions appear to be favorable for reductive dechlorination of TCE near the injection wells. Pantex is monitoring the impact of the bioaugmentation through the use of qPCR and CSIA sampling which began in February 2016. The qPCR and CSIA data, combined with other monitoring data from the Zone 11 ISB area, indicate that complete dechlorination is limited at this time due to low counts of DHC and mild reducing conditions in many areas of the Zone 11 ISB where bioaugmentation has occurred. Additional sampling for CSIA and census DNA for DHC and 1,4-dioxane degrading microbes will be conducted at the Zone 11 ISB during 2018. These analyses will be used to determine the effectiveness of bioaugmentation and to evaluate other potential processes that may be helping break down TCE and 1,4-dioxane through co-metabolic processes. Bioaugmentation in the expanded treatment zone will not occur until the weight of evidence suggests the proper reducing conditions exist for DHC survival and growth.

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 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 2017.

Several Ogallala Aquifer Group 1 wells had nickel, manganese, and boron detections exceeding background levels. However, these exceedances are likely due to stainless steel well screen corrosion, influence from deeper formations, sample turbidity, or background variability. All of these metals detections are significantly lower than their respective GWPS.

Hexavalent chromium was detected above the site-specific background in one well in 2017; however, these detections are only slightly above background and likely represent background variability. Hexavalent chromium was also detected at low levels in PTX06-1033 using a different, less sensitive, method than used for background determination; therefore, this value is not directly comparable to the background. The alternate analysis method was employed for analysis of samples collected during the second quarter of 2017 because of instrument failure. As discussed in the 2016 Annual Report, low-level detections of hexavalent chromium near the SAP PQL of 15 ug/L are false positives or inaccurate elevated detections near the MDL due to the colorimetric analytical method or related to corrosion of stainless steel screen/casing. PTX06-1033 has documented evidence of corrosion, so this detection is likely associated with screen corrosion.

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 2017 at values up to 0.344 ug/L, slightly above the PQL of

0.26-0.27 ug/L, but below the GWPS. 1,2-Dichloroethane was detected in all four quarterly samples in 2017; all detections were below the PQL and GWPS.

Pantex has proactively evaluated potential sources of these contaminants. 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 contaminants, 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 contaminants to reach the Ogallala Aquifer.

Based on all four quarters of data in 2017, the detection of 4-amino-2,6-DNT does not exhibit a trend, and detections of 1,2-dichloroethane are exhibiting a stable trend. Long-term trending continue to indicate a slight increase in concentrations. 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.

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). For many of these wells, it is expected that concentrations will stabilize with an eventual long-term decreasing trend below the GWPS.

Most of the Group 2 wells that have detections of COCs already meet expected conditions at the well. There are 11 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. 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 assess 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 three new wells (PTX06-1184 through PTX06-1186) during 2nd quarter 2017 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 remedy to the southeast boundary of the site and also obtained an access agreement with the landowner to the south to drill wells on their property to aid in determining the extent of contamination. Drilling of the ISB wells was completed in December 2017, and the offsite monitoring wells were completed in January 2018 with three of the offsite wells indicating the presence of water and one well that is dry. Analytical samples were collected from the three wells with water, and one well had concentrations exceeding the GWPS for two HEs. Pantex is continuing to work with the neighboring landowner to the southeast to obtain an access agreement to drill and sample wells on that property.

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 recent SERDP study (2014) provided evidence that aerobic degradation is occurring in the Pantex RDX plume with strong evidence of aerobic degradation found in two monitoring wells. This study provided new methods for better evaluating RDX degradation at Pantex. Pantex has contracted with leading researchers for further study at the Pantex Plant to apply the CSIA and other new analytical techniques to determine where and what type of degradation is occurring across the RDX plume. Groundwater samples for this study have been collected, and laboratory analysis and data evaluation are underway. The study is expected to be completed in June 2018.

Overall, it appears that natural attenuation of HEs may be occurring at Pantex. More data will be required over time to determine trends and possibly estimate rates of attenuation.

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.

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 Pump and Treat Systems

Perchlorate continues to move into the southwestern SEPTS extraction well field. Pantex is evaluating options for treatment of the perchlorate at the main SEPTS system.

Operation of the pump and treat systems was affected in 2017 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 anticipated in late 2018 will improve 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. Pantex is currently evaluating the following available options for use of the treated water including irrigation under the Texas Land Application Permit, injection into the perched aquifer, or injection into the Ogallala Aquifer as storage of water for later use. Of the three options, injection provides the most consistent avenue for release of treated water. Based on past experience at Pantex, irrigation is subject to repair and maintenance issues that will affect operation of the pump and treat systems. Injection into the perched groundwater could be problematic because of issues associated with affecting plumes or operation of the ISB. With time, Pantex will likely pursue more than one option to enable consistent operation of the systems in the future.

E.5.2 Recommended Changes to the ISB Systems

E.5.2.1 Southeast ISB

Because no clear cause for the unexpected conditions in PTX06-1153 has been identified, it is recommended to continue monitoring the water level and analytical data collected in and around the Southeast ISB to continue to attempt to discern groundwater flow patterns.

E.5.2.2 Zone 11 ISB

Pantex is currently evaluating options for the treatment of the TCE plume that extends to the northwest of the current Zone 11 ISB system. Recommendations for a path forward will be provided during 2018 following the review.

E.5.3 Recommended Changes to the Monitoring Network

PTX06-1182 was installed in 2016 in an area that was previously thought to be beyond the extent of perched saturation; the presence of RDX above the GWPS has been confirmed with the most recent sample showing a concentration of 23 ug/L. In response to that information, Pantex installed three new wells (PTX06-1184 through PTX06-1186) during 2nd quarter 2017 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 obtained an access agreement with the landowner to the south to drill wells on their property to aid in determining the extent of contamination. The offsite monitoring wells were completed in January 2018 with three of the wells indicating the presence of water and one well that is dry. Analytical samples were collected from the two wells with water, and one well had concentrations exceeding the GWPS for two HEs. These wells will continue to be monitored and will provide valuable information on the movement of contaminants in this area of the perched groundwater. Pantex is continuing to work with the neighboring landowner to the southeast to obtain an access agreement to drill and sample wells on that property.

E.5.4 Recommended Changes to Soil Remedies

No changes to the landfill remedies are recommended.

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 additional evaluation of data in 2018.

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List of Acronyms

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
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
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
PFM	passive flux meter
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
THF	tetrahydrofuran
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

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).

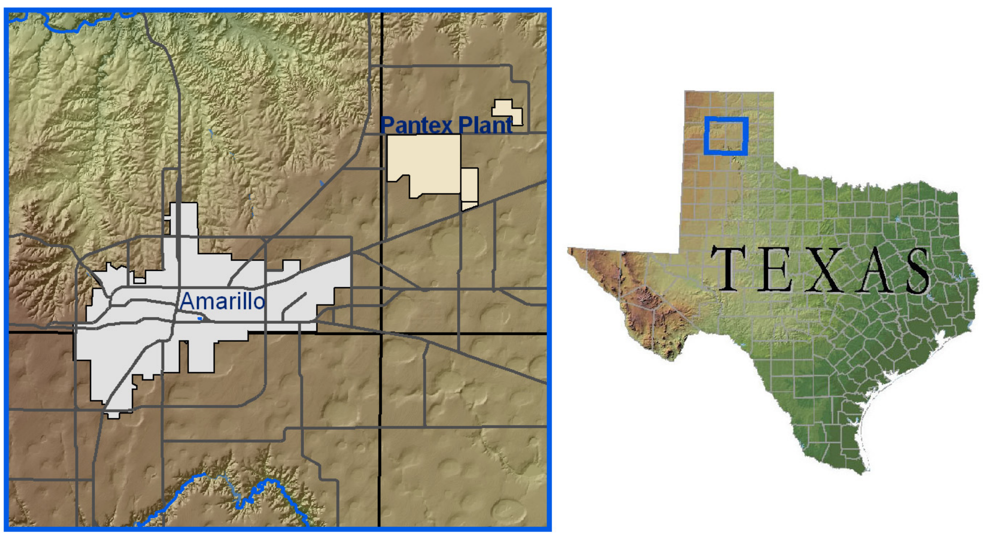

Figure 1-1. Location of Pantex Plant

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.

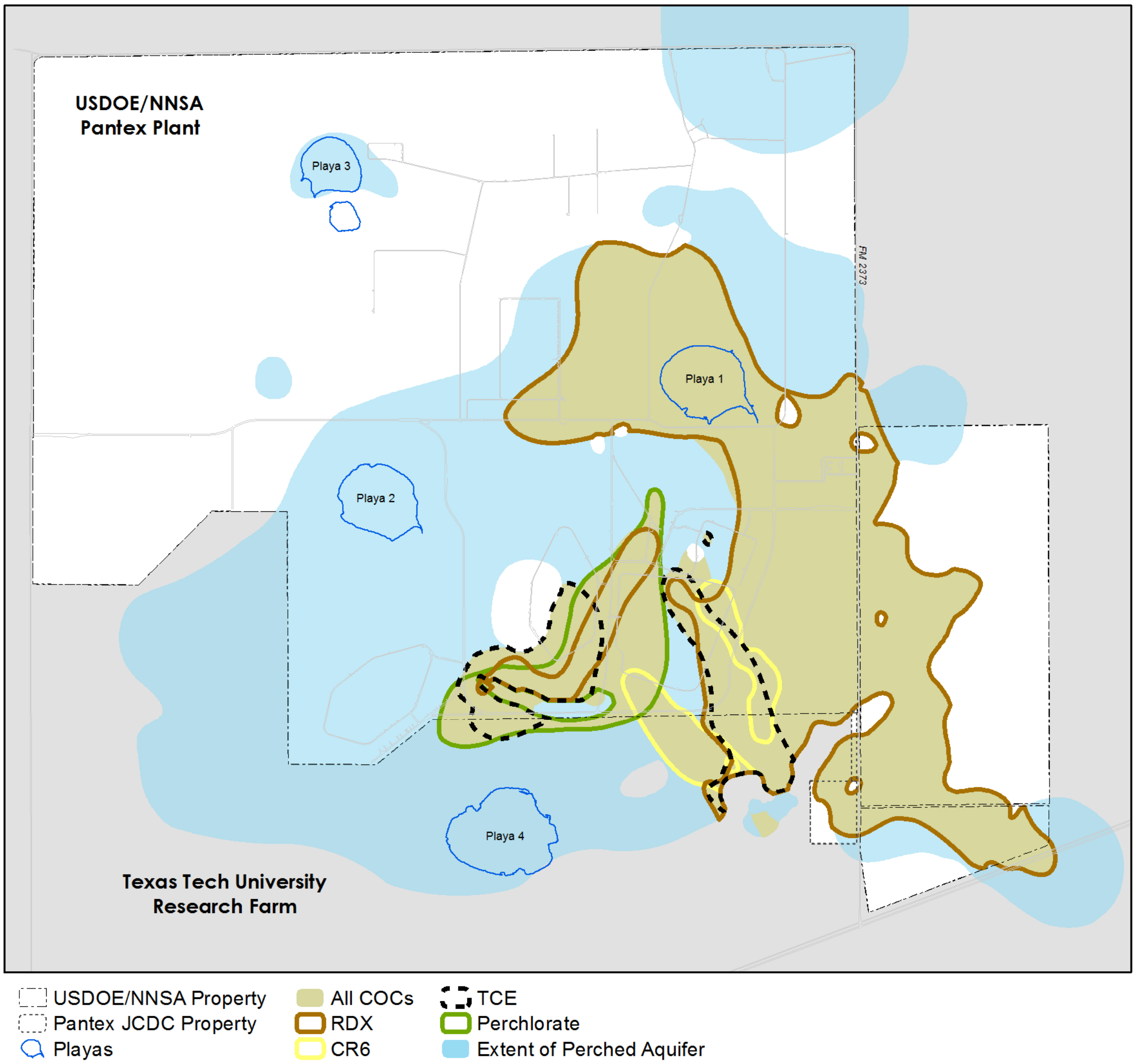

Figure 1-2. Extent of Perched Groundwater and Contaminant Plumes Exceeding GWPS

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 wells changes and minor edits. Compliance plan requirements are included in 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 and submitted in January 2014 (Pantex, 2014a and 2014b). The updated reports were approved by the TCEQ in March 2014 so those changes were fully implemented by July 2014. 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.
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.

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

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

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
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
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.
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 is scheduled for completion by September 2018.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
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.
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 16 units still in active use will be closed in accordance with CERCLA and RCRA permit provisions when they become inactive and are determined to be of no further use. 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.

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.

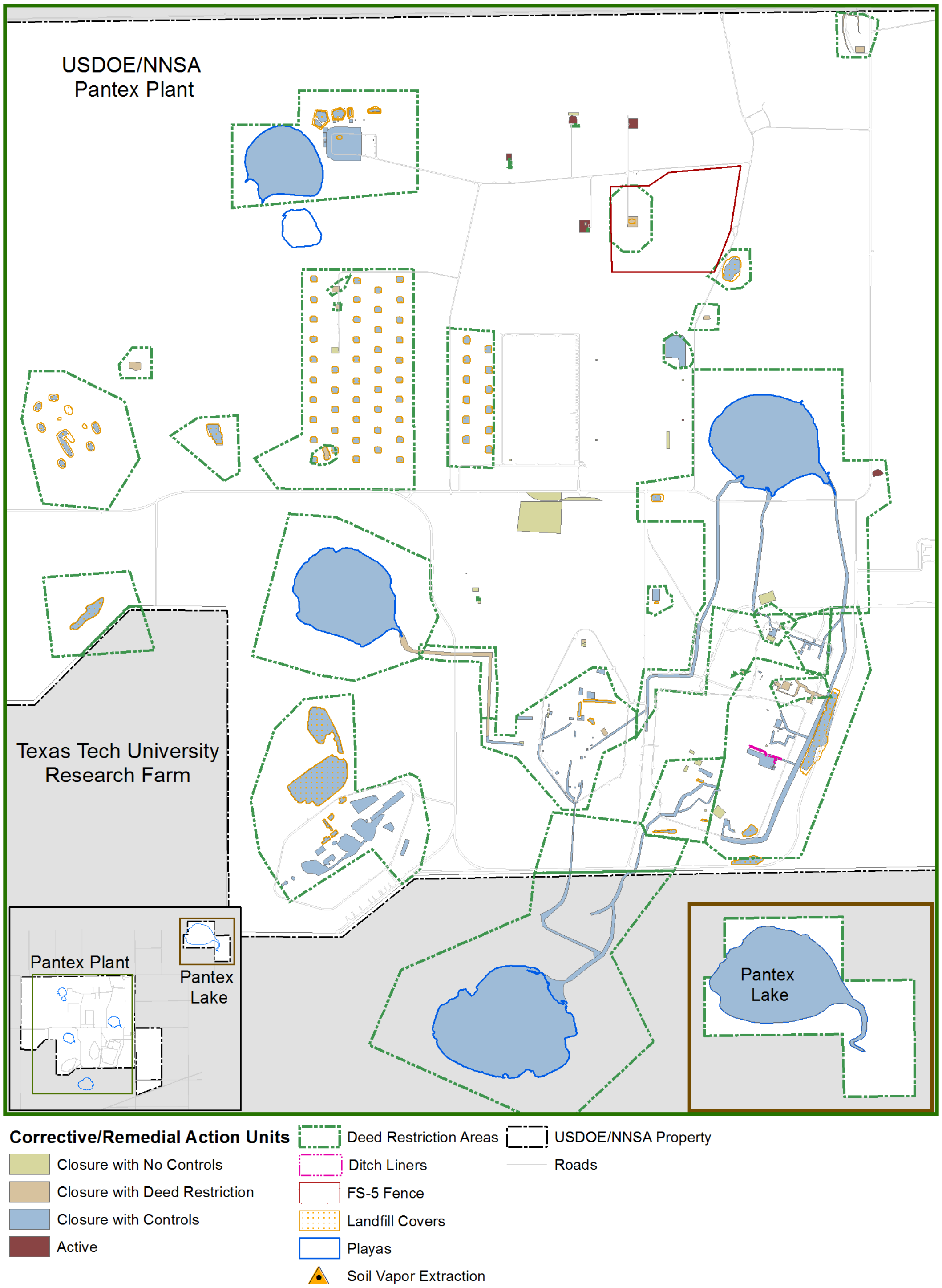

Figure 1-3. Status of Corrective/Remedial Action Units

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. 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 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. These evaluations will be used to help provide a path to closure of the Burning Ground SVE.

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

1.3.2 Protective Covers

The remedial action for landfills included installation and maintenance of protective covers for the Former BG Ash Disposal Trench (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 soils. Closure Turf was installed at Landfill 1 in 2013. Closure Turf was also installed 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 roughly 1 foot wide by 2 feet deep 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.

Anchors were installed to avoid existing utilities in the eastern-most extent of the S-shaped section of the 5-05 Ditch. 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. The new liner installation is documented in Trihydro 2017, included in Appendix H of this report.

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 achieve contaminant mass reduction and reduction in the 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.

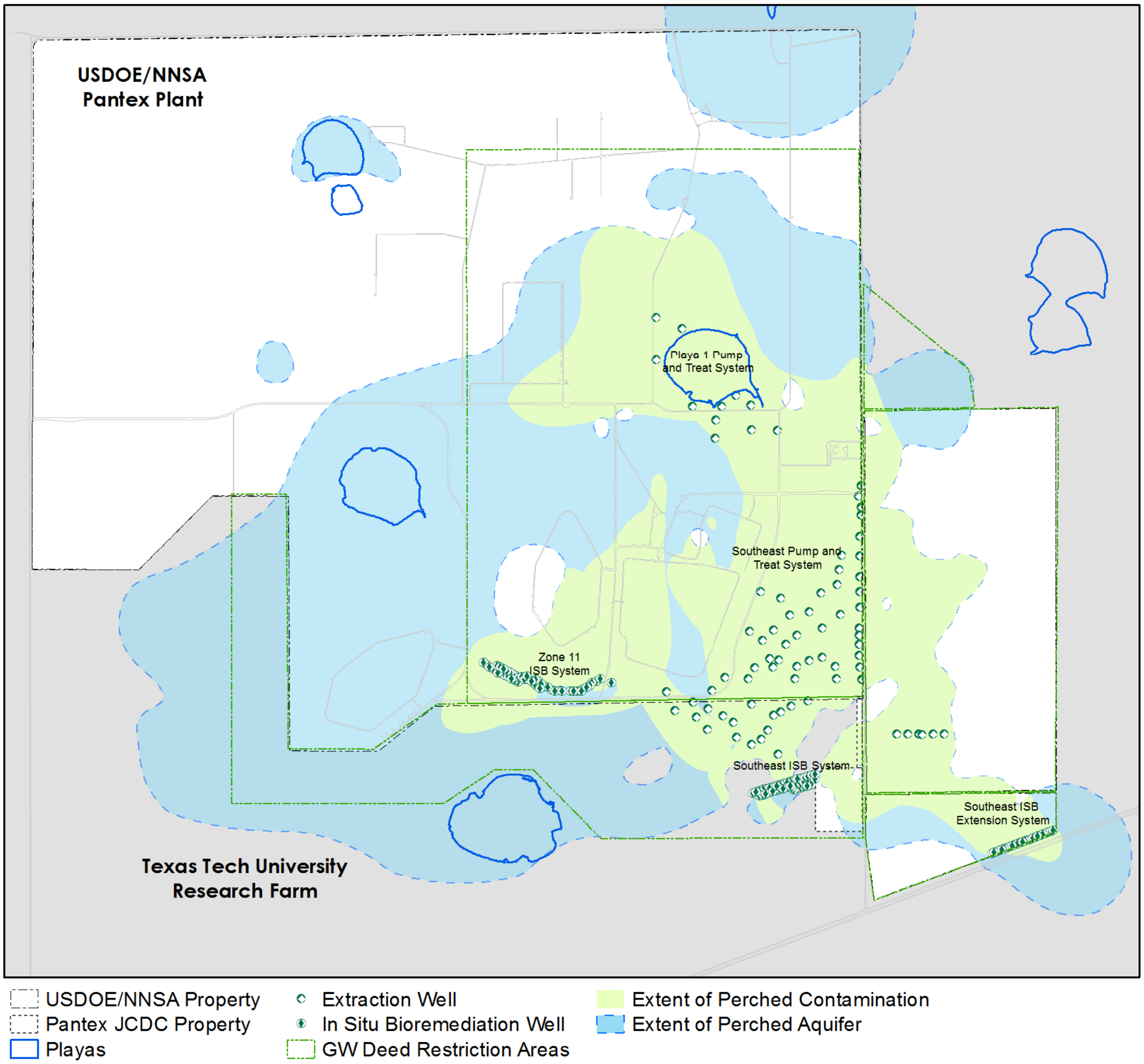

Figure 1-5. Groundwater Remedial Actions

1.4.1 Pump and Treat Systems

As part of the Remedial Action, Pantex installed two pump and treat systems, with 70 operating extraction wells and three 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.

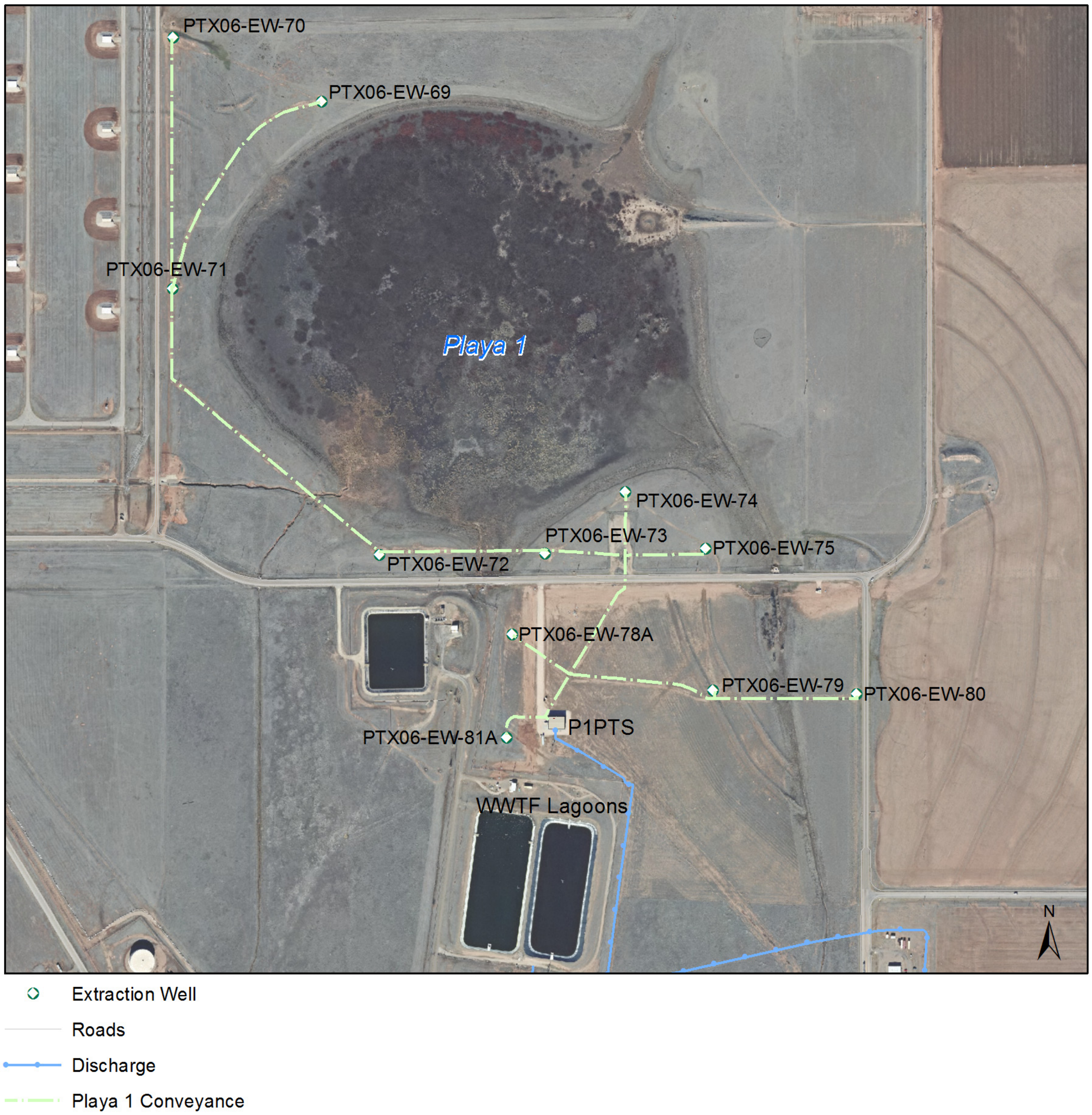

Figure 1-6. P1PTS Wells and Conveyance Lines

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, 59 extraction wells, and 2 injection wells (see Figure 1-7). New extraction wells were drilled east of FM 2373 to provide additional control of plume movement to the southeast. The design for the tie-in of the new wells was completed in 2017 and construction will begin in 2018 to tie-in the wells to the SEPTS.

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.

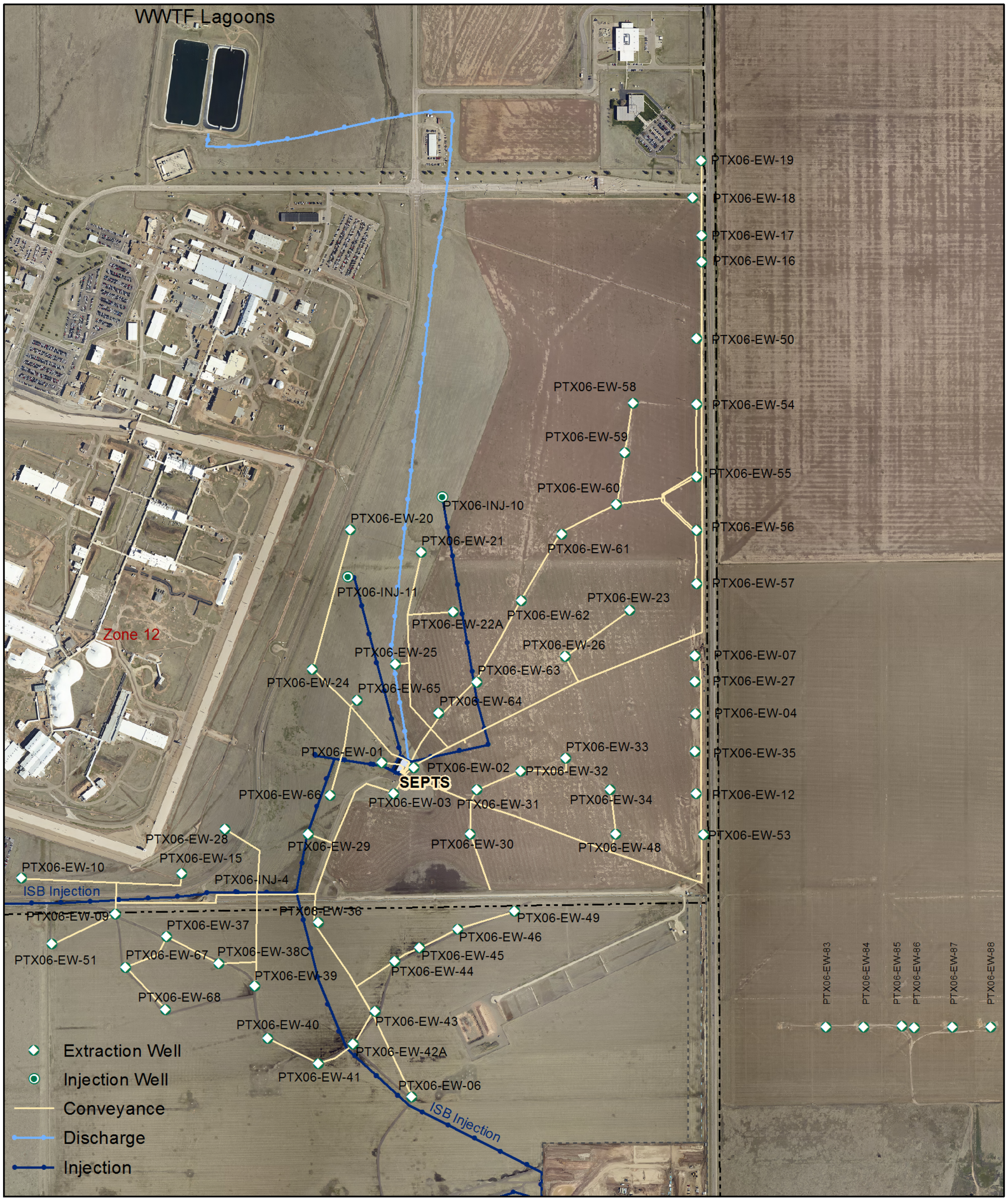

Figure 1-7. SEPTS Wells and Conveyance Lines

1.4.2 *In Situ Bioremediation Systems*

Pantex has installed and operates two ISB systems as part of the final Remedial Action for groundwater. One system is southeast of Pantex Plant on TTU property and one is south of

Zone 11. In 2017, the ISB systems consisted of 88 treatment zone injection wells and 15 in situ performance monitoring wells.

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 2017, 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, originally consisting of 23 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). Pantex expanded the system in late 2014 to include an additional 20 injection wells (18 new wells and 2 previously installed pump test wells), 2 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 side. The two additional TZM wells are expected to eventually replace the monitoring of injection wells on that side of the system. The expansion was installed to address the plume that extended northwest of the 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, 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. The expanded area to the northwest continues to be injected yearly but injections are expected to occur less frequently after the treatment zone is fully established. Eight injection events have been completed for this system. Table 1-3 provides the list of injection events and dates of completion. No new injection events occurred at this system during 2017.

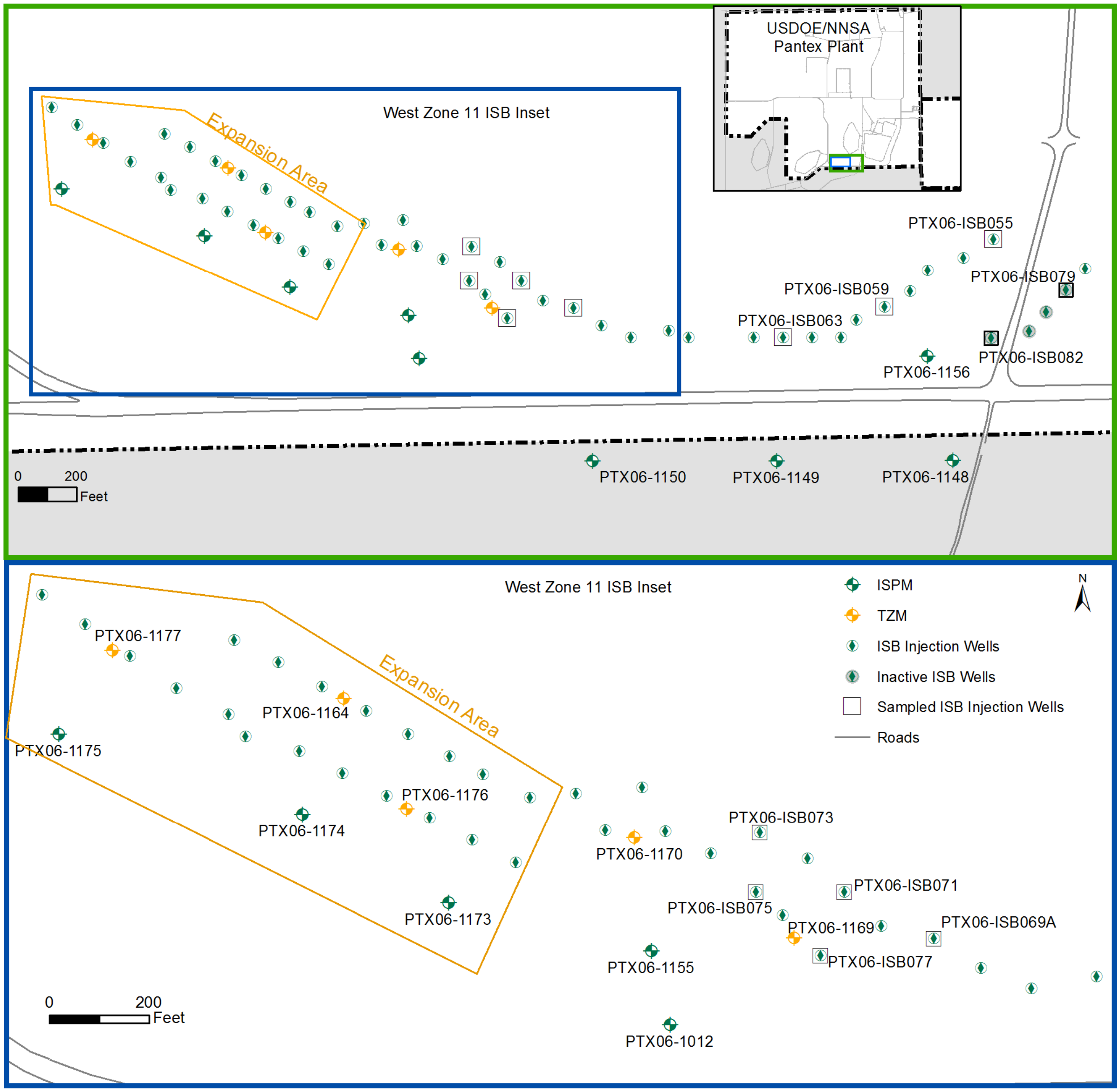

Figure 1-8. Zone 11 ISB Treatment Zone and Performance Monitoring Wells

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

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.

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.

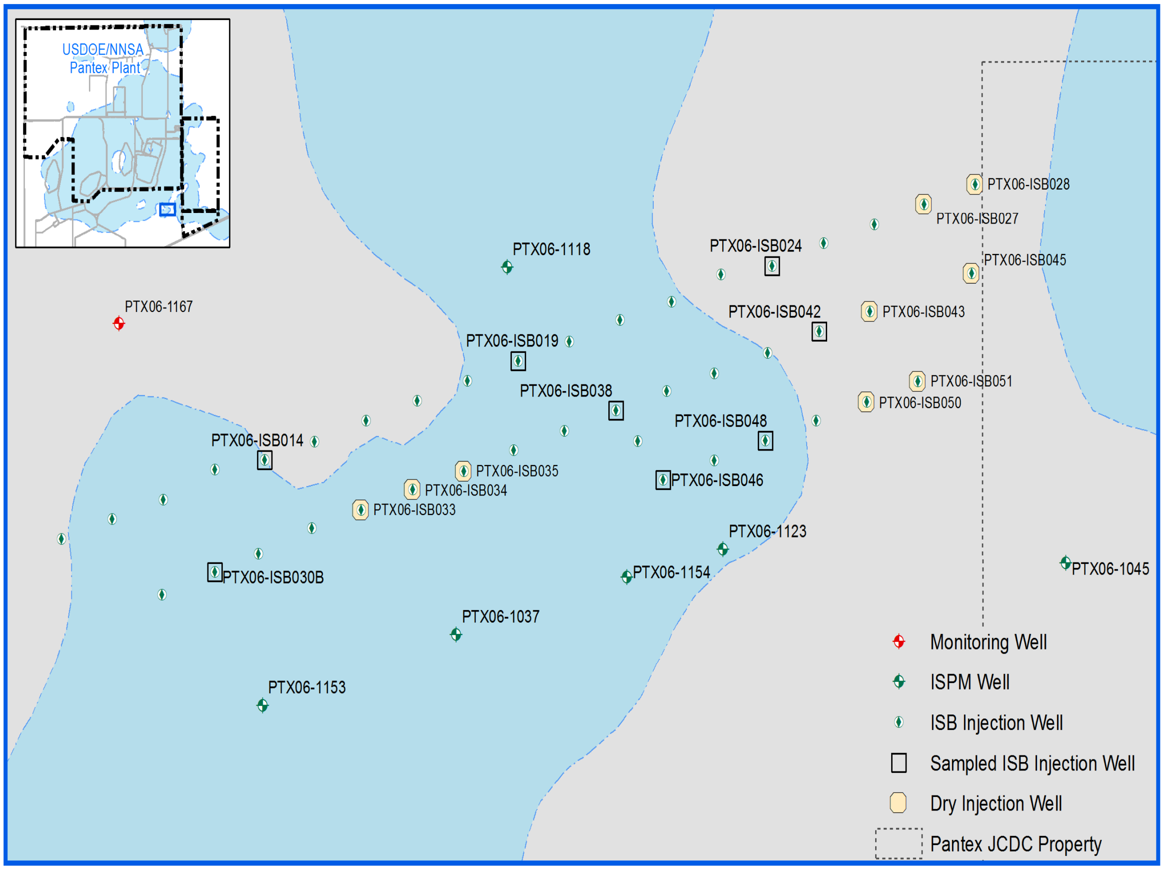

Figure 1-9. Southeast ISB Treatment Zone and Performance Monitoring Wells

Based on the rate of perched groundwater flow and estimated amendment longevity, 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. Six 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

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 has installed a new system 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. A new line of wells along the Pantex southeast boundary, including 30 new wells completed in 2017 and one monitoring well that will be 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.

Based on the rate of perched groundwater flow and estimated amendment longevity, injections are estimated to be necessary about every 12 to 24 months. Pantex plans to start injecting the new system in 2018. Pantex will plan to sample at least six injection wells to evaluate the treatment zone. Additionally, downgradient in situ performance monitoring (ISPM) wells will be sampled downgradient of the system. Figure 1-10 depicts the system, as installed by early 2018.

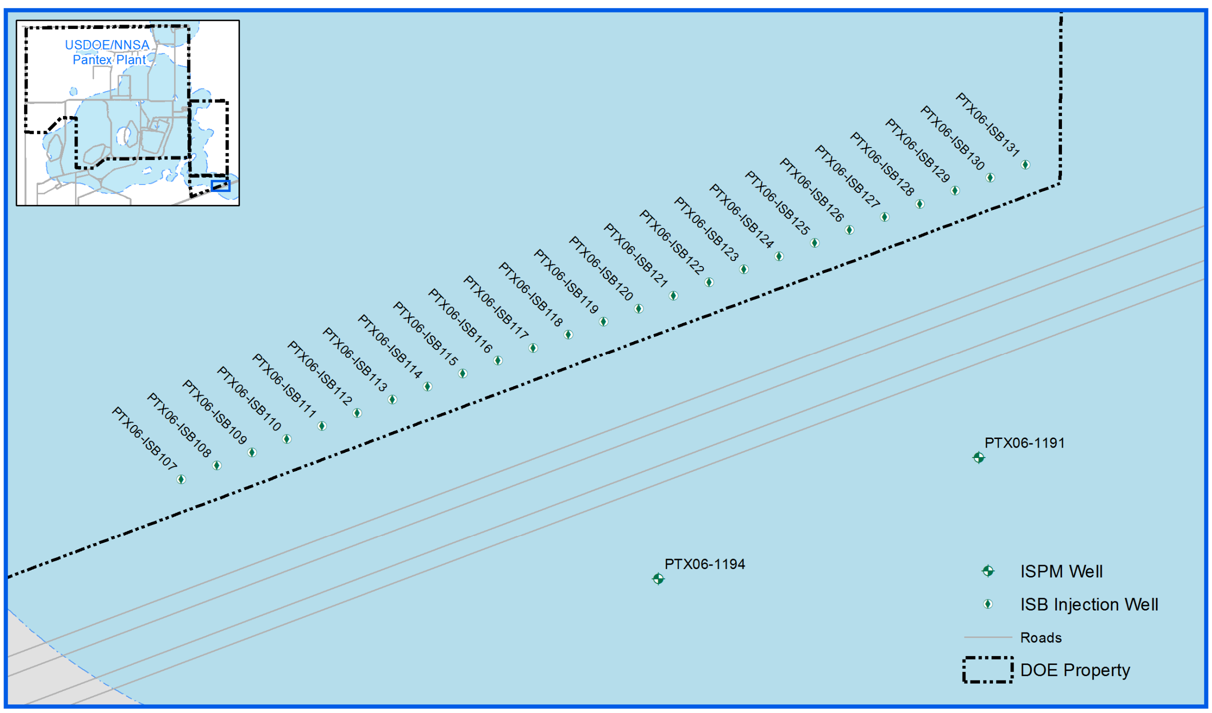

Figure 1-10. Southeast ISB Extension Treatment Zone and In Situ Performance Monitoring Wells

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 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 2017. 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 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.

Groundwater Remedial Action Evaluation Criteria

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

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 data, 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). The final system design was incorporated into the compliance plan 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. The network consists of:

- 128 perched wells – 22 of those wells are monitored for continued dry or limited water conditions; 90 sampled for indicator COCs and other applicable analytes including natural attenuation products, corrosion indicators, and general water quality indicators; and 16 are monitored as in situ performance monitoring (ISPM) wells for the ISB systems. The ISPM wells are monitored for COCs, degradation products, and ISB treatment zone parameters. All 123 perched LTM wells and 42 additional wells not included in the LTM network have water levels measured semi-annually.
- 56 wells are sampled semi-annually, 34 wells annually, 14 wells quarterly, and 6 wells are sampled every five years.
- 42 of the sampled wells (including 36 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 five-year sampling was conducted in 2016 (Figure 1-11).
- Four indicator areas were defined for the perched groundwater. COCs to be monitored are defined for each of those areas.
- One LTM well, PTX01-1002, was plugged and abandoned in early 2017 due to a break in the casing at 25 ft below ground surface. This LTM well removal was approved January 4, 2017.
- PTX06-1184, PTX06-1185, PTX06-1188, PTX06-1189, and PTX06-1190 were added to the network in 2017. PTX06-1184 and PTX06-1185 were monitored in 2017. PTX06-1190 was sampled in early 2018, but results were included in this report to provide a better evaluation of the southeast plume. The other wells were dry when drilled and will continue to be evaluated for water levels semi-annually.

Table 1-5 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 1-5.

Table 1-5. 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
PTX01-1004	Burning Ground	N	Y	9/16/2010		Dry	PS		3770768.71	630729.82

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX01-1009	Burning Ground	N	Y	9/16/2010		Dry	PS		3769018.50	630594.67
PTX06-1037	ISPM Southeast	N	Y	9/16/2010		Active	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
PTX07-1O01	North	N	Y	9/16/2010		Active	PS, UM, RA		3767695.22	638532.53

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX07-1O02	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
PTX06-1120	Southeast	N	Y	9/16/2010		Active	PS		3752735.03	643152.43

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX06-1121	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
PTX07-1P05	Zone 11	N	Y	9/16/2010		Active	UM		3762886.83	637136.13

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
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

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 or approval letter date for the corresponding progress report where the recommendation was made to include the well in the monitoring network.

[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.

