Homestake Mining Company of California

EXPANDED TPP PILOT TEST IN THE ALLUVIAL AQUIFER

SUMMARY REPORT

Grants Reclamation Project

Grants, New Mexico

October 3, 2016

40-8903

NMSS20

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Our Ref.:

AO000120.007A

Date:

July 25, 2016

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ACRONYMS AND ABBREVIATIONS

ALS	ALS Environmental Laboratory in Fort Collins, Colorado
Arcadis	Arcadis U.S., Inc.
BODR	Final Basis of Design Report
CAP	Corrective Action Plan
CCR	Construction Completion Report
COC	constituent of concern
DP	discharge permit
DPI	days post injection
DR	dose response
DRP	Decommissioning and Reclamation Plan Update 2013
Energy	Energy Laboratories
EW	extraction well
ft bgs	feet below ground surface
ft^2	square feet
ft/d	feet per day
gpm	gallons per minute
HMC	Homestake Mining Company of California
IW	injection well
IW-D	deep injection well
IW-S	shallow injection well
LTP	Large Tailings Pile
MCL	maximum contaminant level
Md	mass discharge
mg/d	milligrams per day
mg/kg	milligrams per kilogram
mg/L	milligram per liter
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NRC	U.S. Nuclear Regulatory Commission

P	phosphorus
PMW	performance monitoring well
PO_4	phosphate
lbs/d	pounds/day
ppm	parts per million
PRB	permeable reactive barrier
RO	reverse osmosis
ROI	radius of influence
site	Grants Reclamation Project, located in Grants, New Mexico
TDR	transect dose response well
TDS	total dissolved solids
TPP	tripolyphosphate
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency
work plan	Work Plan for Expanded TPP Pilot Test in the Alluvial Aquifer

EXECUTIVE SUMMARY

Arcadis U.S., Inc. (Arcadis) prepared this report to present the results of the large-scale field pilot test on in-situ uranium treatment in the alluvial aquifer [expanded tripolyphosphate (TPP) Pilot Test] at the Grants Reclamation Project, located in Grants, New Mexico. Homestake Mining Company of California (HMC) is evaluating the potential for in-situ immobilization and treatment of uranium in alluvial groundwater using a TPP amendment. Prior, small-scale pilot tests conducted in 2013 – 2014 indicated that through injection of TPP into the aquifer, dissolved uranium was immediately precipitated in-situ, remained immobilized, and exhibited residual treatment capacity for at least 6 months post-injection, as presented in the TPP Alluvial Pilot Testing Summary Report (Arcadis, 2014). Subsequent sampling confirmed treatment longevity out to 1 year. The addition of phosphate to the groundwater system results in the transformation of dissolved uranium to uranium phosphate minerals; these have very low solubility and this results in precipitation of uranium from the groundwater. Calcium is also incorporated into the precipitate with the formation of calcium uranium phosphate minerals, such as autinite ($Ca(UO_2)(PO_4)$). These forms of uranium represent mineral forms that are present in stable geologic formations that host uranium. Based on the success of the small-scale pilot tests and supporting laboratory bench testing, a large-scale test was initiated in 2015. The alluvial aquifer near the southwest corner of the Large Tailings Pile (LTP) was selected as the area for the large-scale TPP application because of both its proximity to the LTP and the presence of a high mass flux corridor of dissolved uranium in alluvial groundwater. A 750-foot long transect was constructed for the expanded TPP pilot test consisting of the following:

- Injection wells (IWs): 34 IWs, including 17 shallow [screened ~40 – 60 feet below ground surface (ft bgs]) and 17 feet deep (~60 – 80 ft bgs)
- Extraction wells (EWs): 7 EWs, screened at 50-90 ft bgs
- Performance monitoring wells (PMWs): 16 wells [transect dose response wells (TDRs) and PMWs].

The primary objectives of the expanded TPP pilot test included the following:

- Evaluate implementation at the large-scale, including hydraulic characteristics and effective distribution of treatment solution in the subsurface over a larger area.
- Confirm the efficacy and treatment performance of the technology on a larger scale.
- Investigate feasibility as an in-situ barrier for uranium treatment.
- Evaluate long-term effectiveness and sustainability of the treatment technology.

During a baseline sampling event, dissolved uranium concentrations at the expanded TPP transect ranged between 0.097 milligrams per liter (mg/L; IW-1S) and 2.3 mg/L (TDR-2D). TPP injections began on June 15, 2015, and continued through July 30, 2015. Total phosphorus concentrations in the injectate ranged from 644 to 2,453 mg/L as phosphate (i.e., 210 to 800 mg/L total phosphorus as phosphorus). [Note that throughout this report phosphorus is reported either as “phosphorus as phosphate” or “phosphorus as phosphorus.” To convert between phosphorus and phosphate requires that the phosphorus concentration be multiplied by 3].Two fluorescent tracers were added to the treatment solution for visual screening of breakthrough during the beginning of injections into the IW-S and IW-D transects. Fluorescein (at a concentration of 2 mg/L) was injected into the shallow IWs and rhodamine

WT (at a concentration of 55 mg/L) was injected into the deep IWs. Injections continued until tracer breakthrough was visually observed at an associated dose-response well or until the target radius of influence (ROI) for each respective IW was theoretically achieved based on the total injected volume at each IW location. Injection volumes were designed to provide an ROI of 22 feet, based on a mobile porosity of 10%, as estimated during the small-scale pilot tests in the S Area (Arcadis, 2014b). In total, approximately 1.19 million gallons of TPP injectate were injected in the IWs: approximately 573,000 gallons in the shallow and approximately 618,000 gallons in the deep. Groundwater monitoring for up to 9 months post-injection showed the following results:

- Up to 93% of uranium was removed from the dissolved phase at the point of injection (i.e., the IWs); Uranium concentrations decreased from 2.01 mg/L to 0.135 mg/L (below the site standard of 0.16 mg/L) at 6 months post-injection, and uranium treatment remained steady at 0.149 mg/L at 9 months post-injection.
- Nine wells near the expanded TPP transect exhibited significant uranium treatment during the course of the pilot test (up to 86% treatment). Uranium treatment at or above 45% was also observed at wells S1 (50%), S36 (84%), TDR-1S (50%), TDR-1D (69%), TDR-3S (76%), TDR-4S (48%), and PMW-2S (45%).
- Treatment trends at several wells exhibited somewhat irregular patterns of uranium treatment. These wells were either installed outside the achieved ROI of the IWs or were located at the northern or southern end of the expanded TPP transect where changes in groundwater flow directions occurred. .
- The treatment transect was constructed within the hydraulic barrier so that any unpredicted, potential deleterious effects of its operation would not impact water outside of the barrier. The transect was constructed perpendicular to groundwater flow that was predominantly from the northeast to the southwest during the time of construction. Groundwater flow directions changed during the course of operation of the transect due to increased pumping of groundwater to supply the 1,200 gpm required for the reverse osmosis (RO) treatment plant. The increased pumping was anticipated, however, groundwater flow directions were somewhat less consistent than originally planned.
- The lack of a consistent groundwater flow direction did not affect performance of the barrier, as it is functional regardless of flow-direction. Concise evaluation of treatment performance of the expanded TPP transect in some locations was affected due to the orientation of performance monitoring wells across the barrier.
- During the course of the expanded TPP pilot test, five wells exhibited dissolved uranium concentrations that decreased to below the site standard (0.16 mg/L): TDR-3S, TDR-4S, TDR-5S, S36, and IW-11D (Table 4). Baseline concentrations at these locations ranged from 0.17 mg/L (TDR-4S) to 2.01 mg/L (IW-11D). Uranium concentrations remained below the site standard at 9 months post injection at TDR-3S, TDR-4S, and IW-11D.
- Uranium treatment remained strong after the injection solution had washed out as indicated by the fluorescent tracer and phosphate concentrations. For example, at TDR-3S, the concentration of fluorescein (normalized to the injectate concentration) decreased below 5% by 9 months post injection, while uranium treatment reached a peak of 76%.

- In the IWs and monitoring wells exhibiting positive uranium treatment, orthophosphate concentrations remained steady (e.g., between 584 and 968 mg/L phosphorus as phosphate in IW-D) or reached peak concentrations at 9 months post-injection (e.g., 1,460 mg/L in IW-3D). This is consistent with the expected continual hydrolysis of the injected TPP, to release orthophosphate into groundwater over time.
- The addition of phosphate to the aquifer has the potential to release arsenic by displacing arsenic adsorbed to alluvial sediments. Specific concentration limits were placed on arsenic as follows: arsenic concentration should not exceed 0.2 mg/L within the ROI during injections and should not exceed the Federal Maximum Contaminant Level (MCL) (0.01 mg/L) within 60 feet downgradient (note that the New Mexico standard is 0.1 mg/L). These concentration limits were not exceeded. The highest observed arsenic concentration during injections was 0.0043 mg/L at IW-10D.
- The maximum arsenic concentration was below the concentration limit (0.167 mg/L) and was detected at TDR-2D at 6 months post injection [179 days post injection (DPI)], which corresponds to the peak phosphorus and uranium treatment at this location. At the remaining dose response (DR) wells and PMWs along the transect, peak arsenic concentrations were approximately an order of magnitude lower than at TDR-2D (i.e., the remaining wells had peak arsenic concentrations below 0.017 mg/L). Outside of the treatment zone, arsenic concentrations were not significantly elevated above baseline concentrations. These results confirm that any arsenic liberated through the application of this technology will be temporary and limited to the areas immediately proximal to the injection wells.