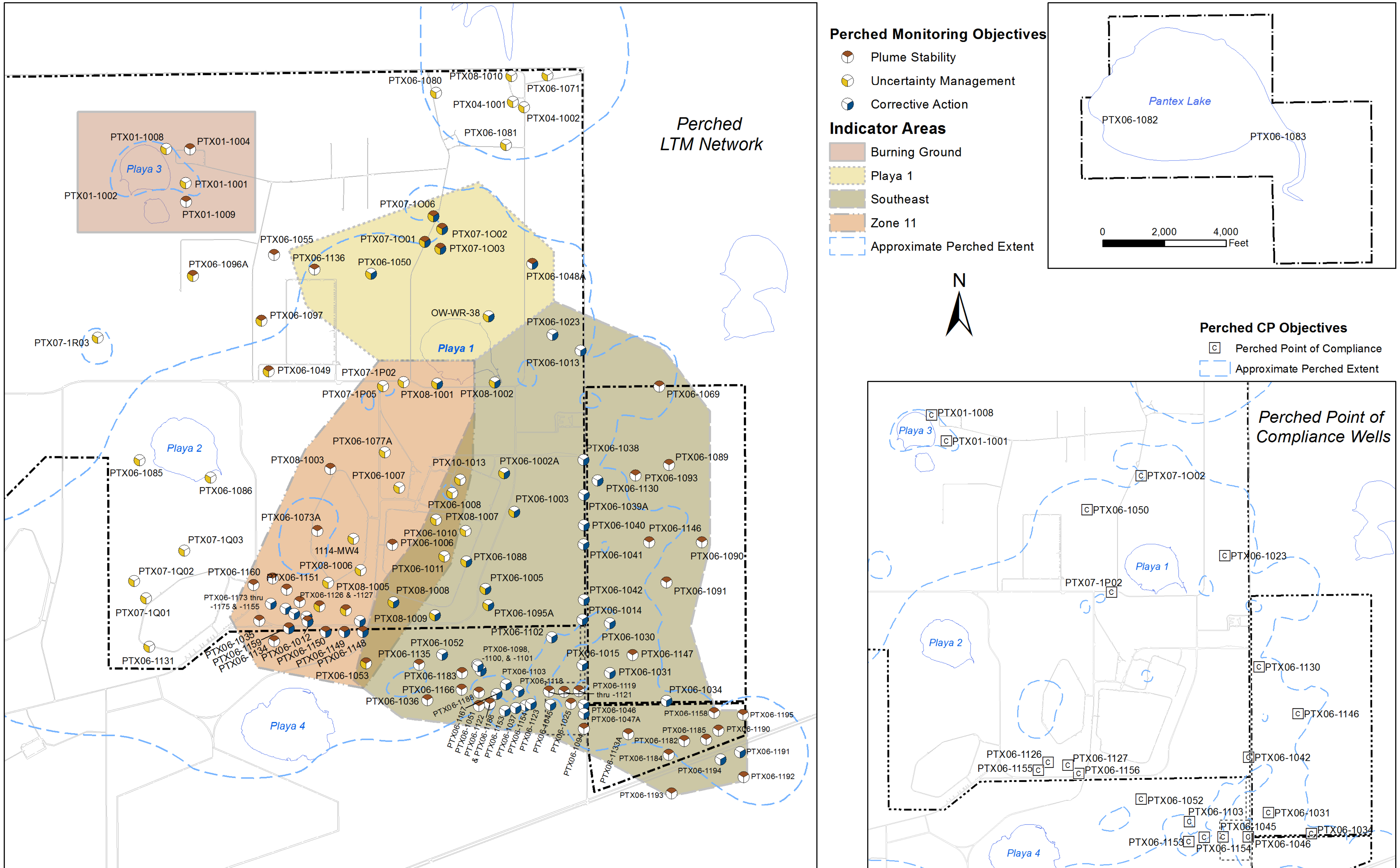

Figure 1-11. Perched LTM Network and Compliance Plan Wells

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1.6.2 Ogallala Aquifer Long-Term Monitoring Network

The final Ogallala Aquifer LTM network consists of the following.

- 26 LTM wells are monitored for indicator COCs and water levels. An additional well is used for monitoring water levels in the Ogallala Aquifer.
- 23 wells are sampled semi-annually and 3 are sampled annually. One well is sampled quarterly for HEs and VOCs.
- Seven wells are sampled at multiple levels every five years. The baseline multi-level sampling was conducted after the wells were installed. All other multi-level sampling events are conducted for future five-year reviews. The five-year sampling was conducted in 2016. An eighth well, PTX06-1137A, was installed with two sampling intervals; however, water levels dropped below the first interval so the well is now only sampled in one interval, at the deepest sampling depth.
- 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 was conducted in 2016.
- 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.
- Pantex experienced problems with two Ogallala monitoring wells during 2017. PTX06-1033 has a broken casing. Pantex recommended not replacing the well to avoid drilling through the perched aquifer and because the well is redundant to downgradient Ogallala monitoring locations. PTX-BEG2 is west of Zone 11 and it was noted that the perched groundwater plume is slowly extending to that area. PTX-BEG2 is not dual cased so presents a cross-contamination risk to the Ogallala Aquifer. Pantex also recommended plugging this well with no replacement to avoid drilling through the perched aquifer and because the well is redundant to downgradient locations. Those wells were approved for plugging and abandonment and will be plugged in 2018.

Table 1-6 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 1-6, 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 1-6. Ogallala Aquifer LTM and Compliance Plan Wells

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	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		Active	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[3]		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[4]		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[3]		Y	N	6/9/2003	9/16/2010	Active				620994.02	3765626.52
PTX06-1075[3]		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		Active	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	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[3]		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]These wells are retained for monitoring water upgradient to Pantex Plant but are not considered as LTM wells.

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

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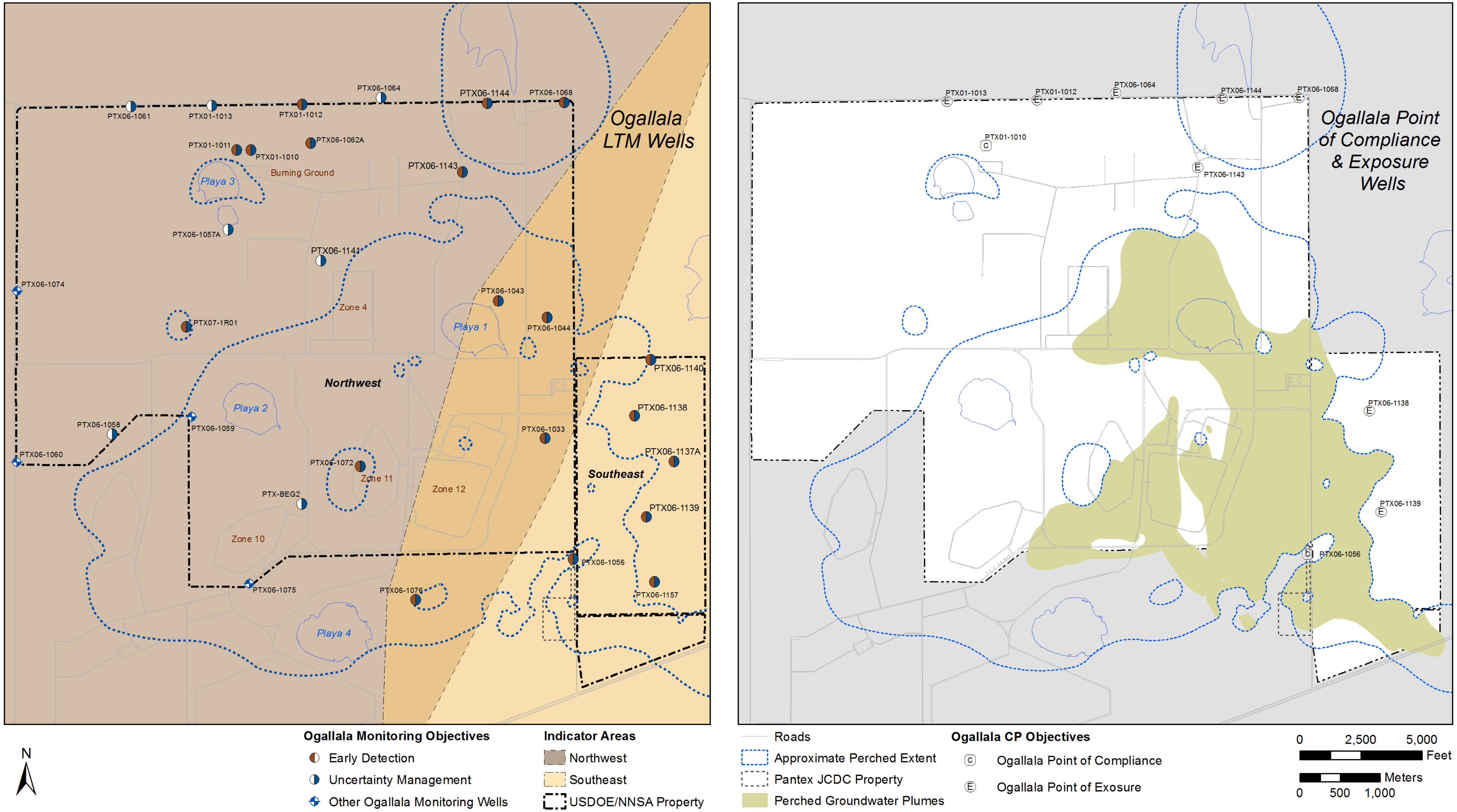

Figure 1-12. Ogallala Aquifer LTM and Compliance Plan Wells

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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 1-7 details all installed wells for the pump and treat systems, as well as their current status, date of plugging and abandonment, and coordinates. Table 1-8 details all installed wells for the ISB systems, as well as their current status, date of plugging and abandonment, and coordinates.

Table 1-9 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.

- Sixteen active ISB wells are used to monitor treatment zone conditions in the two established ISB systems. The newly installed Southeast ISB Extension treatment zone sampling design will be included in the *Sampling and Analysis Plan* update that is scheduled in 2019.
- All available extraction wells (pumping at time of sampling) are 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 2017:

- Twenty-four ISB injection wells were installed along the Pantex southeast boundary to treat a plume of high explosives (primarily RDX) that extends beyond the fence line. One previously installed monitor well was converted for use as an injection well.
- One pump and treat system injection well (PTX06-INJ-12A) was plugged due to problems with the well that were unable to be repaired.
- PTX06-EW-06 and PTX06-EW-21 were removed from active service because the wells have gone dry. Pantex will eventually plug PTX06-EW-21 because it was drilled shallow and will not be useful for continued extraction. PTX06-EW-06 will continue to be used for evaluation of water levels in the southeast area of perched groundwater.

The twenty-five new injection wells are included in Table 1-5, but will not be injected until later in 2018.

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

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
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	07/26/16	Active		644481.36	3753953.55
PTX06-EW-83	07/24/16	Active		644782.02	3753953.69
PTX06-EW-84	07/21/16	Active		645082.73	3753954.16
PTX06-EW-85	09/14/15	Active		645382.52	3753959.20
PTX06-EW-86	09/13/15	Active		645482.05	3753946.07
PTX06-EW-87	08/03/16	Active		645782.09	3753953.71
PTX06-EW-88	09/12/16	Active		646083.18	3753954.30
PTX06-INJ-1	1/12/1993	P&A	9/24/2004	641043	3757545
PTX06-INJ-2	9/8/1996	P&A	11/23/2011	641155.36	3758791.57
PTX06-INJ-3	2/10/2000	P&A	10/25/2004	643226.15	3756469.63
PTX06-INJ-4	2/26/2000	P&A	3/26/2008	640126.87	3755016.27
PTX06-INJ-5	2/10/2000	P&A	10/25/2004	641482	3755164.77
PTX06-INJ-6	2/26/2000	P&A	10/26/2004	642521.57	3755369.02
PTX06-INJ-7	3/7/2000	P&A	10/27/2004	640774.75	3754319.02
PTX06-INJ-8	2/27/2000	P&A	3/25/2008	640419.84	3756164.91
PTX06-INJ-9	2/17/2000	P&A	10/26/2004	642024.8	3756518.86
PTX06-INJ-10	9/12/2004	Active		641005.96	3757505.73
PTX06-INJ-11	8/28/2004	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	8/11/06	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

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
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.

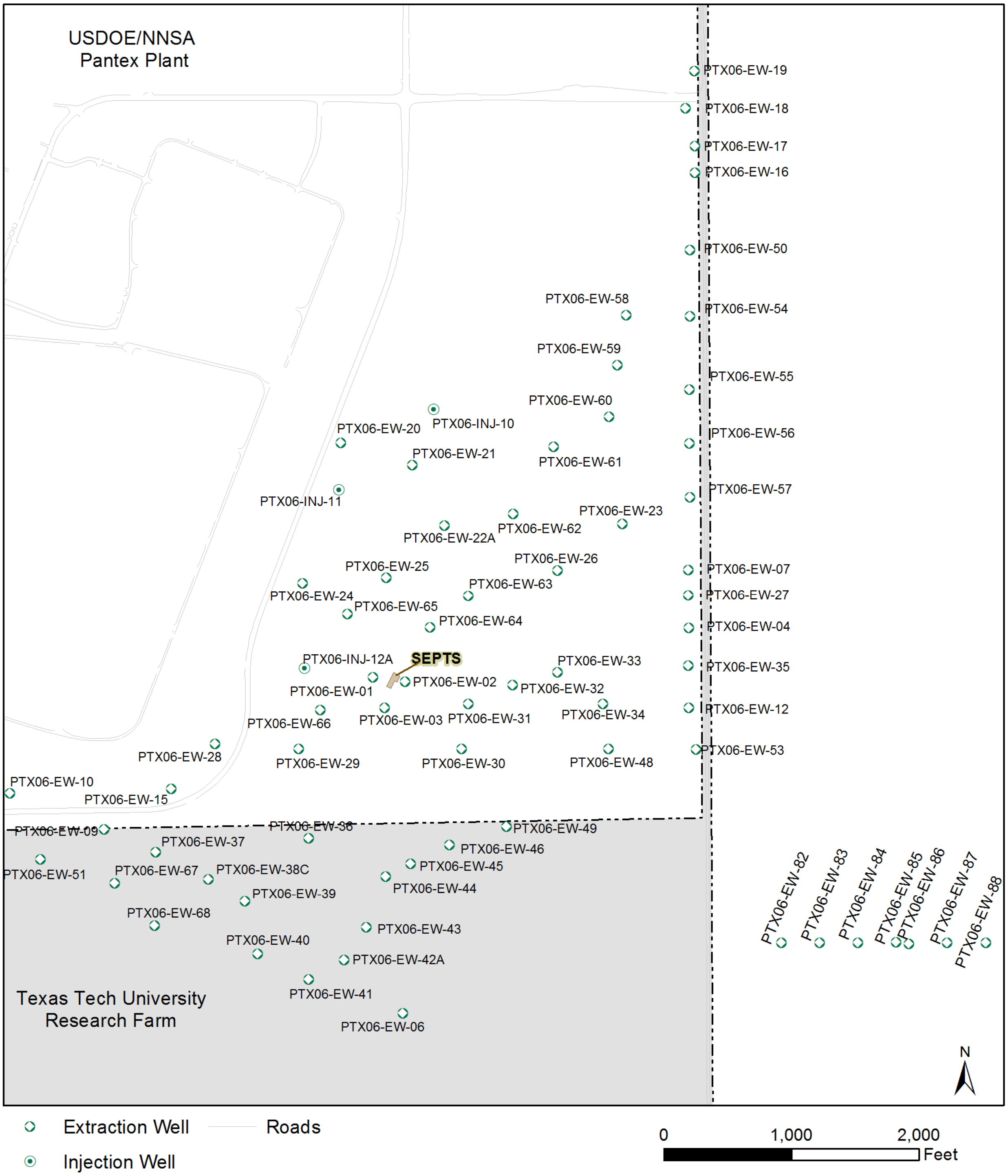

Figure 1-13. SEPTS Wells

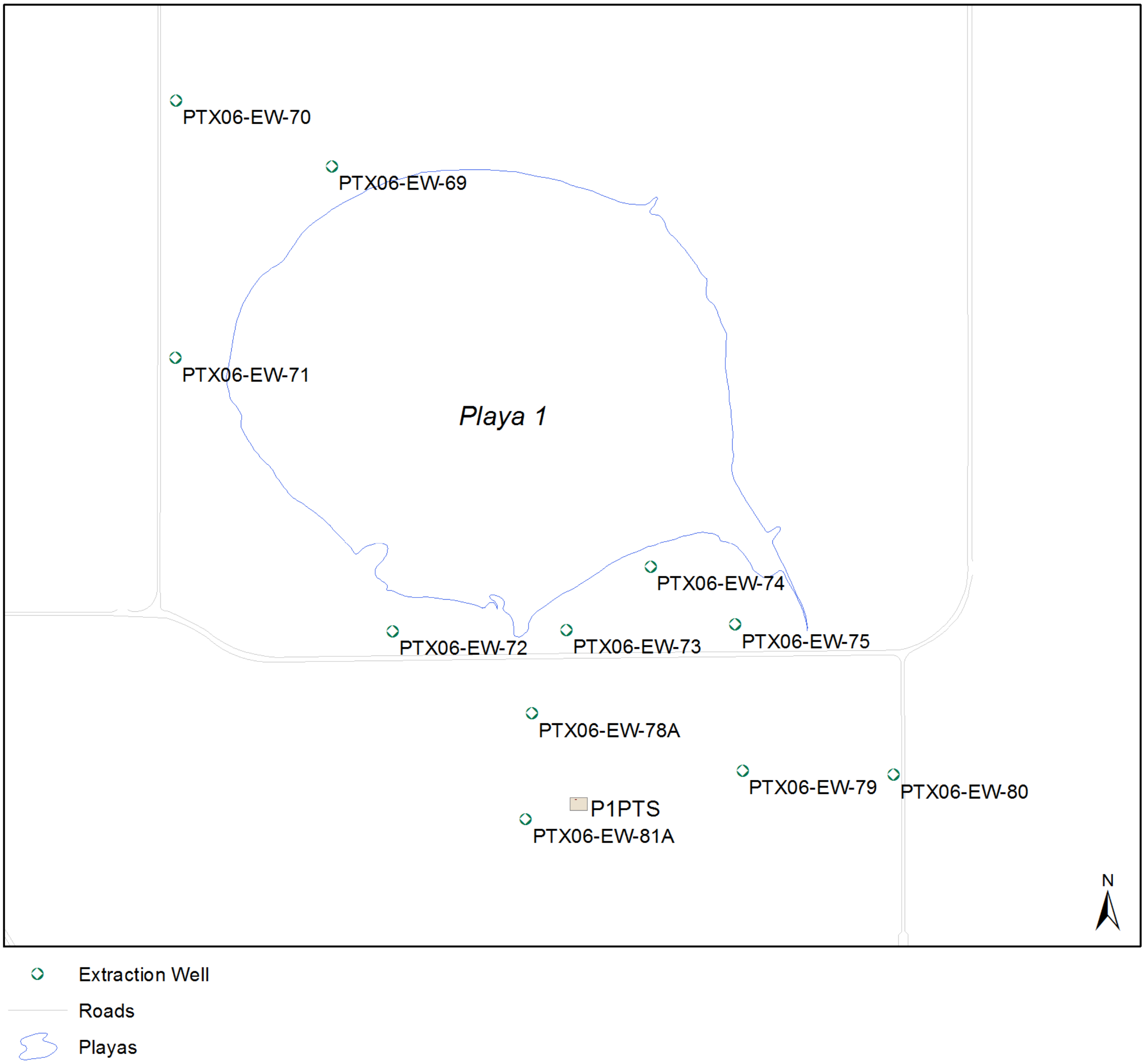

Figure 1-14. P1PTS Wells

Table 1-8. 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
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

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
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	07/24/14	Active			634360.64	3755523.08
PTX06-ISB088A	09/23/14	Active			634266.60	3755570.13
PTX06-ISB089	07/12/14	Active			634200.34	3755606.47
PTX06-ISB090	07/10/14	Active			634117.26	3755650.38
PTX06-ISB091	09/09/12	Active			634032.91	3755697.13
PTX06-ISB092	09/11/12	Active			633944.35	3755745.69
PTX06-ISB093	07/16/14	Active			633857.23	3755794.35
PTX06-ISB094	07/07/14	Active			633769.25	3755838.98
PTX06-ISB095	07/24/14	Active			633652.63	3755742.68
PTX06-ISB096	06/22/14	Active			633559.57	3755807.06
PTX06-ISB097	08/27/14	Active			633470.54	3755870.31
PTX06-ISB098	08/19/14	Active			633384.06	3755929.79
PTX06-ISB099	08/11/14	Active			633757.56	3755690.13
PTX06-ISB100A	09/16/14	Active			633791.28	3755646.03
PTX06-ISB101	08/07/14	Active			633899.71	3755616.85
PTX06-ISB102	07/31/14	Active			633985.55	3755572.69
PTX06-ISB103	09/02/14	Active			634073.50	3755527.39
PTX06-ISB104	08/19/14	Active			634160.38	3755482.36
PTX06-ISB105	08/06/14	Active			634245.60	3755438.20
PTX06-ISB106	07/29/14	Active			634332.49	3755393.36
Southeast ISB Extension						
PTX06-ISB107	04/22/17	Active			647400.94	3750677.17
PTX06-ISB108	12/13/17	Active			647471.65	3750705.36
PTX06-ISB109	12/04/17	Active			647541.96	3750731.23
PTX06-ISB110	12/02/17	Active			647612.02	3750757.59

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
PTX06-ISB111	12/15/17	Active			647682.57	3750783.88
PTX06-ISB112	12/13/17	Active			647753.08	3750810.07
PTX06-ISB113	11/03/17	Active			647823.09	3750836.66
PTX06-ISB114	11/07/17	Active			647894.07	3750862.53
PTX06-ISB115	11/03/17	Active			647964.07	3750888.51
PTX06-ISB116	11/05/17	Active			648034.69	3750914.87
PTX06-ISB117	11/14/17	Active			648105.30	3750940.93
PTX06-ISB118	11/15/17	Active			648175.64	3750967.12
PTX06-ISB119	11/17/17	Active			648245.97	3750993.50
PTX06-ISB120	11/30/17	Active			648316.24	3751019.54
PTX06-ISB121	11/08/17	Active			648386.52	3751045.71
PTX06-ISB122	11/06/17	Active			648457.75	3751072.09
PTX06-ISB123	11/04/17	Active			648527.50	3751098.16
PTX06-ISB124	12/03/17	Active			648597.96	3751124.55
PTX06-ISB125	12/01/17	Active			648668.62	3751150.76
PTX06-ISB126	11/17/17	Active			648738.78	3751176.87
PTX06-ISB127	11/29/17	Active			648809.07	3751203.15
PTX06-ISB128	10/24/17	Active			648879.71	3751229.17
PTX06-ISB129	11/15/17	Active			648950.08	3751255.41
PTX06-ISB130	11/14/17	Active			649020.47	3751282.05
PTX06-ISB131	11/01/17	Active			649090.64	3751308.18

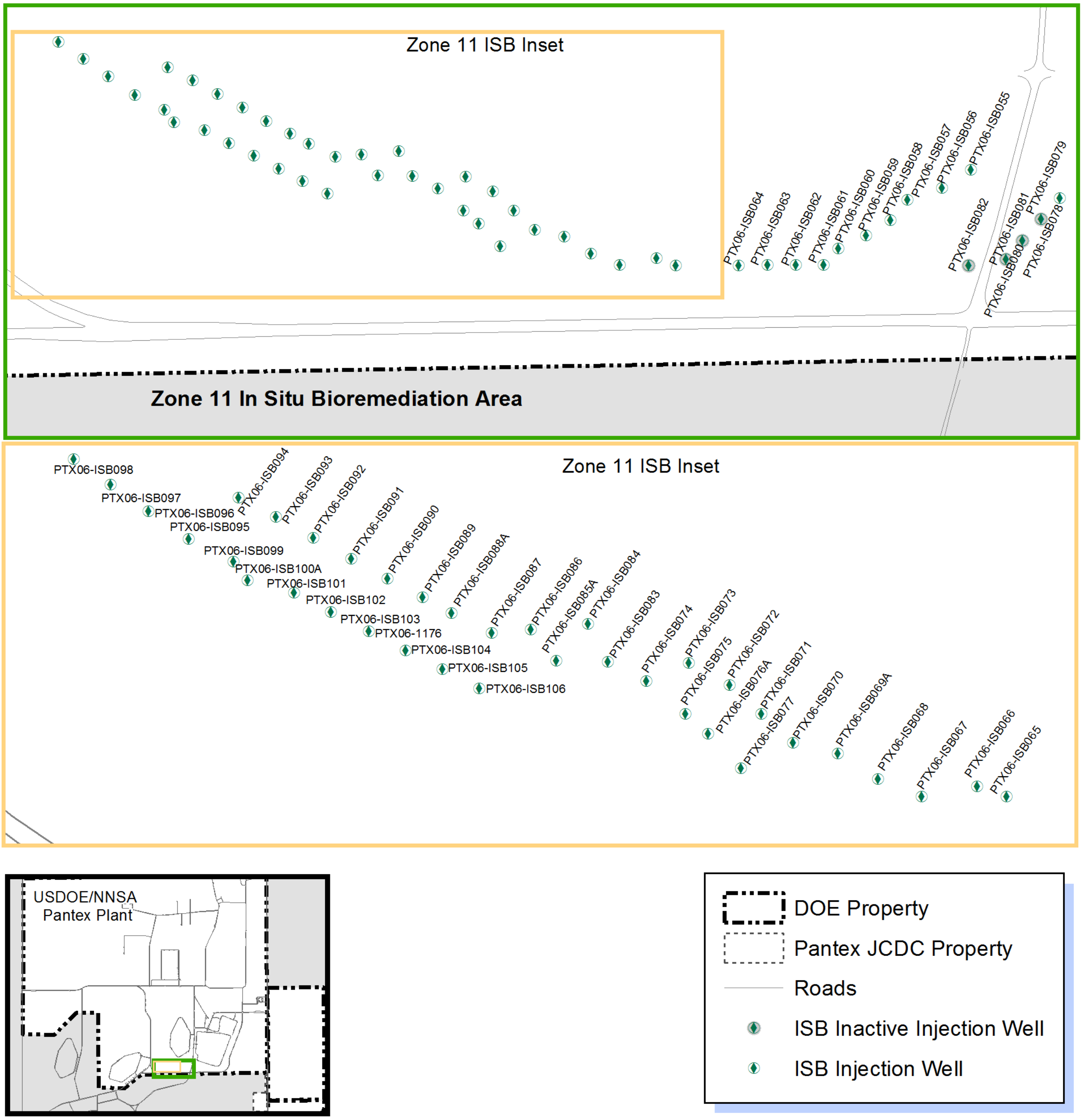

Figure 1-15. Zone 11 ISB System Wells

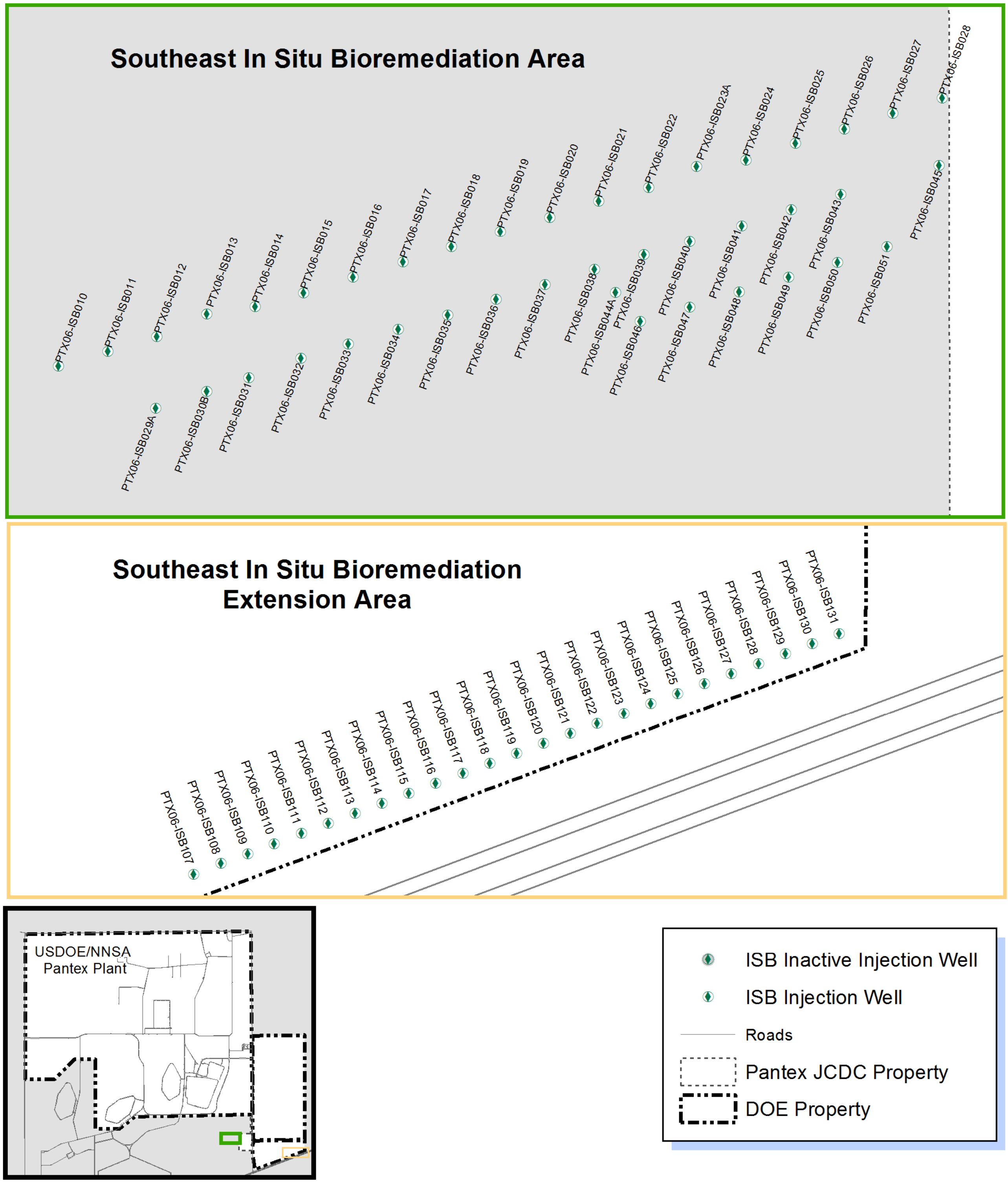

Figure 1-16. Southeast ISB System Wells

Table 1-9. 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.

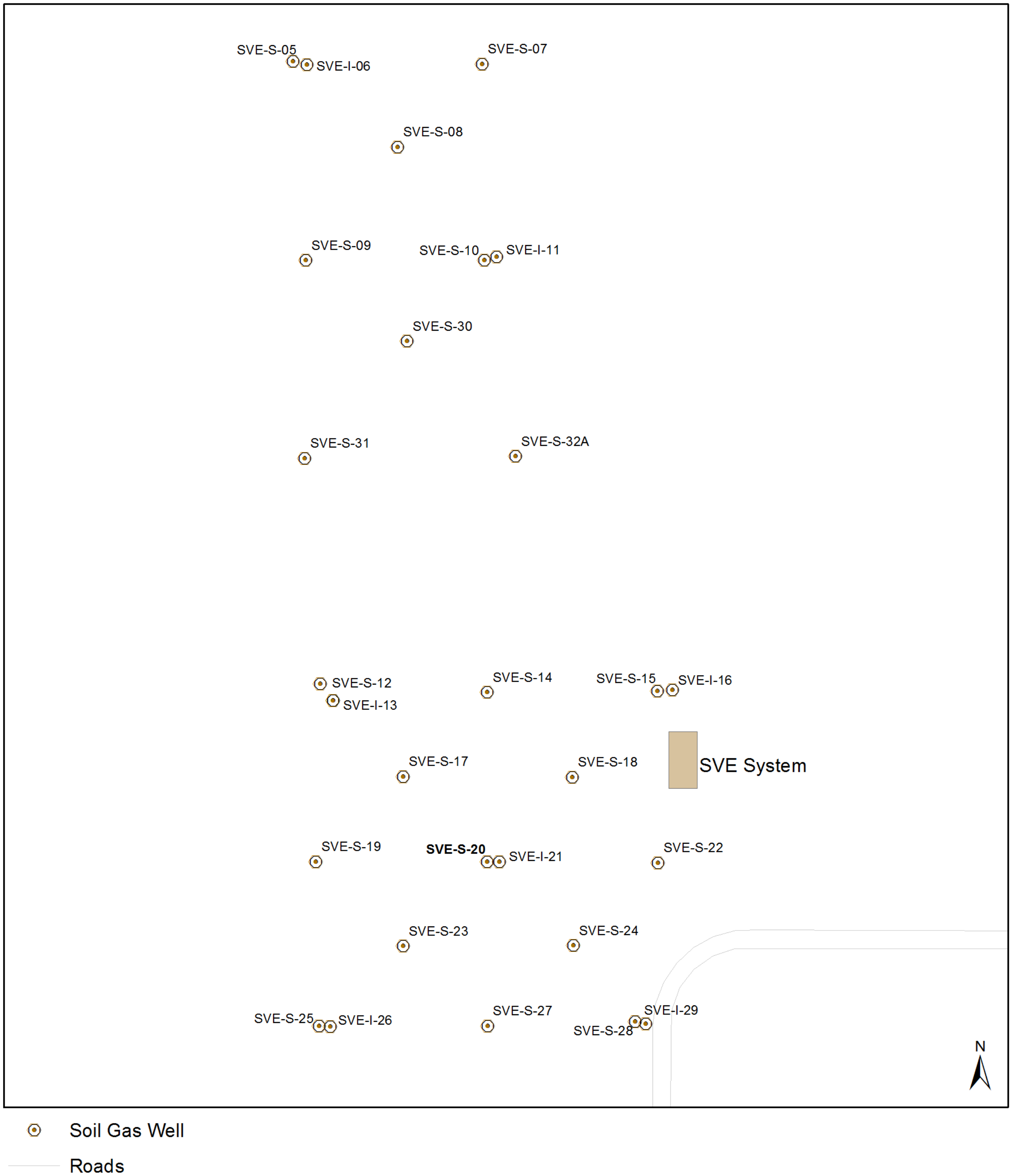

Figure 1-17. Burning Ground SVE Wells

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 2017 since the date of the last report, in 2018 prior to publication of this report, and projected start or completions for July 2018-June 2019 are summarized in Table 1-10. The schedule of activities included in the 2016 report was the basis for this table. Revisions of that schedule are noted in Table 1-10 and are explained in the following text.

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

The significant actions completed in 2017 in relation to the Five-Year Review include:

- Pantex committed to evaluating the expanding plumes of high explosives east of FM 2373. To address the plume expansion, Pantex completed the initial actions identified in the Five-Year Review. However, the initial actions identified further work that is necessary; therefore, Pantex completed the following in 2017:
    - Pantex has contracted with leading researchers for RDX natural attenuation research. The research will determine the type of attenuation as well as spatial variability. A rate of attenuation will be quantified for each identified area of attenuation, if data support the calculation. Well sampling commenced in December 2016 and was completed in February 2017. Due to delays in specialized microbial and RDX isotope analysis, the report has been delayed until June 2018.
    - Three additional wells (PTX06-1184, PTX06-1185, and PTX06-1186) were drilled to address the potentially expanding plume to the southeast. The three wells indicated the presence of water at the Pantex boundary to the south. One well drilled north of the boundary indicated that higher levels of contamination were present toward the eastern side, indicating that the plume may have moved in a more easterly direction. Based on high concentrations (649 ug/L) in PTX06-1185, Pantex planned for installation of an extension of the Southeast ISB remedy at the Pantex boundary.
    - Pantex has installed the Southeast ISB extension and concentrations above 1,000 ppb were found in one well. Based on the information collected at the ISB system wells, Pantex started working with neighbors to the south and southeast to obtain agreements to place wells on their property to evaluate

potential plume movement. Four wells were drilled on the property to the south in early 2018. RDX and 4-amino-2,6-DNT were found above GWPS in one of the wells (see Section 3 plume map for details). Pantex is continuing to work with the neighbor to the southeast and expects to gain an access agreement for drilling and sampling. Those additional offsite wells are expected to be installed by the end of August 2018.

- Pantex recommended completion of an SVE Performance Monitoring Plan to establish criteria for ceasing active SVE system operations. Due to continued problems with rebound tests, Pantex contracted to have the system evaluated. Pantex has recommended (see 4th Quarter 2016 Progress Report) making modifications to the extraction wells to enhance air flow through the subsurface to increase volatilization and promote aerobic degradation of the NAPL source. Those modifications were completed in May 2017. Pantex will continue to monitor influent concentrations to evaluate declining concentrations and removal rates.
- To address incomplete treatment of contaminants (HEs and hexavalent chromium) downgradient of the west end of the Southeast ISB (at PTX06-1153), Pantex installed a new well near the dry well PTX06-1122 to determine if a channel may exist in that area. The new well also encountered dry conditions to the FGZ. Pantex will continue to evaluate the water conditions around PTX06-1153 overtime as the well is declining in water levels.
- Pantex has prepared the draft final Second Five-Year Review. The document was submitted to regulatory agencies in May 2018 for review and comment.

Pantex has also implemented several other recommendations made in the 2016 Annual Progress Report and 2017 Quarterly Progress Reports including:

- Pantex expanded sampling at wells in the southwestern portion of the SEPTS well field to evaluate the movement of the perchlorate plume into that area. Pantex is also evaluating options for the treatment of perchlorate at SEPTS.
- Pantex is modifying the composition of the amendment to attempt better distribution of amendment between wells in the Zone 11 ISB. Pantex will continue to use Newman Zone emulsified soybean oil, but at a lower target percentage, mixed with a soluble carbon (molasses) to achieve the 5% target amendment concentration. Pantex will be conducting a dose response study during the Zone 11 ISB injection that started in late May and continuing into June.

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 in 2017, completion of the RDX natural attenuation study, upgrade of the SEPTS to extend extraction east of FM 2373, construction of the Landfill 3 erosion control design, modification of the Burning Ground SVE to increase NAPL removal and enhance bioremediation, and installation of new injection and monitoring wells to address plume movement in areas outside the influence of the remedial actions. Some of the reporting and plans will require regulatory review and approval and are provided in bold in Table 1-10.

Pantex revisions to the schedule contained in the 2016 Annual Progress Report are as follows:

- Pantex encountered issues with getting some projects contracted during 2017 causing delays for some projects. Pantex is in process of contracting or completing work with most projects expected to be completed in 2018.
- The Cr(VI) study was completed in early 2017. Pantex plans to use the Cr(VI) background concentrations to assist with determining whether detections are related to background or if there is an unexpected condition that would require further attention. The newly established background, using Method 218.7, is 3.2 ug/L. This background is only usable with Method 218.7 or similar method as the limits are so low. Other methods can experience problems with interference, including interference from the preservative that is used in Method 218.7, thus causing higher detections of Cr(VI) in the samples. Pantex will strive to continue using Method 218.7 for analysis of Cr(VI), but may need to substitute another method when problems are encountered with labs or shipping.

Table 1-10. Complete, In-Progress and Upcoming Activities

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Completed Work					
Design for erosion control at Landfill 3	Apr 2016	Aug 2016	June 2017	IAG Article 8.9 HW-50284 Provision XI.E	3Q2015
FY 2017 Well Drilling and Plugging – drilling 6 new wells, plugging two wells, and repair of casing at PTX06-1139	Apr 2017	Jun 2017	June 2017	HW-50284 XI.B.1 and XI.B.2	3Q2016 4Q2016
Extending SEPTS east of FM 2373 – Design	Jun 2016	Sept 2016	June 2017	IAG Article 8 HW-50284 Provision XI.E.1	2015A
Contract Five-Year Review support	Jan 2017	Jun 2017	Oct 2017	IAG Article 21 and HW-50284 CP Table VII, Item 26	
Kick-off Meeting to review annotated outline, agree upon schedule for 2nd Five Year Review, and site inspection	July 2017	Aug 2017	Nov 2017	IAG Article 21 and HW-50284 CP Table VII, Item 26	
Annual Public Meeting	Oct 2017	Nov 2017	Nov 2017		
CR(VI) and Total Cr Groundwater Background Study				HW-50284 Provision XI.F.1	4Q2013
Prepare Draft Final Cr Groundwater Background Report*	May 2016	Nov 2016	Feb 2017		
Extending SE ISB east of FM 2373, near Pantex boundary	Sep 2017	Dec 2017	Dec 2017	HW-50284 XI.B.1 and XI.B.2	2Q2017
Prepare Draft Final Five-Year Review Report	Jul 2017	Jan 2018	April 2018	IAG Article 21 and HW-50284 CP Table VII, Item 26	
Evaluation of groundwater flux in the southeast lobe using passive flux meters	Dec 2017	Mar 2018	June 2018		3Q2017
Evaluation of methods to treat the TCE plume extending to the northwest of the Zone 11 ISB	Nov 2017	Mar 2018	May 2018		

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
2nd Quarter 2017 Progress Report	Aug 2017	Sep 2017	Sep 2017	HW-50284 Provision XI.G.3 and IAG Article 16.4	
3rd Quarter 2017 Progress Report	Nov 2017	Dec 2017	Dec 2017	HW-50284 Provision XI.G.3 and IAG Article 16.4	
4th Quarter 2017 Progress Report	Feb 2018	Mar 2018	Mar 2018	HW-50284 Provision XI.G.3 and IAG Article 16.4	
1st Quarter 2018 Progress Report	Apr 2018	Jun 2018	Jun 2018	HW-50284 Provision XI.G.3 and IAG Article 16.4	
2017 Annual Progress Report	Mar 2018	Jun 2018	Jun 2018	HW-50284 Provision XI.G.3 and IAG Article 16.4	
2nd Semi-Annual 2016 Groundwater Sampling - Monitoring Wells	Jul 2017	Dec 2017	Dec 2017	HW-50284 Provision XI.F	
3Q2016 Groundwater Sampling - ISB System Wells	Jul 2017	Sep 2017	Sep 2017	HW-50284 Provision XI.F	
4Q2016 Groundwater Sampling - ISB System Wells	Oct 2017	Dec 2017	Dec 2017	HW-50284 Provision XI.F	
1st Semi-Annual 2018 Groundwater Sampling - Monitoring Wells	Jan 2018	Jun 2018	Jun 2018	HW-50284 Provision XI.F	
1Q2018 Groundwater Sampling - ISB System Wells	Jan 2018	Mar 2018	Mar 2018	HW-50284 Provision XI.F	
2Q2018 Groundwater Sampling - ISB System Wells	Apr 2018	Jun 2018	May 2018	HW-50284 Provision XI.F	
Work In-Progress					
RDX Natural Attenuation Study	Dec 2016	June 2018*			2015A
Extending SEPTS extraction east of FM 2373 – Construction	Dec 2017	Oct 2018*		IAG Article 8 HW-50284 Provision XI.E.1	2015A

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Zone 11 ISB Injection	Aug 2017	Jun 2018*		IAG Article 8 HW-50284 Provision XI.E.1	
Annual Landfill Maintenance - 2018	Dec 2017	Oct 2018		IAG Article 8.9 HW-50284 Provision XI.E	4Q2015, 2015A
FY 18 Well Drilling – drilling on offsite property and plugging of two Ogallala wells	Jan 2018	Sep 2018		HW-50284 XI.B.1 and XI.B.2	3Q2017 4Q2017
Geophysical study of preferential flow paths of impacted water to the southeast onto offsite land – using technology developed by Willowstick	Feb 2018	Nov 2018			
Landfill 3 Erosion Control Construction	Mar 2018	Sep 2018*		IAG Article 8.9 HW-50284 Provision XI.E	3Q2015
Regulatory Review of Draft Final Five-Year Review Report	May 2018*	June 2018*		IAG Article 21 and HW-50284 CP Table VII, Item 26	
Upcoming Work					
Design and construction of Southeast ISB extension injection components and pad	Jun 2018	Nov 2018		HW-50284 XI.B.1 and XI.B.2	2Q2017
Prepare Final Five-Year Review Report	June 2018*	Jul 2018*		IAG Article 21 and HW-50284 CP Table VII, Item 26	
EPA/TCEQ Approval of Final Five Year Review Report	Jul 2018	Aug 2018		IAG Article 21 and HW-50284 CP Table VII, Item 26	
Southeast ISB Extension Injection	Sep 2018	Dec 2018		IAG Article 8 HW-50284 Provision XI.E.1	
Annual Public Meeting	Oct 2018	Nov 2018			
Sampling and Analysis Plan Update	Nov 2018	Jul 2019		HW-50284 Provision XI.A.7 and XI.E.2	
LTM Design Update	Nov 2018	Jul 2019			

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
FY19 Well Drilling	Dec 2018	Jun 2019		HW-50284 XI.B.1 and XI.B.2	
Annual Landfill Maintenance - 2019	Jan 2019	June 2019		IAG Article 8.9 HW-50284 Provision XI.E	4Q2015, 2015A
Zone 11 ISB Injection	Feb 2019	June 2019		IAG Article 8 HW-50284 Provision XI.E.1	
2nd Quarter 2018 Progress Report	Aug 2018	Sep 2018		HW-50284 Provision XI.G.3 and IAG Article 16.4	
3rd Quarter 2018 Progress Report	Nov 2018	Dec 2018		HW-50284 Provision XI.G.3 and IAG Article 16.4	
4th Quarter 2018 Progress Report	Feb 2019	Mar 2019		HW-50284 Provision XI.G.3 and IAG Article 16.4	
1st Quarter 2018 Progress Report	Apr 2019	Jun 2019		HW-50284 Provision XI.G.3 and IAG Article 16.4	
2018 Annual Progress Report	Mar 2019	Jun 2019		HW-50284 Provision XI.G.3 and IAG Article 16.4	
2nd Semi-Annual 2018 Groundwater Sampling - Monitoring Wells	Jul 2018	Dec 2018		HW-50284 Provision XI.F	
3Q2018 Groundwater Sampling - ISB System Wells	Jul 2018	Sep 2018		HW-50284 Provision XI.F	
4Q2018 Groundwater Sampling - ISB System Wells	Oct 2018	Dec 2018		HW-50284 Provision XI.F	
1st Semi-Annual 2019 Groundwater Sampling - Monitoring Wells	Jan 2019	Jun 2019		HW-50284 Provision XI.F	
1Q2019 Groundwater Sampling - ISB System Wells	Jan 2019	Mar 2019		HW-50284 Provision XI.F	
2Q2019 Groundwater Sampling - ISB System Wells	Apr 2019	Jun 2019		HW-50284 Provision XI.F	

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Develop SVE Performance Monitoring Plan	**Sep 2014*** To be revised pending review of data from modified SVE	**Dec 2014*** To be revised pending review of data from modified SVE		IAG Article 21 and HW-50284 CP Table VII, Item 26	First FYR

*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. The pump and treat systems continued to impact saturated thickness and contaminant mass in the southeast perched groundwater during 2017, although the systems were impacted by shutdowns. 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.

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

Pump and Treat Systems Milestones

2017

- 138.4 million gallons treated
- 76% of treated water beneficially used
- 449 lbs of contaminants removed

Since Startup

- 2.5 billion gallons treated
- 1.7 billion gallons beneficially used
- 14,088 lbs contaminants removed

2.1.1 Playa 1 Pump and Treat System O&M

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 all water flows to be discontinued while the treated water was routed to another location. WWTF treated water is now being routed to Playa 1 until repairs are completed at the irrigation system.

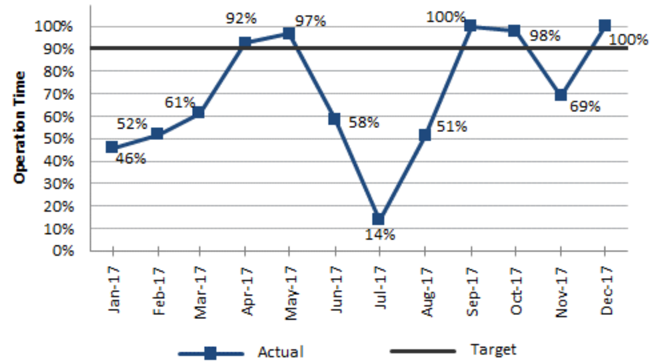

Figure 2-1. P1PTS Operation Time vs Target

The P1PTS operation was below the annual system operational goal by operating 277 days during 2017 with an average annual operational rate of 70%, 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.

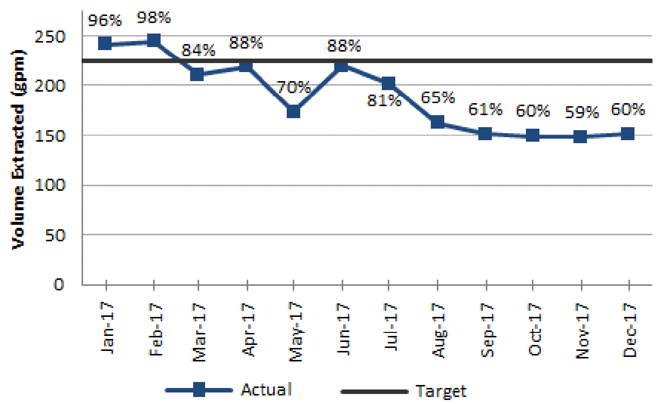

Figure 2-2. P1PTS Average GPM and % Capacity

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 rate of the system was the prioritized goal after June 2014, the 90% throughput goal is still depicted in the graphs and throughput is evaluated to identify potential issues with well operation.

The monthly system operation was primarily affected by the WWTF due to necessary repairs during January, February and March and filter problems in early June and a break at the irrigation system lines that occurred in late June. The system remained down during most of July while an alternate method of water release was prepared since the irrigation system could no longer be used.

The P1PTS system extracted an average of 189 gpm (about 76% of design throughput) from the well field while operating during 2017. 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 67%. The well operation was affected by reduced flows due to issues at the WWTF

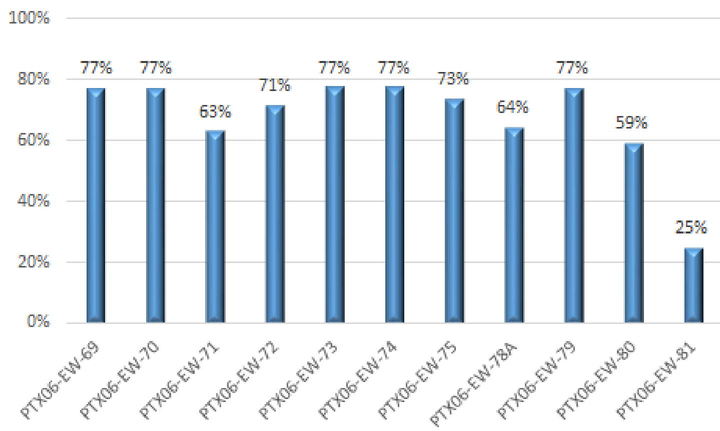

Figure 2-3. P1PTS Well Operation Time

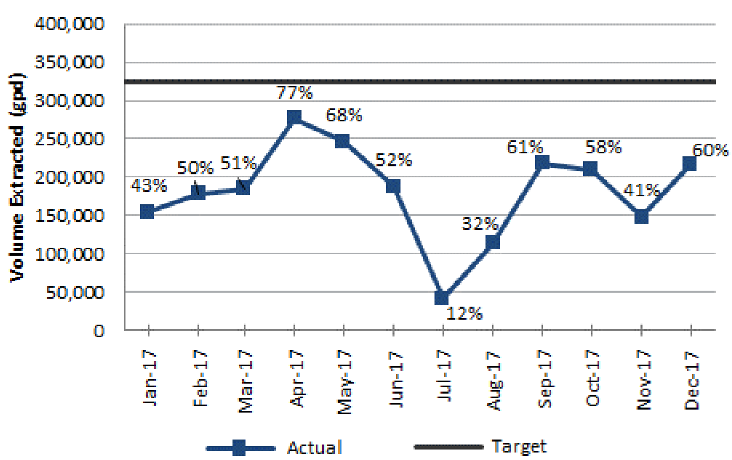

Figure 2-4. P1PTS Average GPD and % Capacity

early in the year and after the irrigation break as limited water is being released to the WWTF and Playa 1. PTX06-EW-81 was installed to help with maintaining flow rate goals when other wells are down. This well was not operated consistently as most other wells were operating and flow was reduced later in the year so the additional well flow was unnecessary. Other wells were also shut down intermittently due to the reduced flows in the last half of 2017.

Figure 2-4 reflects the overall system efficiency considering system operation 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 after June 2014, 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 181,400 gpd during 2017, about 50% 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 WWTF filter issues and the irrigation filter bank break which required flow to be redirected and reduced. Minor loss of operation occurred due to carbon change-outs, power losses, and repairs. The system was shut down due to the WWTF/irrigation system for 8 days in March, 9 days in June, and 23 days in July, related to the irrigation filter bank break and repairs at the WWTF. It was shut down for 11 days in March for carbon change-out and repairs at the WWTF. The system was also shut down for 13 days in February and 16 days in January to allow the SEPTS to operate while flows were reduced to the WWTF and to allow for repairs at the WWTF.

The system treated approximately 66.8 million gallons during 2017, with an average treatment volume of about 5.6 million gallons per month. The monthly treatment flow volumes are depicted in Figure 2-5. As discussed above, monthly total flow was low because of impacts from the WWTF and irrigation system break.

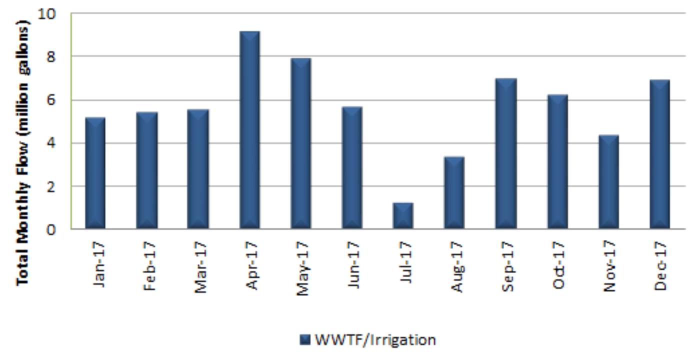

Figure 2-5. P1PTS System Monthly Total Flow

During 2017, the system removed approximately 20 lbs of RDX and 8.7 lbs of all other HEs (see Figure 2-6). The average removal rate of HEs was about 0.4 lbs per million gallons (lbs/Mgal) of treated water. The system has removed a total of 515 lbs of RDX and 205 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. Two wells (PTX06-EW-79, and 80) at the P1PTS have the greatest effect on the influent concentrations of HEs because they are in a more heavily contaminated portion of the plume. PTX06-EW-79 flow or operation was affected later in the year in response to reduced flows to the WWTF and Playa 1. PTX06-EW-80 was offline from January through March due to communication problems. The downtime of these wells affected the mass removal of the system during those months. Additionally, operational downtime also affected mass removal at this system.

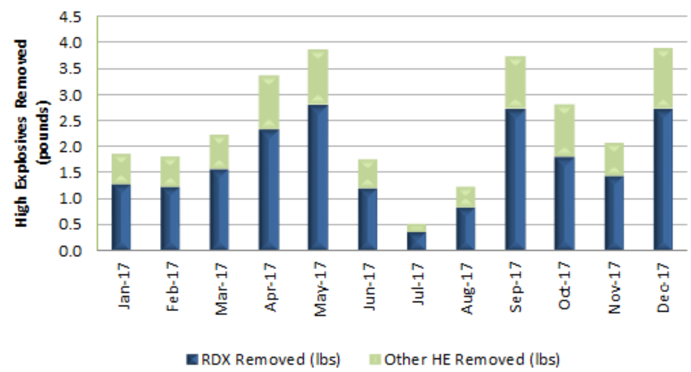

Figure 2-6. P1PTS Mass Removal by Month

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 2017 was 36.3 ug/L. The maximum influent RDX concentration in 2009 was 200 ug/L and 47.2 ug/L in 2017. This system primarily reduces saturated thickness and head on the southeast perched groundwater, although mass removal is also achieved.

Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below the laboratory PQL and the GWPS. There were no COCs detected within the effluent during 2017. The complete set of effluent data collected during 2017 is included in Appendix D electronic data tables.

Pantex also evaluates extraction wells near SWMU 5-12 for evidence of contamination from the SWMU 5-12 ditch that could impact P1PTS. Wells in that area indicate the presence of perchlorate and 1,4-dioxane, which are not treatable by GAC. Evaluation of extraction well data indicated the presence of perchlorate in one well (PTX06-EW-72) and the presence of 1,4-dioxane in three wells (PTX06-EW-71, PTX06-EW-72, and PTX06-EW-78A). The summary of extraction well data is presented in Table 2-1. The perchlorate result was less than the laboratory PQL and GWPS. Two of the 1,4-dioxane detections slightly exceeded the PQL, but all detections were less than the GWPS. There have been no detections of 1,4-dioxane in the influent or effluent of the P1PTS. There was a single detection of perchlorate in the influent of the P1PTS, below the PQL and GWPS, see the table below. Pantex will continue to monitor the appropriate extraction wells.

Table 2-1. Summary of Detections at Extraction Wells and P1PTS Influent

Well ID	Analyte	Sample Date	Measured Value (ug/L)	Lab PQL (ug/L)	>Lab PQL?	GWPS (ug/L)	>GWPS?
PTX06-EW-72	Perchlorate	5/15/2017	6.37J	12	N	26	N
PTX06-EW-71	1,4-dioxane	5/15/2017	1.04J-	1	Y	7.7	N
PTX06-EW-72	1,4-dioxane	5/15/2017	1.08J-	1	Y	7.7	N
PTX06-EW-78A	1,4-dioxane	5/15/2017	0.961J-	1	N	7.7	N
PL1-INFLUENT	Perchlorate	6/7/2017	4.2J	12	N	26	N

J- = The associated numerical value is an estimated quantity with a suspected negative bias.

During 2017, the P1PTS was in its ninth year of operation. Operational performance was below goals for most of the year. Performance was primarily affected by problems at the WWTF/irrigation system, with carbon change-outs and minor maintenance also affecting the system for short periods. 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/irrigation system, P1PTS is shut down or flow is restricted at both systems to avoid injection, if possible. During 2017 the filter bank break at the irrigation system heavily impacted flow and goals to remove water from Playa 1 and avoidance of reinjection into the perched aquifer. Pantex is continuing to evaluate alternative methods for use of treated perched groundwater.

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 to about 158 Mgal annually, if operated at 100%.

The SEPTS operated all or part of 287 days during 2017 with an average operational rate of 75% 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 due to various repairs or carbon change-out at the facility, the irrigation filter bank break and resulting evaluation, and by various repair issues at the WWTF in February, March, May, and June. Operation now continues, but primarily at lower flow rates due to a combination of 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. While operational rate of the system was the prioritized goal after June 2014, the 90% throughput goal is still depicted in the graphs and well throughput is evaluated to identify potential issues.

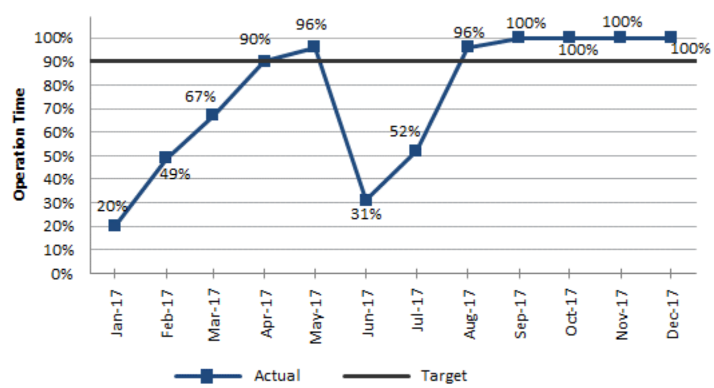

Figure 2-7. SEPTS Operation Time vs Target

The system extracted an annual average of 191 gpm (about 64% 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

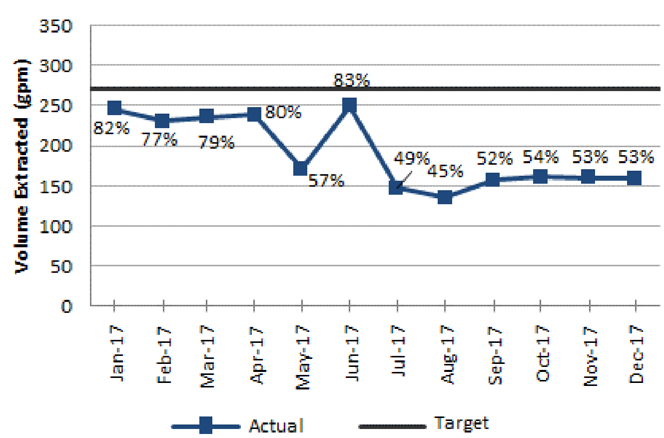

Figure 2-8. SEPTS Average GPM and % Capacity

full flow from the pump and treat systems, flow was reduced to avoid injection into the perched aquifer.

The well operation was affected by reduced flows after the irrigation break and well lines were shut down while new water and communication lines were installed for the new administrative building. The new lines were installed along the Pantex fence line, next to our untreated water conveyance, so our extraction lines were shut down and evacuated to avoid potential releases to the environment in case of an accidental line break. The shutdown of lines along the fence line notably affected the operation of priority 1 wells.

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, will be connected in 2018.

Although perched groundwater levels are declining, the extractions 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 Error! Reference source not found. Seven priorities were set:

- Priority 1 Wells: Wells along the eastern edge of the well field (along the eastern fence line) 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.
- 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 with reducing 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-transmissive zone so is a very low-producing well. For this reason, it was not placed in a high priority for pumping.

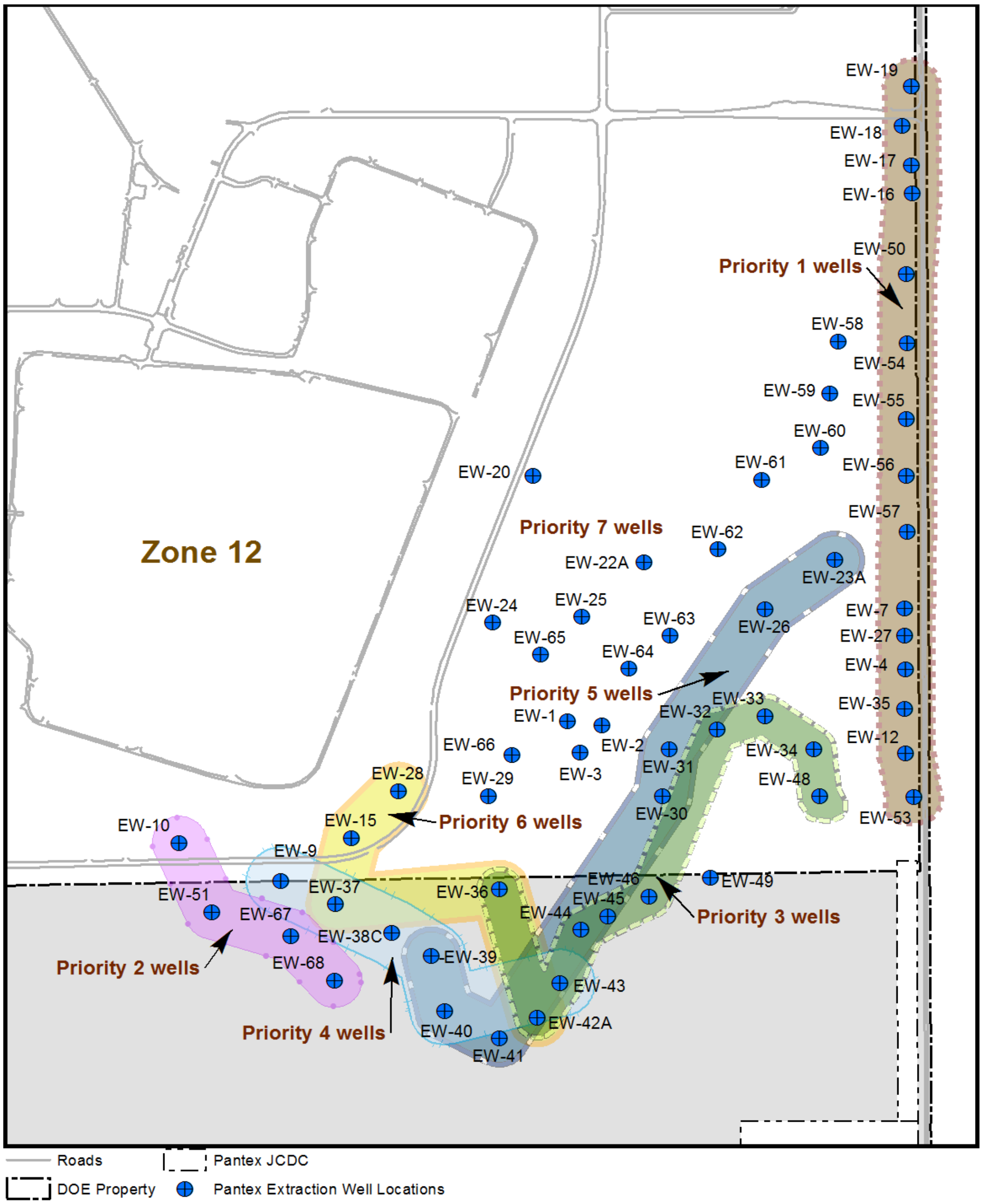

Figure 2-9. Extraction Well Prioritization

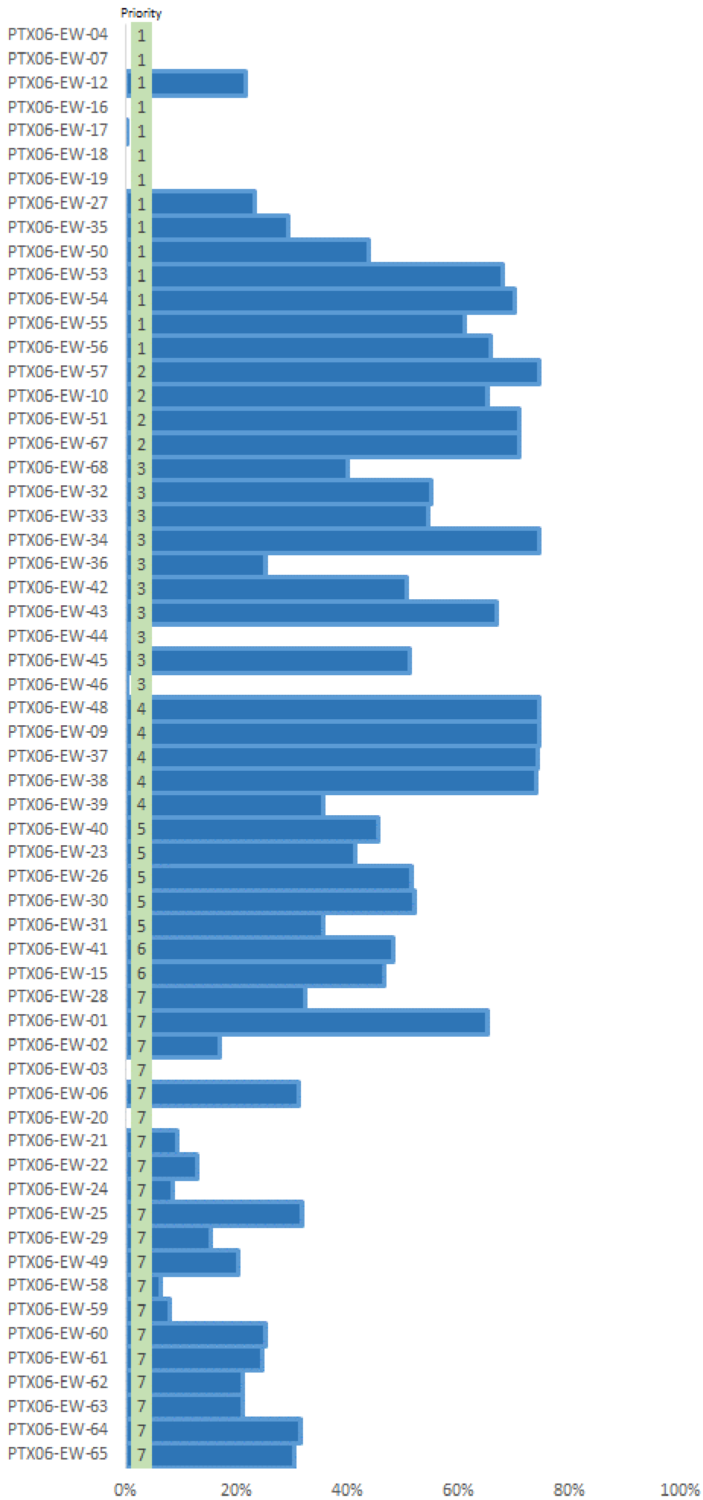

Figure 2-10. 2017 SEPTS Well % Operation

This prioritization was implemented in 2009 after the 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 were affected by the shutdown of wells while ASC lines were installed. Priority 6 and 7 extraction wells are operated periodically to ensure that wells remain operational. Priority 6 and 7 wells within the highest saturated zones are also operated at a higher frequency to meet the goal of reducing the saturated thickness in those areas and to meet throughput goals for the system. 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. Wells along the northern fence line are frequently cycling off due to the limited saturation in that area. PTX06-EW-21 and PTX06-EW-06 have gone dry. The prioritization of the well pumping is expected to be discontinued in the future as the capacity of the pump and treat system will exceed extraction rates.

As noted in the 4th Quarter 2017 Progress Report, a well video at PTX06-EW-58 indicated multiple stress fractures in the casing. Pantex has been evaluating options to avoid drilling a new well that could take a lengthy amount of time to tie-in to the system. Pantex will likely line the 6-inch well with a 5-inch casing and continue operating the well until it fails. This repair will be completed after contracting has been set up.

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 194,409 gpd (about 45% of design capacity) for 2017 based on total possible hours of operation and total inflow from the well field.

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 affected by loss of throughput to the WWTF/irrigation system after the irrigation filter bank break and from loss of wells while the lines to the ASC were installed. Operational time was affected by the maintenance (carbon change-out), WWTF repairs, and the irrigation filter bank break and resulting evaluation.

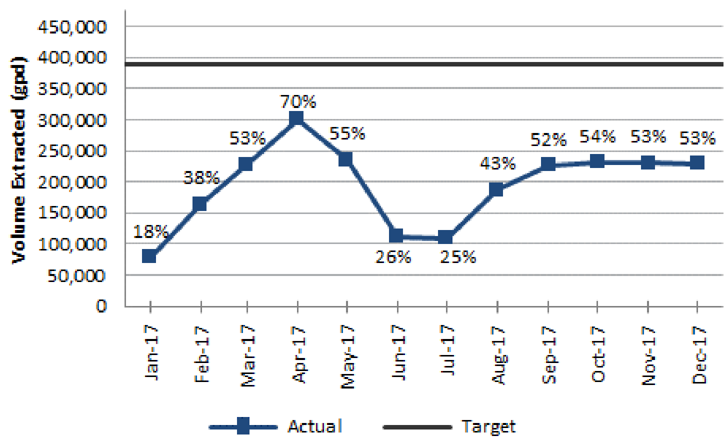

Figure 2-11. SEPTS Average GPD and % Capacity

The system treated over 71 million gallons of extracted water during 2017. The total volume treated by month and the final disposition of the treated water is depicted in

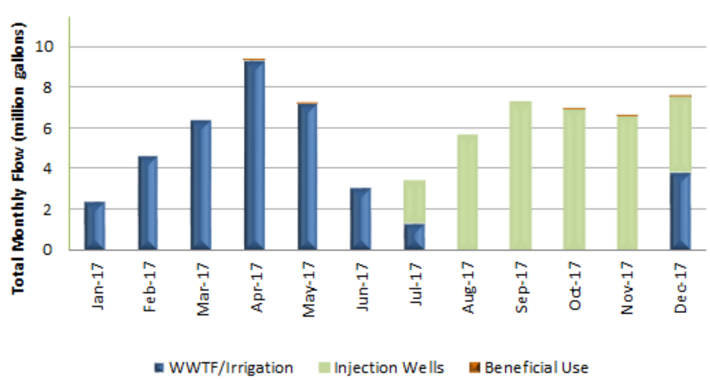

Figure 2-12. SEPTS Total Flow Volume and Disposition of Effluent

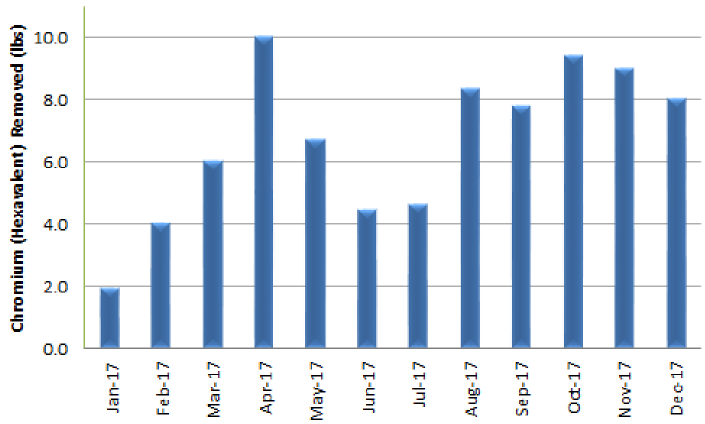

Figure 2-13. SEPTS Chromium Mass Removed by Month

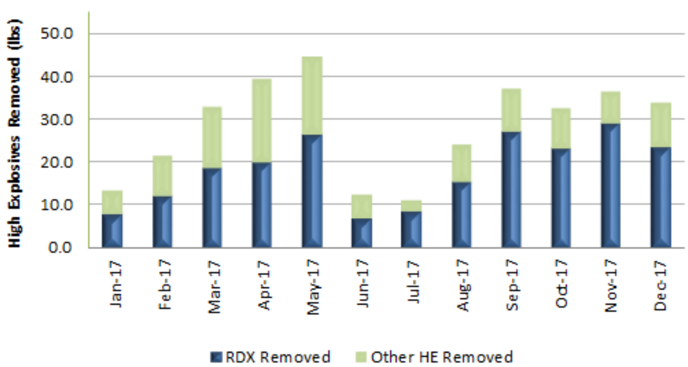

Figure 2-14. SEPTS High Explosive Mass Removed by Month

Figure 2-12. This system released about 18% of the treated water to the WWTF, 81% was injected into the perched aquifer, and the remaining 1% was beneficially used for drilling wells. With the implementation of the revised operational goals, Pantex expects to continue minimizing injection and reducing saturated thickness.

The SEPTS primarily removes RDX and hexavalent chromium from the perched groundwater. The system removed about 81 lbs of hexavalent chromium, 219 lbs of RDX, and 119 lbs of all other HEs during 2017. The total mass removed by month is depicted in Figure 2-13 and Figure 2-14. The average removal rate of hexavalent chromium was 1.2 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 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 concentrations about 570 ug/L in 2009, the first year of the full remedial action, to about 361 ug/L in 2017. Hexavalent chromium average influent concentrations in 2009 were about 214 ug/L while concentrations were about 142 ug/L in 2016.

This system has treated approximately 11,800 lbs of HEs and 1,560 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 2-2. The complete set of effluent data collected during 2016 is included in Appendix D.

Table 2-2. Summary of Effluent Detections at SEPTS

Sample Date	Analyte	Measured Value (ug/L)	Bkgd (ug/L)	> Bkgd?	PQL (ug/L)	> PQL?	GWPS (ug/L)	> GWPS?
1/4/2017	RDX	0.239J	--	NA	0.272	N	2	N
6/7/2017	Total Chromium	6.4J	31.8	N	10	NA	100	N
6/7/2017	Total Chromium	6.5J	31.8	N	10	NA	100	N
11/1/2017	Chloroform	1.1J	--	NA	3	N	80	N

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 2017 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, it is possible that 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 closest downgradient extraction wells in 2017. 1,4-Dioxane was also detected in the three wells added as a best management practice. All detections of perchlorate and 1,4-dioxane were below the GWPS. See Table 2-3 for a summary of these results for 2017.

Table 2-3. Summary of Perchlorate and 1,4-Dioxane Detections at SEPTS Extraction Wells

Well ID	Sample Date	Analyte	Measured Value (ug/L)	Lab PQL (ug/L)	>Lab PQL?	GWPS (ug/L)	>GWPS?
PTX06-EW-66	5/16/2017	1,4-Dioxane	3.02	1	Y	7.7	N
PTX06-EW-1	5/16/2017	1,4-Dioxane	0.738J	1	N	7.7	N
PTX06-EW-65	5/16/2017	1,4-Dioxane	0.484J	1	N	7.7	N
PTX06-EW-10	9/13/2017	Perchlorate	10.7J	12	N	26	N
PTX06-EW-51	9/18/2017	Perchlorate	11.1J	12	N	26	N
PTX06-EW-9	9/18/2017	Perchlorate	4.04J	12	N	26	N

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

These perchlorate results were discussed in the 4th Quarter Progress Report. As recommended in that report, Pantex will continue to evaluate 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 increase near GWPS. Pantex has increased sampling at more downgradient wells to evaluate the movement of perchlorate into the SEPTS well field to the southwest of the system. Sampling has been increased to semi-annual in those wells to evaluate concentration trends.

This is the second year that 1,4-dioxane has been detected in extraction wells on the southeast side of Zone 12. The concentrations upgradient and at the extraction wells do not indicate increasing concentrations near the GWPS, so Pantex will continue to observe the 1,4-dioxane in accordance with the current monitoring plan.

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. Pantex is evaluating options for the reuse of the water to avoid injection of the treated water into the perched aquifer.

2.2 ISB Systems

Pantex has installed and operates two ISB systems as part of the final Remedial Action for groundwater. One system is southeast of Pantex Plant on TTU property and one is south of Zone 11. System information and maps are provided in Section 1.4.2. In 2017, the operating ISB systems consisted of 88 treatment zone injection wells and 15 in situ performance monitoring wells. Pantex has installed a new ISB system to the southeast along Pantex property boundary, but the system is not yet operating. Injection is expected to begin in 2018.

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 2017, 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 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 5 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.

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, even without injection for three events. 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.

2.2.1.2 Operation of Zone 11 ISB

No injections or rehabilitation occurred at the Zone 11 ISB during 2017. Due to delays in procurement, the contract was not awarded until early 2018. Injection into the expansion area of the system (to the northwest) will be completed by July 2018. The original portion of the system and the expansion area will be injected in 2019.

2.2.2 Southeast ISB

2.2.2.1 History of Southeast ISB

Due to upgradient pump and treat operations, areas within and surrounding the Southeast ISB continue to demonstrate that water conditions are changing. ISPM wells PTX06-1045 and PTX06-1118 have not been sampled since 2009 and 2010, respectively, as water levels have declined in the wells. Downgradient ISPM well PTX06-1123 had water levels decline during 2nd quarter 2015 and has remained dry. 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). 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. However, because of effects from biofouling, trends may not actually reflect the overall change in the aquifer in the ISB.

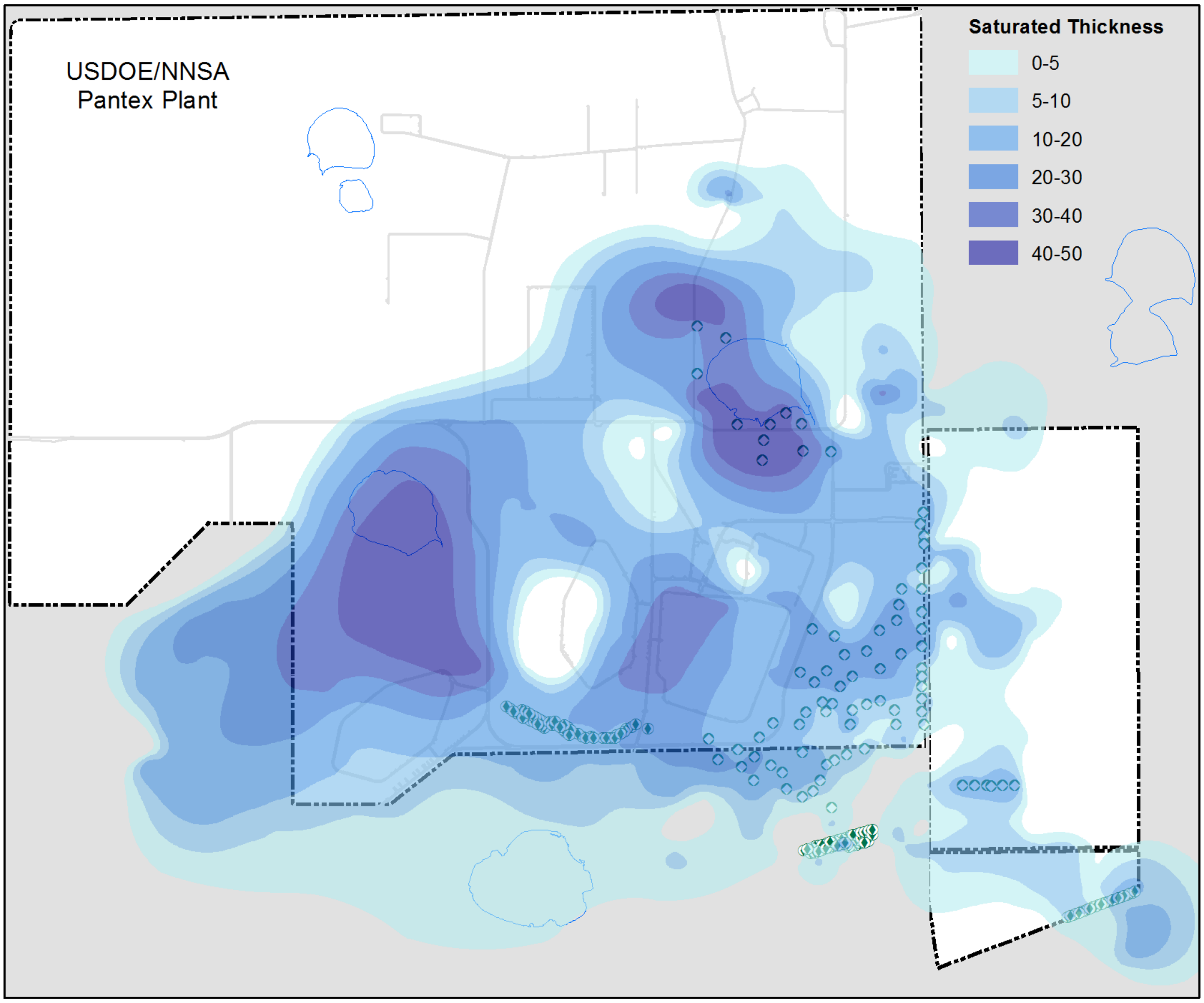

Figure 2-15. Perched Aquifer Saturated Thickness, 2017

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. Based on water level trends and the continued upgradient extraction of water, it is expected that less than half of the system will be injected at the next injection event and fewer wells would require injection by 2022.

2.2.2.2 Operation of Southeast ISB

No injections or rehabilitation occurred at the Southeast ISB during 2017. The next scheduled injection is in 2019.

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 are 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 2017. The system was intermittently operated with shutdowns for maintenance, repairs, modifications, extreme temperatures, and power outages. The system was shut down for extended times in March, August and September due to failure of the heating element and failure of the scrubber pump. The system was shut down until parts were obtained and replaced. In May, Pantex modified the system to include above-ground pipe intakes on wells surrounding SVE-S-20 to promote volatilization and enhance bioremediation. Average operation at the system was about 76% for 2017.

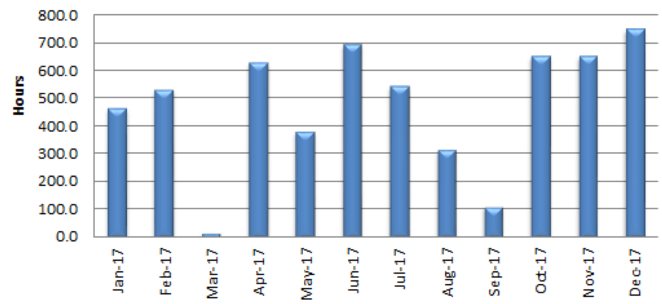

Figure 2-16. SVE System Operation

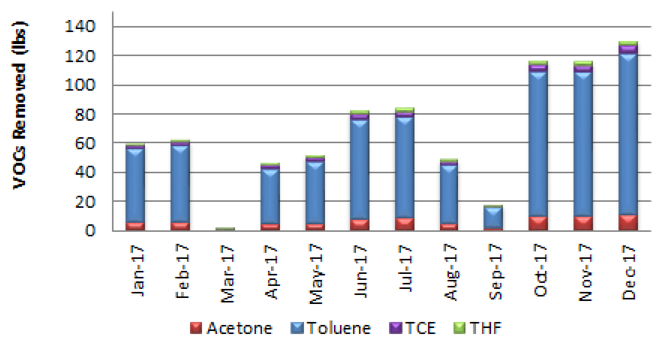

Figure 2-17. Burning Ground SVE Mass Removal

Calculated mass removal for 2017 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 more than 2% of the total VOC concentration were included in the calculation. Mass removal has been impacted by the shutdowns for modifications and repairs.