These results demonstrate effective treatment of uranium at several wells near the expanded TPP transect, despite changing groundwater hydraulics. Low concentrations of uranium observed in the IWs, DR wells, and PMWs are due to the addition of the TPP amendment (and the slow release of orthophosphate). Dilution effects from the injection solution were not a factor. The injection solution had dissolved uranium concentrations between 1.3 and 4.3 mg/L, well above the lowest achieved dissolved uranium concentrations at many of the PMWs and well above many of the baseline concentrations of IWs, TDRs, and PMWs in the expanded TPP transect. In addition, uranium treatment persisted even as the fluorescent tracers remain low or washed out from the ROI. This indicates that dissolved uranium was transported into the treatment zone from the IW areas and was immobilized by the phosphate precipitates. Uranium treatment was not observed at each monitoring well along the transect, likely due to the variable groundwater flow conditions at the site during the expanded TPP pilot test that inhibited the distribution of phosphate in the alluvial aquifer. The groundwater hydraulics were a factor in the pilot test, but the treatment results indicate that the transect functions effectively as a groundwater treatment barrier regardless of flow direction through the barrier. In summary, the pilot test confirmed the following:

- **Injection and distribution of reagent target volumes are achievable over an extended injection period.**
- **Rapid treatment of dissolved uranium to below site standards was realized after introduction of reagents, with continued treatment over 9 months (270 DPI).**
- **The concentration of calcium within the alluvial groundwater system is adequate to provide for the precipitation of calcium uranium phosphate minerals, as well as for the formation of**

calcium phosphate that can further sorb uranium; the neutral to slightly alkaline groundwater pH is also favorable for uranium precipitation and for the stability of these precipitates.

- **Secondary water quality effects of TPP injection were minor, short-lived, and localized within the ROI of the injection wells.**

The expanded TPP pilot test in the alluvial aquifer southwest of the LTP and within the hydraulic barrier demonstrated that an injection-based approach to treat uranium in-situ at the site is feasible. The results show that the TPP in-situ treatment for dissolved uranium is a viable option for the groundwater restoration program. An in-situ approach is best implemented at key locations within the aquifer to focus treatment on areas where uranium concentrations in groundwater are elevated and persistent. Groundwater can be injected upgradient of a TPP barrier and then extracted downgradient of the barrier, resulting in the best use of the emplaced reactive barrier with the greatest amount of hydraulic control to direct groundwater flow through the barrier. Additionally, TPP barriers can be emplaced across the distal portions of the plume in conjunction with the Restoration Strategy in order to enhance uranium removal and speed operation of the strategy. Arcadis recommends further expansion of the TPP barrier to further evaluate operations and treatment effectiveness so that the technology can be integrated with the existing groundwater Restoration Strategy to effectively and economically reach site closure, and to treat those areas where uranium persists and continues to serve as a source to the alluvium.

1 INTRODUCTION

On behalf of Homestake Mining Company of California (HMC), Arcadis U.S., Inc. (Arcadis) prepared this Summary Report (report) of the Expanded Tripolyphosphate (TPP) Pilot Test in the Alluvial Aquifer. The purpose of this report is to present the results of the large-scale field pilot test on in-situ uranium treatment in the alluvial aquifer (expanded TPP Pilot Test) at the Grants Reclamation Project, located in Grants, New Mexico (Figure 1).

HMC is evaluating the in-situ immobilization and treatment of uranium in groundwater using a TPP amendment. In 2013, the New Mexico Environment Department (NMED) approved a pilot test in two areas of the site's alluvial aquifer. During the small-scale pilot test, a chemical reagent mixture of TPP and calcium chloride was successfully injected into two locations within the alluvial aquifer (the S Area and X Area). The results of this small-scale pilot test indicated that dissolved uranium was immediately precipitated in-situ, remained immobilized, and exhibited residual treatment capacity for at least 6 months post-injection, as presented in the TPP Alluvial Pilot Testing Summary Report (Arcadis, 2014). Subsequent sampling confirmed treatment longevity out to 1 year. Based on the success of the small-scale pilot test and supporting laboratory bench testing, HMC proposed continuing the evaluation of TPP for uranium immobilization through an expanded TPP pilot test in the alluvial aquifer. The design and construction of the expanded TPP Pilot was presented in the Work Plan for Expanded TPP Pilot Test in the Alluvial Aquifer (work plan) (Arcadis, 2015a). The alluvial aquifer at the southwest corner of the Large Tailings Pile (LTP) was selected for large-scale TPP application because of both its proximity to the LTP and the presence of a high mass flux corridor of dissolved uranium in alluvial groundwater (Arcadis, 2015a). In March through May 2015, a 750-foot long transect of injection, extraction, and performance monitoring wells (Figure 2) was constructed for the expanded TPP pilot test at the southwest corner of the LTP. The transect design is summarized in the Final Basis of Design Report (BODR) (Arcadis, 2015b). The well installation and construction details are summarized in the Construction Completion Report (CCR) (Arcadis, 2015c).

The installation and operation of the expanded TPP pilot test transect in the alluvial aquifer occurred in three phases:

- Phase 1: optimization of the injection program (e.g., reagent selection, injection sequence, and bench testing).
- Phase 2: system construction (i.e., well installation and development, system infrastructure installation, hydraulic testing, and system start-up testing).
- Phase 3: operation of the system for the first injection event, as well as subsequent performance monitoring events that extended through 9 months after injections ended.

The BODR (Arcadis, 2015b) summarized the results of Phases 1 and 2. This report summarizes Phase 3, including the details of the first injection event and subsequent post-injection performance monitoring and data evaluation.

1.1 Objectives

The primary objectives of the expanded TPP pilot test were as follows:

- Evaluate larger-scale hydraulics and effective distribution of treatment solution in the subsurface. A line of injection wells installed along a 750-foot long transect at the southwest corner of the LTP were used to deliver reagent to the most permeable lithologies within the saturated thickness of the alluvial aquifer. A series of dose response and performance monitoring wells and fluorescent tracers were used to evaluate the distribution of the injected reagent in the subsurface.
- Confirm the efficacy and treatment performance of the technology on a larger scale. Results from the small-scale alluvial aquifer pilot test indicated treatment of uranium up to 97% (Arcadis, 2014). Performance monitoring during the expanded treatment test allowed for the evaluation of subsurface distribution and maximum treatment capacity of the TPP amendment at a larger scale. Results from this evaluation will be used to optimize the treatment technology prior to full-scale implementation.
- Investigate feasibility as an in-situ barrier for uranium treatment. Long-term performance monitoring of the expanded treatment test provided an opportunity to evaluate this technology as a method to treat and control uranium in the alluvial groundwater plume along a transect resulting in a reduction of downgradient impacts.
- Evaluate long-term sustainability of the treatment technology. Initial results from the small-scale pilot test exhibited sustained treatment of uranium through 1 year post-injection. The larger-scale pilot test further examined the longevity of the TPP treatment and residual treatment capacity of the TPP transect over an extended time period (9 months).

1.2 Report Organization

This report describes the results of Phase 3 of the expanded TPP pilot test in the alluvial aquifer, including TPP injections and subsequent performance monitoring. The remaining sections of this report are organized as follows:

- Section 2 discusses the relevant history and background of the site.
- Section 3 summarizes the expanded TPP pilot test construction, injection and monitoring approaches, and baseline groundwater monitoring results.
- Section 4 presents the results of the performance evaluation, including the achieved amendment concentrations, observed uranium treatment, hydraulic influences near the transect, and residual treatment capacity of the TPP transect.
- Section 5 presents the conclusions from this report and the recommended path forward.
- Section 6 lists the references cited throughout this report.

2 SITE HISTORY AND BACKGROUND

2.1 Site Description

HMC owns and operates the site, which is a former uranium mill located in Cibola County, New Mexico. Currently, the primary activity at the site is the containment and treatment of groundwater through a groundwater restoration program. The objective of this program is to restore concentrations of the constituents of concern (COCs), including uranium, to levels that meet site standards established for each of the affected aquifers at the site. The U.S. Nuclear Regulatory Commission (NRC), the NMED, the United States Environmental Protection Agency (USEPA), and the New Mexico Office of the State Engineer currently share regulatory responsibilities for the site.

An updated and revised Corrective Action Plan (CAP) describing the current site restoration program was submitted to the NRC in March 2012 (HMC, 2012). The updated CAP includes detailed information about current site conditions, recent modifications to the groundwater restoration program, and key aspects of the proposed future components of the CAP, including the evaluation of alternative groundwater treatment technologies.