Since modifications were completed at the system, the influent flow rate was increased from 32 scfm to 40 scfm in May and increased again to about 44 scfm at the beginning of 4th quarter. Flow rates increased by 25% and 34% from 1st quarter baseline, causing a rise in mass removal as well.

The system removed about 813 lbs of VOCs during 2017. Since inception, the SVE system has removed over 19,600 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 2017 effluent PID readings for the system indicate that destruction efficiency was 96% or greater.

2.3.2 Engineered and Institutional Controls

The soil remedial actions at Pantex are discussed in Chapter 1. The SVE system 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 2017, Pantex conducted landfill inspections in accordance with the newly 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 newly 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 2017. 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 small holes/voids from wildlife. Additionally, the landfills can be affected by heavy rainfall and drought conditions that frequently occur in the Texas Panhandle. Pantex experienced heavy rainfall through September 2017 and then had long-term drought conditions since that time. 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 personnel and equipment. However, to ensure long-term 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 such as those identified during the 2015 and 2016 inspections (e.g., Landfill 3 erosion) have been contracted separately for design and construction. Each contracting effort will be followed-up with inspections to evaluate the effectiveness of the actions. The key findings and maintenance actions completed from 2017 soil inspections is included in Table 2-4. The 2018 landfill maintenance task has been planned and is expected to be complete by October 2018.

Table 2-4. 2017 Key Findings and Corrective Actions for Soil SWMUs

Findings	Corrective Actions
Previous Findings	
SWMU 57 Landfill 6 has large holes and areas that require reseeding	This landfill will be removed as it was incorrectly identified as needing work. This landfill work should have been identified as SVS 6. Pantex has already addressed work at SVS 6. Pantex has conducted an inspection to verify that this landfill does not require any maintenance.
SWMU 60 and 61 (Landfill 9 and 10, respectively) had low areas where ponding and infiltration could occur.	Will be addressed through new landfill maintenance contract. Seeding will also be conducted after filling of low areas. Landfill 10 included in 2018 maintenance contract. Landfill 9 prioritized in 2019 maintenance contract.
SVS 7a/7b numerous small landfills with holes and depressions.	Will be addressed through new landfill maintenance contract. Seeding will also be conducted after filling of holes. Prioritized for 2019 contract maintenance.
SWMU 54, Landfill 3 has extensive erosion in areas along the nearby ditch. Heavy rainfall in 2015 caused erosion of those areas. Erosion of areas near parking areas and culverts also need to be addressed.	Pantex has completed a design to remedy the erosion and to address improvement of the cover where needed. Pantex is currently contracting for construction of the repairs and upgrades to address erosion. Construction will be complete by the end of 2018.
SWMU 68c, SWMU 54, SWMU 64, SWMUs 37-44, and SVS 6 landfills (Landfills 2, 3, 13, Burning Ground, and Zone 7, respectively) had low spots and distressed vegetation when inspected for the First Five-Year Review. Review of the landfills during 2015 indicated that the landfills had a few holes that need to be filled. The vegetation is still sparse in the reseeded areas. Side slope erosion was noted on Landfill 3. Landfill 13 has holes/voids on the north and southwest edges of the landfill.	These areas were identified during the Five-Year Review as needing erosion control. The work was contracted and low areas were backfilled, seed applied per the landfill reseeding plan, and erosion control mats were applied on sloped areas in 2013. Pantex continues to evaluate the effectiveness of the maintenance. Based on the 2015 review, most of the landfill vegetation has recovered due to heavy rainfall that occurred during 2015. A long-term maintenance contract was issued in 2016 to address remaining small areas that needed seeding and periodic repair of holes and depressions in the surface of the landfill covers. In late 2016/early 2017 Pantex addressed SWMU 68c with the installation of Closure Turf and SWMU 64 was addressed through the new landfill maintenance contract. Landfill 3 (SWMU 54) is being contracted separately and will be addressed by the end of 2018.
2017 Findings	

Findings	Corrective Actions
SWMU 37-39, Burning Ground Landfills need reseeding in one slope area	Included in 2018 maintenance contract.
SWMU 68b, Landfill 1 geomembrane and liner is damaged in four areas.	Separate maintenance contract required – scheduled for 2019.
SWMU 56, Landfill 5 depressions and re-seeding.	Prioritized for 2019 maintenance contract.
SVS 6 holes and voids to be filled and re-seeded.	Included in 2018 maintenance contract.
Unassigned AOC Landfills near Zone 10 depressions and holes to be filled and re-seeded.	Prioritized for 2019 maintenance contract.
SVS 5 depressions to be filled and re-seeded.	Prioritized for 2019 maintenance contract.

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 maintenance contract and larger issues, such as erosion, will be addressed through separate contracts. The active landfill area at Pantex is continually maintained by the Waste Operations Department and old landfills in that area will be addressed by onsite Waste Operations personnel.

Ditch Liner Inspection and Maintenance

Pantex also previously noted during inspection that the ditch liner in Zone 12 was degrading, pulling away from the top anchor trenching, and had a few small tears. Because the liner was near the end of its life cycle, Pantex contracted to replace the liner in 2017, with installation completed in March. The new liner, consisting of a 45-millimeter Chlorosulfonate Polyethylene (commonly referred to as Hypalon), is more resistant to UV light and is heavier, providing a longer life cycle for the liner. The liner was anchored using a Platipus® anchor system along the bottom of the ditch. The original liner and Platipus® anchors were left in place with the new liner installed over them, providing an extra layer of protection. The implementation report for the liner installation is provided in Appendix H. As discussed above, a new maintenance plan was developed for the new liner.

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 inspected 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 2-5 provides information on projects that were not complete by the last annual report as well as new SWMU interference projects from 2017. Eight new permits were issued in 2017 with four completed in 2016.

Table 2-5. SWMU Interference Log

Log #	State Approval Date	SWMU #	Explanation of Work
SIN16-004	06.17.16	SWMU 55	Infrastructure group must excavate to repair post indicator valve (PIV). Backhoe, loader, CAT Excavator and other equipment will be used. Status: Completed June 2017. Soils returned to SWMU.
SIN16-006	08.01.16	AOC 13	A temporary generator will be added on a new pad to 12-108. A new road will also be installed along with an underground duct bank. In addition to this, a new ATS system will be installed to accompany the existing system to help support the load of the new generator. The underground duct bank trench is estimated to be 150 feet long and 6 feet deep. All soils are going to be returned to their original area. The portion of the trench that is within a SWMU will require soils to be kept separate from what is not within a SWMU. Status: Active
SIN16-007	07.29.16	SWMU 137	Repair or replace existing PIV 12SP367 valve near Building 12-47 and 12-42 to restore regular water flow to the HPFL line. The Yard group will be excavating the area using a hydro-excavator. They will hydro-excavate approximately 10 feet below grade, exposing at least 2 feet of the leaking system. Status: Completed June 2017. Soils returned to SWMU.
SIN16-008	11.15.16	Multiple	Excavation for all utilities within SWMU's and SWMU extents for the new Administrative Support Complex. Status: Active
SIN16-009	10.07.16	SWMU 13	Installing a new concrete pad for a transformer on the East side of 11-51A. Area will be leveled and the excavation area will consist of approximately 45 square feet with a maximum depth of 4 feet. Status: Active
SIN17-001	N/A	SWMU 70	Work on the Landfill at Firing Site 5 to fill and compact holes. Requested from Radiation Safety to coordinate the Rad Safety Concerns. Status: Cancelled
SIN17-002	02.10.17	SWMU 68C	Installation of Closure Turf at Landfill 2. This will include grubbing of vegetation and digging a 1 ft by 2 ft anchor trench around the landfill cover. Status: Complete March 2017. 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.
SIN17-004	5/18/2017	SWMU 78	Mechanical and electrical upgrades will be made at FS-11A and FS-24. Upgrades require expansion of 4 pads (3 east of FS-11A, 1 north of FS-24. Pad extensions will be 4' x 4' x 1' deep. Status: Completed December 2017. Soils returned to SWMU.
SIN17-005	6/16/2017	SWMU 68a	Installation of new stairs on the southeast side of 12-61. Status: Complete April 2017. Soil returned to SWMU.
SIN17-006	8/1/2017	SWMU 56	Expansion of the southwest section of the parking lot of 12-103. 11" of soil will be graded off an area of 246' x 105'. Soil will be disposed of in the Pantex landfill. Status: Complete October 2017. Soil disposed at onsite landfill.

Log #	State Approval Date	SWMU #	Explanation of Work
SIN17-007	6/12/2017	Zn 11 Extents	Repair of sectional valves on the high pressure fire loop line northeast of Bldg. 11-15. Status: Active.
SIN 17-008	11/27/2018	95, 5-03	New Concrete Pad at Building 12-18 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, 2013c) 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 2017 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 plans to implement a chemical rehabilitation program in 2018 to address the perched wells as the growth has completely blocked portions of the screens in some wells. 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 2017:

- Performed 44 well videos to evaluate the condition of wells and determine if re-development or other maintenance was required.
- Performed pump service (removal/installation of pump and tubing bundles) to prepare for well videos, re-development, special sampling, measurement of pump and tubing bundle length, lengthen sampling depths due to declining water levels, install diverters, and replace pumps.
- Re-developed 12 wells to reduce silting and clean the well screens.

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 2-6. During 2017 Pantex installed six monitoring wells and twenty-four ISB injection wells. One well in the ISB pilot study area was evaluated to better understand water levels in that area.

Table 2-6. Well Elevations

Well	Northing	Easting	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
Wells Installed in 2017				
PTX06-1184	3750638.25	646625.06	3514.11	3516.17
PTX06-1185	3751139.83	647878.41	3515.29	3517.37
PTX06-1188	3752340.04	640691.28	3529.17	3531.30
PTX06-1189	3752711.44	640322.51	3529.87	3531.96
PTX06-1190	3751439.52	648281.31	3516.51	3518.59
PTX06-ISB107	3750677.17	647400.94	3513.98	3516.01
PTX06-ISB108	3750705.36	647471.65	3514.20	3516.31
PTX06-ISB109	3750731.23	647541.96	3514.18	3516.25
PTX06-ISB110	3750757.59	647612.02	3514.33	3516.41
PTX06-ISB111	3750783.88	647682.57	3514.63	3516.75
PTX06-ISB112	3750810.07	647753.08	3514.57	3516.60
PTX06-ISB113	3750836.66	647823.09	3514.60	3516.68
PTX06-ISB114	3750862.53	647894.07	3514.70	3516.72
PTX06-ISB115	3750888.51	647964.07	3514.84	3516.79
PTX06-ISB116	3750914.87	648034.69	3514.80	3516.79
PTX06-ISB117	3750940.93	648105.30	3514.84	3516.78
PTX06-ISB118	3750967.12	648175.64	3514.86	3516.81
PTX06-ISB119	3750993.50	648245.97	3514.83	3516.75
PTX06-ISB120	3751019.54	648316.24	3514.94	3516.95
PTX06-ISB121	3751045.71	648386.52	3515.20	3517.26
PTX06-ISB122	3751072.09	648457.75	3515.12	3517.21
PTX06-ISB123	3751098.16	648527.50	3515.06	3517.30
PTX06-ISB124	3751124.55	648597.96	3515.02	3517.11
PTX06-ISB125	3751150.76	648668.62	3515.16	3517.15
PTX06-ISB126	3751176.87	648738.78	3515.03	3517.09
PTX06-ISB127	3751203.15	648809.07	3515.09	3517.14
PTX06-ISB128	3751229.17	648879.71	3515.08	3517.11
PTX06-ISB129	3751255.41	648950.08	3515.12	3517.13
PTX06-ISB130	3751282.05	649020.47	3515.23	3517.28
PTX06-ISB131	3751308.18	649090.64	3515.20	3517.20
Wells Surveyed in 2017				
PTX06-1100	3753578.45	640285.44	3531.76	3534.79

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 2017 purged contaminated groundwater exceeding GWPS from sampling events and maintenance activities was containerized, then the volume of water was logged and the water 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. 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 2017, 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, as needed. 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 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.

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.

3.0 Groundwater Remedial Action Effectiveness

In this section, the groundwater remedial action is evaluated for overall effectiveness during 2017 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 2017 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 2017 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 2013 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 0.005 ft/ft near Playa 1, 0.002 ft/ft near Playa 2, 0.004 ft/ft downgradient of Zone 12, and 0.001 ft/ft south of Zone 11.

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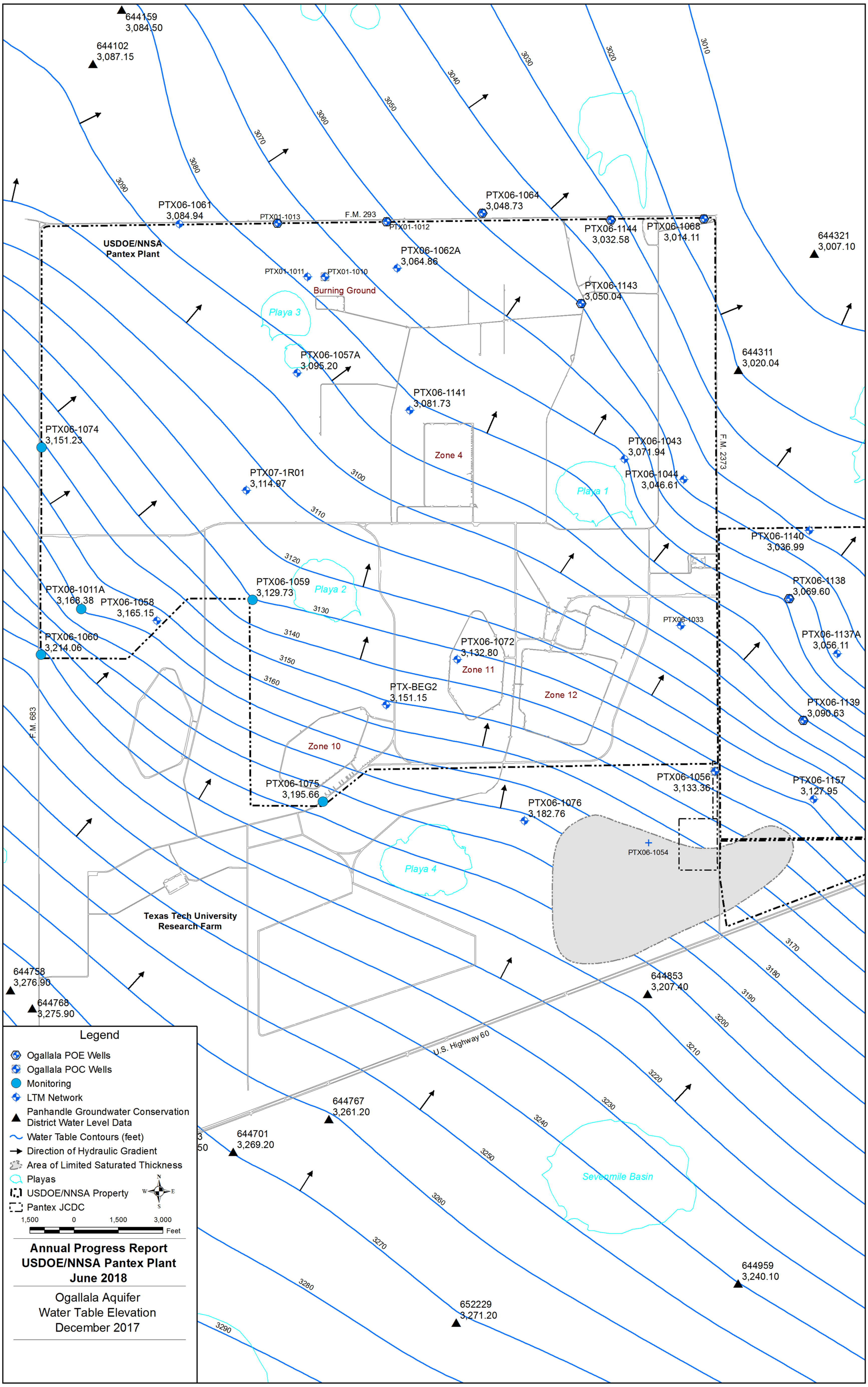

Figure 3-1. Ogallala Aquifer Water Levels

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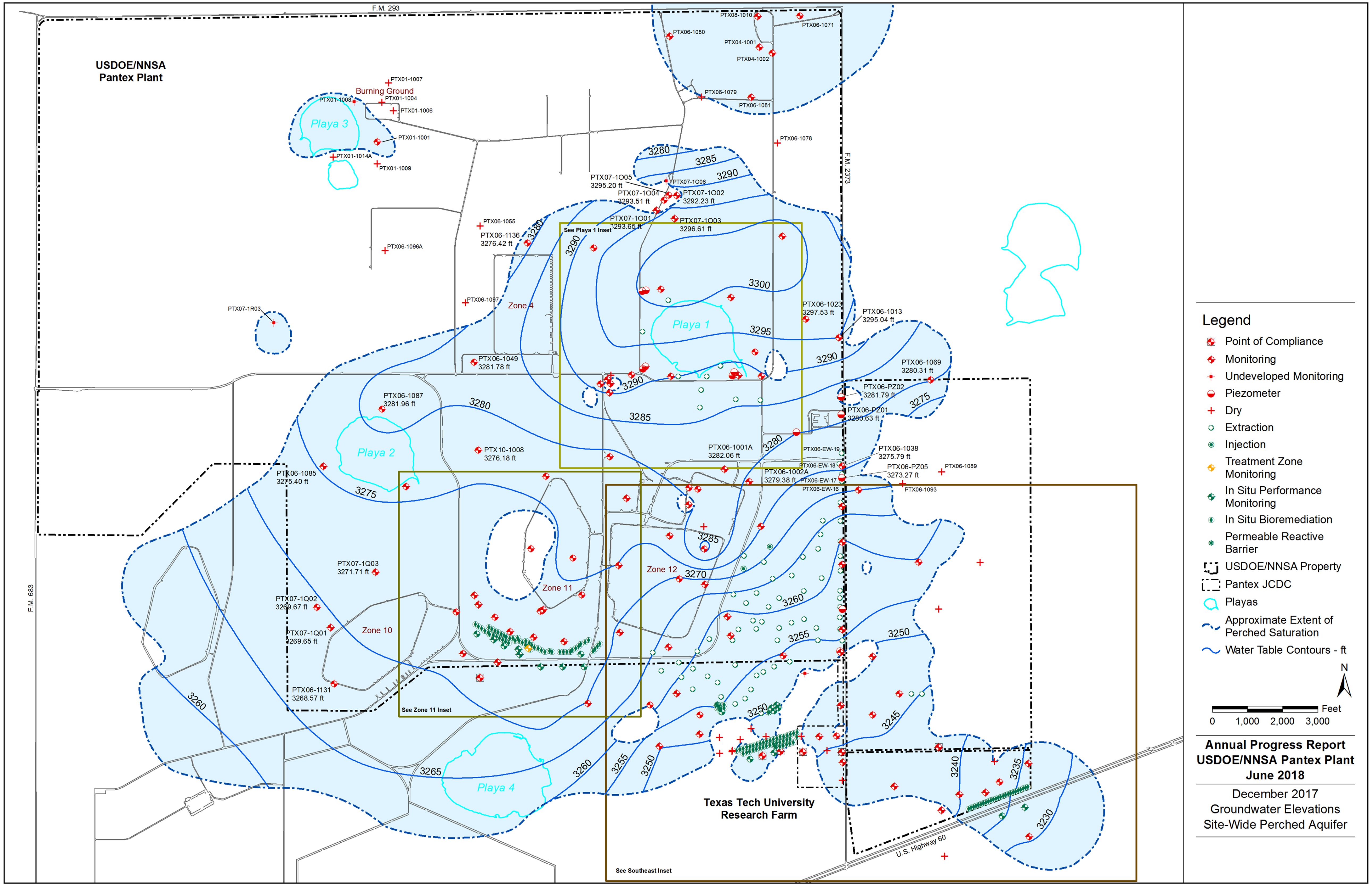

Figure 3-2. Perched Aquifer Water Levels

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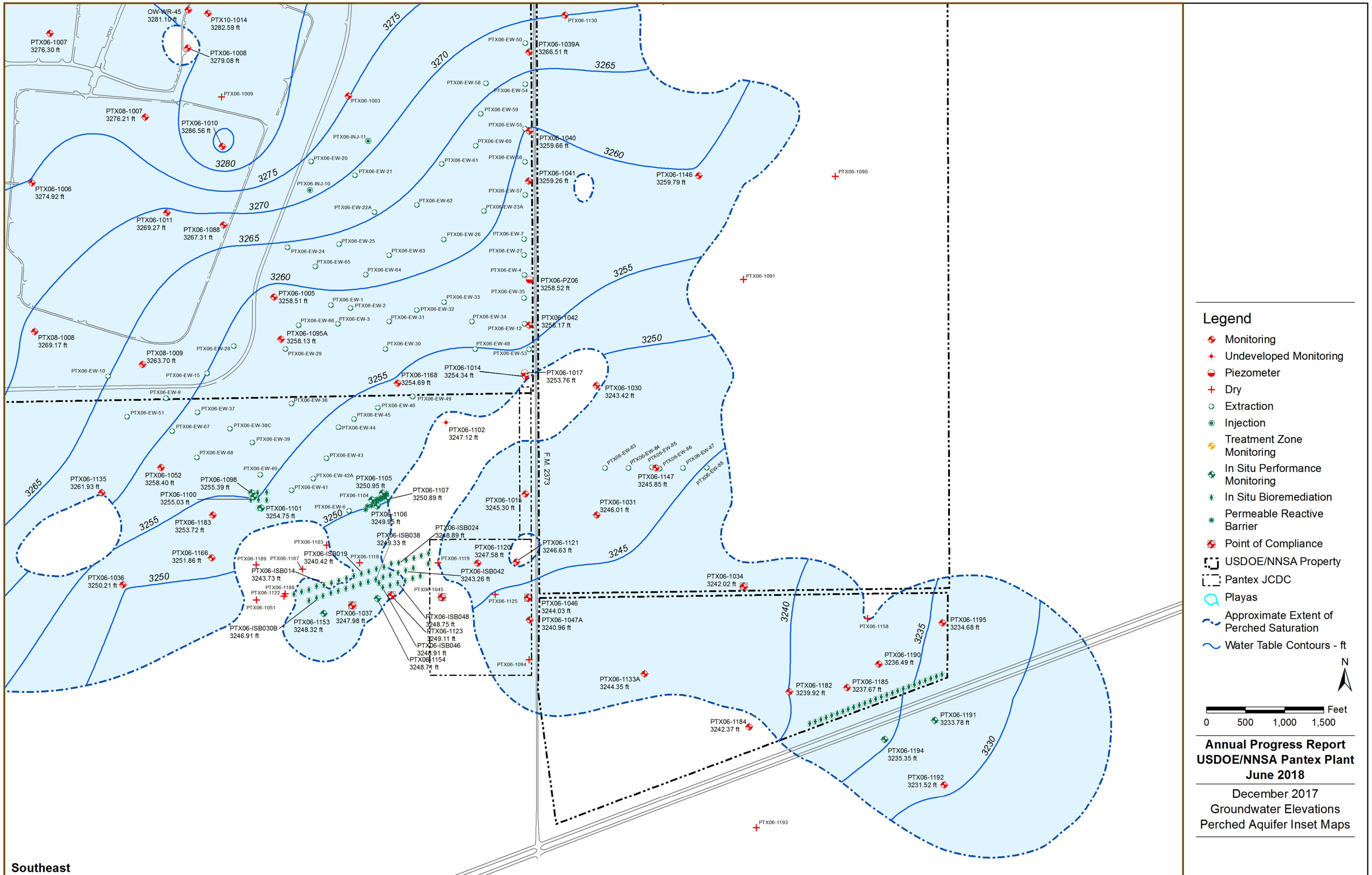

Figure 3-3. Perched Aquifer Water Levels, Southeast Inset Map

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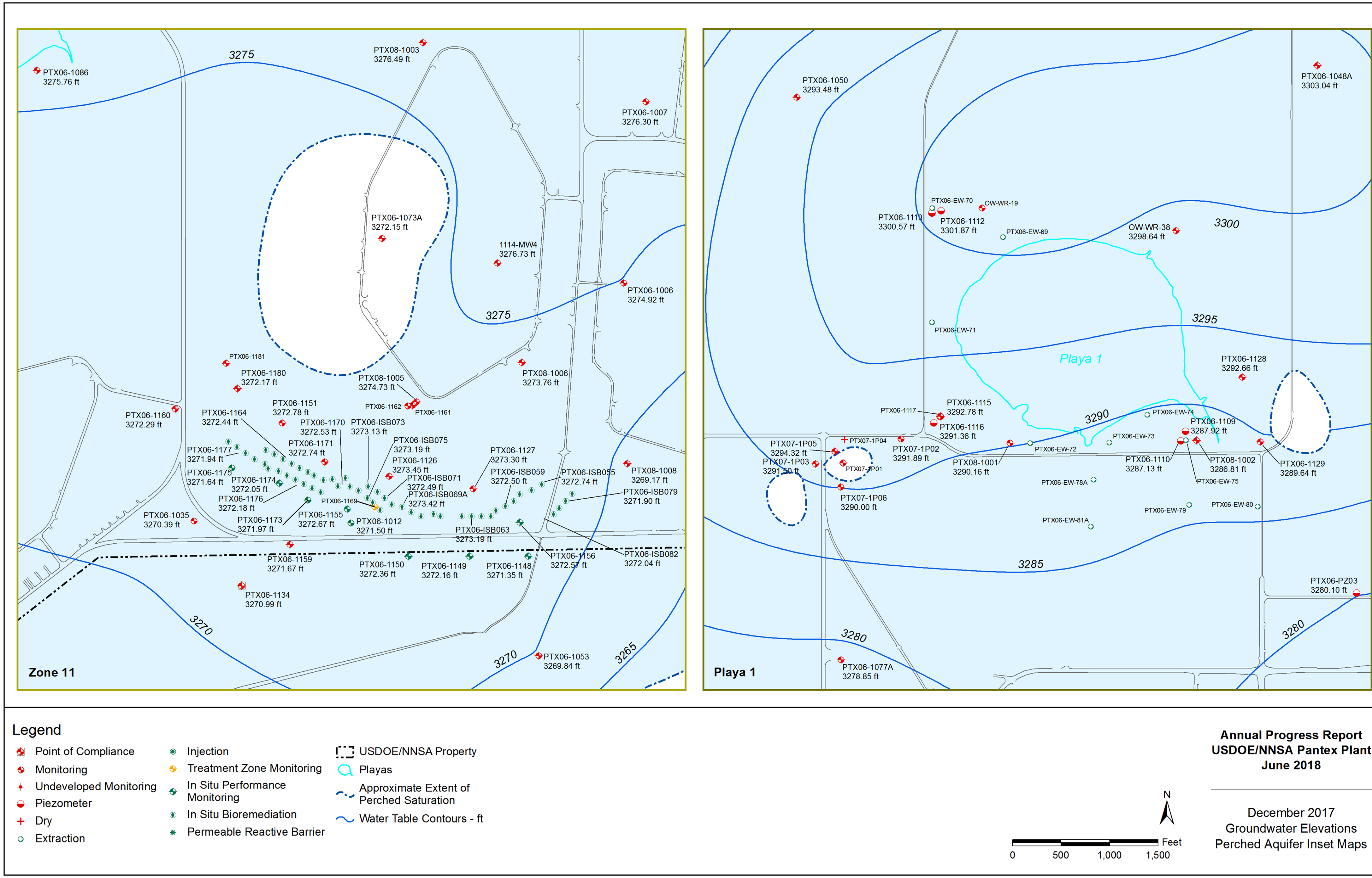

Figure 3-4. Perched Aquifer Water Levels, Zone 11 and Playa 1 Inset Maps

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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 are exhibiting short-term decreasing trends in water levels. Above normal precipitation during the spring and summer of 2016 and again in the summer of 2017 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. Similar short-term increases have been observed in these wells in the past, and decreasing trends have already resumed with a return to normal precipitation. Away from Playa 1, comparison of the short-term and long-term trends for wells located in Zone 11 and Zone 12 shows that many wells in this region have begun to exhibit short-term decreasing trends in water level. These trends could be an indication of expansion of the zone of influence of the pump and treat systems as the perched aquifer saturated thickness below Playa 1 is reduced.

A discussion of the remedial action effectiveness is included in a later section.

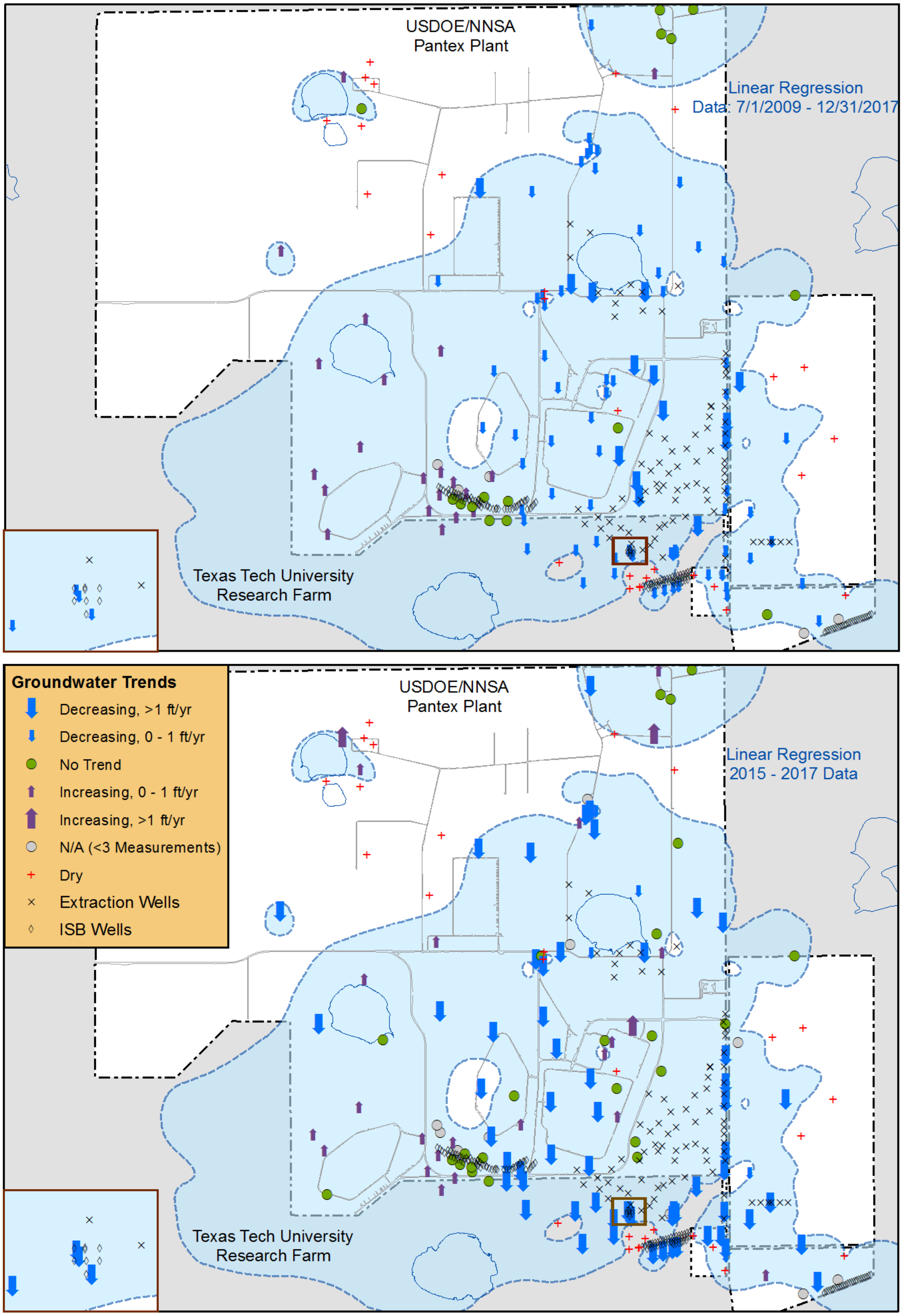

Figure 3-5. Water Level Trends in the Perched Aquifer

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) only eight wells (depicted in Figure 3-6) exhibited conditions inconsistent with the current expected conditions or trends. Water levels rose a few feet in PTX06-1088, in the latter half of 2017 in response to above normal precipitation during the summer of 2017. Similarly, a recent “No Trend” condition was observed in several wells in the southeast area (PTX06-1002A, PTX06-1003, PTX06-1005, PTX06-1038, and PTX06-1095A). Most of these wells exhibited a short-term increasing trend in 2016 or 2017 in response to above normal precipitation; no water was observed in one of these wells, PTX06-1003, in 2017. The long-term water level trend is decreasing for all of these wells.

An apparent increasing trend was identified for PTX06-1051. 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 0.15 ft of water was measured above the bottom of the well screen in both measurements in 2017. The water level indicated by these measurements is several feet below the elevation where perched water would be expected if it occurred in this area. Pantex will complete a well video survey in 2018 to evaluate the condition of the well and potential sources of this water. This well will continue to be monitored for changes in the water level.

Water levels in PTX06-1088 rose abruptly in the latter half of 2017. This well is located on the east side of Zone 12; the reversal in trend may be associated with the above normal precipitation during the summer of 2017 and increased recharge through drainage features in that area.

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 recent trend was identified as increasing, inspection of the hydrograph shows that water levels are nearly constant in 2016 and 2017. 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 2015 and 2016 and increased recharge through a large borrow pit to the south.

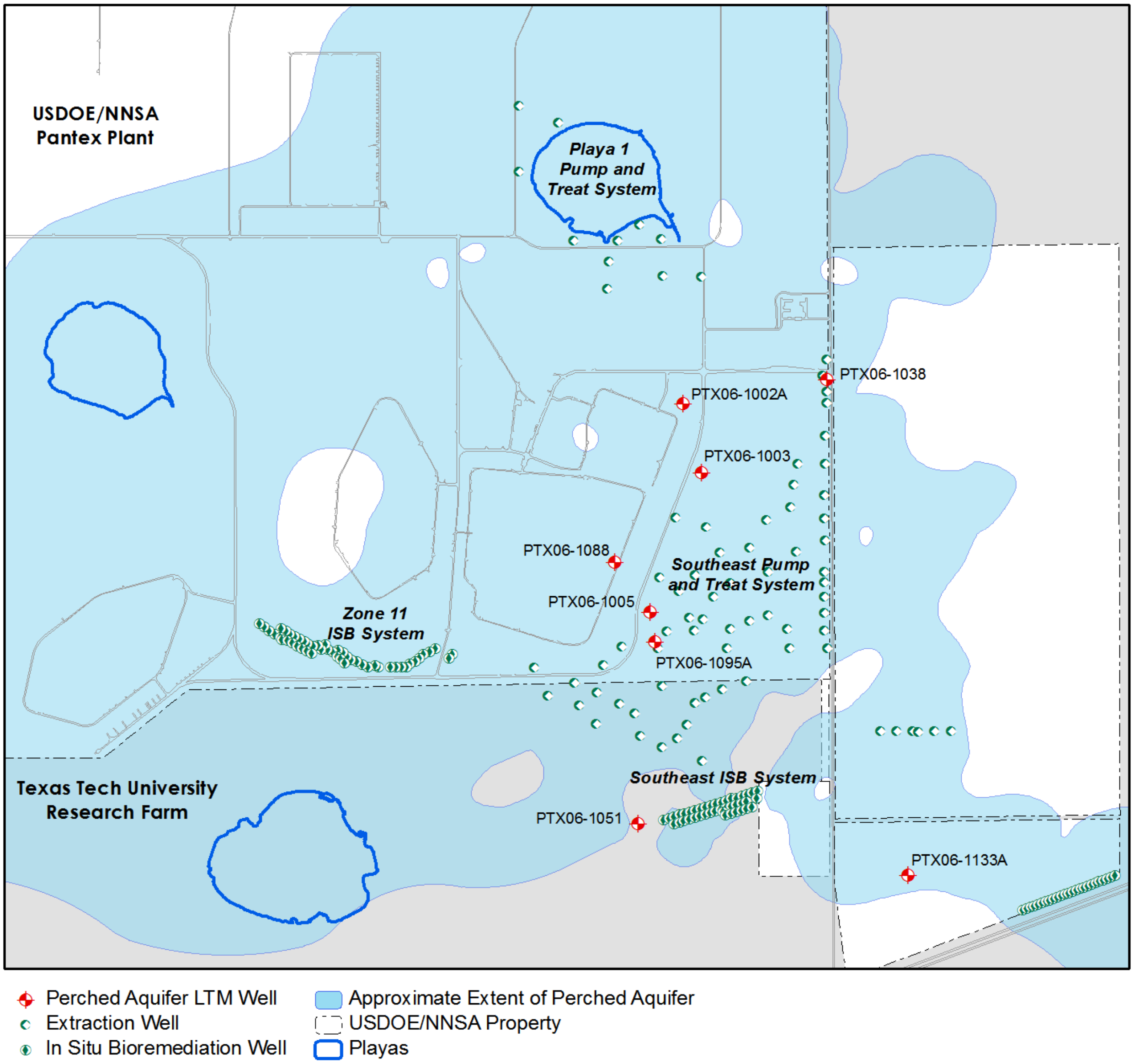

Figure 3-6. Perched Wells with Unexpected Water Level Trends

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, stable, or does not demonstrate a trend at all monitoring points near source areas (Playa 1 and 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). 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.

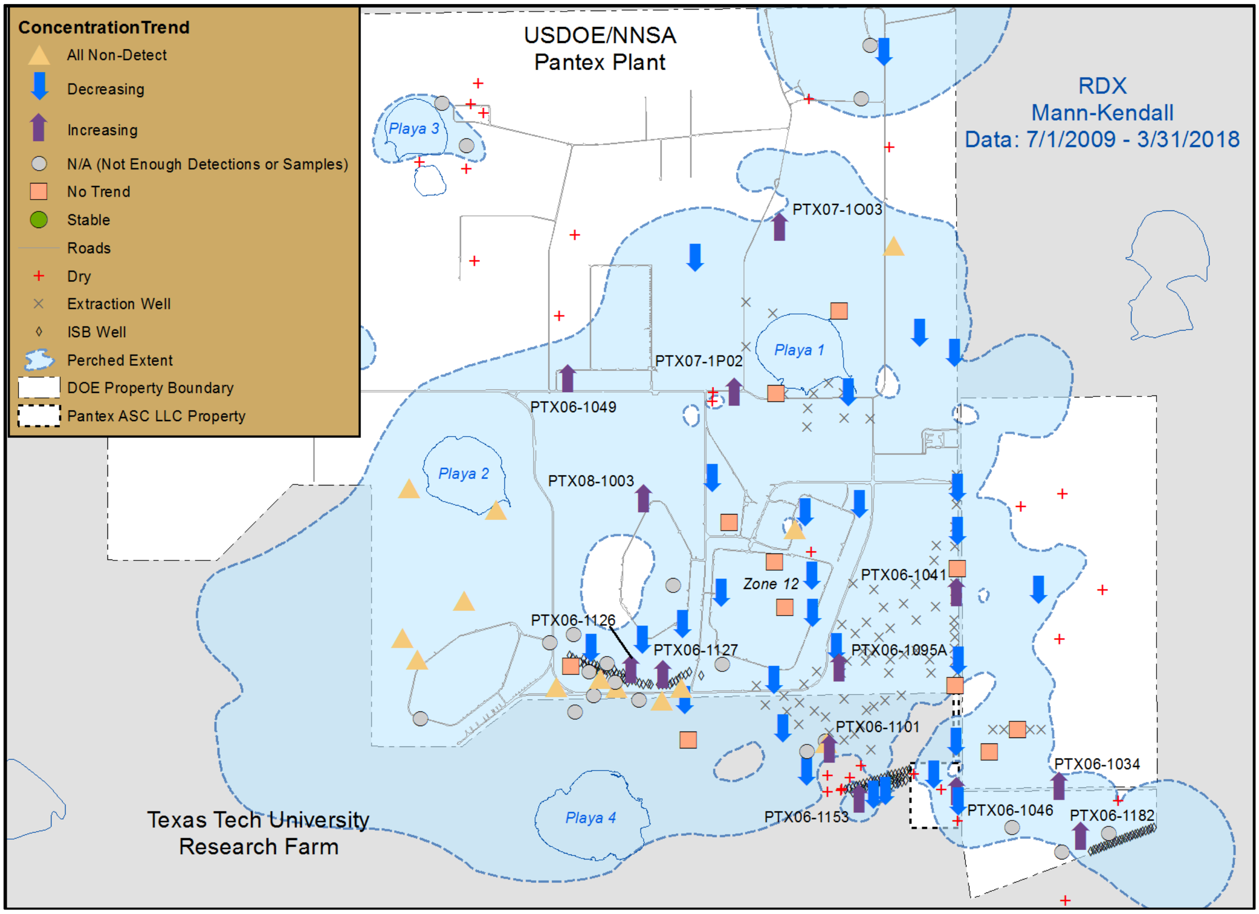

Figure 3-7. RDX Trends in the Perched Aquifer

Overall, 13 monitoring wells exhibited increasing trends in RDX using data since the start of remedial actions, as depicted in Figure 3-7.

- Three wells located in the far southeast lobe of perched groundwater (PTX06-1034, PTX06-1046, and PTX06-1182) are exhibiting increasing trends in RDX, likely due to plume movement into these wells. This area has been identified as a region that is not currently under the effect of a remedial action.
- PTX06-1041, installed along the eastern edge of the extraction well field, is exhibiting an increasing trend in RDX, but is under the direct influence of nearby extraction wells. Both long-term and short-term trends indicate decreasing concentrations, and the variable trend may result from affected water from the east being pulled back into the well field or other pumping effects.
- RDX was first observed at low concentrations in PTX06-1049 in 2011, then steadily increased until 2014, and have since declined to levels below the GWPS in 2017. 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.

- PTX06-1095A is within the influence of the SEPTS well field, but is also located less than 50 feet downgradient of the Permeable Reactive Barrier Pilot Study wells PTX06-PRB01A and PTX06-PRB02. The increasing trend is likely due to the PRB losing treatment effectiveness and concentrations returning to baseline conditions. Data since 2017 indicate concentrations are again declining in this well.

- 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 steadily increasing. 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 increasing RDX trends and exceeded the GWPS for the first time in 2017. 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, which 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 increasing trend in RDX. However, this well exhibited higher historic RDX concentrations and exhibits a decreasing trend considering all data. In addition, concentrations have been stable for the last three 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 a slight increasing 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.

- PTX08-1003, 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, six perched aquifer wells are exhibiting increasing trends in hexavalent chromium below the GWPS since remedial actions began:

- 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.

- An apparent increasing trend was identified for PTX06-1015; however, samples collected during the past three years have fluctuated above and below the sample PQL. The trend for the last four samples is stable, and all concentrations are well below the GWPS of 100 ug/L. 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.

- A probably increasing trend was identified for PTX06-1120; however, samples collected during the past two years have fluctuated above and below the sample PQL. The trend for the last four samples is stable. Concentrations of total chromium in this well have also fluctuated and are increasing 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 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. No trend is indicated for the last four samples, and concentrations remain below the GWPS.

- An apparent increasing trend was identified for PTX08-1009; however, no 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.

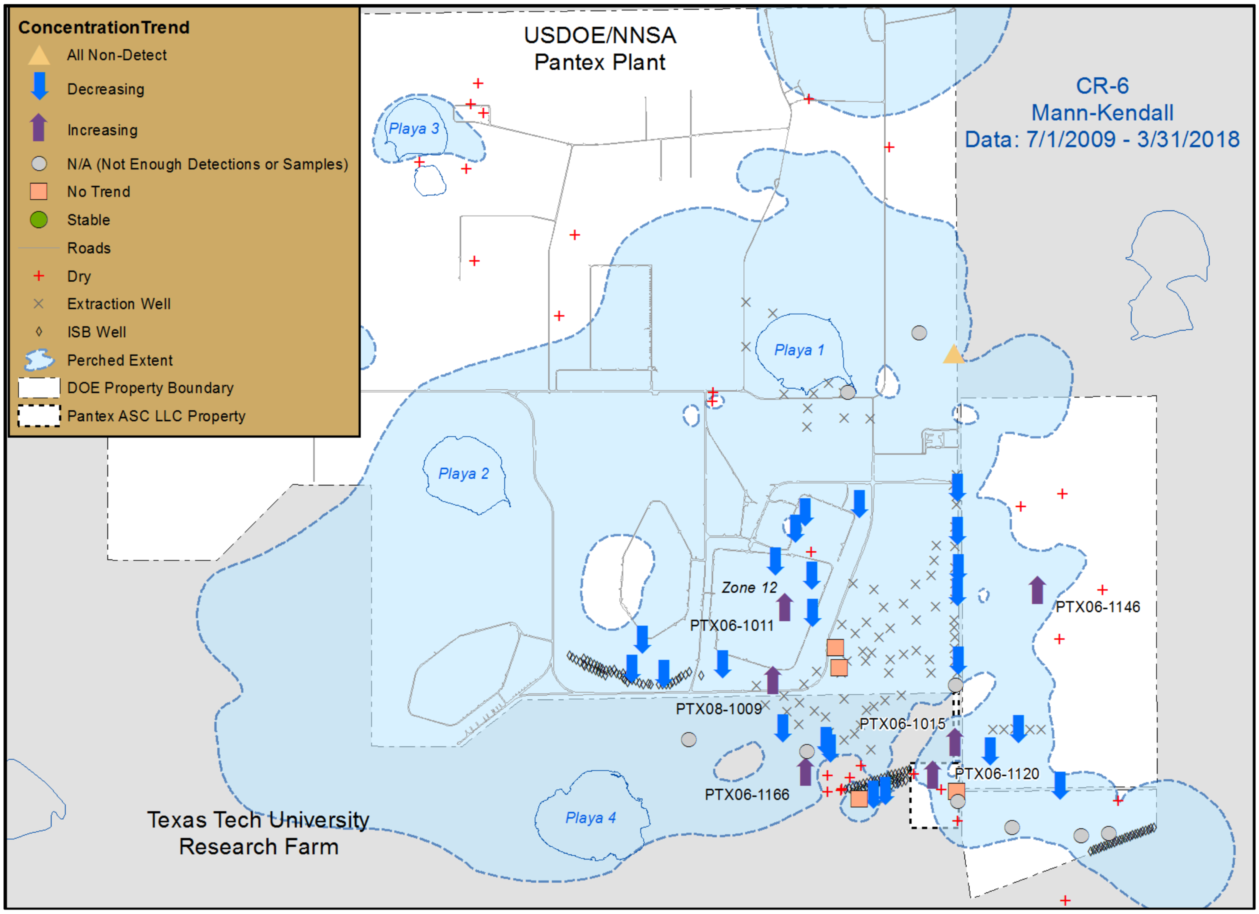

Figure 3-8. Hexavalent Chromium Trends in the Perched Aquifer

3.1.4.3 Perchlorate Trends

As depicted in Figure 3-9, seven 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. 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 a probably increasing trend based on data collected since the start of remedial actions in 2009. However, no trend is indicated for the last four samples. These fluctuations could be caused by changes in gradients and plume movement from the SWMU 5-13A ditch. Another possible cause of these shifting trends could be caused by 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 probably increasing trend was identified for PTX06-1077A. However, samples collected in the past several years 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 continues to increase in PTX08-1008 since the increasing trend was observed following the November 2014 sampling event. The observed increase 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.

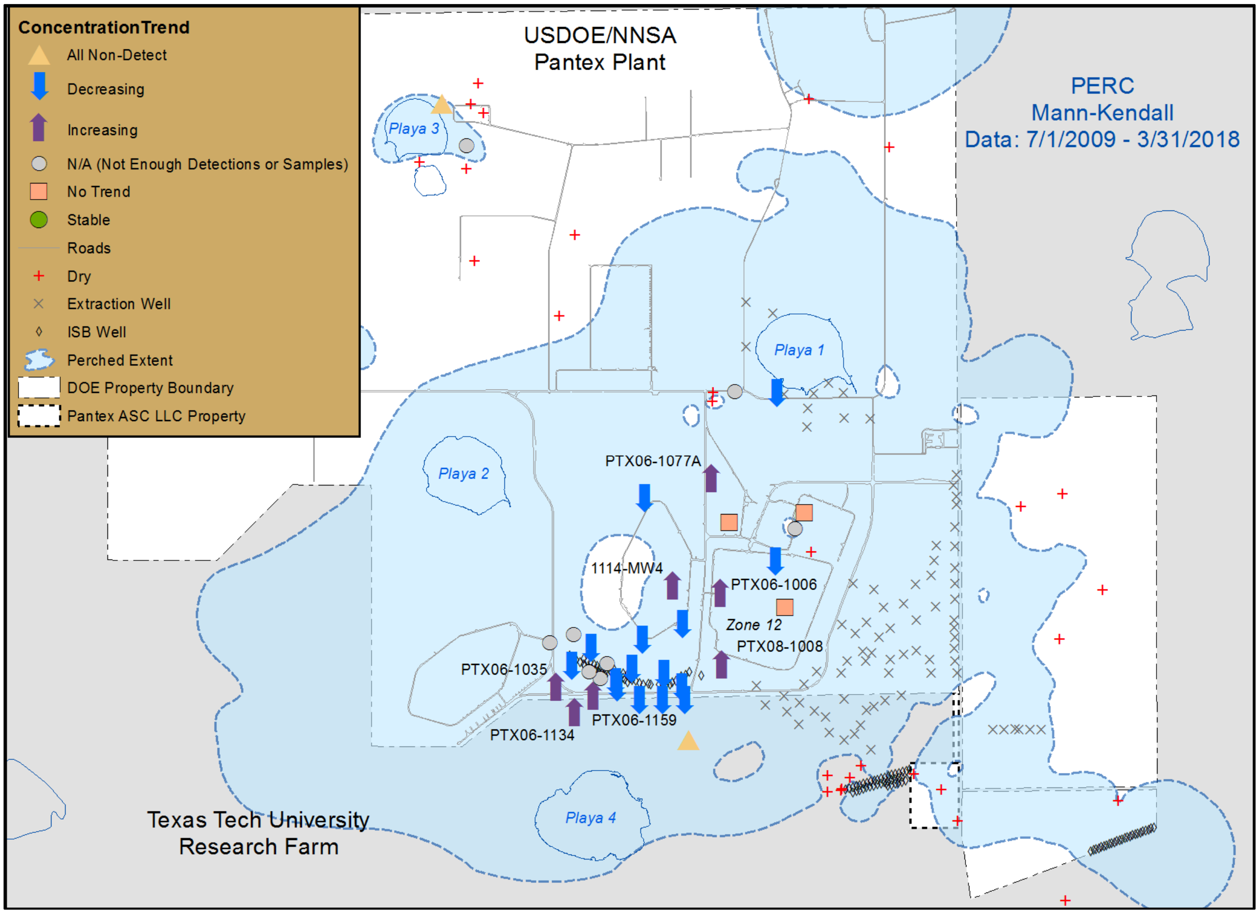

Figure 3-9. Perchlorate Trends in the Perched Aquifer

3.1.4.4 TCE Trends

As depicted in Figure 3-10, 17 monitoring wells are exhibiting increasing trends in TCE concentration since the start of remedial actions:

- An apparent Increasing trend was identified for OW-WR-38 located northeast of Playa 1. Detections have been sporadic since 2009, and all sample results have been 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.

- A probably increasing trend was identified for PTX06-1006 where TCE has been consistently detected below the sample PQL since 2011. Although the trend is probably increasing, detections remain below the PQL.

- Slightly increasing trends were identified 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 the last four samples is decreasing.

- PTX06-1035, PTX06-1134, PTX06-1150, and PTX06-1159 which are downgradient of the Zone 11 ISB, are exhibiting increasing trends in TCE concentration due to general plume movement downgradient. However, 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 remain below the GWPS.

- An apparent increasing trend was identified for PTX06-1048A located northeast of Playa 1. However, concentrations remain below historical maximum levels for this well and below the GWPS. For all data at this well, the trend is decreasing, and the trend is stable for the last four samples. 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.

- TCE is exhibiting an apparent increasing trend in PTX06-1049, located west 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 2006 and was been slowly increasing at levels below the GWPS through 2015, but declining concentrations were observed in 2016 and 2017. The trend in this well is decreasing for the last four samples.

- 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. The increasing trend is likely due to the PRB losing treatment effectiveness and concentrations returning to baseline conditions.

- An apparent increasing trend below the GWPS was identified for PTX06-1098, located on the upgradient side of the ISB pilot system, based on recent samples collected from 2015. 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.

- Increasing trends were identified for PTX06-1100 and PTX06-1101 based on recent samples which indicate a sudden increase from non-detect or low-level detections near the PQL to TCE levels exceeding the GWPS. Both wells are 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.

- An apparent Increasing trend was identified for PTX06-1160 located northwest of the Zone 11 ISB system. However, the first detections in this well occurred in 2016, and all sample results have been below 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 do not indicate actual increasing concentrations in this area. No trend was identified for the last four samples.
- 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. 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.

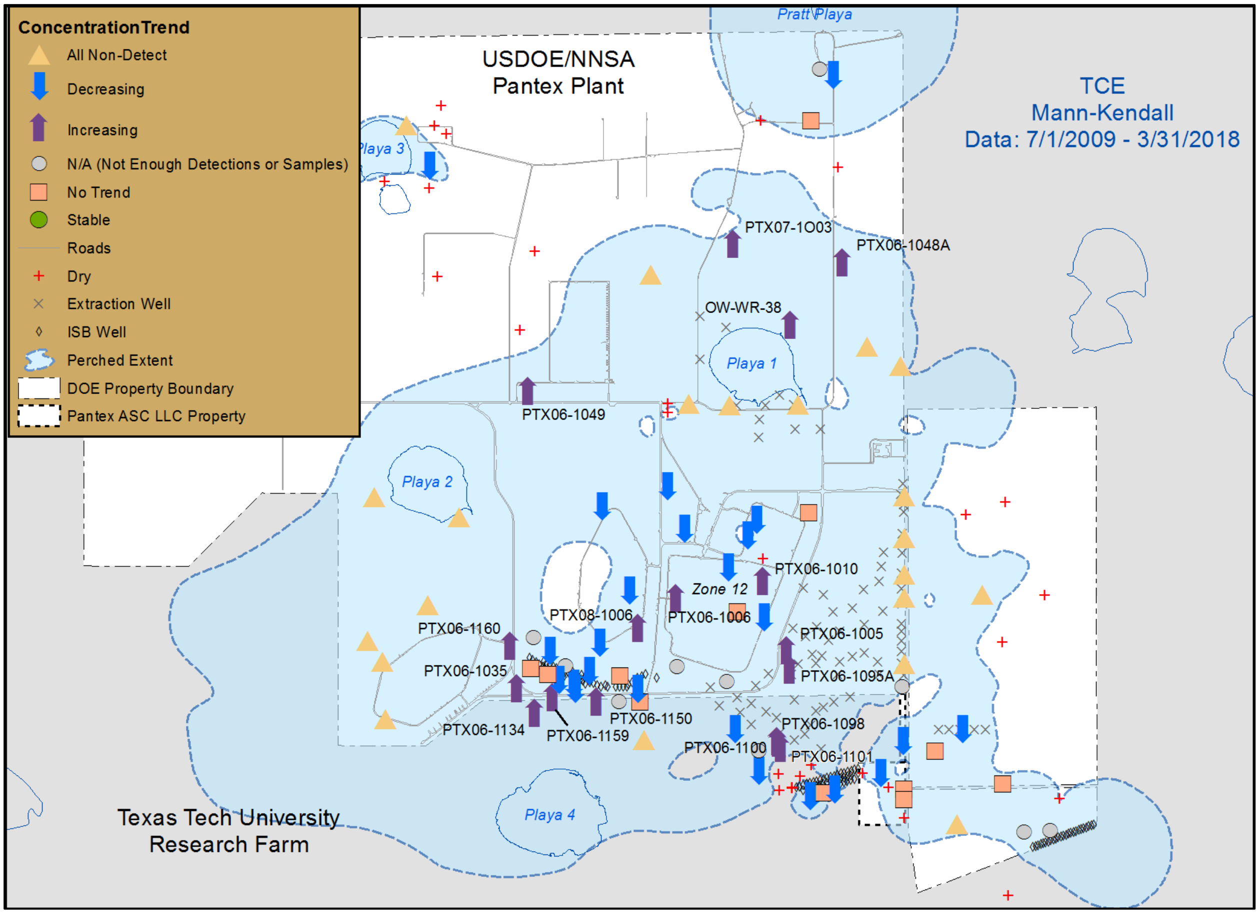

Figure 3-10. TCE Trends in the Perched Aquifer

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, 34 wells did not exhibit trends (since the start of remedial actions) consistent with the expected conditions. Twelve wells (OW-WR-38, PTX06-1010, PTX06-1011, PTX06-1041, PTX06-1048A, PTX06-1077A, PTX06-1098, PTX06-1100, PTX07-1O03, PTX07-1P02, PTX08-1003, and PTX08-1009) 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 7 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 22 monitoring wells (depicted in Figure 3-11), 1114-MW4, PTX06-1005, PTX06-1006, PTX06-1015, PTX06-1034, PTX06-1035, PTX06-1046, PTX06-1049, PTX06-1095A, PTX06-1101, PTX06-1120, PTX06-1126, PTX06-1127, PTX06-1134, PTX06-

1146, PTX06-1150, PTX06-1153, PTX06-1159, PTX06-1160, PTX06-1166, 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.

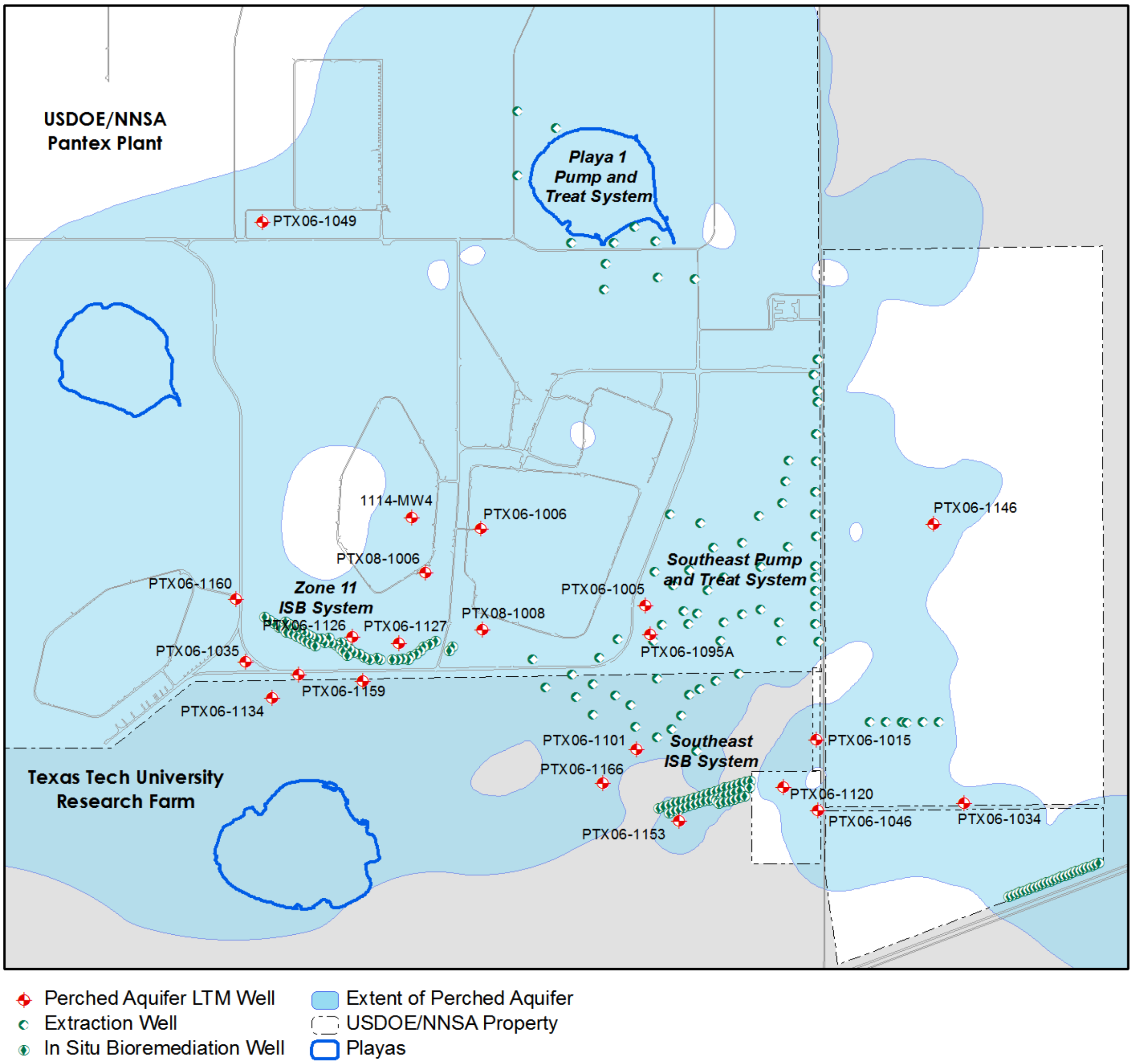

Figure 3-11. Perched Wells with Unexpected COC Trends

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 2017. Each isoconcentration map presents the highest detected concentration for each constituent using validated analytical data from January to December 2017. The 2017 data were supplemented with more recent data acquired in early 2018 from new wells installed in the far southeast part of the perched groundwater. 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 from the Southeast ISB injection wells 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 now 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, hexavalent chromium, perchlorate, and TCE. Maps for MNX, DNX, TNX, TNT, 2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, 1,3,5-trinitrobenzene, 1,4-dioxane, 1,2-dichloroethane, *cis*-1,2-dichloroethene, and PCE 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, chloroform, and vinyl chloride) 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 2017. 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 2017. 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 detected above the GWPS of 360 ug/L in only one perched aquifer well sampled in 2017. This isolated exceedance could not be used to map a distinct plume. 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 2017. Therefore, an isoconcentration map was not prepared for this compound.

2,4-Dinitrotoluene

2,4-Dinitrotoluene was detected above the GWPS of 1 ug/L in only one perched aquifer well sampled in 2017. This isolated exceedance could not be used to map a distinct plume. Therefore, an isoconcentration map was not prepared for this compound.

2,6-Dinitrotoluene

2,6-Dinitrotoluene was not detected above the PQL or GWPS in any perched aquifer well sampled in 2017. 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 2017. 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 2017. Therefore, an isoconcentration map was not prepared for this compound.

Vinyl Chloride

Vinyl chloride was detected above the GWPS of 2 ug/L in only one perched aquifer well sampled in 2017. This isolated exceedance could not be used to map a distinct plume. This well is under the influence of the Zone 11 ISB system where low-level vinyl chloride is expected. Therefore an isoconcentration map was not developed for this compound.

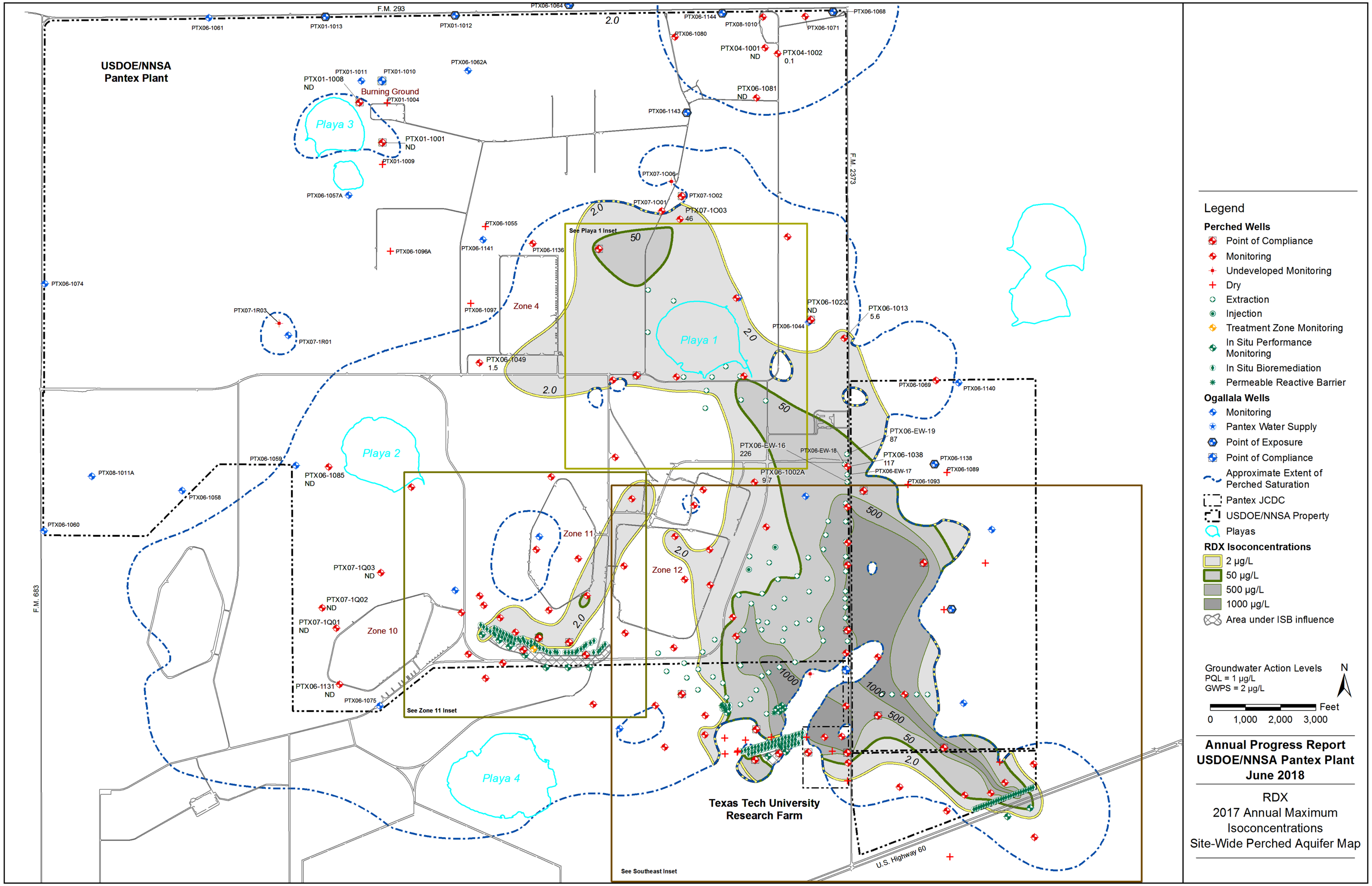

Figure 3-12. RDX Isoconcentration Map

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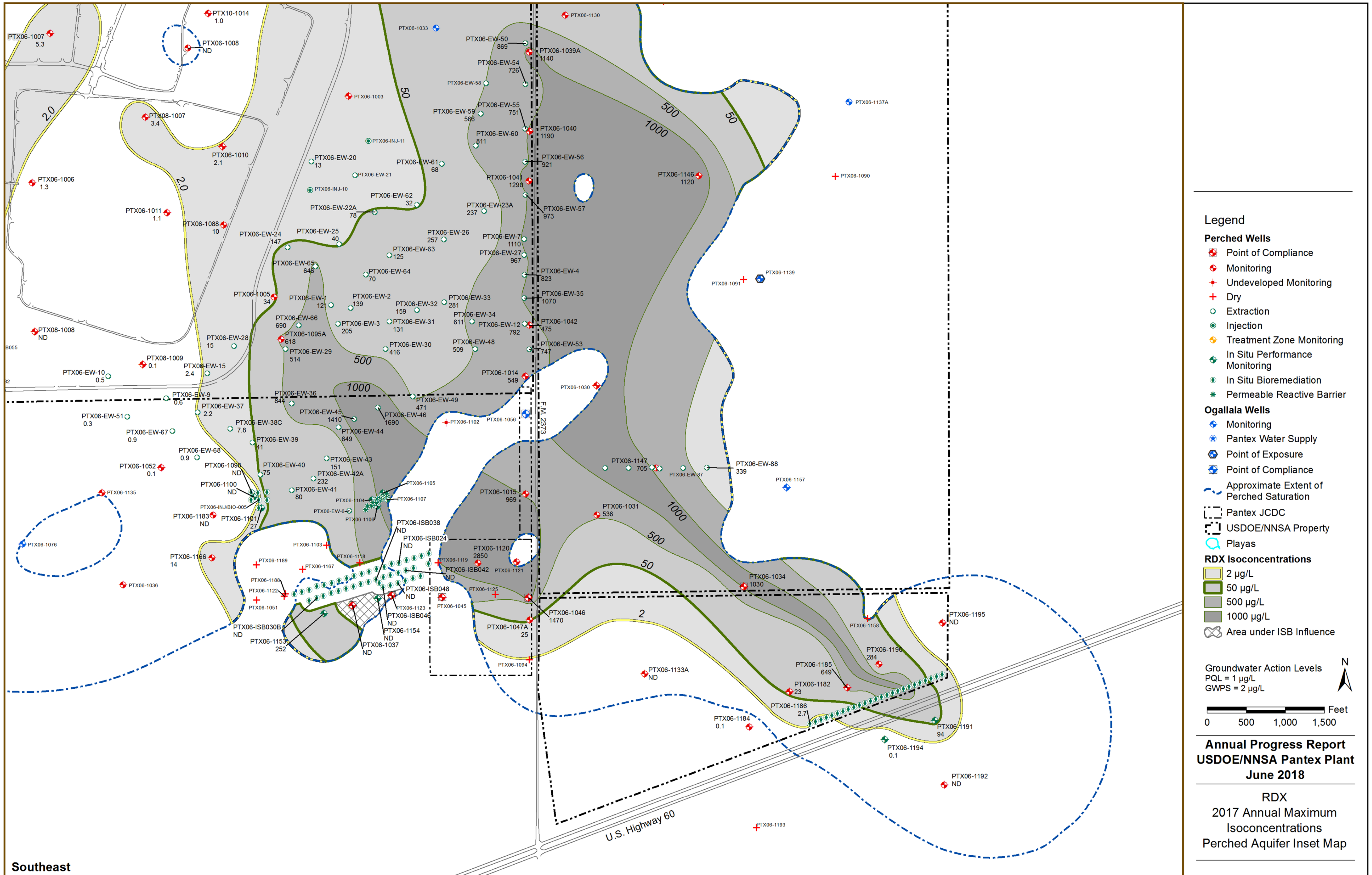

Figure 3-13. RDX Isoconcentration Southeast Inset Map

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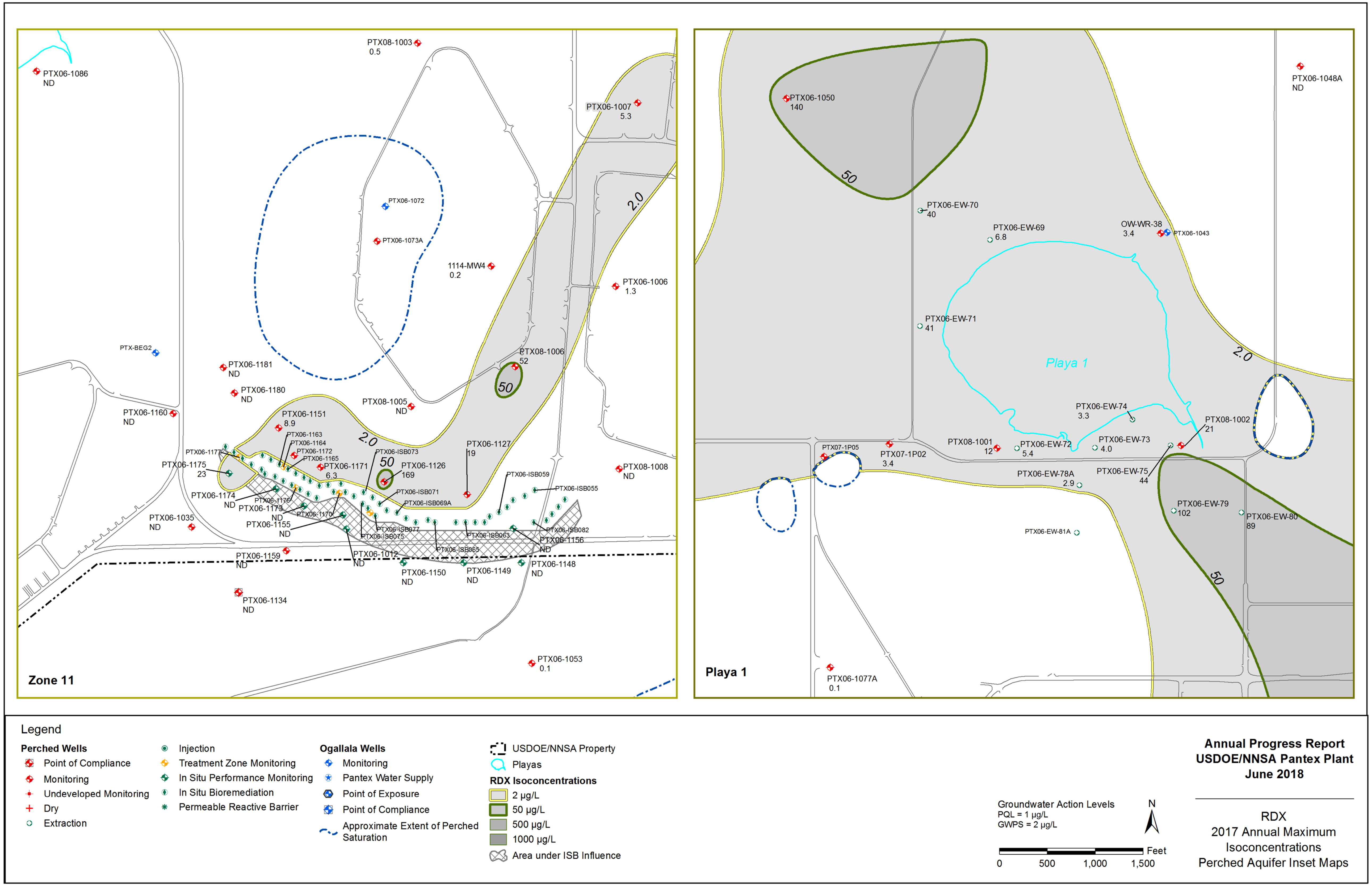

Figure 3-14. RDX Isoconcentration Zone 11 and Playa 1 Inset Maps

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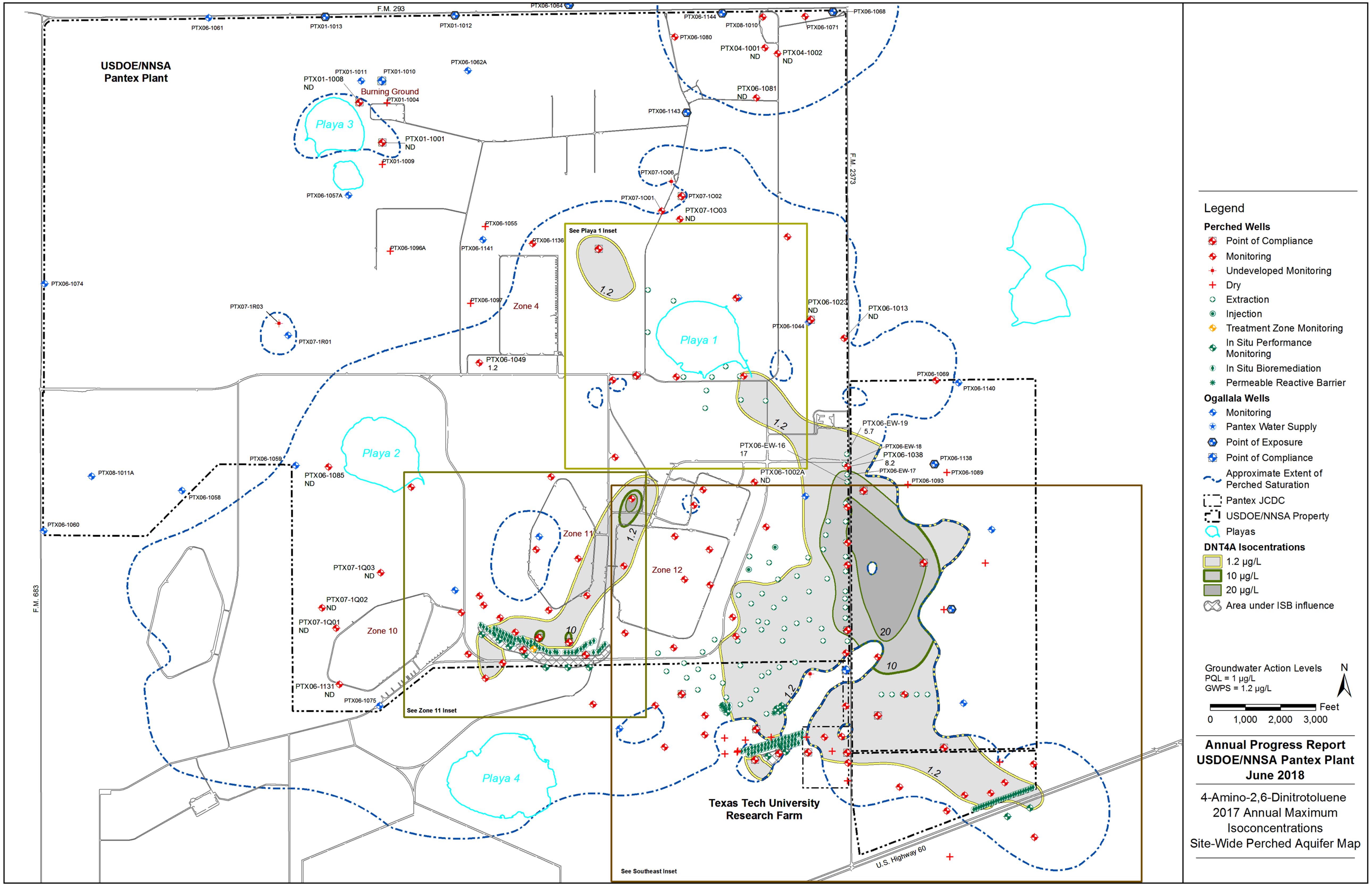

Figure 3-15. DNT4A Isoconcentration Map

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Figure 3-16. DNT4A Isoconcentration Southeast Inset Map

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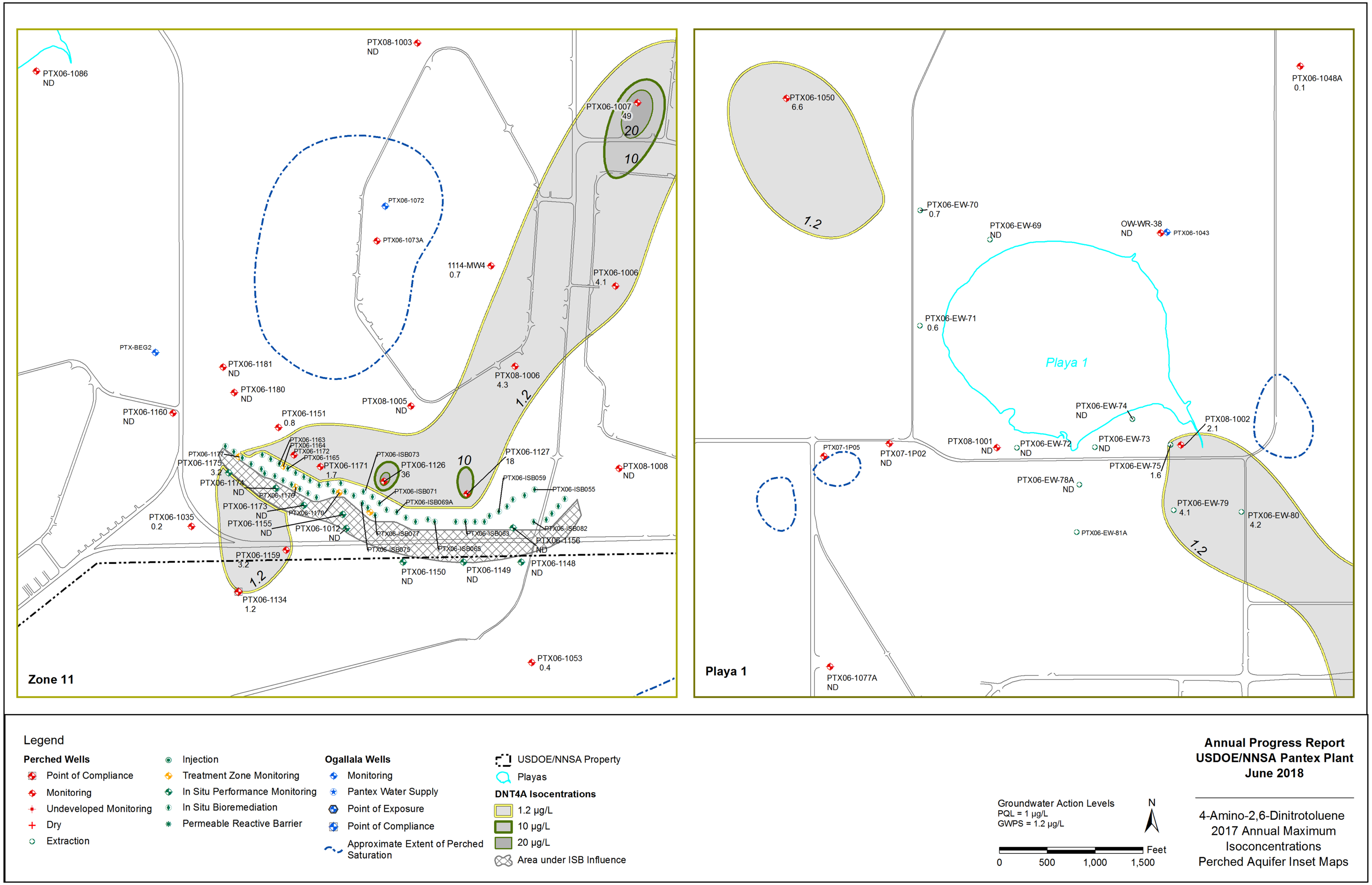

Figure 3-17. DNT4A Isoconcentration Zone 11 and Playa 1 Inset Maps

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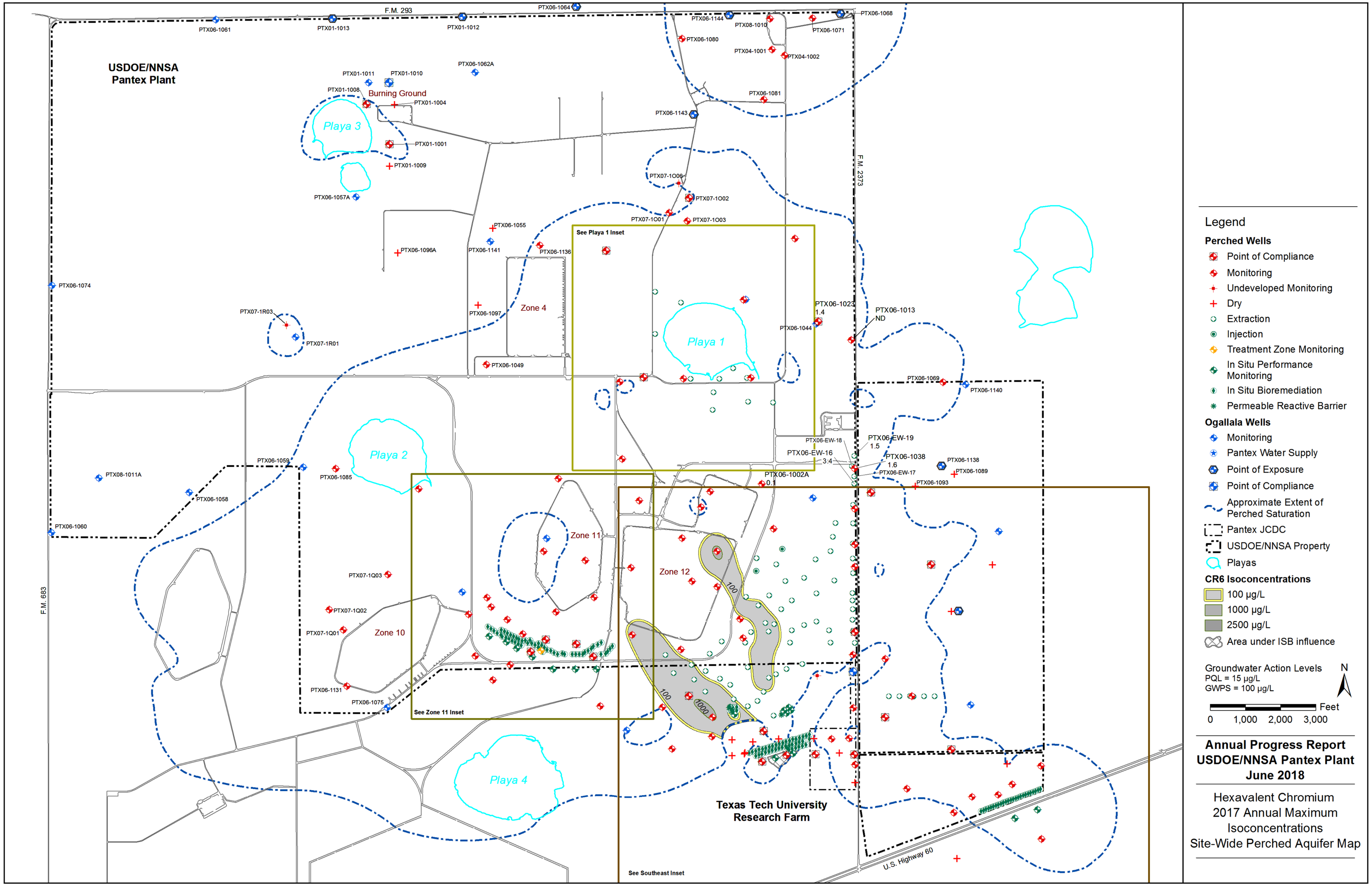