On September 18, 2014, NMED's discharge permit (DP-200) was renewed for the site. The permit specifies discharge, operations, monitoring, and reporting requirements for groundwater restoration activities and requirements to meet New Mexico environmental standards. The implementation of full-scale alternative treatment technologies (subsequent to the completion of pilot testing), including TPP, are covered by the permit.

2.2 Site Description and History

The approximately 1,085-acre site is located 5.5 miles north of Milan, New Mexico. Uranium milling operations occurred at the site from 1958 to 1990, processing ore from several mines. During the operation of the mill, tailings were deposited in two on-site tailings piles: the Small Tailings Pile and the LTP. At the time of placement, naturally occurring constituent concentrations in the uranium ore were elevated in the tailings pore water. These constituents are considered COCs for the site and include uranium, selenium, molybdenum, sulfate, chloride, total dissolved solids (TDS), nitrate, vanadium, thorium-230, and radium-226/-228.

Pore water seepage from the LTP has impacted shallow groundwater, specifically in the alluvial aquifer directly beneath and downgradient of the LTP. This seepage is the primary source of impacts at the site. The seepage is the focus of restoration efforts, which began in 1977 and are currently expected to continue through 2020. To limit potential future impacts from the LTP and to inhibit the expansion of the plume, a groundwater restoration program began in 1977, focusing on both source control and plume mass removal. Active restoration efforts are expected to continue through 2020, with final evaporation of extracted water continuing through 2022.

The CAP (HMC, 2012) includes five major operational components: (1) source control, (2) plume control, (3) reverse osmosis (RO) treatment, (4) evaporation, and (5) land treatment. Land treatment was discontinued in 2014. The four components of the current CAP work in combination as a proven strategy to achieve source control and plume remediation. The source control program limits future contaminant migration from the LTP. The plume control program inhibits the downgradient migration of contaminated groundwater and sends impacted groundwater to the RO plant for treatment. Evaporation is an additional water management strategy that allows HMC to achieve target treatment rates. Water treatment residuals accumulate as a result of RO treatment and evaporation. These residuals require management and final disposition, which is detailed in the Decommissioning and Reclamation Plan Update 2013 (DRP) (Arcadis, 2013). In-situ treatment of uranium does not generate treatment residuals that require management above ground; instead, uranium is immobilized as a low-solubility mineral form within the aquifer system. In-situ treatment returns uranium to a stable mineral form, similar to the form it existed in prior to mining and milling.

The endpoint of the CAP and restoration program is the achievement of the site standards. NRC, USEPA, and NMED agreed on groundwater site standards for each COC for each aquifer. These standards were incorporated into the NRC license through License Amendment No. 39 as groundwater protection standards. The site standards were finalized in 2006 after background water quality was evaluated. Site standards for key COCs are included in Table 2.

2.3 Site Conceptual Model

The geologic and hydrogeologic settings of the site are complex, and significant effort has been made during the past 40 years to understand the regional and local conditions of the site. Much of that information is summarized in the Background Water Quality Evaluation of the Chinle Formation Report (HMC and Hydro-Engineering, 2003) and in Section 3 of the Updated and Revised CAP (HMC, 2012).

The shallow unconfined aquifer in the area (the alluvial aquifer) includes the Quaternary Alluvium and surficial volcanic flows. Deeper confined aquifers include three bedrock aquifers in the Chinle Formation and a regional bedrock aquifer in the San Andres Limestone and the Glorietta Sandstone. Each aquifer unit subcrops at the base of the alluvium, where hydraulic connectivity occurs in areas of alluvium saturation (mixing zone). Two bedrock faults traverse the site area along a northeast-southwest orientation, adding to the subcrop zone complexity. The primary source impacting groundwater at the site is the gradual seepage of pore water from the tailings as it consolidates following deposition in the LTP. This tailings pore water contains elevated concentrations of uranium and other COCs as a result of the residual chemistry of the alkaline leach milling process. This seepage water moves from the bottom of the LTP into the partially saturated zone above the alluvial aquifer directly beneath the LTP. The tailings pore water seepage then flows downgradient, to the southwest of the LTP, where it is currently managed by the plume control program. The concentration of dissolved uranium in the alluvial aquifer is highest in the areas immediately to the south and southwest of the LTP (Arcadis, 2014). Thus, this area of the alluvial aquifer was selected for the expanded TPP pilot test.

2.4 Alluvial Pilot Testing Summary

In 2013, Arcadis conducted a small-scale TPP pilot test in the alluvial aquifer. The goals of the pilot test were to evaluate the effectiveness and feasibility of in-situ uranium treatment in the alluvial aquifer via the addition of a phosphate amendment, and to collect design parameters necessary for field implementation on a larger scale (e.g., groundwater flow directions, optimized injection solution concentrations, and optimized injection volumes). To accomplish these objectives, two locations were selected for TPP pilot tests: the S Area (west of the LTP) and the X Area (northeast of the LTP) (Figure 1). The objectives of the small-scale alluvial pilot test were to evaluate the efficacy of uranium immobilization, as well as the long-term stability and residual treatment capacity of uranium phosphate precipitates the subsurface. In the S Area, a total of 16,400 gallons of injection solution were injected into the aquifer: 13,400 gallons of TPP solution and 3,000 gallons of calcium chloride solution. In the X Area, 5,400 gallons of injection solution were injected into the alluvial aquifer: 3,900 gallons of TPP solution and 1,500 gallons of calcium chloride solution.

The TPP pilot test in the alluvial aquifer demonstrated that TPP could be injected into the subsurface without significant well-fouling, dissolved uranium concentrations immediately decreased below site standards in higher permeability lithologies (i.e., the sands in the S Area), and treatment was sustained through 1 year post-injection. Uranium that was precipitated during the small-scale pilot test remained immobilized and treatment persisted throughout the test even as the reagent washed out of the reactive zone and after attempts at remobilization (through push-pull testing). Secondary water quality effects (e.g., elevated dissolved arsenic concentrations) were minor, short-lived, and localized within the monitoring network nearest to the injection wells. This small-scale test in the alluvial aquifer demonstrated that an injection-based approach to treat uranium in-situ at the site is feasible. Results showed that the TPP in-situ treatment approach is a viable option for the groundwater restoration program.

3 EXPANDED TPP PILOT TESTING

The goals of the expanded TPP pilot test were to evaluate larger-scale hydraulics and effective distribution of treatment solution in the subsurface, confirm the efficacy and treatment performance of the technology on a larger scale, investigate feasibility as an in-situ barrier for uranium treatment, and evaluate long-term sustainability of the treatment technology. To accomplish these objectives, a large-scale transect of injection, extraction, and performance monitoring wells was installed in the alluvial aquifer in an area of high uranium flux (i.e., at the southwest corner of the LTP). The design of the expanded TPP transect and the pilot test work plan were detailed in the work plan (Arcadis, 2015a) and BODR (Arcadis, 2015b). The CCR (Arcadis, 2015c) describes the system construction (including well and system infrastructure installation), hydraulic testing, and system start-up procedures. The system design, construction, and baseline sampling results presented in these reports are briefly summarized below.

3.1 System Design and Construction

As described in the work plan (Arcadis, 2015a) and BODR (Arcadis 2015b), the constructed transect is 750-foot long and is located along the southwest corner of the LTP (Figure 1). The transect was constructed as follows:

- A series of 34 evenly spaced injection wells (IWs) were installed along the 750-foot transect, with a 20-foot screened interval for each well. Two transects of injection wells were installed, one for shallow injection wells (IW-S) and one for deep injection wells (IW-D). The IW-S transect was installed approximately 10 feet upgradient (to the north-northeast) and offset laterally on approximately 22-foot centers from the IW-D transect. Well construction details are included in Table 1. The final screened interval at each IW location was determined by the observed lithology to optimize reagent delivery in the zones of highest dissolved uranium flux (e.g., coarse sand and gravel lenses). A transect layout map is shown on Figure 2, and Figure 3 presents a geologic cross-section parallel to the IW transects.
- A line of seven evenly spaced extraction wells (EWs) was installed approximately 50 feet upgradient of the injection well transect. The EWs are fully screened (40-foot screen lengths) from 50 to 90 feet below ground surface, with screen elevations vertically offset from the IW-D screens to enhance distribution both laterally and vertically within the alluvial aquifer.
- A network of 10 nested transect dose-response wells (TDRs) were installed at five locations and six nested performance monitoring wells (PMWs) were installed at three locations. These wells were located within, upgradient, and downgradient from the IWs and EWs to monitor the performance of the well transect during and after injections. These wells were installed at radii between 10 and 30 feet from the nearest IWs and at similar screen intervals. Previously installed wells in the area (e.g., S36 and S1) were also identified and included as dose response and PMWs, as appropriate, to augment the monitoring network. The locations of these wells are shown on Figure 2, and well construction details are included in Table 1.