Figure 3-18. Hexavalent Chromium Isoconcentration Map

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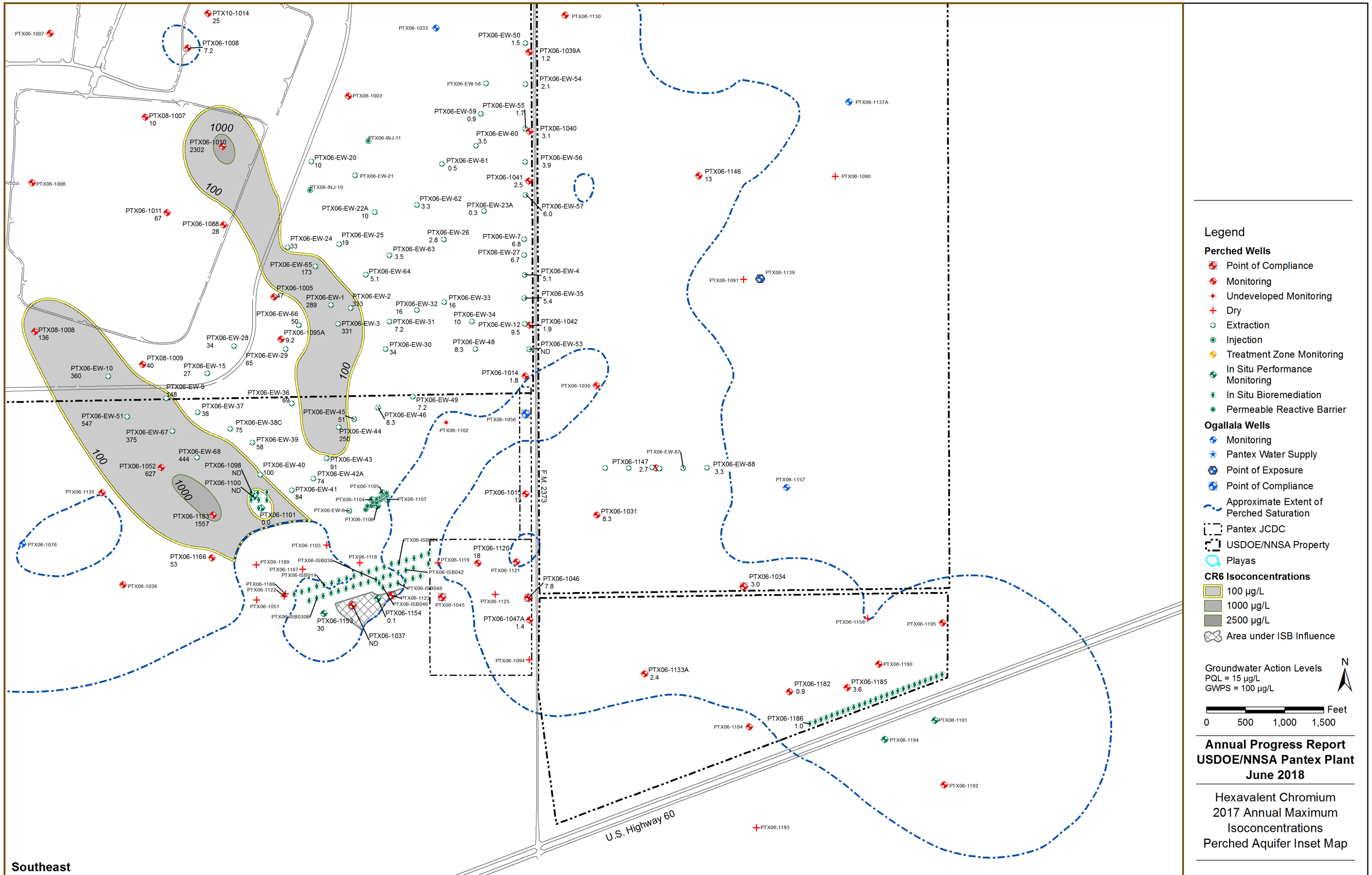

Figure 3-19. Hexavalent Chromium Isoconcentration Southeast Inset Map

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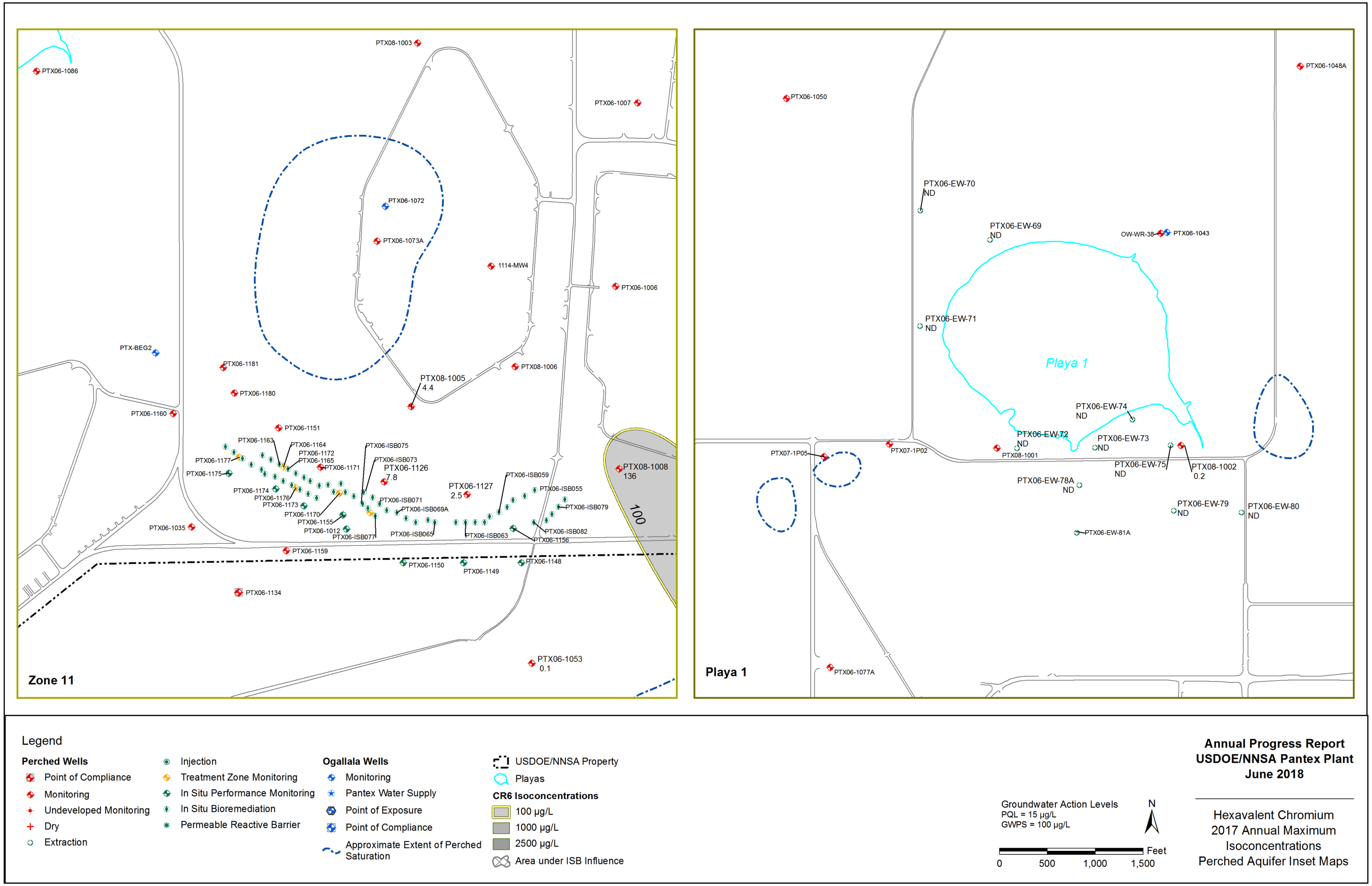

Figure 3-20. Hexavalent Chromium Isoconcentration Zone 11 and Playa 1 Inset Maps

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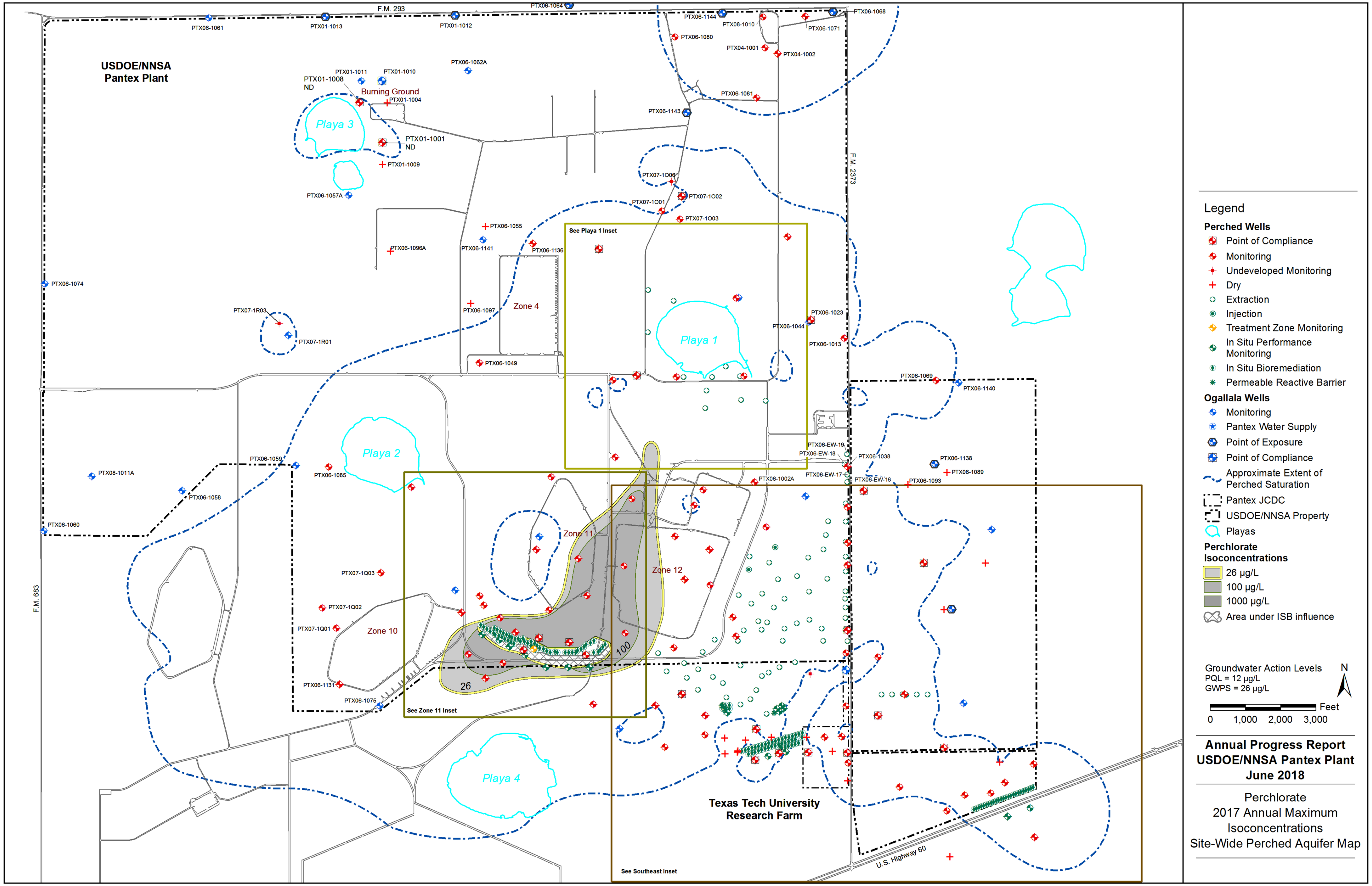

Figure 3-21. Perchlorate Isoconcentration Map

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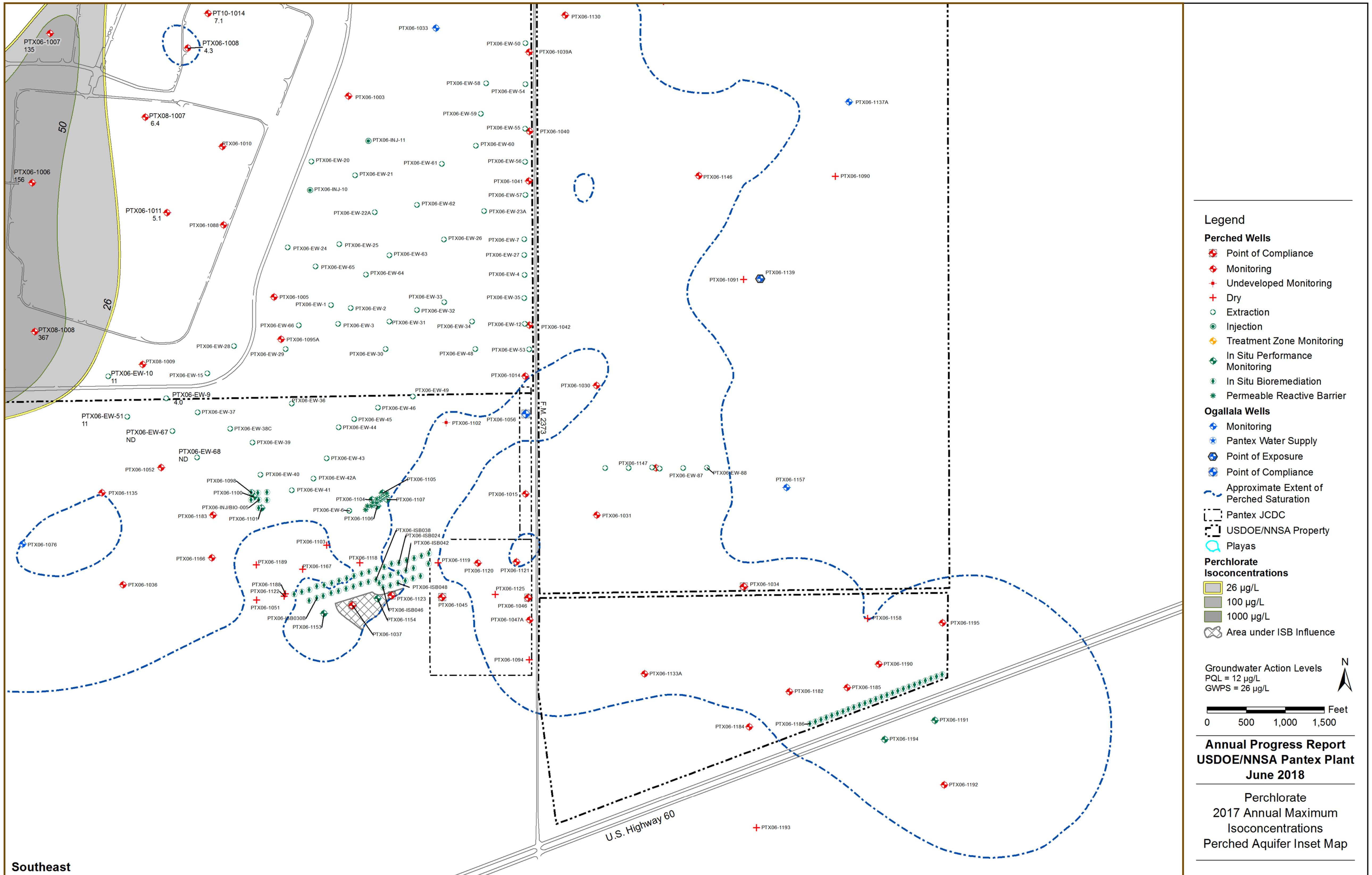

Figure 3-22. Perchlorate Isoconcentration Southeast Inset Map

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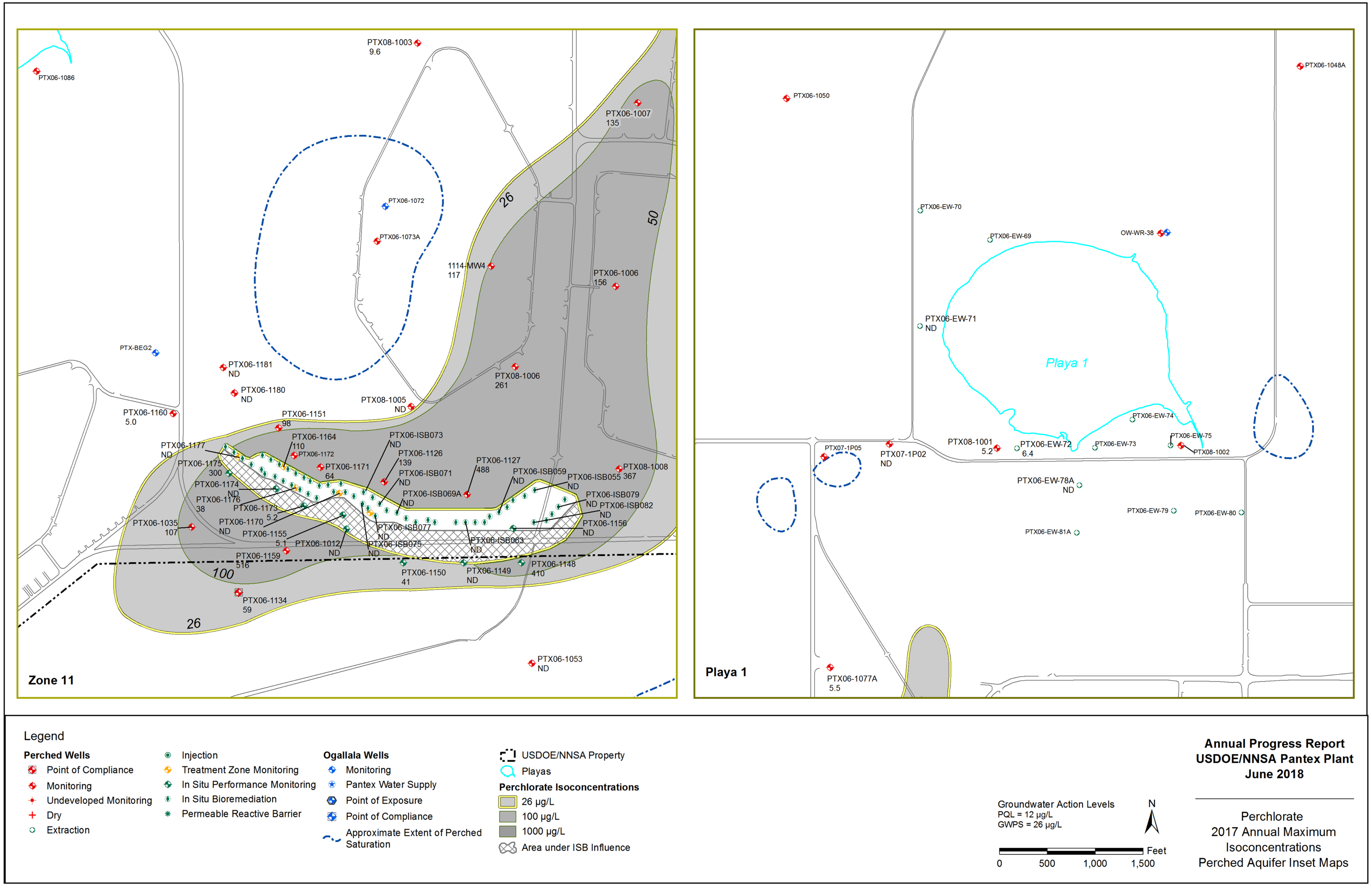

Figure 3-23. Perchlorate Isoconcentration Zone 11 and Playa 1 Inset Maps

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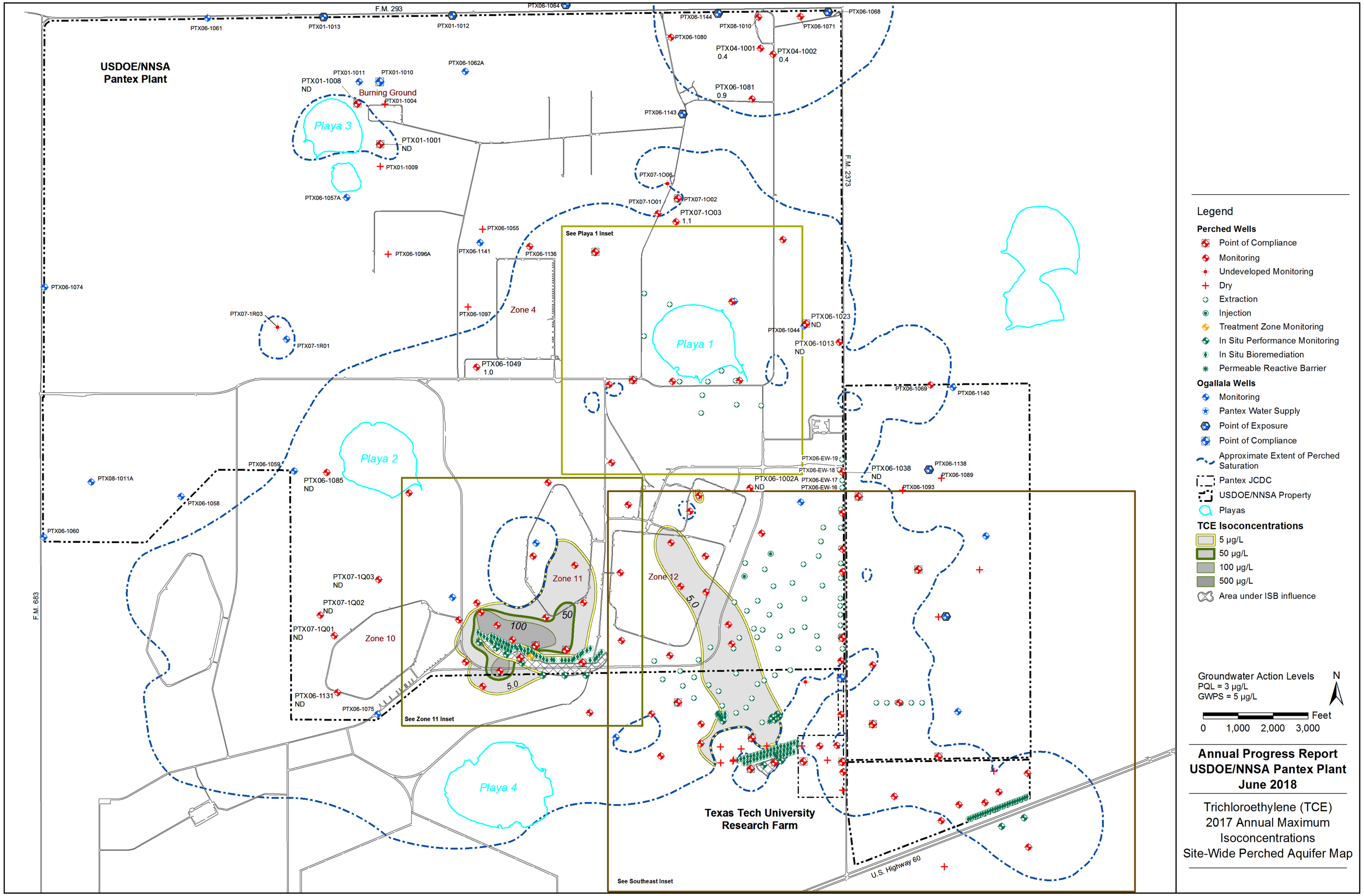

Figure 3-24. TCE Isoconcentration Map

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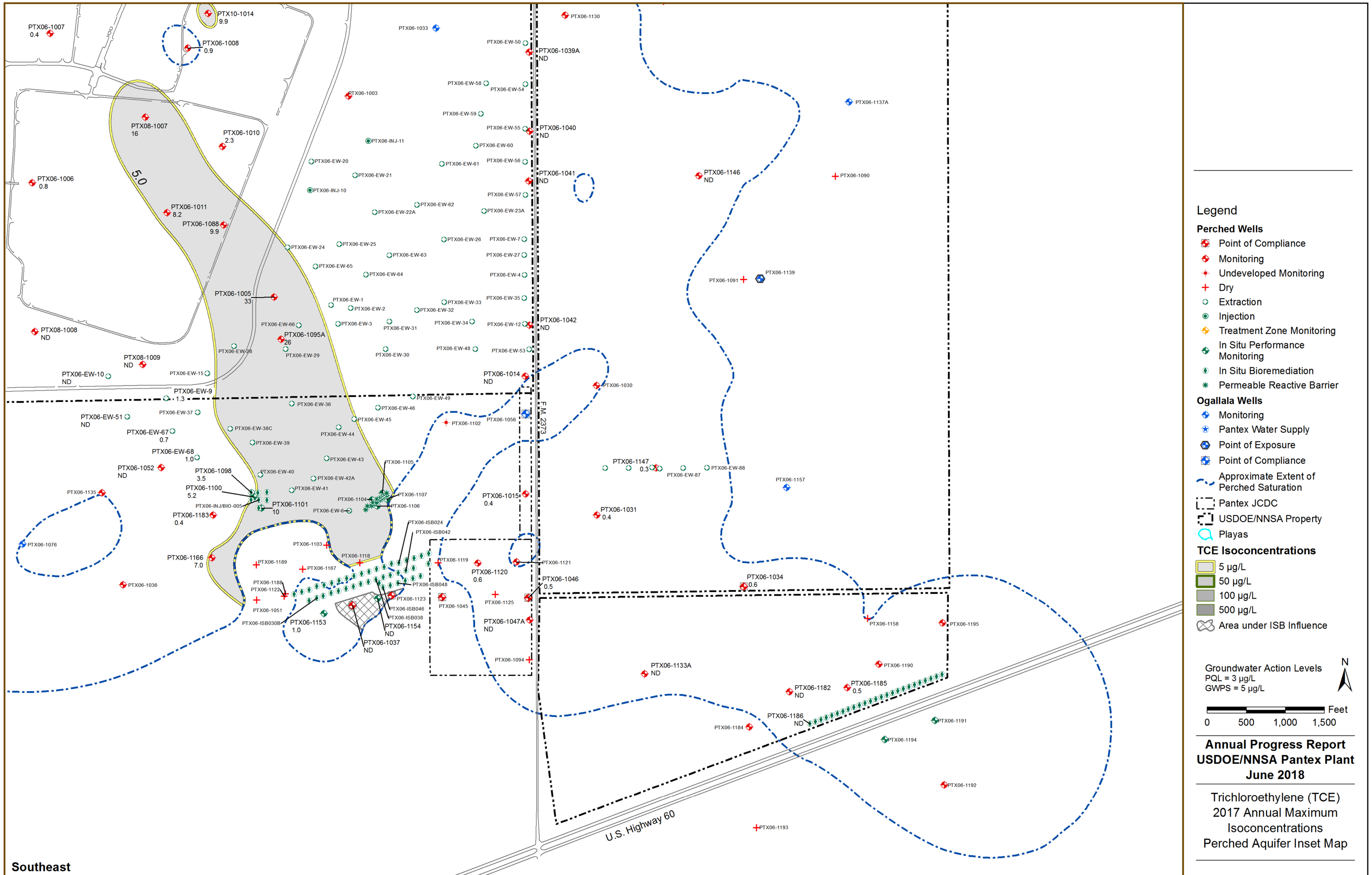

Figure 3-25. TCE Isoconcentration Southeast Inset Map

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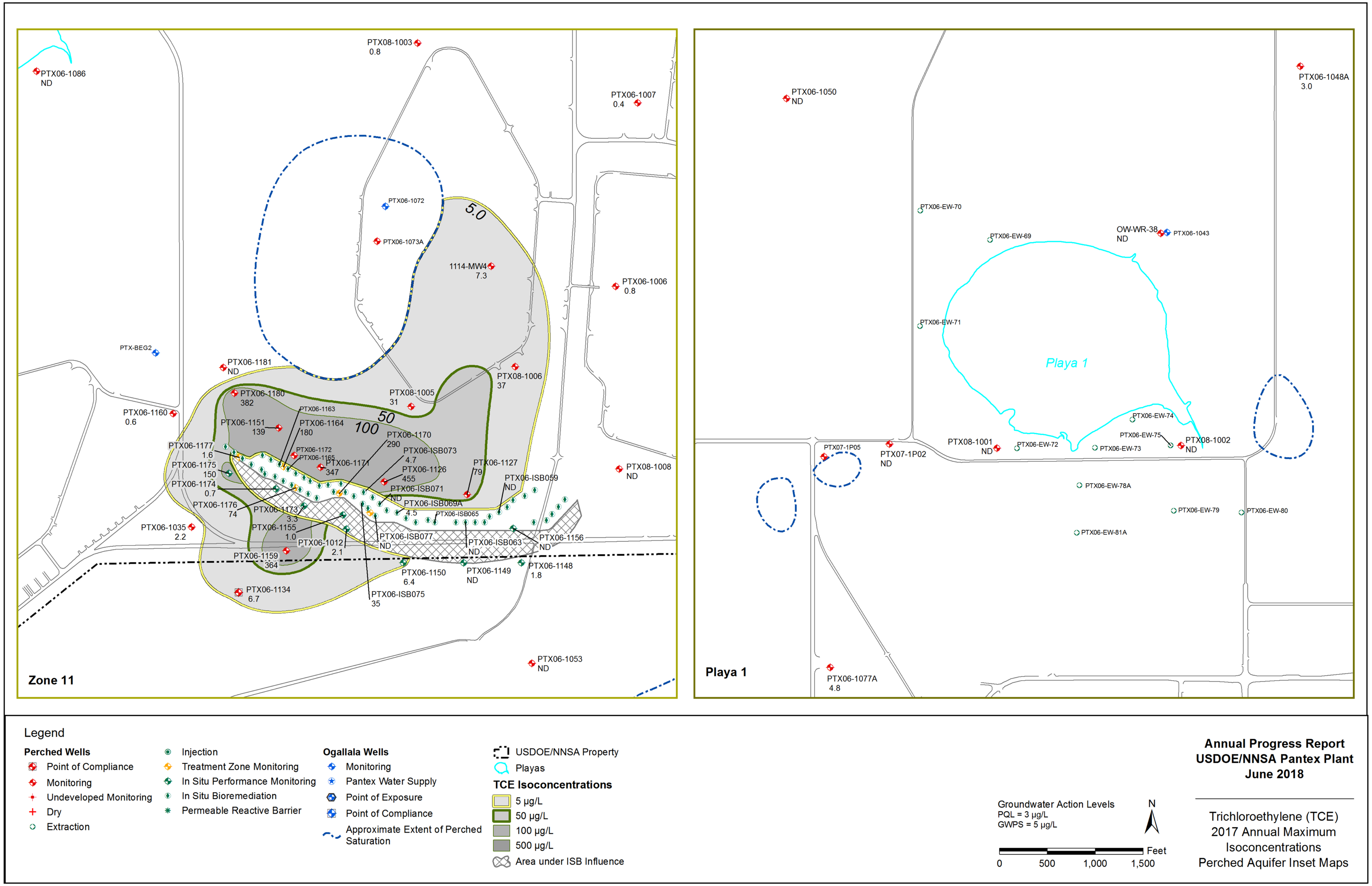

Figure 3-26. TCE Isoconcentration Zone 11 and Playa 1 Inset Map

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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 2009–2017 is included in the following sections. 2017 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 may be 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.

When compared to the 2009 HE plume estimates, the shapes are generally similar, with some small differences that are primarily due to slight variations in the data and low values defining the boundaries. Breakdown product plumes are variable and will likely continue to be variable as natural attenuation and remedial actions continue in the perched aquifer.

In order to attempt to evaluate HE plume movement from 2009–2017, 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 2017, 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 and PTX06-1147 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 is actively working to determine the downgradient extent of the plume and has already completed a line of injection wells as part of an extension to of the Southeast ISB remedy to intercept this plume as it migrates to the southeast.

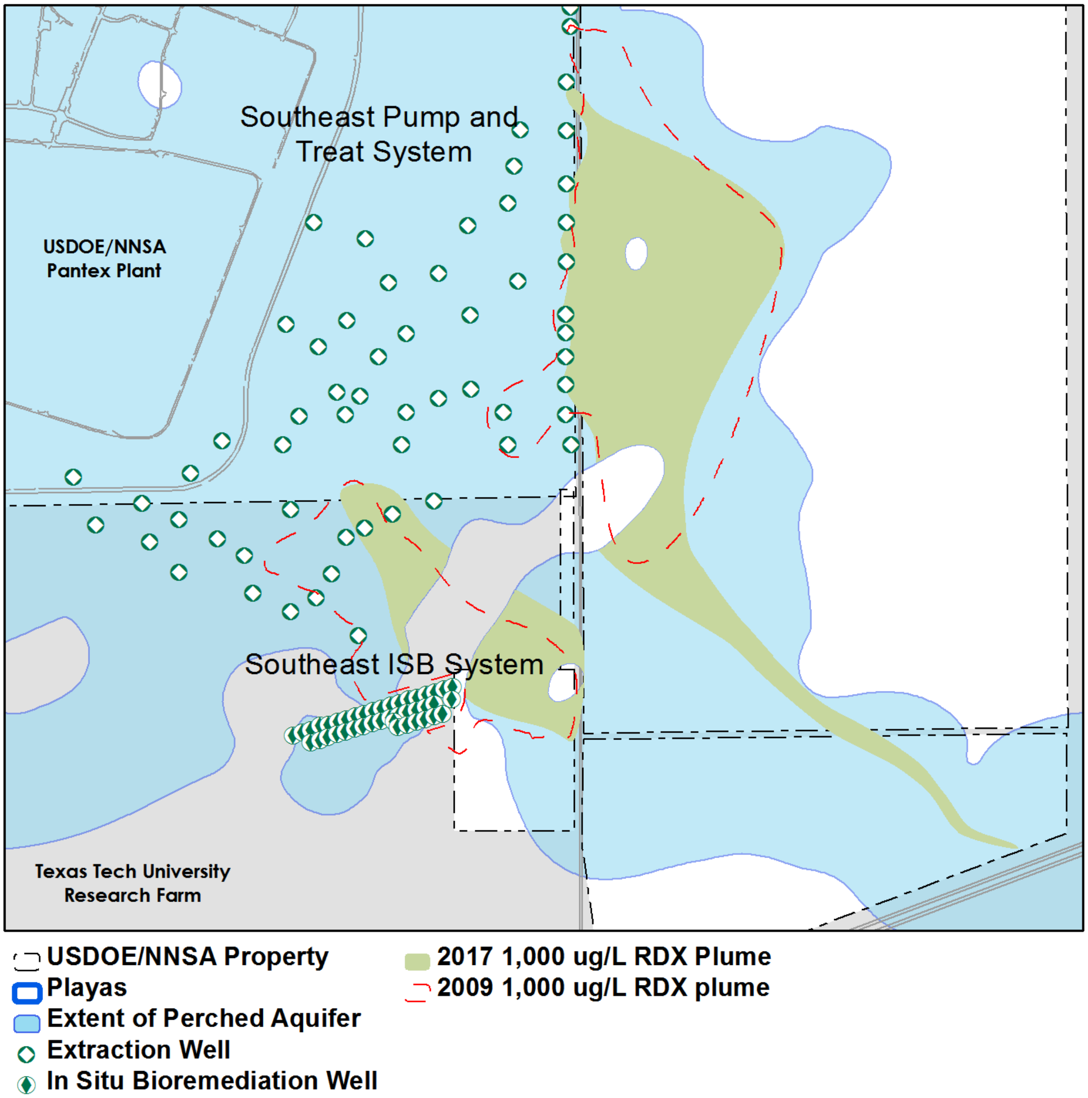

Figure 3-27. RDX Plume Movement, 2009-2017

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.
- The plume is now separated into two distinct areas because of the decline in concentrations in extraction wells north of the ISB system.

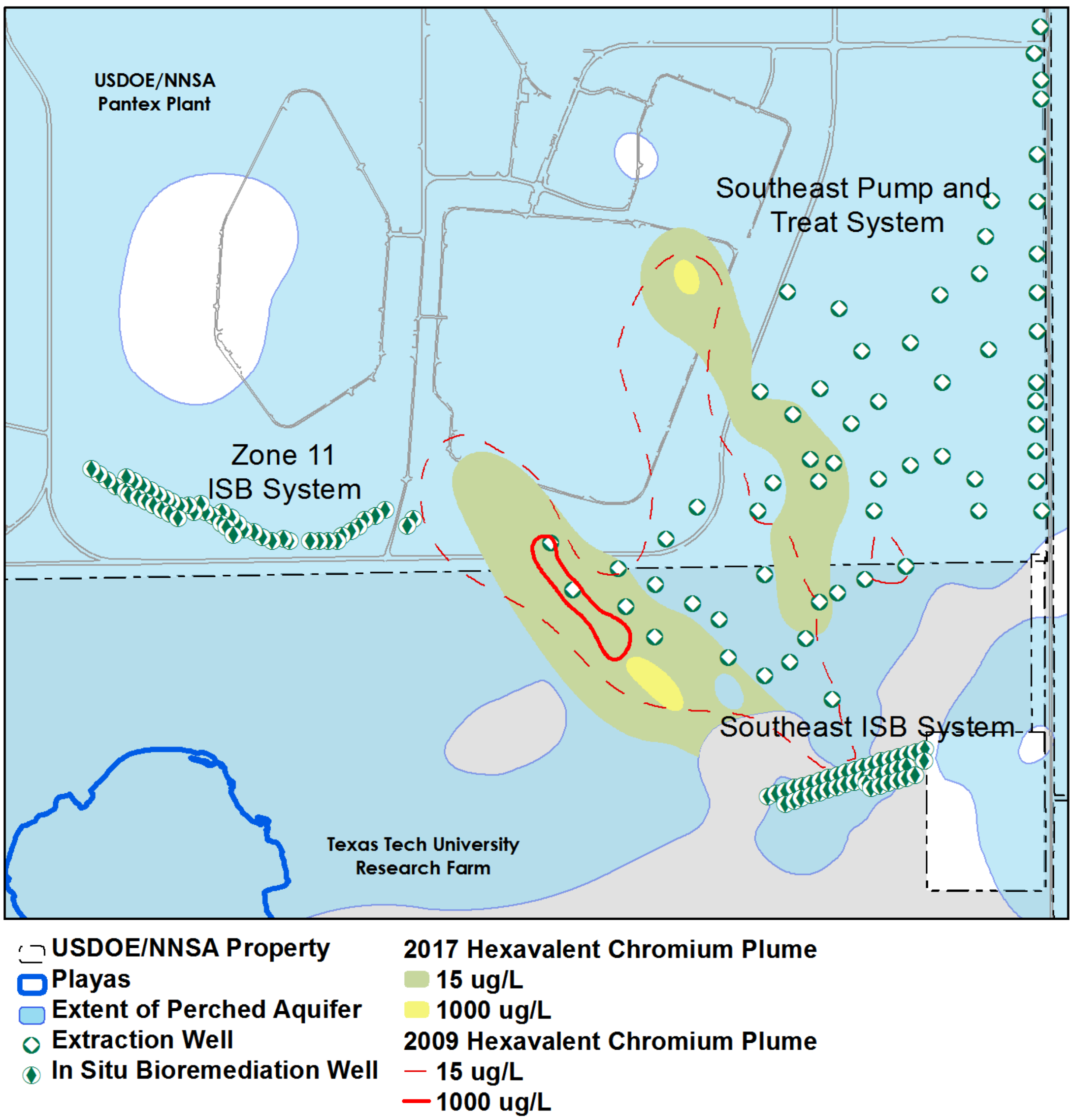

Figure 3-28. Hexavalent Chromium Plume Movement, 2009–2017

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 decreasing, but remain steady or are increasing 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. The hydraulic gradient in this area has shifted more eastward because of the influence of the SEPTA, and a portion of the perchlorate plume in this area should be captured by SEPTS extraction wells.

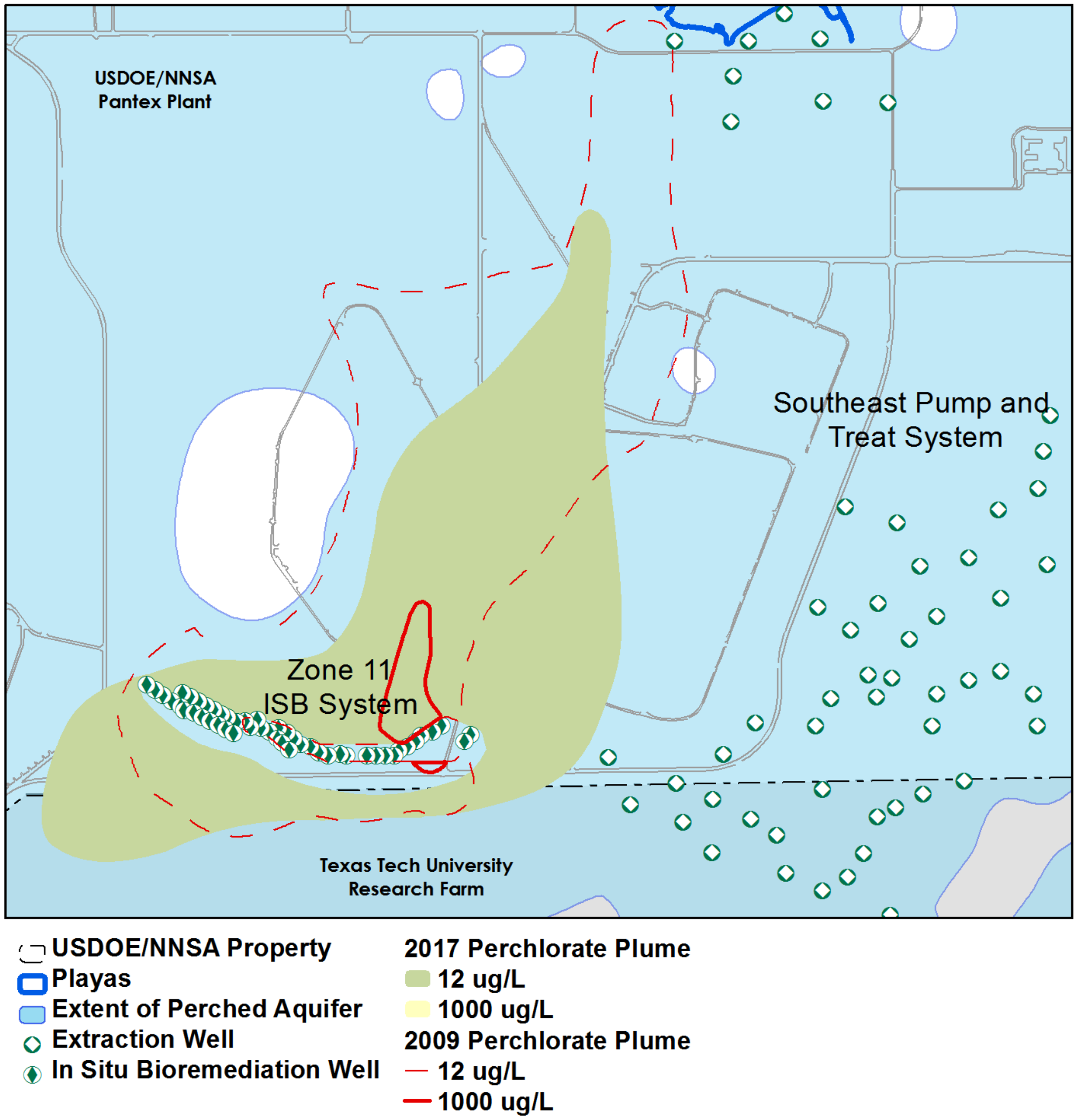

Figure 3-29. Perchlorate Plume Movement, 2009-2017

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 into perched groundwater. 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 2017 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 southwest due to general gradient in the area and recently installed wells to the west.

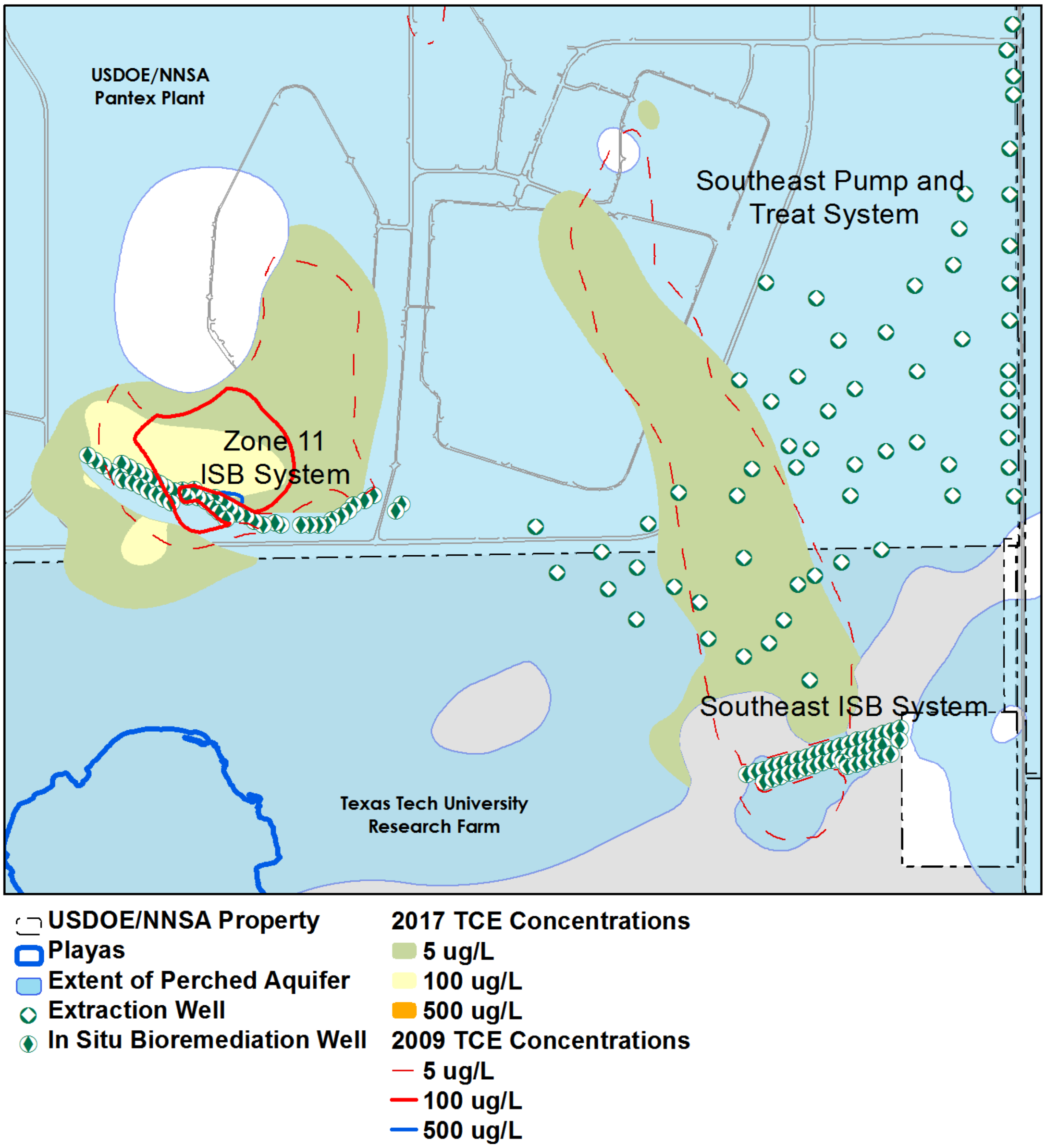

Figure 3-30. TCE Plume Movement, 2009-2017

3.2 Remedial Action Effectiveness

3.2.1 Southeast Pump and Treat System

The objective of the SEPTS (Figure 3-31) 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 3-32 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.

Figure 3-31. SEPTS Extraction Wells and Conveyance Lines

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. 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 3-32. Capture zones, shown in Figure 3-32 for the extraction wells, were calculated using a single-layer groundwater flow model of the perched aquifer. Average 2017 extraction flow rates for each well were used in the calculations.

Operation of the pump and treat systems was affected in 2017 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 anticipated in late 2018 will improve 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. Pantex is currently evaluating the following available options for use of the treated water.

- Irrigation under the Texas Land Application Permit – this option requires a permit modification to establish new irrigation areas and surface irrigation as alternatives, as well as the time to design and construct new infrastructure for irrigation. This is viewed as the longest-term option with the expected timeframe for completion at three years or more.
- Injection into the perched aquifer – this option is currently utilized; however, Pantex will need to examine expanding the injection into areas west of Zone 11 and the Zone 11 ISB as well as a possible injection line between Zone 11 and 12 to control the change in the flow divide. Evaluation will focus on injecting to aid the Zone 11 ISB operation and arrest further movement of COCs from Zone 11 to the east. This option would avoid pushing the plumes out of the SEPTS area, which has been observed with prolonged injection into injection wells near the SEPTS well field. Some of the infrastructure required for this option is already in place, such as a line that provides water to the Zone 11 ISB. This option will require a modeling evaluation to ensure any measures taken will not diminish or interfere with treatment at the Zone 11 ISB. Additional time is required for procurement of the study and design and construction of the infrastructure. This is viewed as a shorter-term option with the expected timeframe for completion at about two years.
- Injection into the Ogallala Aquifer as storage of water for later use - Pantex would have to modify the current UIC permit and improve reliability of treatment and controls to ensure the treated water always meets the drinking water standards. Because

Ogallala Aquifer injection would not affect perched groundwater plumes, more options are available for areas of potential injection. This is also viewed as a shorter-term option because the timeframes for UIC modification and design and construction of the infrastructure are expected to be about 1.5 to 2 years.

Of the three options, injection provides the most consistent avenue for release of treated water. Based on past experience at Pantex, irrigation is subject to repair and maintenance issues that will affect operation of the pump and treat systems. Injection into the perched groundwater could be problematic because of issues associated with affecting plumes or operation of the ISB. With time, Pantex will likely pursue more than one option to enable consistent operation of the systems in the future.

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 have been very effective in 2017. When comparing the 2017 conditions to LTM Design expected conditions, the majority of monitor wells are meeting expected conditions in the seventh 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 71 million gallons of extracted water to concentrations below the PQL and the GWPS. While the SEPTS did not consistently meet all throughput goals during 2017 due to system upgrades, reduced flow to the WWTF and irrigation system, and maintenance activities, Pantex continues to optimize the system operation.

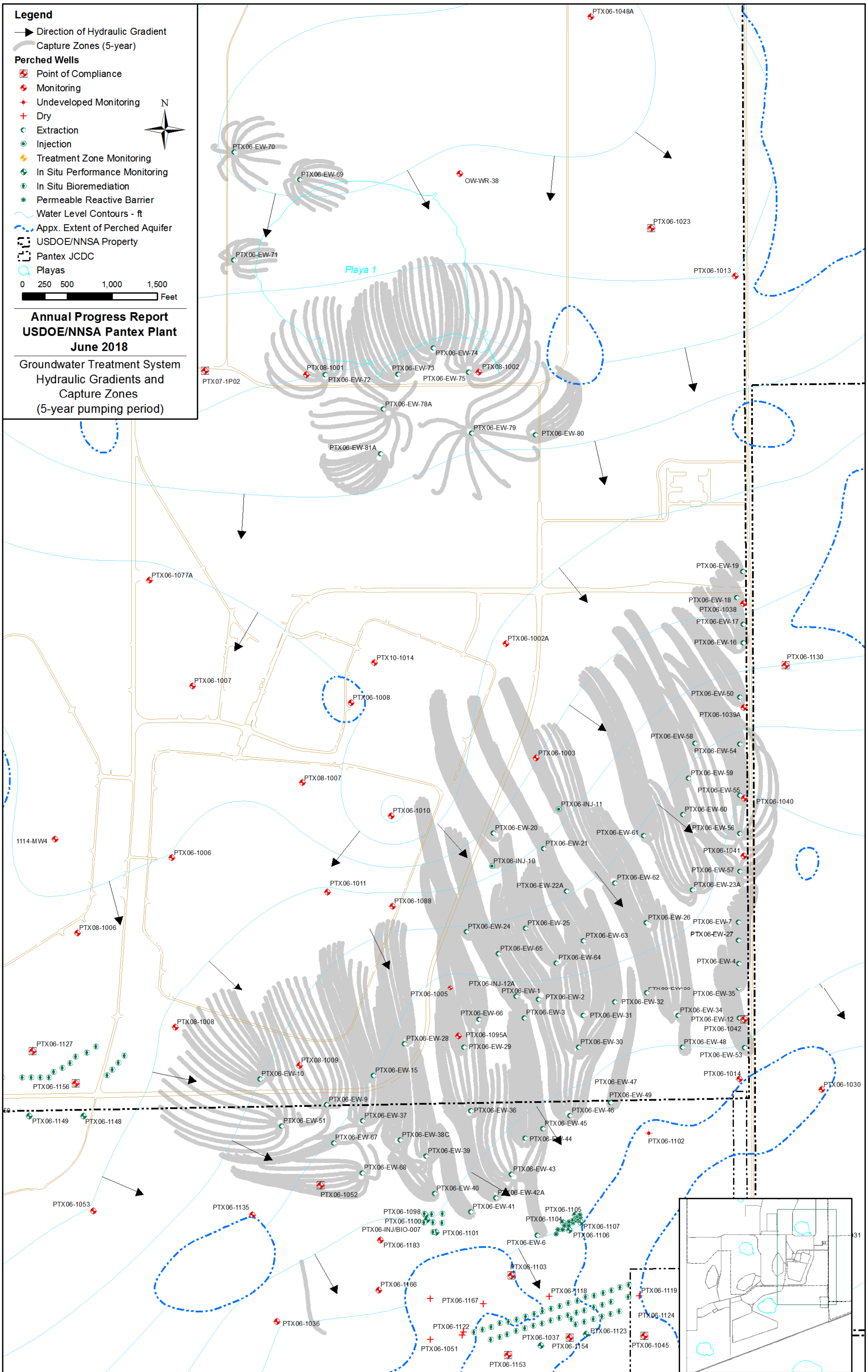

Figure 3-32. Pump and Treat System Capture Zones

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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 10 wells near Playa 1 (see Figure 3-33) 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 3-32 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. Because of the thicker saturated interval near Playa 1 and more consistent pump operation as compared to the SEPTS, cones of depression are established around the extraction wells.

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 has begun to be 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 have been very effective in 2017. When comparing the 2017 conditions to LTM Design expected conditions, most wells are meeting expected conditions.

During 2017, the system treated almost 67 million gallons or extracted water. Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below the PQL and the GWPS.

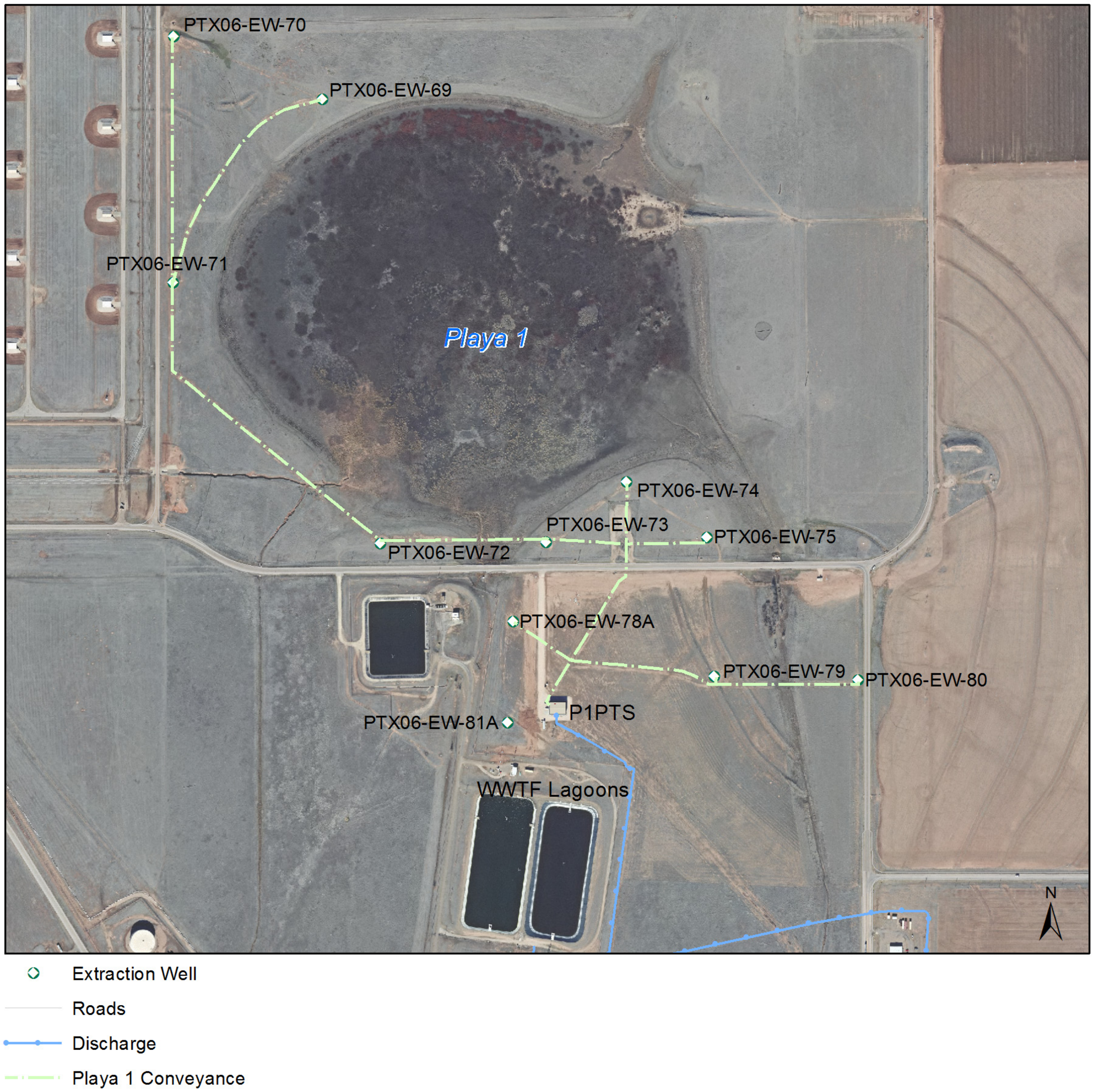


Figure 3-33. P1PTS Extraction Wells and Conveyance Lines

3.2.3 ISB Systems

Pantex has installed and operates two ISB systems. One system is southeast of Pantex Plant on TTU property and one is south of Zone 11. The ISB systems consist of 90 active treatment zone wells and 15 active ISPM wells.

The objective of the ISB systems is to establish an anaerobic biodegradation treatment zone 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 and prevalent volatile fatty acids [VFAs]). These parameters are important because reducing conditions and adequate nutrients must be present to treat the COCs.

The bioremediation amendment, or carbon source, selected for the ISB systems is an emulsion of sodium lactate and soybean oil called Newman Zone™. The formulation provides both a rapidly-utilized electron donor (sodium lactate) and a slow-release long-term electron donor (soybean oil). As illustrated in Figure 3-34, the complex carbon source slowly ferments releasing lighter weight organic compounds, such as VFAs, which are further used for microbial energy and growth. Many steps of the fermentation process produce hydrogen, which is utilized by some microbes to directly metabolize COCs. As long as optimal subsurface reducing conditions and VFAs are available, a diverse microbial community can be sustained which leads to in situ treatment of COCs. Total VFAs are evaluated at the ISBs and serve as a good indicator that fermentation is occurring. TOC was selected as an indicator that an adequate carbon source remains available for continued ISB treatment. Pantex monitors for a wide range of VFAs and those results are included in Appendix D.

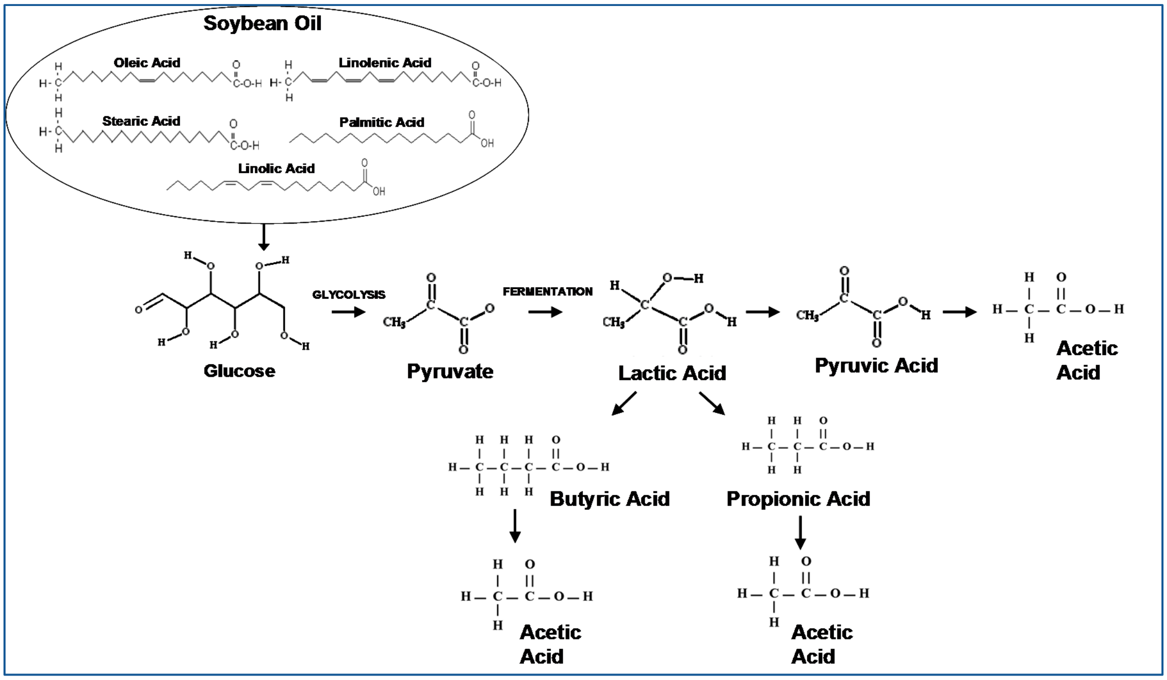


Figure 3-34. Soybean Oil Fermentation Pathways

In addition, geochemical conditions can be evaluated to determine if adequate reducing conditions exist to achieve reduction. Figure 3-35 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.

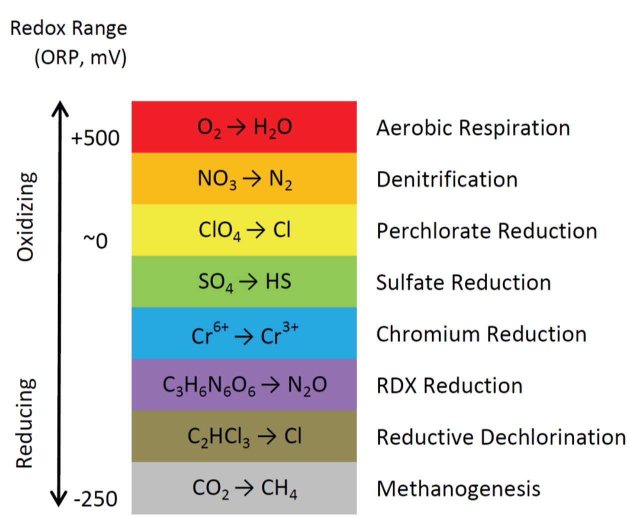


Figure 3-35. Typical Geochemical Redox Ranges

In addition to specific indicators to help determine if additional injections are required, Pantex monitors for a wide range of VFAs, metals, and general chemistry parameters. The VFAs help determine if fermentation is occurring and also help determine the fermentation pathways. 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 out into 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 2017, consists of 48 injection wells installed in a zone of saturated thickness of approximately 15–20 ft. Five treatment zone wells, ten ISB injection wells, and nine downgradient 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. The expansion area has only received two injections, so reducing conditions are still being established at the injection wells. Eight injection events, described in Section 2.2.1, have been completed through 2016; no injections or rehabilitation occurred at the Zone 11 ISB during 2017. The seventh injection event included bioaugmentation of the western side of the Zone 11 ISB where reducing conditions are established.

During 2017, Pantex monitored five treatment zone (TZM) wells, ten injection wells, and nine downgradient performance monitoring wells to evaluate the Zone 11 ISB (see Section 1.4.2 map). Pantex also monitors three treatment zone wells in the second row to better evaluate conditions in higher concentration and/or flow areas. 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. Therefore, PTX06-1169 is being sampled concurrently with the monitored injection wells, and a SAP revision will be requested if the data collected in the new well more accurately represents treatment zone conditions.

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.

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) and perchlorate. Expected conditions are that the indicator constituent concentrations will begin to 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, total organic carbon, and total VFAs 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 3-35, 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 and acetic acid should increase after injection, but decline over time as the amendment is consumed.

Prior to the 3rd quarter 2016 injection, the TOC remained high in the majority of the injection wells, but VFAs had decreased in all but one of the monitored injection wells. After injection, the TOC and VFA concentrations responded variably across the treatment zone wells, with most indicating stable TOC and increased VFAs. Through 2017, TOC remained stable while VFAs have declined. The TOC data indicates that a fair to good food source is available at the wells to allow continued biological activity and remediation of the COCs.

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 only received two injections, so deeper reducing conditions are just being 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. Additionally, wells downgradient of the expansion area are not expected to fully demonstrate treatment until up to two years following the second injection, which occurred in 2016.

Evaluation of data in the treatment zone wells indicates mild to strong reducing conditions (ORP $<$ –100 and sulfate at low levels) on the eastern side of the Zone 11 ISB where perchlorate is the primary COC. Monitored conditions indicate that all treatment zone wells had nitrate and sulfate reduced indicating that deeper reducing conditions at treated wells are present.

Reducing conditions across the western side ranged from very mild (ORP $>$ 0 and sulfate rebounding in some wells) to strong. Monitored conditions indicate that sulfate was reduced in six of ten treatment zone wells, indicating that deeper reducing conditions are present at injected wells for the reduction of TCE. Review of data at injection wells as compared to treatment zone wells that are located between injection wells indicate that reducing conditions 25 to 50 ft from injection wells are mild and likely not conducive to reduction of TCE. However, methane concentrations were high in most treatment zone wells indicating that strong reducing conditions continue to occur in many areas.

Table 3-2 summarizes the current and maximum COC concentrations in each ISB, TZM, and ISPM well. The five TZM wells are located on the western side of the ISB. Three of these wells are located within the expansion zone; only PTX06-1169 and PTX06-1170 are located within the established treatment zone.

PTX06-1012 and PTX06-1155 are on the western side of the ISB where TCE is the primary COC, although baseline concentrations of perchlorate also exceeded the GWPS in that area. PTX06-1156 is on the eastern side of the Zone 11 ISB where perchlorate is the primary COC. PTX06-1148, 1149, and 1150, which are located further downgradient from the ISB treatment zone, were converted to ISPM wells in 2014. Monitoring data from these three wells to date suggest that affected water has reached PTX06-1149 but not PTX06-1148 or PTX06-1150. However, due to their distance from the treatment zone, effects are not expected for another few years. PTX06-1173, 1174, and 1175 are downgradient of the expansion zone; declines in concentrations of perchlorate have been observed at all three wells and may indicate the effects of treatment while declines in concentrations of TCE at PTX06-1173 and PTX06-1174 may indicate treatment is occurring at those wells. Wells downgradient of the expansion area were not expected to demonstrate treatment until up to two years following the second injection.

Table 3-2. Summary of 2017 Zone 11 ISB Monitoring Well Data for TCE and Perchlorate

	Perchlorate					Trichloroethene				
Well ID	Max[a]	1Q	2Q	3Q	4Q	Max[a]	1Q	2Q	3Q	4Q
In Situ Bioremediation Wells										
PTX06-ISB055	3000	<12	<12	<12	<12UJ	16	<3UJ	<3	<3	<3UJ
PTX06-ISB059	970	<12	<12	<12	<12UJ	<3	<3UJ	<3	<3	<3UJ
PTX06-ISB063	39	<12	<12	<12	<12	0.75J	<3	<3	<3	<3
PTX06-ISB069A	880	<60	<60	<24	<12	62	4.5J+	3J+	0.57J +	<3
PTX06-ISB071	400	<12	<12	<12	<12	1500	<3	<3	<3	<3
PTX06-ISB073	380	<60UJ	<60	<24	<12	560	4.7J+	2.8J+	<15	<3UJ
PTX06-ISB075[b]	97	<12	<12UJ	<12UJ	<12	440	3.7	5.4	31	35
PTX06-ISB077	840	<12UJ	<12	<12	<12	310	<3	<3	<3UJ	<3
PTX06-ISB079	<24	<12	<12	<12UJ	<12	<3	<3	<3UJ	0.5UJ	<3
PTX06-ISB082	3090	<12	<12UJ	<12UJ	<12	9.6	<3	<3	0.55U J	<3
In Situ Treatment Zone Monitoring Wells										
PTX06-1164	130	110	110	98	86	180	130	120	140	180
PTX06-1169	<12	--	--	<12	--	13	--	--	1.5J	--
PTX06-1170	<120	<12	<12	<12UJ	<12	500	26	250	260	290
PTX06-1176	240	38	38	31	9.3J	220J	74	62	45	18
PTX06-1177	210	<12	<12	<12UJ	<12	130	1.2J	0.91J	1.9J B	0.86J
In Situ Performance Monitoring Wells										
PTX06-1012	341	<12	<12	<12	<12	580	1.7J	1.6J	2.1J	1.3J
PTX06-1155	487	<12	<12	<12	5.1J	660	0.36J	0.47J	0.95J	0.42J
PTX06-1156	2140	<12	<12	<12	<12	7.4	<3	<3	<3	<3
PTX06-1148	1290	370	340	410	380	3.63	1.8J	1.7J	1.4J	1.5J
PTX06-1149	684	<12	<12	<12	<12	0.39J	<3	<3	<3	<3
PTX06-1150	235	41	26J	37	31	6.4	6	6.4	5.1	5.4
PTX06-1173	16J	<12	<12	<12	5.2J	100J	3.3	1.1J	0.85J	0.61J
PTX06-1174	170J	<12	<12	<12	<12	160J	0.6J	0.51J	0.73J	<3
PTX06-1175	340J	300	290	230	190	150	140	150	140	130

Concentrations provided in ug/L.
Highlighted cells indicate concentrations less than the GWPS.
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.
UJ – The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

Perchlorate concentrations were non-detect or below GWPS in six of the nine downgradient ISPM wells during 2017. Perchlorate is exhibiting a decreasing trend in PTX06-1150 and PTX06-1175 and has been decreasing in PTX06-1148 although no trend is indicated for the last four samples in this well. TCE concentrations were non-detect or below GWPS in seven of the nine downgradient ISPM wells during 2017 and were decreasing in PTX06-1173 with only the first quarterly sample above GWPS. TCE concentrations in PTX06-1150 have been slightly increasing, but exhibited a decreasing trend for 2017. PTX06-1175 is downgradient of the expansion area and is not expected to exhibit decreasing trends for several years.

TCE continues to be reduced to cis-1,2-DCE, with TCE concentrations near or below GWPS in all but four wells inside of the treatment zone and cis-1,2-DCE present above the GWPS in three of the wells. The presence of TCE and cis-1,2-DCE continues to indicate partial treatment in the non-injected treatment zone wells because concentrations tend to be higher in the noninjected 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 one well inside the treatment zone. Ethene and ethane were detected at low concentrations in five wells, indicating that TCE is being completely degraded in limited amounts in some areas of the treatment zone. When TCE concentrations inside the treatment zone are low (< 300 ug/L), these low degradation rates may be enough to treat TCE and its breakdown products to GWPS. Upgradient data still indicate TCE concentrations fluctuating above 300 ug/L periodically.

Two wells (PTX06-1150 and PTX06-1175) demonstrate TCE concentrations above the GWPS, although concentrations are near the GWPS in PTX06-1150. The first breakdown of TCE, cis-1,2-DCE, continues to be detected above the GWPS in PTX06-1155 and PTX06-1173. However, concentrations have decreased in these wells, with the latest concentrations near the GWPS, indicating that treatment of TCE and its breakdown products are very close to meeting the GWPS in treated water from the original portion of the system. Additionally, downgradient wells PTX06-1155, PTX06-1173, and PTX06-1174 demonstrate the presence of ethene and vinyl chloride indicating that full treatment is occurring on a limited basis and is helping decrease concentrations to the GWPS.

Although some areas in the treatment zone indicate mild reducing conditions, downgradient data indicate that treatment is effectively reducing contaminants and risk.

Pantex is monitoring the impact of the bioaugmentation through the use of qPCR and compound specific isotope analysis (CSIA) sampling which began in February 2016. The qPCR and CSIA data, combined with other monitoring data from the Zone 11 ISB area, indicate that complete dechlorination is not likely occurring at this time due to low counts of DHC and mild reducing conditions in many areas of the Zone 11 ISB where bioaugmentation has occurred. Additional sampling for CSIA and census DNA for DHC and 1,4-dioxane will be conducted at the Zone 11 ISB during 2017. These analyses will be used to determine the effectiveness of bioaugmentation and to evaluate other potential processes that may be helping break down TCE and 1,4-dioxane through cometabolic processes. Bioaugmentation in the expanded treatment zone described in Section 2.2.1 will not occur until the weight of evidence suggests the proper reducing conditions exist for DHC survival and growth.

Metals concentrations are 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, PTX06-1148, PTX06-1149, PTX06-1155, PTX06-1156, PTX06-1173, and PTX06-1174 and barium concentrations in PTX06-1156, PTX06-1173, and PTX06-1174 exceeded GWPS in 2017. However, 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. This can be seen in recent metals trends in the downgradient wells as arsenic and manganese were previously increasing but are now decreasing or exhibit no trend in PTX06-1012 and PTX06-1149.

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 42 injection wells within the treatment zone and six 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. Pantex has 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.

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, six downgradient performance monitoring wells, and one upgradient performance monitoring well are used to evaluate the Southeast ISB. Three performance monitoring wells (PTX06-1045, PTX06-1118, and PTX06-1123) for the Southeast ISB have gone dry and have not been monitored since 2009, 2010, and 2015 respectively.

Table 3-3 summarizes the current and maximum COC concentrations in each ISB and ISPM well. Evaluation of data in treatment zone wells indicates adequate reducing conditions for the treatment of RDX and hexavalent chromium. RDX was not detected above GWPS in any treatment zone wells in 2017. The closest downgradient monitoring wells for the Southeast ISB 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 200 ug/L although hexavalent chromium concentrations have dropped below the GWPS. Pantex continues to monitor this well and other new wells installed nearby to determine if treated water is slow to reach it, or if this well may not be hydraulically connected to the Southeast ISB.

Graphs of the amendment indicators and COCs for the six ISB injection wells sampled, as well as concentrations for target indicators at the three performance monitoring wells for this system are included in Appendix E. The conditions in the treatment zone and performance monitoring wells are discussed below.

Table 3-3. Summary of 2017 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	<0.5	<0.5	--	--
PTX06-ISB030B[b]	NE	NE	NE	NE	NE	2.7	<0.5	<0.5	<0.5	<0.5UJ
PTX06-ISB038	NE	NE	NE	NE	NE	421	<0.5	<0.5	<0.5	<0.5UJ
PTX06-ISB042[b]	NE	NE	NE	NE	NE	2920	<0.5	--	--	--
PTX06-ISB046	NE	NE	NE	NE	NE	4350	<0.5	<0.5	<0.5	<0.5UJ
PTX06-ISB048	NE	NE	NE	NE	NE	--	<0.5	<0.5	<0.5	<0.5UJ
In Situ Performance Monitoring Wells										
PTX06-1037	108.5	<0.4UJ	<0.02UJ	<0.02UJ	--	2800	<0.272	<0.272UJ	<0.263UJ	<0.263
PTX06-1123[b]	10	--	--	--	--	4300	--	--	--	--
PTX06-1153	159	30.1J-	24.4J	19.7J	23.6	450J	213	205J	200J	252
PTX06-1154	29.2	0.14J-	<0.02UJ	<0.02UJ	--	630	<0.275	<0.278UJ	<0.263UJ	<0.263

Concentrations provided in ug/L.
*NE – Hexavalent chromium was not evaluated in the ISB treatment zone due to interference from the amendment.
Highlighted cells indicate non-detect or concentrations less than the GWPS.
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] PTX06-1123, PTX06-ISB014, PTX06-ISB019, PTX06-ISB024, and PTX06-ISB42 were either dry or had limited water and could not be sampled for all or part of 2017.
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. In addition, this well went dry in the second half of 2011. PTX06-1118 is upgradient to the ISB system and is used to monitor the influent COC concentrations and has been dry since late 2009.

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 below the GWPS. During 2017, 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. Pantex will continue to monitor PTX06-1153 for contaminant concentrations and water levels over time.

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. 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.

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 2017. 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 at both wells throughout 2017. These results indicate 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.

Many of the injection and performance monitoring wells indicate variable water conditions at the Southeast ISB. Only four of eight treatment zone monitoring wells were sampled in all four quarters of 2017 because of low water or dry conditions. Two Southeast ISB performance monitoring wells (one upgradient and one farther downgradient) remain dry and cannot be sampled. PTX06-1123, a downgradient performance monitoring well, has not been sampled since August 2015 due to low water conditions. The remaining three downgradient wells demonstrate declining water levels, with only PTX06-1153 containing more than 4 ft of water above the bottom of screen. Injection was completed at only 50 percent of the injection wells during the 2016 injection event due to 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 will evaluate the timing and need for further injections after the 2019 injection event.

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 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.

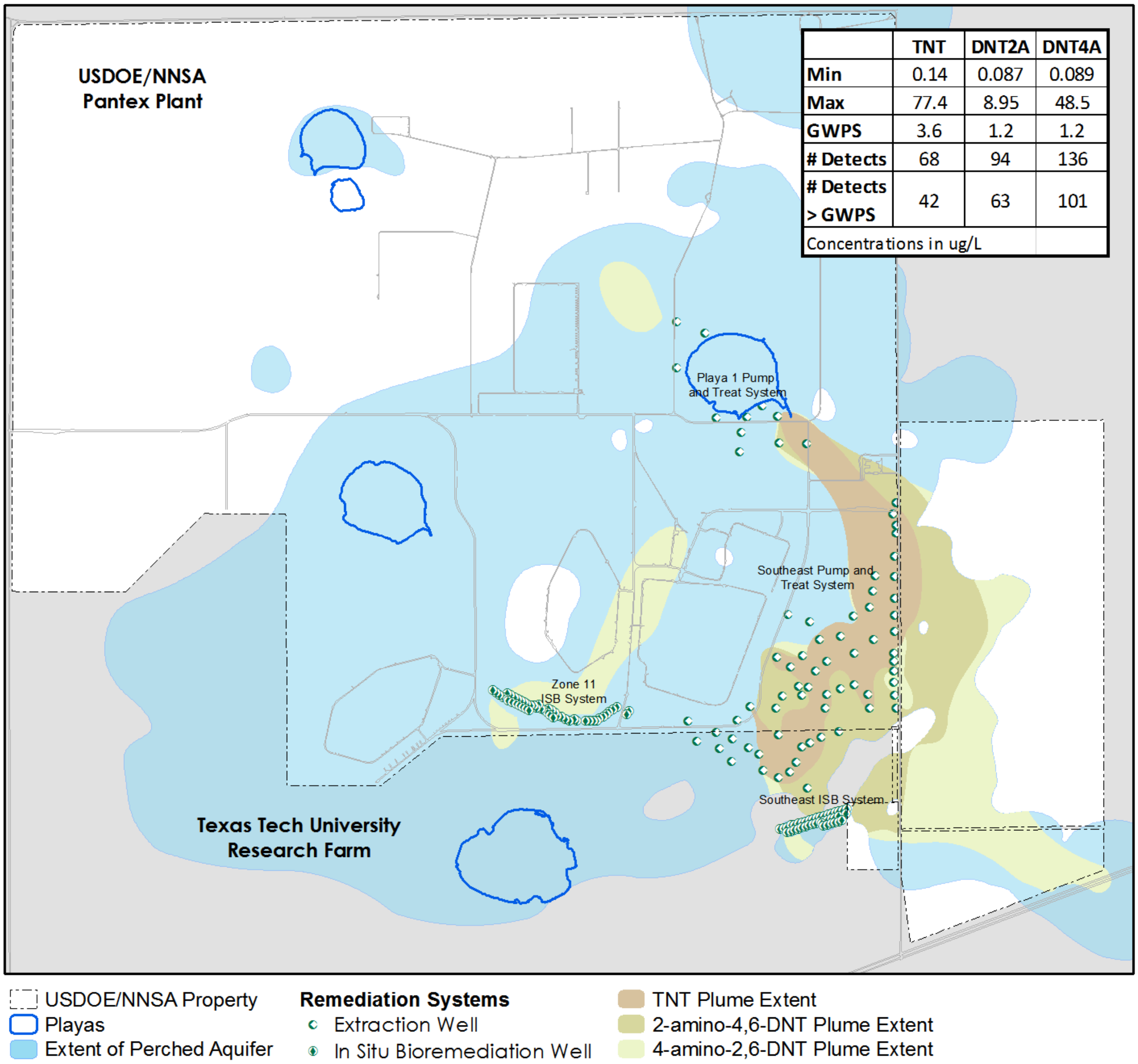
RDX can degrade under aerobic and anaerobic conditions, but achieves best reduction under anaerobic conditions. As more data are collected, trending and statistical analysis can be used to evaluate the degradation of RDX. Trending of concentrations is also performed at each well to determine if concentrations 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 3-36). 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-

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

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 3-36.

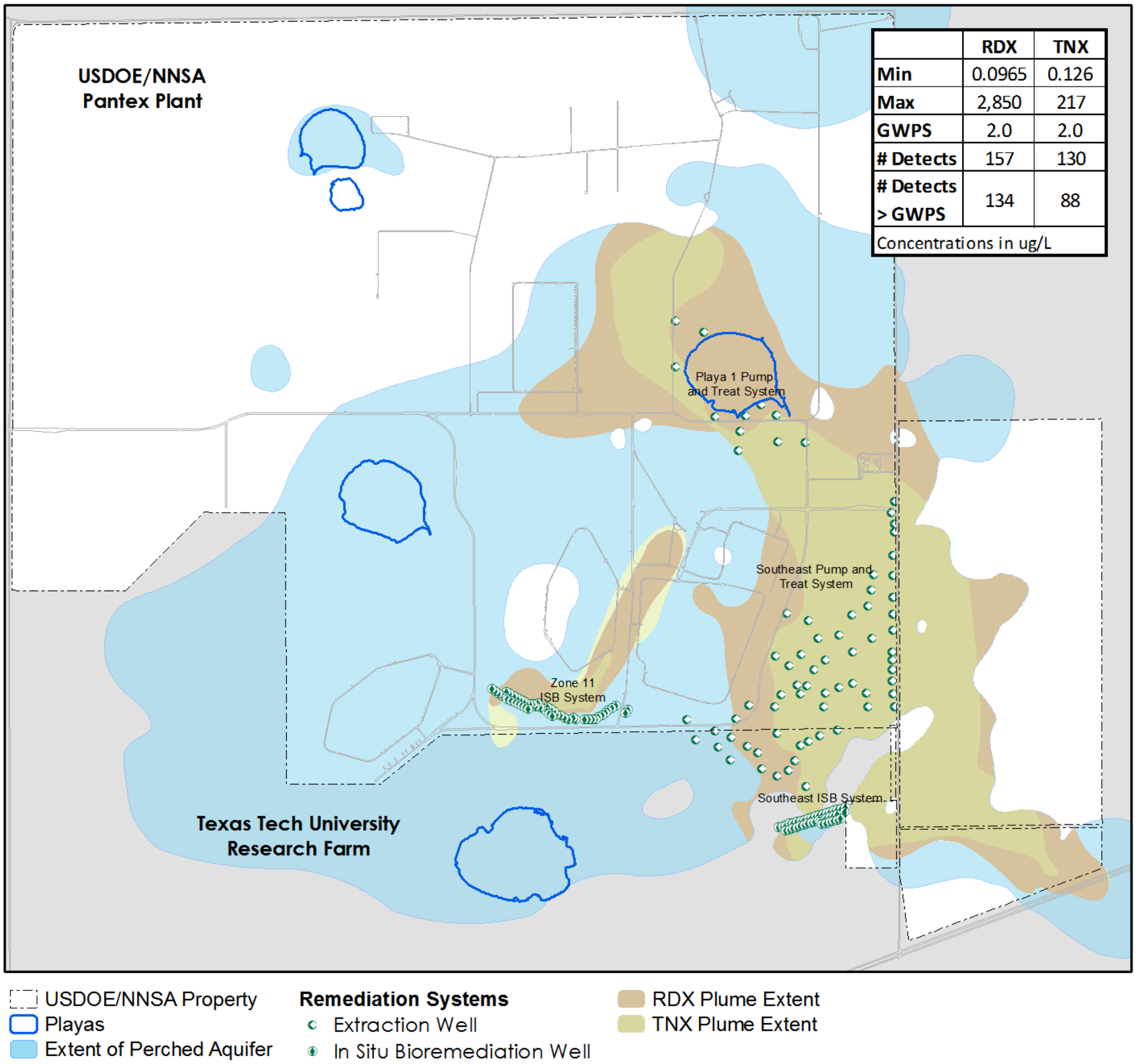


	TNT	DNT2A	DNT4A
Min	0.14	0.087	0.089
Max	77.4	8.95	48.5
GWPS	3.6	1.2	1.2
# Detects	68	94	136
# Detects > GWPS	42	63	101
Concentrations in ug/L			

Figure 3-36. 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 is occurring, RDX and all breakdown products would be expected to decrease over time. Figure 3-37 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. More data will be required over time to determine trends and rates of attenuation.