3.2 Baseline Sampling

Groundwater samples were collected after well development from select wells along the transect to provide a baseline for constituent concentrations prior to injections in April 2015. Water-level monitoring was also conducted in May 2015 to confirm the predominant groundwater flow direction near the transect prior to injection. Baseline groundwater samples were collected from 41 wells (Table 3):

- A subset of 15 IWs from along the IW-D and IW-S transects
- Ten TDRs (TDR-1S/D through TDR-5S/D)
- Six PMWs (PMW-1S/D through PMW-3S/D)
- Ten previously installed wells near the TPP transect (S1, S3, S14, S15, S18, S26, S27, S28, S36, and SA).

As directed by HMC, the samples from these wells were submitted to Energy Laboratories (Energy) in Casper, Wyoming where they were analyzed for the full analyte list included in Table 2 (except for fluorescent tracer, which was not present in the aquifer prior to injections). Table 3 presents a summary of the sampling program, and Table 4 presents results for the key analytical parameters from the baseline sampling event.

The dissolved uranium concentrations from the baseline sampling event are presented on Figures 3 and 4. Dissolved uranium concentrations are generally consistent with historical results in the southwest corner of the LTP (Arcadis, 2014). During the baseline sampling event, dissolved uranium concentrations at the expanded TPP transect ranged between 0.097 milligrams per liter (mg/L; IW-1S) and 2.3 mg/L (TDR-2D).

Figure 3 presents the baseline sampling results from the IWs, showing the variation of dissolved uranium concentrations with depth in the alluvial aquifer. Seven shallow IWs (IW-1S, IW-3S, IW-6S, IW-10S, IW-12S, IW-15S, and IW-17S) and eight deep IWs (IW-1D, IW-3D, IW-7D, IW-10D, IW-11D, IW-13D, IW-15D, and IW-17D) were sampled during the baseline monitoring event (Table 4). Along the TPP transect, higher dissolved uranium concentrations were observed in the deeper screened intervals. Dissolved uranium concentrations at the IW-S locations ranged from 0.097 mg/L at IW-1S to 1.59 mg/L at IW-12S. Among the IW-D locations, the dissolved uranium concentrations ranged from 0.58 mg/L at IW-1D to 2.01 mg/L at IW-11D. The average baseline dissolved uranium concentrations in the IW-S and IW-D wells were 0.53 mg/L and 1.34 mg/L, respectively. Higher dissolved uranium concentrations were generally observed in locations where higher permeability materials (e.g. sand and gravel) are present (Figure 3). Upgradient of the expanded TPP transect, baseline dissolved uranium concentrations were approximately one order of magnitude higher, ranging from 13.1 mg/L at well S3 to 31.6 mg/L at well SE6.

Figure 4 presents the dissolved uranium concentrations from the baseline sampling event in April 2015, with the green and yellow shaded areas representing the historic observed concentrations of dissolved uranium in the alluvial aquifer from 2010 to 2014 (Arcadis, 2014). Consistent with historic results, the dissolved uranium concentration in the alluvial aquifer near the expanded TPP transect is highest in the center of the transect, with slightly lower observed dissolved uranium concentrations at the northern and southern end of the transect.

Potentiometric contour maps are presented in Figures 5A and 5B. The potentiometric contour map from the May 27, 2015 monitoring event (Figure 5A) presents the groundwater flow conditions observed prior to the initiation of TPP injections.

3.3 Injection Approach

Injected amendment solution consisted of TPP that was mixed with groundwater pumped from six of the seven EWs (i.e., EW-1 and EW-3 through EW-7). EW-2 was not used to extract groundwater during the injection period due to poor hydraulic performance during well development and hydraulic testing (Arcadis, 2015b). However, pumping rates from the other six EWs were sufficient to maintain the target injection rates. During injections, EW-1 and EW-3 maintained extraction rates between 2.7 and 4.5 gallons per minute (gpm), and EW-4 through EW-7 generally maintained extraction rates between approximately 12 and 14.5 gpm.

A common pipeline conveyed extracted groundwater from the six operating EWs to the reagent mixing system. The majority of the extracted groundwater was routed to the TPP dosing tank. A portion of the extracted groundwater was routed to the TPP mix tank. TPP was delivered to the treatment system area in granular form (in super sacks) and loaded into a hopper. The elevated hopper allowed for automated addition of the TPP reagent to the mix tank, where a combination of mechanical mixers and jet eductors served to fully dissolve the dry reagent in the aqueous solution. The highly concentrated solution was then transferred to the dosing tank by a transfer pump with a variable frequency drive (VFD). This connection to the VFD controlled the dosing rate and volume dosed. An eductor located in the dosing tank helped to further mix the untreated extracted groundwater as the reagent solution was dosed. Instruments and alarms facilitated automatic flow adjustments within the system. The BODR (Arcadis, 2015b) and the CCR (Arcadis, 2015c) provide additional details on the system design and construction. After reagent mixing, the TPP-amended groundwater flowed through an injection conveyance piping network to the 34 IWs. Each IW was outfitted with a ball valve and totalizer, allowing injections to be diverted to a specific subset of the IWs and for injections at each wellhead to be controlled and monitored.

TPP injections began on June 15, 2015 and continued through July 30, 2015. The target injectate concentration was 2,000 mg/L of TPP (as phosphate). Samples of the injectate solution were periodically sent to Energy and ALS Environmental Laboratory (ALS) in Fort Collins, Colorado to confirm TPP concentrations. Analytical results from these injectate samples are presented in Table 5. Actual total phosphorus concentrations ranged from 644 to 2,453 mg/L as phosphate (i.e., 210 to 800 mg/L total phosphorus as phosphorus; Table 5). The system was initially manually calibrated and adjusted to obtain the target dosing. As a result, injectate concentrations at the beginning of the injection period were occasionally higher or lower than the target. Measured dissolved uranium concentrations in the injectate solution ranged from 1.3 to 4.1 mg/L (Table 5). These dissolved uranium concentrations are within the range observed in other wells proximal to the test area (Figure 4 and Table 4). At any given time, injections occurred in a select subset of the 34 IWs. Injections first began in select shallow IWs, and the target injection rates for each IW were selected based on the specific capacity of each well during hydraulic testing (Arcadis, 2015c). Injection rates and water levels at the IWs were monitored twice daily and adjusted as necessary to prevent backflow into the injection lines. Injections were also initiated at additional IWs as necessary to maintain the maximum sustainable injection rate of the system.

Fluorescent tracers were added for visual screening of breakthrough during the beginning of injections into the IW-S and IW-D transects. Two fluorescent tracers were used: fluorescein (at a concentration of 2 mg/L) was injected into the shallow IWs and rhodamine WT (at a concentration of 55 mg/L) was injected into the deep IWs (Table 5). Injections continued until a tracer breakthrough was visually observed at an associated dose-response well or until the target radius of influence (ROI) for each respective IW was theoretically achieved based on the total injected volume at each IW location. Injection volumes were designed to provide an ROI of 22 feet, based on a mobile porosity of 10%, as estimated during the small-scale pilot tests in the S Area (Arcadis, 2014b). Once the tracer was observed at the nearest dose response (DR) well, an analytical sample was collected from the DR well (Table 2) and fluorescent tracers were no longer added to the injectate. Analytical results for these injection performance monitoring samples are presented in Table 4. Once the ROI was achieved, the injection valve at each IW was closed, and other IW valves were opened as necessary to maintain and maximize the total system flow rate. TPP injections continued through July 30, 2016. In total, approximately 1.19 million gallons of TPP injectate were injected in the IWs: approximately 573,000 gallons in the shallow and approximately 618,000 gallons in the deep. Total injection volumes at each well are presented in Table 6.

After several weeks of injections, TPP scaling and precipitation was observed in the system pipes. This corresponded with a slight decline in observed injection rates (i.e., injectability). To minimize precipitate build-up and potential fouling of the system and injection wells, a flush of unamended groundwater (i.e., groundwater without TPP reagent) was occasionally injected into the IWs throughout the injection period to clean the system pipelines. Following TPP injections, a final unamended groundwater flush was conducted to clean the system between July 30 and August 5, 2015. In total, approximately 100,000 gallons of unamended groundwater were injected in the IWs as a part of the groundwater flushes (Table 6).

3.4 Performance Monitoring

Two monitoring programs were used for the pilot test: injection monitoring (immediately before and during active injection) and performance monitoring (post-injection). The performance-monitoring program is summarized in Table 3 and included analysis listed in Table 2. Baseline monitoring samples and 1-week post-injection monitoring samples were analyzed for the full analytical parameter list. Subsequent performance monitoring events included analyses for only the key analytes identified in Table 2. Analytical results for the key analytes for all monitoring events are presented in Table 4.

As directed by HMC, all performance-monitoring samples were submitted to Energy for analysis; however, the turnaround time for these analyses was too long (more than 6 weeks) to obtain results during the injection period. Therefore, to obtain analytical data for adequate injection monitoring (and timely adjustments to the injection program), select groundwater samples were sent to ALS and analyzed for key constituents (e.g., arsenic, uranium, phosphorus, and orthophosphate). The results were received in less than 7 days. The purpose of these analyses was to confirm the distribution of key injectate parameters and to monitor COC concentrations (arsenic and phosphorus).

3.5 Contingency Planning

During injections, arsenic and phosphorus were monitored in the field using portable chemical analyses kits and quick turnaround time analyses. Active monitoring of phosphorus and arsenic were a component of the Conditional Temporary Permission to Discharge Letter issued by NMED (NMED, 2013). The following concentration limits were established:

- Arsenic: 0.2 mg/L at dose response wells and concentrations needed to attenuate to 50% of the concentration observed at the dose response well at the farthest downgradient monitoring well. Note that the New Mexico Administrative Code (NMAC) 20.6.2.3103 standard for arsenic in groundwater is 0.1 mg/L.
- Phosphate: 1,500 mg/L phosphorus as phosphate above baseline at dose response wells and 150 mg/L phosphorus as phosphate above baseline at the farthest downgradient performance well.

Arcadis created a groundwater monitoring and contingency action plan for secondary groundwater effects based on these concentration limits. This monitoring plan was strictly followed throughout the duration of pilot testing. Arsenic and phosphate concentrations were monitored periodically during injections using both HACH kits (for field measurement) and quick turnaround time analyses that were sent to ALS. Dissolved arsenic and phosphorus did not exceed these limits at dose response wells at any point during the expanded TPP pilot test.

4 PERFORMANCE EVALUATION

Baseline and post-injection analytical and water-level monitoring data have been collected through 9 months post-injection [approximately 270 days post injection (DPI)] for key parameters necessary to evaluate the performance of the expanded TPP pilot test, including field parameters (pH and conductivity), dissolved uranium and phosphorus, and arsenic. Analytical samples for dissolved calcium and fluorescent tracers (fluorescein and rhodamine WT) were also routinely collected.

Field and analytical data from the alluvial pilot test were used to evaluate the achieved injectate amendment concentrations, the achieved in-situ amendment concentrations, the distribution of the injection solution in the alluvial aquifer, the efficacy of uranium immobilization, the residual treatment capacity, and the secondary geochemical and hydraulic effects from the injections.

4.1 Hydraulic Conditions Observed During Testing

Water levels were routinely monitored at up to 47 wells near the expanded TPP transect as part of the expanded TPP pilot test performance monitoring program. The objective of the water-level monitoring was to determine the prevailing groundwater flow direction in the vicinity of the transect to facilitate evaluation of TPP treatment and performance monitoring data.

Baseline groundwater-level monitoring occurred on May 27, 2015 to determine the prevailing groundwater flow direction prior to initiation of TPP injections. The baseline monitoring event confirmed a groundwater flow direction from the north-northeast to the south-southwest in the alluvial aquifer (Figure 5A), which was comparable to that observed during the small-scale pilot test (Arcadis, 2014). Depth-to-water and groundwater elevation measurements from the baseline, 1-week, 3-weeks, 6-weeks, 3-months, 6-months, and 9-months post-injection monitoring events are presented in Table 7. In addition to these events, a small subset of seven wells (S1, S2, S5, SM, SN, SO, and SP) near the TPP transect were monitored weekly by HMC staff as part of monitoring the RO treatment plant operation. These limited but more frequent water-level monitoring events were used to support the evaluation of changing groundwater flow conditions near the TPP transect. Figures 5A and 5B present selected potentiometric contour maps that exhibit the range of groundwater flow conditions that were observed throughout the expanded TPP pilot test.

As described in Section 2, the RO treatment plant is currently a key component of the CAP. In August 2015, upgrades to the RO treatment were completed as part of the ongoing plume control program, and the RO treatment plant began operating at flow rates up to 1,200 gpm. Much of the water from the plume control program is extracted from the alluvial aquifer in the vicinity of the expanded TPP transect (e.g., well SA). Figures 5A and 5B demonstrate that the variable operation of the RO treatment plant had a significant effect on the groundwater hydraulic conditions near the TPP transect, altering the groundwater flow direction from that observed during baseline conditions which were used to inform the transect design and orientation:

- August 24, 2015: groundwater flow conditions exhibited a relatively flat hydraulic gradient from north to south through the TPP transect.
- August 31, 2015: groundwater flow conditions exhibited a steep gradient from east to west perpendicular to the TPP transect.

- October 26, 2015 (3 months post-injection): groundwater flow conditions again exhibited a relatively flat gradient from north to south through the TPP transect, with localized cones of depression and mounding around extraction well SA and injection well ST.
- January 25, 2016 (6 months post-injection): groundwater flow was focused toward the TPP transect from both east and west of the TPP transect, with groundwater channeled southwards within the TPP treatment zone.
- April 25, 2016 (9 months post-injection): the predominant groundwater flow direction was eastwards through the TPP transect, with flow towards the LTP and extraction well SA.

The extremely variable groundwater flow conditions near the expanded TPP transect likely affected the performance of the TPP transect by creating uneven distribution of orthophosphate in the subsurface and limiting the time available for transport of treated groundwater away from the TPP transect. Orthophosphate is released slowly over time by the injected TPP reagent. As this orthophosphate is released, apatite and uranyl-phosphate minerals precipitate and bind uranium in an insoluble form in the subsurface (Arcadis, 2014 and references therein). As orthophosphate is released, uranium concentrations are expected to decrease in the alluvial aquifer, as evidenced by decreasing uranium concentrations in downgradient performance monitoring wells (Arcadis, 2014). However, variable groundwater flow conditions during the expanded TPP pilot test did not transport groundwater consistently in one downgradient direction. Therefore, the distribution of orthophosphate in the subsurface was likely not consistent, and there was also not sufficient time for TPP amended groundwater to travel from the TPP transect to downgradient performance monitoring wells (e.g., PMWs or EWs) before the flow direction changed. As a result, the evaluation of the TPP transect and the observed uranium treatment were focused on the TDRs and IWs that were closest to the IW transect where treatment was most likely to be observed. Regardless of changing groundwater flow conditions, the TPP transect was able to treat uranium in groundwater. The TPP transect functions to remove uranium in groundwater flowing in any direction through the barrier. The challenge related to changing flow conditions, that were a function of site operations, is in the interpretation of the data rather than treatment efficacy. The following sections describe TPP amendment distribution and data related to treatment effectiveness.

4.2 Achieved Amendment Concentrations

Table 8 presents the targeted and achieved injection parameters for the expanded TPP pilot test. The targeted injectate phosphorus concentration was 2,000 mg/L total phosphorus as phosphate. During the injection period, five samples of the injectate solution were sent to Energy and ALS to confirm the achieved injectate concentrations. The results from these analyses are presented in Table 5. Table 8 presents the average injected total phosphorus concentrations in the IW-S and IW-D wells, as well as the average injected total phosphorus concentration for the entire transect (both shallow and deep injection wells). The average injected phosphorus concentrations were approximately 1,100 mg/L for the IW-S wells, 1,400 mg/L for the IW-D wells, and approximately 1,300 mg/L for the entire transect (Table 8). The achieved average injectate concentrations were approximately 50 to 70% of the target concentration. The variability in injected concentrations was likely due to manual calibration of the system dosing mechanism (as described in Section 3.3).

Targeted in-situ total phosphorus as phosphate concentrations were 1,000 mg/L. The achieved in-situ total phosphorus as phosphate concentrations were 2 to 12 times higher than targeted (Table 4) at the IWs. To monitor phosphate breakthrough during injection and performance monitoring, groundwater samples were collected from three injection wells (IW-3D, IW-9D, and IW-11D). Total phosphorus as phosphate concentrations ranged from 2,000 mg/L to 10,000 mg/L, with an average achieved in-situ total phosphorus concentration of approximately 5,300 mg/L as phosphate (PO_4) (Tables 4 and 8). The variability in the observed and targeted concentrations of total phosphorus is likely due to batching variability (Table 5), as described in Section 3.3. These concentrations were measured at injection wells. Concentrations at the dose-response wells remained below the concentration of phosphorus as phosphate (1,500 mg/L), requiring contingency action to limit phosphate concentrations (discussed below).

At the DR wells, phosphorus concentrations were less than 5% of the achieved in-situ concentrations at the IWs and less than 15% of the achieved injectate concentrations. The maximum observed total phosphorus concentration at a dose-response well was 25.6 mg/L as phosphorus (P) (78.5 mg/L as PO_4) at TDR-2D on January 25, 2016 (approximately 6 months post-injection; Table 4). This corresponds to phosphorus concentrations that were less than 10% of the targeted in-situ concentrations of phosphorus. TDR-2D is located approximately 22 feet from the nearest IW. At the two closest IWs to dose-response well TDR-2D, approximately 36,000 and 42,000 gallons of TPP solution were injected into IW-6D and IW-5D, respectively, corresponding to an approximate ROI of 23 feet. TDR-2D is located on the edge of this estimated ROI. These data suggest that either there was attenuation of phosphate concentrations in the subsurface during injections due to retardation and sorption effects or that achieved ROIs were smaller than anticipated (e.g., due to a larger-than-expected mobile porosity). Higher TPP concentrations and/or injection volumes would be required to overcome retardation and sorption effects to achieve similar in-situ concentrations of total phosphorus as those observed at the IWs. Attenuation and sorption of phosphorus is a positive attribute of the injected chemical as it allowed for emplacement of the reactive treatment zone, without "wash out" of the injected reagent.