A recent SERDP study (2014) provided evidence that aerobic degradation is occurring in the Pantex RDX plume. Strong evidence of aerobic degradation was found in two monitoring wells, one near the SEPTS extraction wells, and one near the southeast edge of the plume. One other well near the source (Playa 1), indicated that degradation is occurring, but no aerobic breakdown products were found. Prior to this study, Pantex had been unable to determine what type of degradation is occurring (biotic/abiotic and anaerobic/aerobic) across the plume. Because different types of degradation may be occurring near the source areas and changing to aerobic degradation as the plume moves away, the rate of attenuation is difficult to quantify because it will vary across the plume. 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 has contracted with leading researchers for further study at the Pantex Plant to apply the CSIA and other new analytical techniques to determine where and what type of degradation is occurring across the RDX plume. Groundwater samples for this study have been collected, and laboratory analysis and data evaluation are underway. The study is expected to be completed in 2018. If data support quantification of attenuation rates in the future, rates will be calculated.



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

Figure 3-37. 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 2017, 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 3-38. The wells are evaluated with respect to:

Group 1 47 locations (designated by boxes on Figure 3-38) 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 3-38) 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.

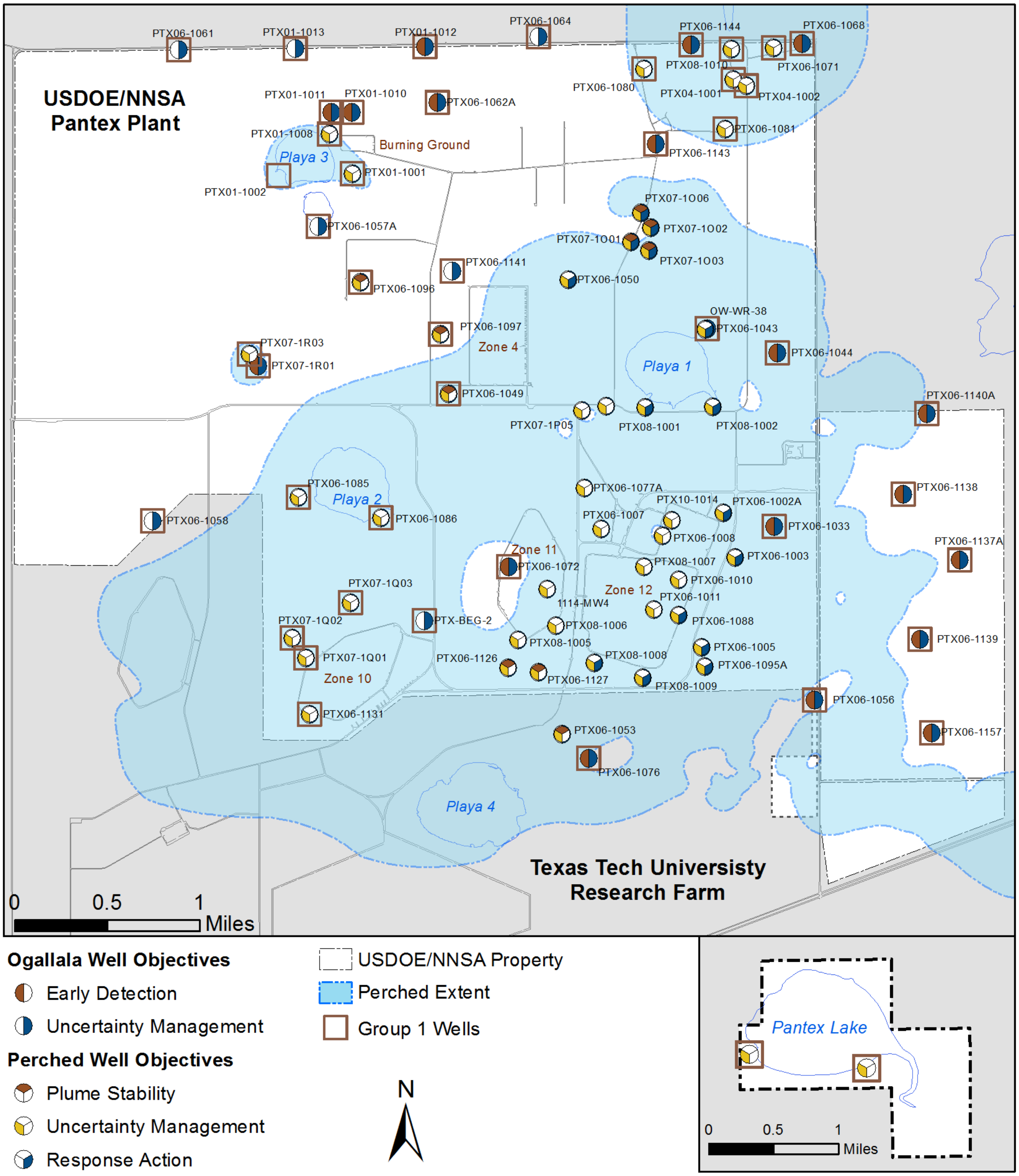


Figure 3-38. Uncertainty Management and Early Detection Wells

3.4.1 Group 1 Wells

No Group 1 perched aquifer wells had unexpected conditions in 2017. Detections of indicator COCs occurred in four Group 1 perched aquifer wells in 2017 (PTX04-1001, PTX04-1002, PTX06-1049, and PTX06-1081). All detections of indicator COCs at these wells were below GWPS except for a single exceedance of 4-amino-2,6-dinitrotoluene in PTX06-1049 in May 2017. The concentration of 4-amino-2,6-dinitrotoluene in this well has been declining since 2014, and the subsequent sample collected in 2017 was below the GWPS.

3.4.1.1 Ogallala Aquifer Wells

In 2017, detection of organic constituents or metals above background (for those metals with site-specific background concentrations) occurred in five Ogallala wells. Data for these detections is provided in Appendix D, Table D-1. This table does not include boron detections as these data are summarized in Table D-2.

Manganese and nickel were detected above background values in one well in 2017 (PTX06-1033), but the detections were well below the GWPS. Both manganese and nickel have been identified as indicators for stainless steel corrosion; the remaining corrosion indicators did not demonstrate increasing concentrations in these wells. This well has had confirmed screen corrosion as documented by increasing concentrations of metals and confirmed by well video. Previous rehabilitation of this well in 2013 and 2015 resulted in temporary declines in nickel concentrations followed by increasing concentrations in subsequent samples. During well maintenance in 2017, a video survey of PTX06-1033 indicated that a casing joint had been damaged at about 228 ft bgs, and grout is intruding into the well. As a result of these conditions, samples can no longer be collected in this well. Because repair of the well is not feasible, this well was recommended for plugging and abandonment with no replacement well drilled because the well is located within an impacted area of perched groundwater. TCEQ approved this recommendation in a letter dated November 15, 2017.

Hexavalent chromium was detected in twelve wells (PTX06-1033, PTX06-1043, PTX06-1044, PTX06-1056, PTX06-1068, PTX06-1076, PTX06-1137A, PTX06-1138, PTX06-1139, PTX06-1140, PTX06-1144, and PTX06-1157) in 2017 below the GWPS of 100 ug/L. The detections in all of the wells were below the SAP PQL of 15 ug/L.

In February 2017, Pantex developed and had approval of a regional background concentration study for total and hexavalent chromium in the Ogallala Aquifer. Background concentrations were developed for RRS 1 criteria under the Risk Reduction Rule (30 TAC §335 Subchapter S). Under RRS 1, background levels for naturally occurring constituents are set using environmental data or PQLs, whichever are greater. To determine background levels for use in comparison to Ogallala or perched groundwater data collected for monitoring of the Remedial Action, Pantex utilized a 95 percent upper tolerance limit (UTL) with 95 percent coverage (UTL95-95), as approved in the previous Risk Reduction Rule

Guidance (Pantex 2004) and in accordance with 30 TAC §335.163(8)(C). ProUCL version 5.1.002 (EPA 2016) was used to check data distributions and calculate the appropriate UTL. The calculated background for total chromium in groundwater is 6.6 ug/L for analysis with Method 6020 Low-Level. The calculated background for Cr(VI) in groundwater is 3.2 ug/L for analysis with Method 218.7.

Of the twelve wells with detections of hexavalent chromium, only one exhibited concentrations above the background. PTX06-1157 had two detections for hexavalent chromium at 3.66 and 3.61 ug/L in 2017 utilizing Method 218.7. These detections are slightly above background and likely represent background variability.

Hexavalent chromium was also detected in PTX06-1033 at 7.33 ug/L using Method SW7196A. Because a different, less sensitive, method was used, this value is not directly comparable to the background. Method SW7196A was employed for analysis of samples collected during the second quarter of 2017 because of instrument failure for equipment utilizing Method E218.7. As discussed in the 2016 Annual Report, low-level detections of hexavalent chromium near the SAP PQL of 15 ug/L are false positive or inaccurate elevated detections near the MDL due to the colorimetric analytical method or related to corrosion of stainless steel screen/casing. As noted previously, PTX06-1033 has documented evidence of corrosion, will no longer be sampled because of damage to the casing, and is scheduled for plugging and abandonment in 2018.

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 2017 at values up to 0.344 ug/L, slightly above the PQL of 0.26-0.27 ug/L, but below the GWPS. 1,2-Dichloroethane was detected in all four quarterly samples in 2017; 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 2017, the detection of 4-amino-2,6-DNT do not exhibit a trend, and detections of 1,2-dichloroethane are exhibiting a stable 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.

In the fourth quarter of 2017, PTX06-1068 and PTX07-1R01 had low-level detections for 1,4-dioxane. Previous samples collected in the second quarter at both wells were non-detect. The detection in PTX06-1068 was slightly above PQL of 1 ug/L while the detection in PTX07-1R01 was below the PQL. Per the contingency plan, only PTX06-1068 was resampled, and 1,4-dioxane was not detected in the resample result.

As presented in Table D-2, boron was detected at concentrations slightly above the background value of 194 ug/L in five Ogallala wells in 2017, including PTX06-1043, PTX06-1056, PTX06-1062A, PTX06-1139, and PTX06-1157. Because the boron concentrations at these wells are very close to background and observed boron concentrations tend to be considerably variable, 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, manganese, 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 3-4, indicate that across all data, nine wells are indicating increasing or probably increasing trends. Note as described previously, PTX06-1033 (included in Table 3-4) will no longer be sampled due to well failure.

Table 3-4. Increasing Trends in Group 1 Ogallala Aquifer Wells

Well	COC	Concentration Trend
PTX06-1033	B	Increasing
PTX06-1033	CR	Increasing
PTX06-1033	CR-6	Increasing
PTX06-1033	MN	Increasing
PTX06-1043	B	Probably Increasing
PTX06-1043	CR	Increasing
PTX06-1056	DNT4A	Increasing
PTX06-1056	CR	Probably Increasing
PTX06-1058	CR	Probably Increasing
PTX06-1061	B	Increasing
PTX06-1068	CR	Increasing
PTX06-1068	CR-6	Increasing
PTX06-1076	CR	Increasing
PTX06-1157	B	Probably Increasing
PTX-BEG2	MN	Increasing

Six wells indicate increasing or probably increasing trends for chromium. However, the detections were below background in all of these wells except for PTX06-1033. 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. Detections of manganese and nickel in PTX06-1033, discussed previously, along with the chromium, indicate that corrosion of the stainless-steel well screen is affecting this well.

PTX06-1033 and PTX06-1068 exhibited increasing trends in hexavalent chromium. Hexavalent chromium was detected in PTX06-1033 in 2017, but was non-detect in the three preceding samples. The apparent increasing trend is associated with the recent detection and use of one-half the sample detection limit for non-detect data in the trend analysis. As discussed in the 2012 Annual Progress Report, the increasing trend at PTX06-1068 is likely due to several 2012 detections associated with the corrosion of the stainless steel sampling pump. All other detections have been below PQL or representative of background. In the most recent sample, the detected concentration of hexavalent chromium in PTX06-1068 was 2.0 ug/L, below the background of 3.2 ug/L established for the Ogallala Aquifer.

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

Mann-Kendall trending across all data also indicates that manganese is increasing or probably increasing in two Ogallala Aquifer wells, PTX06-1033 and PTX-BEG3. However, all manganese detections are well below the GWPS of 1,716 ug/L. The increasing trend in PTX06-1033 is associated with corrosion of the stainless steel well screen. The apparent increasing trend in PTX-BEG2 is caused by using one-half the sample detection limit in the trend analysis; manganese has not been detected in the last three samples from this well.

As discussed above, PTX06-1056 exhibited an increasing trend in 4-amino-2,6-dinitrotoluene across all data, but detected concentrations remain below the GWPS of 1.2 ug/L, and no trend is indicated in recent data.

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-3 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-3:

- 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 PTX06-1007, PTX06-1008, and PTX10-1014 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 either dry or have water only in the well sump.

The remaining 11 wells that are exhibiting increasing trends when the expected condition is a decreasing or stable trend are discussed below.

- 1114-MW4, located in central Zone 11, is exhibiting an increasing trend for perchlorate and probably increasing trend for 1,4-dioxane, possibly due to increased mass flux and plume movement downgradient 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 a probably increasing trend in TCE; however, detections have been sporadic at levels below the PQL and GWPS. The trend is due to the use of one-half the sample detection limit as a surrogate for trend identification.

- PTX06-1010 is exhibiting increasing trends in TCE and chloroform while the expected condition is a long-term decreasing trend. These trends may be due to increased mass flux at the source area (WMG 10) or possible downgradient plume movement from the source.

- PTX06-1011 is exhibiting an increasing trend in hexavalent chromium while the expected condition is a stable or decreasing trend below GWPS. Hexavalent chromium concentrations in this well remain below the GWPS in this well, and the trend may reflect the variable influence of the remedial actions in this area.

- PTX06-1077A is exhibiting an apparent probably increasing trend in perchlorate; however, all detections in 2017 were below the PQL and the trend is due to the use of one-half the sample detection limit as a surrogate for trend identification.

- PTX06-1088 is exhibiting an increasing trend in PCE 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.

- PTX07-1P02 is exhibiting an increasing trend in RDX since the start of remedial actions while the expected condition is a stable or decreasing trend below GWPS. However, the long-term trend is decreasing, and RDX concentrations are variable near the GWPS.

- PTX08-1006 is exhibiting an increasing trend in TCE, while the expected condition is a long-term decreasing trend. This well is located in southeast Zone 11 and the trends are likely due to plume movement away from upgradient sources.

- PTX08-1007 is exhibiting a slight increasing trend in 1,4-dioxane below the GWPS since the start of remedial actions while the expected condition is a long-term decreasing trend. Although the trend was identified as increasing, little actual change in concentration has been observed over the past eight years. The most recent sample was detected below the PQL.

- PTX08-1008 is exhibiting increasing trends in perchlorate, 1,4-dioxane, and 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. Although 1,4-dioxane has been detected at low levels near the PQL in recent samples, the trend analysis was affected by the use of one-half the sample detection limit as a surrogate for non-detects. The long-term trend for chloroform is decreasing, recent detections have been below the PQL and below the GWPS, and all samples in 2017 were non-detect.

- 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, little actual change in concentration has been observed over the past three years, the trend analysis was affected by the use of one-half the sample detection limit as a surrogate for non-detects, and the long-term trend is decreasing.

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-4 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. Constituents detected above background include manganese and nickel. Iron was also detected, but was not included in Table D-4 because no GWPS has been established. Manganese and nickel were each detected in a single well at levels exceeding background concentrations. However, both of these are indicators of corrosion of stainless steel screens, and both of these wells had stainless steel screens at the time of sampling.

3.4.3 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 three new wells (PTX06-1184 through PTX06-1186) during 2nd quarter 2017 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 to the southeast boundary of the site and also obtained an access agreement with the landowner to the south to drill wells on their property to aid in determining the extent of contamination. Drilling of the ISB wells was completed in December 2017, and the offsite monitoring wells were completed in January 2018 with three of the wells indicating the presence of water and one well that is dry. Analytical samples were collected from the two wells with water, and one well had concentrations exceeding the GWPS for two HEs. Pantex is continuing to work with the neighboring landowner to the southeast to obtain an access agreement to drill and sample wells on that property. Sample results at the newly completed ISB wells and wells on the neighboring property have been included in the data used for plume mapping in this report. Refer to Figure 3-13 for well locations and estimated plume extent.

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 evaluate the effectiveness of the remediation program.

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.

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 3-39. 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.

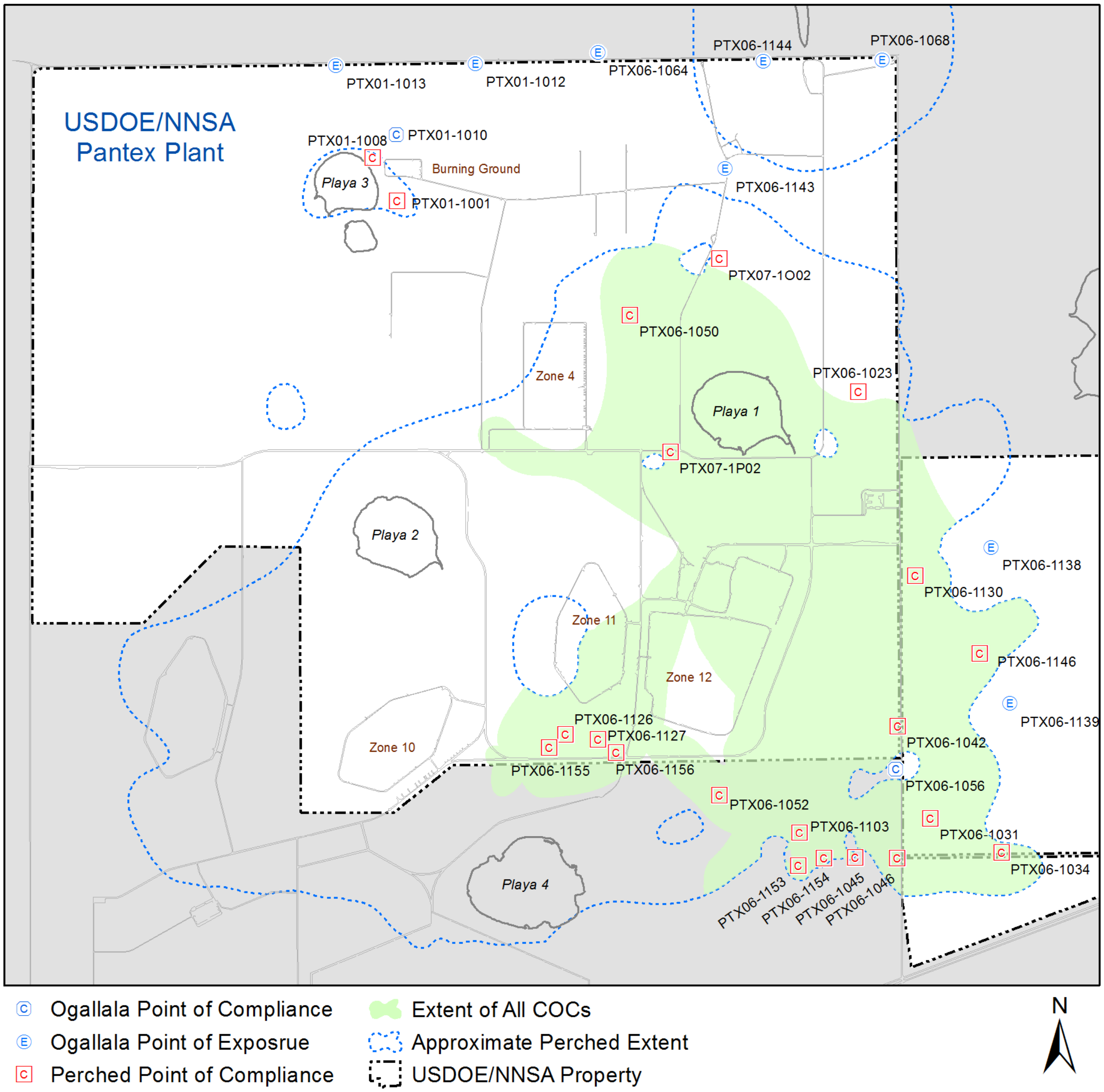


Figure 3-39. POC and POE Wells

4.0 Soil Remedial Action Effectiveness

Three soil remedial actions were implemented to prevent cross-contamination of 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 small-scale Burning Ground SVE system operated intermittently during 2017 with about 5,713 hours of operation during the year, or 65 percent operation, and was down for power outages, replacement of the scrubber pump and heating element, and maintenance or repairs. The small catalytic oxidizer (CatOx)/wet scrubber system installed in 2012 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 813 lbs of VOCs during 2017.

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 quarterly 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 2017, analytical samples were collected more frequently following completion of modifications with a total of eight samples collected for laboratory analysis from June through December.

Table 4-1 presents a summary of detected 2017 data and the average concentrations from 2007-2008. The 2017 data were collected at the influent port of the current SVE system following completion of modifications.

The 2017 measured values are typically lower than the 2007-2008 data collected at the system, but higher than 2016 values because of the increased air flow through the formation following completion of system modifications. Maximum and average values are lower than the baseline concentrations, with the majority of the COC maximum concentrations still within the same order of magnitude. This change in concentration will continue to be analyzed to determine if a long-term trend emerges. Methylene chloride was detected in all seven of eight post-modification samples in 2017 (although the non-detect sample had an elevated detection limit higher than all previous detected values in 2017) 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 dilutions by the laboratory lessen.

Table 4-1. Burning Ground SVE Data Summary

Analyte	2017 Measured Value			2007-2008 Measured Value		
	Ave	Max	Min	Ave	Max	Min
Acetone	39,750	56,000	27,000	82,666	140,000	38,000
Toluene	221,250	270,000	180,000	477,307	990,000	45,000
Methylene chloride	3,570	5,200	2,600	ND	ND	ND
PCA	5,060	7,100	2,900	3,356	6,300	760
TCE	8,240	9,100	6,500	26,714	41,000	13,000
Tetrahydrofuran (THF)	9,550	14,000	5,900	20,107	26,000	9,500

Results for 2017 based on data collected after system modifications were completed.
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 4-2Table 4-1 provides a summary of the statistical trending. The results indicate that, for the four main COCs, i.e., acetone, toluene, TCE, and tetrahydrofuran [THF], three of the four exhibit decreasing trends considering all data collected since 2013, while no trend is indicated for acetone. The trends of the recent (last four) concentration measurements for the four main COCs are either decreasing or stable.

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

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

The average monthly PID measurements collected at the system influent, summarized in Figure 4-1, are showing some variability, but linear regression results for the dataset, represented by the trend line on the graph, indicate an increasing trend. This increase is likely due to a shutdown period in mid-2015 with concentrations spiking at start up and decreasing over time. Average influent concentrations in 2017 were generally lower than in 2016 and decreased significantly following the system modifications. Average influent concentration for June through December was about 350 ppm compared to an average of about 530 ppm for January through May. Continued decreases in PID readings are expected as operations continue.

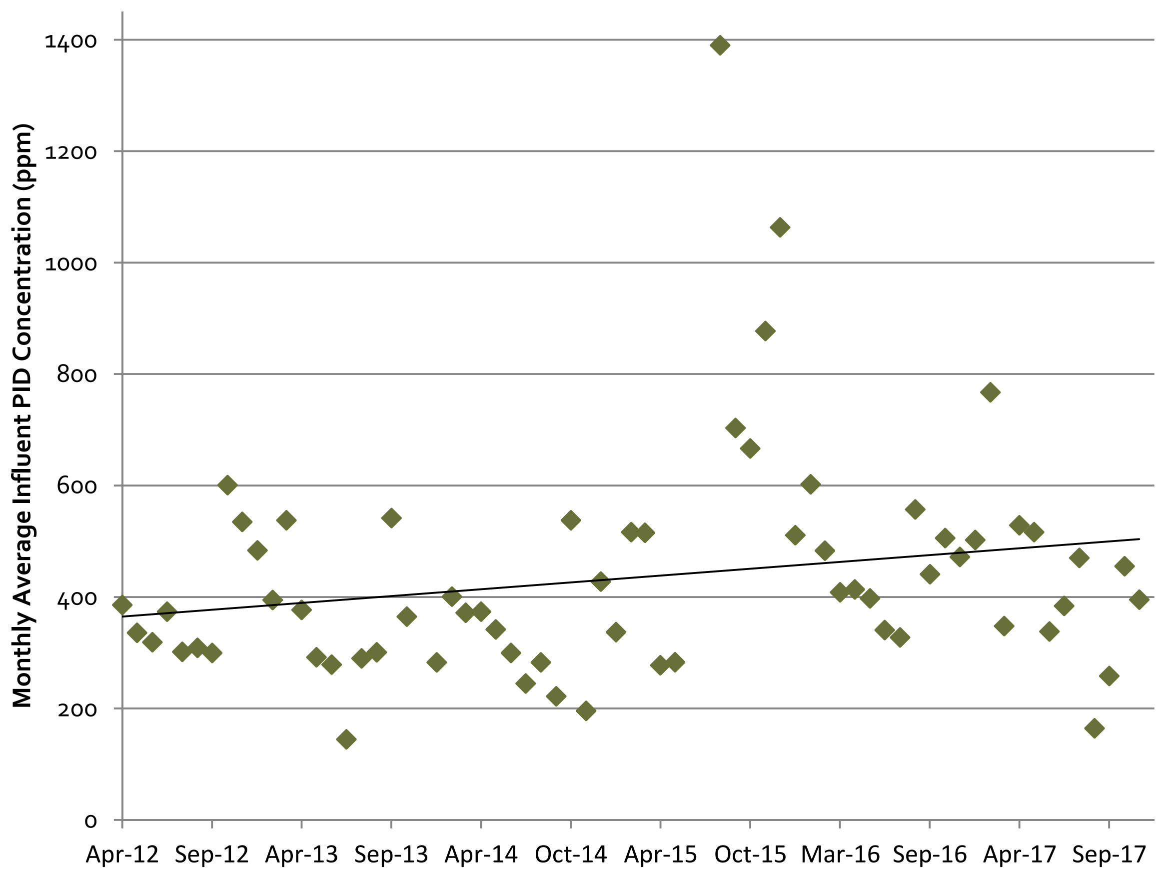


Figure 4-1. Influent Average PID VOC Concentrations vs. Time

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 will help 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 set up at approximately 32 scfm to 44.5 scfm during the 4th quarter of 2017. Hourly VOC removal rates increased with increased flow. The observed SVE system performance improvements are illustrated in Figure 4-2 which shows that in the fourth quarter, the mass removal rate of VOCs in pounds per hour had increased by 50 percent over first quarter baseline values with an increase of 34 percent in the extraction air flow rate. Pantex will continue to monitor the system for mass reduction in the influent vapor stream and for evidence of bioremediation.

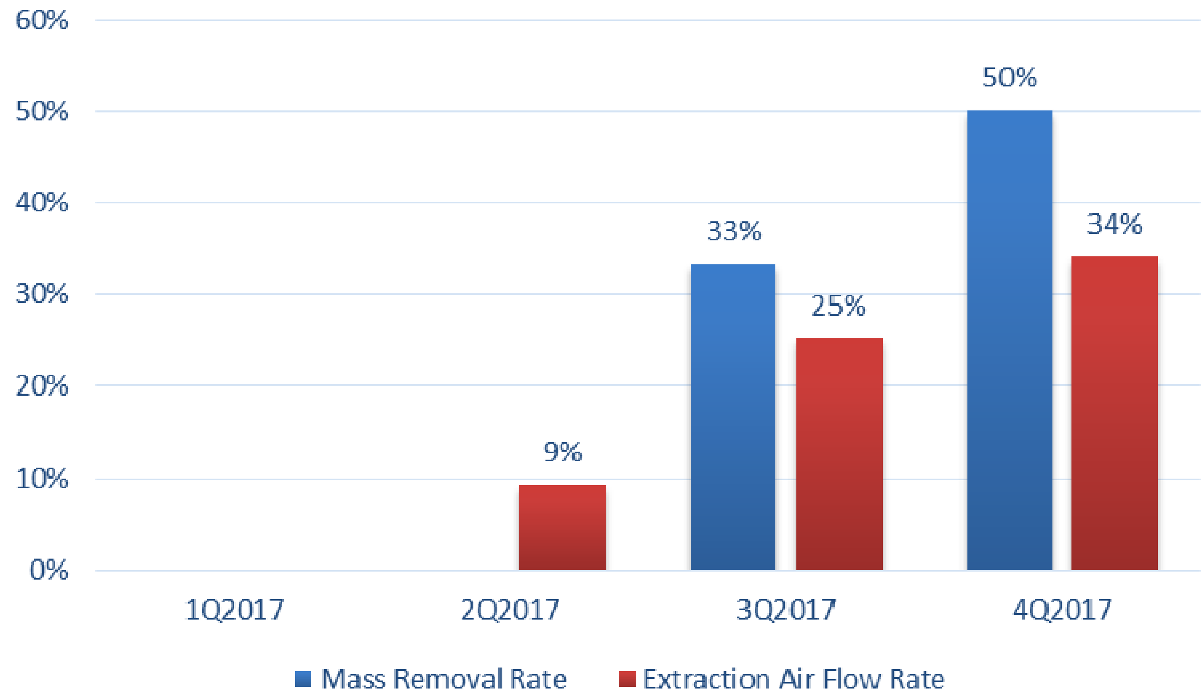


Figure 4-2. SVE System Performance Improvements After Modification

Pantex will provide further recommendations based on review of influent SVE data over time. The SVE system continues to treat soil gas and residual NAPL in the solvent evaporation pit/chemical burn pit area. This treatment regime mitigates 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 2017. As discussed in Section 3.4.2, eleven 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, exhibit trends that might indicate a new release related to a soil source. An apparent increasing trend for perchlorate and probably increasing trend for 1,4-dioxane were identified for this well. Historical perchlorate concentrations at 1114-MW4 were much higher than recent levels, and the long-term trend for this well is 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 2017 Annual Report

Overall, the groundwater remedial actions have been effective in 2017. The remedial actions continue to operate and meet short-term expectations for cleanup of the perched groundwater in areas under the influence of the remediation systems. Perched water levels are declining, COC mass is being removed or reduced, and institutional controls provide protection for use of impacted groundwater, while the remedial actions continue to operate to meet long-term goals. The influence of both pump and treat systems will continue to expand as the saturated thickness is reduced in the perched aquifer.

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 2017, 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 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 contamination based on fate and transport modeling. A cement bond log was run 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 contamination to reach the Ogallala Aquifer.

New perched groundwater wells installed outside the previously defined extent of the southeast lobe of the perched aquifer indicate that water and contamination have migrated further to the southeast and to offsite property. Pantex has extended the Southeast ISB remedy to that area along the Pantex boundary and plans to continue investigating offsite to determine the nature and extent of contamination and to aid in determining a path to cleanup.

The pump and treat systems throughput performance was affected by shutdowns for repairs at the WWTF and a 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. Both systems are now operating at a reduced flow to continue to capture water in high priority locations to control migration of plumes and minimize injection into the perched aquifer.

The Zone 11 ISB system has a well-established treatment zone in the original portion of the system where injection has occurred since 2009, while deeper reducing conditions are just being established at injection wells within the expansion area that has only received two injections. 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. Review of data at injection wells as compared to treatment zone wells that are located between injection wells indicate that reducing conditions 25 to 50 ft from injection wells are mild and likely not conducive to reduction of TCE. Downgradient Zone 11 ISPM wells are exhibiting effects from the original treatment zone, with perchlorate not detected and TCE greatly reduced in all three original downgradient wells. At the wells downgradient of the expansion zone, declines in concentrations of perchlorate have been observed and may indicate the effects of treatment while declines in concentrations of TCE at two of the wells may indicate treatment is occurring at those wells. Wells downgradient of the expansion area were not expected to demonstrate treatment until up to two years following the second injection.

To address the incomplete treatment of TCE, bioaugmentation for the original treatment zone was completed during the 2015 injection event; bioaugmentation for the expanded treatment zone will not occur until the weight of evidence suggests the proper reducing conditions exist for DHC survival and growth. Pantex is monitoring the impact of the bioaugmentation through the use of qPCR and CSIA data which, combined with other monitoring data, indicate that complete dechlorination is limited at this time due to low counts of DHC and mild reducing conditions in many areas of the Zone 11 ISB where bioaugmentation has occurred. Additional sampling for CSIA and census DNA for DHC and 1,4-dioxane will be conducted at the Zone 11 ISB during 2018. These analyses will be used to determine the effectiveness of bioaugmentation and to evaluate other potential processes that may be helping break down TCE and 1,4-dioxane through co-metabolic processes.

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 below the GWPS. During 2017, 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. Pantex will continue to monitor PTX06-1153 for contaminant concentrations and water levels over time.

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 the 2016 rainfall continued to improve vegetative cover on the landfills. Further work is required in a few areas to fully revegetate the covers and will be conducted through the new long-term maintenance contract. Pantex will also address, through contracting, erosion at Landfill 3 caused by heavy rainfall. The ditch liner is maintained and prevents the infiltration of water that would cause migration of HEs in soils to the perched aquifer. Because of the age of the liner and noted degradation in a few areas, Pantex contracted to replace the liner in 2017 with installation completed in March. The new liner will be more resistant to UV light and is heavier to provide a longer life cycle for the liner. 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 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, Pantex completed a hydrologic evaluation of these areas in 2012. This evaluation is to be updated annually as part of the annual progress reporting. The 2017 update included the addition of groundwater data collected during 2017. Key findings from the new dataset include:

- Groundwater elevations are suggesting continuing effects of pump and treat operations, resulting in reduced mass flux to the southeast.
- Data suggest continued plume movement from the eastern edge of the perched aquifer extent moving southward. Preliminary aquifer testing data suggest this area is conducive to groundwater extraction, which would reduce the flux of COCs to the south. A total of six new extraction wells have been installed east of FM 2373 in a line running east-to-west. Data collected from these wells indicates this is an area of greater saturated thickness than found to the north or south.

Based on the information from the aquifer testing and the understanding that water extraction would limit the perched contaminant migration to the southeast lobe and potential downward migration to the Ogallala, Pantex is actively working to tie-in the new extraction wells to the SEPTS to limit further migration of impacted perched water southward along the eastern margin of the perched aquifer. Tie-in is expected to be complete in 2018.

Pantex has contracted with leading researchers for further study to apply the CSIA and other new analytical techniques to determine where and what type of natural attenuation is occurring across the RDX plume at the Pantex Plant. Groundwater samples for this study have been collected, and the study will be complete by June 2018. If data support quantification of attenuation rates, rates will be calculated to support the evaluation of natural attenuation in areas not under the influence of a remedial action.

Pantex is also collecting groundwater flux data from the southeast area using passive flux meters to help identify areas of higher flux. The passive flux meter study was started in March 2018 and was scheduled for completion in June 2018. Further information will be collected to help identify faster or preferential flow paths that are thought to occur in the southeast area. A geophysical study will be performed by Willowstick to help identify the flow path that appears to be carrying the COCs at a faster rate to the far southeast area and to offsite land. This study is scheduled to be completed by November 2018.

5.2 Conclusions from the First Five-Year Review

The first Five-Year Review Report for the Pantex Remedial Action was submitted in December 2012 and final approval was received in August 2013. While the recommended changes outlined in the 2012 Annual Report did not change, this section will remain in the Annual Progress Reports in order to track the recommendations and subsequent actions taken to address them. Pantex is currently completing the second Five-Year Review, scheduled for completion in September 2018, and recommended actions from that report will be included in the next annual report.

Some issues were noted from the first Five-Year Review that require Pantex to gather additional information to assess the active remedies and the areas that are outside the influence of the remedies and to develop and implement plans to correct noted issues. Deficiencies were also noted in the active remedies so Pantex recommended further actions to optimize remedies or monitoring to ensure continued protection of human health and the environment. The majority of the identified issues and recommendations for optimization have been resolved or the work is ongoing. The status of the remaining issues and recommendation follows:

- Recommendation: There are no criteria established for ceasing SVE system operations. Pantex recommended completion of an SVE Performance Monitoring Plan.
    - Because of continued problems with rebound tests, Pantex contracted to have the system evaluated. Pantex recommended (see 4th Quarter 2016 Progress Report) making modifications to the extraction wells to enhance air flow through the subsurface to increase volatilization and promote aerobic degradation of the NAPL source. Those modifications were completed in May 2017. Pantex will continue to monitor influent concentrations to evaluate declining concentrations and removal rates and will provide recommendations after evaluation of the data collected in 2017 and 2018.
- Issue: Plumes of high explosives (primarily RDX) are expanding east of FM 2373 and in the southeast lobe of the perched aquifer. Pantex completed the initial actions identified in the Five-Year Review. However, the initial actions identified further work that is necessary; therefore, Pantex completed the following actions during 2017:
    - Three additional wells (PTX06-1184, PTX06-1185, and PTX06-1186) were drilled to address the potentially expanding plume to the southeast. The three wells indicated the presence of water at the Pantex boundary to the south. One well drilled north of the boundary indicated that higher levels of contamination were present toward the eastern side, indicating that the plume may have moved in a more easterly direction. Based on high concentrations (649 ug/L) in PTX06-1185, Pantex planned for installation of an extension of the Southeast ISB remedy at the Pantex boundary.
    - Pantex has installed the Southeast ISB extension and concentrations above 1,000 ppb were found in one well. Based on the information collected at the ISB system wells, Pantex started working with neighbors to the south and southeast to obtain agreements to place wells on their property to evaluate potential plume movement. Four wells were drilled on the property to the south in early 2018. RDX and 4-amino-2,6-DNT were found above GWPS in one of the wells (see Section 3 plume maps for details). Pantex is continuing to work with the neighbor to the southeast and expects to gain an access agreement for drilling and sampling. Those additional offsite wells are expected to be installed by the end of September 2018.
    - As discussed above, Pantex has contracted with leading researchers to determine if natural attenuation is a possible remedy for areas that are not under the influence of a remedial action. That work continued through 2017 and is scheduled to be complete in June 2018.

- Issue: Incomplete treatment of contaminants (HEs and hexavalent chromium) downgradient of the west end of the Southeast ISB (at PTX06-1153).
  - Pantex injected amendment into two dry injection wells to attempt to influence PTX06-1153. The wells have received two injections, in 2013 and 2015. Partially treated water has been observed again at PTX06-1153 in 2017, possibly indicating some influence from the injections.
  - Passive flux meters were deployed in fall 2016. A primary objective of the PFM testing was to evaluate the hypothesis that contaminant concentrations have persisted in PTX06-1153 because groundwater in the vicinity of this well is stagnant. Results of the PFM testing show that measureable groundwater flux was observed in PTX06-1153, and PTX06-1153 is not located in a stagnant groundwater zone. The reduced seepage velocity calculated for PTX06-1153 does suggest that flow to the well may be inhibited. Given the location of PTX06-1153, apparent groundwater flux through the well may indicate a groundwater-flow pathway around the western end of the Southeast ISB. Pantex installed a new well west of the ISB in 2017 to evaluate the potential for movement of water around the western end of the ISB; however, perched groundwater was not encountered and the well indicates dry conditions to the west of the ISB. Pantex will continue to evaluate data collected and develop a path forward for this area as needed.

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 Pump and Treat Systems

Perchlorate continues to move into the southwestern SEPTS extraction well field. Pantex is evaluating options for treatment of the perchlorate at the main SEPTS system.

5.3.2 Recommended Changes to the ISB Systems

Pantex recommended an extension of the current ISB remedy for the southeast groundwater plume at the southeast Plant property boundary. The system was installed in late 2017 and will be injected in 2018, after infrastructure is constructed (roads, injection pad, electrical). Two ISPM wells and two monitor wells were drilled downgradient of the system on offsite property. Pantex plans to install further ISPM and monitor wells to the east of the currently installed offsite wells.

5.3.2.1 Southeast ISB

Pantex has continued to evaluate the reason for incomplete treatment at downgradient ISPM well PTX06-1153. Pantex installed a new well west of the Southeast ISB in 2017, with the new well continuing to indicate dry conditions to the west of the ISB. Data collected in 2017 indicate that partially treated water is reaching PTX06-1153 again. It is possible that the injection in the upgradient dry wells may be impacting conditions at PTX06-1153. Pantex will continue to monitor the wells for water levels and the presence of COCs. Water levels at this well continue to decline with the current saturated thickness less than 6 ft at this location.

5.3.2.2 Zone 11 ISB

Pantex is currently evaluating options for the treatment of the TCE plume that extends to the northwest of the current Zone 11 ISB system. Recommendations for a path forward will be provided during 2018 following the review.

5.3.3 Recommended Changes to the Monitoring Network

Pantex installed additional wells downgradient of PTX06-1182 in 2017 to determine perched groundwater and contaminant extent in this area. Pantex has installed wells PTX06-1184, PTX06-1185, and PTX06-1186. These wells indicated the presence of RDX extending to the southeast. Based on the high concentrations of RDX detected in PTX06-1185, Pantex obtained funding to drill a line of ISB wells along the property boundary to the southeast to intercept the further movement of the RDX plume to offsite properties. Pantex drilled all ISB wells and two additional monitor wells to define extent to the east. Pantex has also planned for offsite wells, pending obtaining agreements with landowner. Pantex has obtained one landowner agreement and installed wells in early 2018. One of four wells indicated the presence of RDX above the GWPS. Pantex is continuing to pursue a second agreement to install further wells to the southeast to ensure the extent of the plume is identified. Pantex is also deploying passive flux meter technology to evaluate groundwater flux through the area to the southeast. Passive flux meter data is expected to be complete by June 2018. Pantex will also contract for a geophysical study of the southeast area, extending offsite, to identify preferential flow paths that the COCs are believed to be following. That study will be completed after all planned offsite wells are installed and is anticipated to be complete by November 2018.

5.3.4 Recommended Changes to Soil Remedies

No changes to the landfill remedies are recommended.

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 further evaluation of data in 2018.

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