4.3 Injected Solution Breakthrough

Injection solution breakthrough was visually monitored at dose response wells during injections using fluorescent tracers. TDR-4S/D and TDR-5S/D were installed a few feet outside the anticipated ROI, and thus were used as PMWs rather than DR wells during injections (Arcadis, 2015b). Nearby IWs (e.g., IW-10D) were substituted as DR wells in the place of TDR-4S/D and TDR-5S/D. Fluorescein was injected into the IW-S wells (at a concentration of approximately 2 mg/L) and rhodamine WT was injected into IW-D wells (at a concentration of approximately 55 mg/L). After 10 days of injections in the IW-S wells, fluorescein tracer was visually detected at IW-10D. IW-10D was monitored as a DR well during shallow zone injections and prior to the beginning of deep zone injections. The presence of fluorescein in an IW-D well suggests that there was a slight downward gradient induced during injections in the IW-S wells. Tracer was first visually detected at DR wells TDR-1S/D and TDR-3S/D 2 days later, after approximately 220,000 gallons were injected into the IW-S wells.

The peak fluorescein tracer concentration during injections was observed at IW-10D at approximately 10% of the injectate concentration (Table 4). Once injections ended, tracer concentrations continued to increase at DR wells. The peak fluorescein concentration (21%) was observed at TDR-3S at approximately 6 weeks post injection (approximately 42 DPI). Fluorescein concentrations at TDR-3S decreased gradually through 6 months post-injection, when fluorescein was still present at approximately 4% of the injectate concentration. Peak fluorescein concentrations at TDR-1S and TDR-2S were less than 3% of the injectate concentration. These results confirm that the DR wells were located on the outer edge of the ROI of the shallow zone (IW-S) injections. Normalized tracer concentrations for TDR-3S are shown on the normalized amendment signature plot in Figure 7.

Rhodamine WT was first observed in trace amounts at DR wells TDR-2D and TDR-3D approximately 20 days after injections began. Peak rhodamine WT concentrations were observed at TDR-2D at concentrations between 2.5 and 4% of the injected concentration from 3 weeks through 3 months post-injection. Rhodamine WT then decreased slightly at TDR-2D (to 1.8% of the injected concentration through 9 months post-injection). All other dose response wells detected less than approximately 1% through 9 months post-injection. These results confirm that the DR wells were located on the outer edge of the ROI of the deep zone (IW-D) injections. Normalized tracer concentrations for TDR-2D are shown on the normalized amendment signature plot in Figure 7. At-a-glance charts showing key performance monitoring parameters for all wells are included in Appendix A. These data suggest that the injected volumes were sufficient to achieve ROIs of approximately 22 feet at most IW locations.

4.4 Uranium Treatment

Tables 4 and 5 present the results of the expanded TPP pilot test performance monitoring events. At-a-glance charts of the key performance parameters for all wells are included in Appendix A.

4.4.1 Efficacy of Uranium Immobilization

Although variations in the groundwater flow direction impacted the interpretation of performance of the expanded TPP pilot test, monitoring data at several TDRs, PMWs, and nearby S wells demonstrate that effective treatment of uranium can be achieved at the transect. Figure 6A presents uranium treatment trends for select wells near the expanded TPP transect that demonstrate the best performance. Figure 6B presents contours of uranium treatment through time along the transect. Key observations from the TPP pilot test are as follows:

- Up to 93% of uranium was removed from the dissolved phase at the point of injection (i.e., the IWs). At IW-11D, uranium concentrations decreased from 2.01 mg/L to 0.135 mg/L (i.e., below the site standard) at 6 months post-injection, and uranium treatment remained steady at 0.149 mg/L at 9 months post-injection.
- Nine wells near the expanded TPP transect exhibited significant uranium treatment during the course of the pilot test (Figure 7 and Table 4). TDR-2D exhibited the best treatment of uranium (86%). Uranium treatment at or above 45% was also observed at wells S1 (50%), S36 (84%), TDR-1S (50%), TDR-1D (69%), TDR-3S (76%), TDR-4S (48%), and PMW-2S (45%).
- Treatment trends at several wells (e.g., TDR-2S, TDR-2D, TDR-4D, and TDR-5S) exhibited somewhat irregular patterns of uranium treatment (Figure 7 and Table 4). However, these wells were either installed outside the achieved ROI of the IWs (i.e., TDR 4S/D and TDR-5S/D were installed greater than 22 feet away from the nearest IW) or are located at the northern or southern end of the expanded TPP transect where changes in groundwater flow directions would have had the greatest

impact. The remaining dose response and performance monitoring wells did not show significant uranium treatment. The lack of a consistent groundwater flow direction likely limited the performance of the expanded TPP transect in these locations.

- During the course of the expanded TPP pilot test, five wells exhibited dissolved uranium concentrations that decreased to below the site standard (0.16 mg/L): TDR-3S, TDR-4S, TDR-5S, S36, and IW-11D (Table 4). Baseline concentrations at these locations ranged from 0.17 mg/L (TDR-4S) to 2.01 mg/L (IW-11D). Uranium concentrations remained below the site standard at 9 months post injection at TDR-3S, TDR-4S, and IW-11D.
- Uranium treatment remained high after the injection solution had washed out as indicated by the fluorescent tracer and phosphate concentrations. For example, at TDR-3S, the concentration of fluorescein (normalized to the injectate concentration) decreased below 5% by 9 months post injection, while uranium treatment reached a peak of 76% (Figures 6A and 7).
- In the IWs and monitoring wells exhibiting positive uranium treatment, orthophosphate concentrations have remained steady (e.g., between 584 and 968 mg/L in IW-D) or reached peak concentrations at 9 months post-injection (e.g., 1,460 mg/L in IW-3D), as shown in Table 4. This is consistent with the expected hydrolysis of TPP to release orthophosphate.

These results demonstrate effective treatment of uranium at several wells near the expanded TPP transect, despite challenging groundwater hydraulics. Low concentrations of uranium observed in the IWs, DR wells, and PMWs are due to the addition of the TPP amendment (and the slow release of orthophosphate). Dilution effects from the injection solution are not a factor. The injection solution had dissolved uranium concentrations between 1.3 and 4.3 mg/L, well above the lowest achieved dissolved uranium concentrations at many of the PMWs and well above many of the baseline concentrations of IWs, TDRs and PMWs in the expanded TPP transect. In addition, uranium treatment persists even as the fluorescent tracers remain low or washout from the ROI. This indicates that dissolved uranium is being transported into the treatment zone from the IW areas and being immobilized by the phosphate precipitates. Although uranium treatment was not observed at each monitoring well along the transect, this was likely due to the variable groundwater flow conditions at the site during the expanded TPP pilot test, which inhibited the distribution of phosphate in the subsurface. However, despite the challenging groundwater hydraulics, these results indicate that the transect functions effectively as a groundwater treatment barrier if consistent groundwater flow conditions could be maintained during the injection and performance monitoring periods,

4.4.2 Long-Term Stability and Treatment Capacity

One of the original goals of the pilot test was to demonstrate long-term treatment capacity of the TPP amendment. Uranium can be removed from solution via phosphate treatment through two mechanisms: precipitation of uranium-containing phosphate minerals (primarily autunite, $Ca(UO_2)(PO_4)$), or sorption to a phosphate mineral surface (primarily apatite, $Ca_{10}(PO_4)_6(OH)_2$). The expanded TPP pilot test worked through the addition of soluble phosphates to the groundwater at a concentration above calcium-phosphate saturation. The injected solution provided the chemical building blocks to promote precipitation of autunite and apatite. Formation of autunite is generally rapid, occurring on the scale of days to months. However, the sorptive capacity of autunite and apatite can persist for much longer. Mehta and fellow researchers (2014) found that in systems with high calcium and phosphate, even when direct precipitation of autunite is not occurring, dissolved uranium is still removed from solution through sorption reactions with apatite. In fact, sorption to apatite can reduce dissolved uranium to a lower concentration than would result from the precipitation of autunite alone (Arey et al., 1999), making it the ideal polishing treatment when low resulting uranium concentrations are necessary.

This sorptive ability of apatite is what drives its use in permeable reactive barriers (PRBs), where water passively flows through an emplaced barrier, resulting in treatment of dissolved uranium. Field applications of hydroxyapatite PRBs have shown that when solid-phase apatite media is used, uranium is removed from solution through sorption onto apatite surfaces (Fuller et al., 2002; Fuller et al., 2003). Instead of physically installing a barrier with commercial apatite, Arcadis has chemically injected the soluble building blocks for an apatite barrier and allowed it to form in place in the subsurface. The advantages of this include reduced disturbance of the subsurface and minimal groundwater flow disturbance, as are likely to occur with physically emplaced barriers.

Recent sampling events on site have shown that white solids, which are most likely amorphous calcium-tripolyphosphate solids that react over time to release phosphate, are present in the injection wells. Uranium treatment in these wells is close to 100% [i.e., IW-11D (Appendix A)], indicating that a number of processes are likely occurring including autunite precipitation and uranium sorption to hydroxyapatite, effectively removing uranium from groundwater. As long as solid calcium phosphates are present in the subsurface along the TPP transect, uranium treatment will persist.

Once autinite is formed or uranium is sorbed to apatite, it is exceedingly stable relative to the potential for remobilization. Evidence for this stability comes from laboratory studies and from natural analogs, specifically uranium ore bodies that are comprised of phosphate minerals. In the laboratory, sediment that contained uranium was leached with groundwater (to simulate conditions at the Hanford Site in Washington). Prior to leaching, some of the soil was treated with soluble phosphate and another batch of soil was left untreated (Shi et al., 2009). For those soil samples that were treated with phosphate, uranium leaching was up to 3 orders of magnitude less than the untreated soil [with leaching at approximately 2 parts per million (ppm) without phosphate and approximately 0.002 ppm with phosphate]. The authors cite two processes for the lower leaching of uranium in the presence of phosphate: 1) uranium adsorption to phosphate mineral precipitates and 2) the transformation of uranium to less soluble forms in the presence of phosphate. The Coles Hill deposit in Virginia is a uranium ore body that is primarily comprised of uranium phosphate minerals. The lower part of the weathering profile of the orebody, which consists of groundwater saturated saprolite under oxidizing conditions, contains up to 1,300 milligrams per kilogram (mg/kg) uranium (Jerden et al., 2003). This concentration is approximately 1.5 times greater than the average ore grade of the deposit, indicating that the saturated saprolites are enriched relative to the underlying primary ore. Uranium within this zone is predominantly associated with U(VI) phosphates of the meta-autunite mineral group. Groundwaters from this zone contain less than 14 micrograms per liter (µg/L) uranium, suggesting that the U(VI) phosphate minerals present within the Coles Hill saprolites are capable of buffering dissolved uranium concentrations to significantly low concentrations. In addition, over time, uranium sorbed to hydroxyapatite can transform to autinite, making it more stable. This finding has been shown in the natural analog study of uranium in the Seia granite in the Eastern Desert of Egypt (Abd El-Naby and Dawood, 2008).

The treatment trends in the expanded TPP transect show strong indications of the long-term treatment capacity of the TPP amendment, as indicated by the following observations:

- Dissolved uranium concentrations have remained below the site standard at 9 months post injection at TDR-3S, TDR-4S, and IW-11D.
- Of the 13 wells that exhibited uranium treatment during the expanded TPP pilot test, six wells exhibited peak or near-peak treatment at 9 months post-injection (S1, TDR-1D, TDR-2S, TDR-3S, TDR-3D, and TDR-4S), and four wells exhibited peak or near-peak treatment at 6 months post-injection (TDR-1S, TDR-2D,TDR-4D, and PMW-2S; Figures 6A, 6B, and 7 and Table 4). These peaks in treatment have occurred even as other signatures of the injection solution remained low or decreased to baseline levels.
- Uranium treatment has remained high at DR wells and PMWs, despite the washout of other amendment signature parameters (Figures 6A and 6B and Table 4). At IW-11D, uranium treatment remained at 93% between 6 months and 9 months post-injection, even though the concentration of fluorescent tracer declined from 89 to 53% (indicating washout of the injection solution near the IW).

These observations demonstrate that the TPP amendment has the potential to provide long-term stability and residual treatment capacity.

4.4.3 Uranium Flux Estimates

The performance of the expanded TPP pilot test demonstrated that significant uranium treatment was observed at key well locations. The precipitation and removal of uranium from the aquifer can be quantified by calculating the mass discharge of uranium in the alluvial aquifer under treated and untreated conditions as follows:

$$M_d = KiAC$$

Where Md is the mass discharge of uranium [in milligrams per day (mg/d)], K is the hydraulic conductivity of the aquifer [in feet per day (ft/d)], i is the average hydraulic gradient, A is the area of the aquifer [in square feet (ft^2)], and C is the concentration of dissolved uranium (in mg/L). The mass of uranium removed from the alluvial aquifer can be calculated by comparing the mass discharge of uranium after TPP treatment with the estimated mass discharge of uranium over the same time period if the alluvial aquifer had remained untreated.

Table 9 presents the mass removal estimates for the TPP transect within the ROI of the IWs:

- *Uranium Concentration (C):* At the IWs, IW-11D was the only location where multiple post-injection performance monitoring samples were collected (at 6 months and 9 months post-injection). This location consistently exhibited 93% uranium treatment compared with the baseline sample at 9 months post injection (Table 4). In addition to the samples collected from IW-11D, one additional post-injection monitoring sample was collected from IW-3D at 9 months post-injection. Observed uranium concentrations were elevated above baseline at this location. The lack of observed treatment at this location is possibly due to two factors: either the variable groundwater flow conditions limited distribution of phosphate around this IW, or the peak treatment of uranium occurred much earlier than 9 months post-injection. Since there was no additional data for IW-3D to determine the extent of treatment at this location, the analytical results from IW-11D were used to estimate the mass of uranium removed from the transect.

Seven shallow IWs and eight deep IWs were sampled during the baseline monitoring event (Table 4). The average baseline dissolved uranium concentrations in the IW-S and IW-D wells were 0.53 and 1.34 mg/L, respectively. If all of the IWs exhibited an average uranium treatment of 93% at 9 months post-injection, then the average dissolved uranium concentrations post-injection would be approximately 0.036 and 0.09 mg/L at the IW-S and IW-D wells, respectively.

- *Hydraulic Gradient (i):* The average hydraulic gradient observed at the IWs throughout the expanded TPP pilot test was 0.03 feet per foot. The hydraulic gradient was estimated at each of the IWs based on the groundwater elevation contours observed during performance monitoring events (see Figures 5A and 5B). The hydraulic gradient for the TPP transect was then estimated by averaging the hydraulic gradient at each IW during each monitoring event.
- *Area (A):* Using a transect length of 750 feet and a conservatively thin treatment zone thickness of 20 feet for both the IW-S and IW-D transects (i.e., the screen length on each IW), the estimated treatment area is 15,000 ft^2 for both the IW-S and IW-D transects. This results in a treatment area of 30,000 ft^2 for the entire expanded TPP treatment transect.
- *Hydraulic Conductivity (K):* Given the permeable lithology (e.g., sand with gravel lenses) of the alluvial aquifer near the expanded TPP transect, an estimated hydraulic conductivity of 10 ft/d, which is a reasonable value based on literature estimates of hydraulic conductivity (Morris and Johnson, 1967).
- *Mass Discharge (Md):* The daily mass discharge of uranium if the alluvial aquifer was untreated would be 0.15 pounds per day (lbs/d) and 0.38 lbs/day for the IW-S and IW-D transects, respectively. After treatment, the estimated mass discharge of uranium is 0.01 lbs/day and 0.03 lbs/day for the IW-S and IW-D transects, respectively.

The uranium removal rate of the expanded TPP transect was calculated by subtracting the estimated mass discharge of uranium after treatment from the estimated mass discharge of uranium if the transect were untreated: 0.14 lbs/day and 0.35 lbs/day for the IW-S and IW-D wells, respectively (Table 9). When multiplied by the total days post-injection (273 days), the estimated mass removal of uranium was 38 pounds for the IW-S transect and 96 pounds for the IW-D transect. The total estimated uranium removal for the expanded TPP pilot test at 9 months post-injection was approximately 134 pounds. Given the persistence of uranium treatment observed at IW-11D at 9 months post-injection, uranium removal may still be ongoing and is likely to continue.

4.5 Secondary Geochemistry Effects

The addition of phosphate to the aquifer has the potential to release arsenic by displacing arsenic adsorbed to alluvial sediments. To evaluate this risk, arsenic and phosphorus concentrations were monitored in real-time during injection using field portable chemical analyses as required by NMED, and field data were confirmed by laboratory analyses at Energy and ALS (Table 4). Specific concentration limits were placed on arsenic as follows: arsenic concentration should not exceed 0.2 mg/L within the ROI during injections and should not exceed the Federal Maximum Contaminant Level (MCL) (0.01 mg/L) within 60 feet downgradient (note that the New Mexico standard is 0.1 mg/L). These concentration limits were not exceeded. The highest observed arsenic concentration during injections was 0.0043 mg/L at IW-10D (Table 4).

During long-term performance monitoring, arsenic concentrations were elevated by approximately two orders of magnitude above baseline values in the DR wells within the ROI along the expanded TPP transect. However, the concentration limits placed on arsenic were not exceeded. Figure 8 presents the maximum observed arsenic concentration at each of the DR and PMWs along the transect as well as the date the sample was collected (in DPI). The maximum arsenic concentration was below the concentration limit (0.167 mg/L) and was detected at TDR-2D at 6 months post injection (179 DPI), which corresponds to the peak phosphorus and uranium treatment at this location. At the remaining DR wells and PMWs along the transect, peak arsenic concentrations were approximately an order of magnitude lower than at TDR-2D (i.e., the remaining wells had peak arsenic concentrations below 0.017 mg/L). Outside of the treatment zone, arsenic concentrations were not significantly elevated above baseline concentrations (Table 4). These results confirm that any arsenic liberated through the application of this technology will be temporary and limited to the areas immediately proximal to the injection wells.

5 CONCLUSIONS AND RECOMMENDED PATH FORWARD

The TPP pilot testing in the alluvial aquifer at the Grants Reclamation Project site demonstrated the following:

- **Injection and distribution of reagent target volumes are achievable over an extended injection period.** TPP was injected into the alluvial aquifer over the course of 6 weeks. While well fouling and loss of injectability was observed, periodic flushes with unamended groundwater maintained sufficient injectability at the IWs to achieve target ROIs.
- **Immediate treatment of dissolved uranium to below site standards was realized after introduction of reagents, with continued sustained treatment over 9 months (270 DPI).** Treatment was observed during injections at some DR and PMWs (e.g., S36), with uranium concentrations observed below the site standard. Up to 93% of uranium was removed from the dissolved phase injection zone (from 2.01 to 0.135 mg/L at IW-11D). Uranium treatment persisted even as tracers and reagents washed out from the ROI. Sustained treatment without rebound in uranium concentrations indicated that dissolved uranium was transported into the treatment zone from outside the expanded TPP transect and was immobilized by the phosphate precipitates.
- **Variations in groundwater flow conditions influenced the distribution of orthophosphate in the aquifer and limited the performance evaluation to wells closest to the expanded TPP transect.** Groundwater flow directions and gradients were inconsistent across the expanded TPP transect throughout the 9 month performance monitoring period. As a result, a smaller treatment area was established. Effective treatment was demonstrated in a few, select areas. Stronger datasets are likely achievable if groundwater conditions are unchanged during operation of future injection and monitoring events.
- **Secondary water quality effects of TPP injection were minor, short-lived, and localized within the ROI of the injection wells.** Arsenic concentration limits were not exceeded during the pilot test. Concentrations of arsenic were elevated, as expected, whenever significantly elevated phosphorus concentrations were present but declined as phosphorus and other amendment solution indicator parameters washed out of the ROI. The concentrations of phosphorus and fluorescent tracer returned to near baseline values by 9 months post-injection in all DR wells and PMWs.

The expanded TPP pilot test in the alluvial aquifer within the hydraulic barrier demonstrated that an injection-based approach to treat uranium in-situ at the site is feasible. The results show that the TPP in-situ treatment approach is a viable option for the groundwater restoration program. An in-situ approach is best implemented at key locations within the aquifer to focus treatment on areas where uranium concentrations in groundwater are elevated, persistent, and in a place where consistent groundwater flow directions can be maintained (either naturally or through active groundwater extraction). Alluvial flushing in these areas may require extensive pore-volume replacement to reach site groundwater standards and, therefore, may require an extended period of time to meet restoration goals.

A follow-up injection event at the expanded TPP transect will be useful to evaluate the effectiveness of TPP at creating a treatment barrier around the LTP, injectability into the wells after a period of non-use, and to evaluate any limits to the long-term stability and treatment capacity of the expanded TPP transect. The effort would specifically confirm the following:

- Appropriate placement of additional EWs in combination with IWs to effectively distribute the injected reagent through the TPP transect.
- Effective treatment of uranium under consistent groundwater flow conditions.
- Effective treatment of higher uranium concentrations.
- The lowest concentration of uranium achievable through continued operation of a TPP transect under consistent groundwater flow conditions (with continuous operation of the extraction wells to direct water through the barrier).
- Continued operation of the IW network over a period of time (approximately 1 year) with successive additional injections of phosphate to continually maintain treatment within the barrier and to evaluate the ability to repeatedly inject TPP.

The intent of the expanded TPP application in the alluvial aquifer will be to establish:

- A portion of an injection well network that can be used to effect significant reductions in concentrations of the areas of the aquifer with the highest uranium concentration; and
- Treatment within an area of the aquifer that may potentially serve as a future source of uranium to the north and east plumes after the LTP flushing program is completed.

If successful, the network can be "built out" from the current expanded TPP transect to a full-scale treatment network.This can be accomplished in a timely manner to assist the alluvial flushing program in meeting the site restoration goal of 2020.

6 REFERENCES

Abd El-Naby, H.H., and Y.H. Dawood. 2008. Natural attenuation of uranium and formation of autunite at the expense of apatite within an oxidizing environment, south Eastern Desert of Egypt. Applied Geochemistry, 23, 3741-3755.

Arey, J. S., J. C. Seaman, and P. M. Bertsch. 1999. Immobilization of Uranium in Contaminated Sediments by Hydroxyapatite Addition. Environmental Science and Technology, 33, 337-342.

Arcadis. 2013. Decommissioning and Reclamation Plan Update 2013 SUA-1471. Prepared for the Homestake Mining Company of California. April.

Arcadis. 2014. TPP Alluvial Pilot Testing Summary Report. July 3.

Arcadis. 2015a. Work Plan for Expanded TPP Pilot Test in the Alluvial Aquifer. March 2.

Arcadis 2015b. Construction Completion Report for Expanded TPP Pilot Test in the Alluvial Aquifer. July 21.

Arcadis 2015c. Basis of Design Report, Grants Expanded TPP Pilot Test in the Alluvial Aquifer. March 3.

Fuller, C. C., J. R. Bargar, J. A. Davis, and M. J. Piana. 2002. Mechanisms of Uranium Interactions with Hydroxyapatite: Implications for Groundwater Remediation. Environmental Science and Technology, 36, 158-165.

Fuller, C. C., J. R. Bargar, and J. A. Davis. 2003. Molecular-Scale Characterization of Uranium Sorption by Bone Apatite Materials for a Permeable Reactive Barrier Demonstration. Environmental Science and Technology, 37, 4642-4649.

HMC. 2012. Grants Reclamation Project Updated Corrective Action Program. Prepared for the Nuclear Regulatory Commission. March.

HMC and Hydro-Engineering. 2003. Grants Reclamation Project, Background Water Quality Evaluation of the Chinle Aquifers. Consulting Report for Homestake Mining Company of California.

Jerden, J.L., Jr., A.K. Sinha, and L. Zelazny. 2003. Natural immobilization of uranium by phosphate mineralization in an oxidizing saprolite-soil profile: chemical weathering of the Coles Hill uranium deposit, Virginia. Chemical Geology, 199, 129-157.

Mehta, V. S., F. Maillot, Z. Wang, J. G. Catalano, and D. E. Giammar. 2014. Effect of co-solutes on the products and solubility of uranium(VI) precipitated with phosphate. Chemical Geology. 364, 66-75.

Morris, D.A. and I.A. Johnson. 1967 Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey, U.S. Geological Survey Water-Supply Paper 1839-D, 42p.

NMED. 2013. Homestake Mining Company-Conditional Temporary Permission to Discharge: Phase 2 of "TPP alluvial pilot testing work plan," Sections 26 and 27 (Township 12 North, Range 10 West). February 14.

Shi, Z., L. Chongxuan, J.M. Zachara, Z. Wang, and B. Deng. 2009. Inhibition effect of secondary phosphate mineral precipitation on uranium release from contaminated sediments. Environmental Science and Technology, 43, 8344-8349.

TABLES

Table 1: Summary of Well Construction Details
Expanded TPP Pilot Test in the Alluvial Aquifer Summary Report
Grants Reclamation Project
Grants, New Mexico

ARCADIS Design & Consultancy for natural and built assets

Well ID	Easting (meters)	Northing (meters)	TOC Elevation (ft amsl)	Well Purpose	Approximate Distance from IW (feet)	Diameter (inches)	Constructed Screened Interval (ft bgs)	Constructed Total Depth (ft bgs)
IW-1S	1543422	488225	6573.45	Injection	--	4	38-58	63
IW-1D	1543443	488206	6574.57			4	60-80	85
IW-2S	1543373	488232	6573.93	Injection	--	4	34-54	59
IW-2D	1543401	488218	6573.79			4	58-78	83
IW-3S	1543329	488242	6574.08	Injection	--	4	34-54	59
IW-3D	1543352	488226	6574.66			4	54-74	79
IW-4S	1543286	488251	6573.55	Injection	--	4	41-61	66
IW-4D	1543309	488236	6574.11			4	61-81	86
IW-5S	1543239	488261	6574.90	Injection	--	4	39-59	64
IW-5D	1543264	488245	6574.85			4	65-85	90
IW-6S	1543195	488270	6574.43	Injection	--	4	37-57	62
IW-6D	1543218	488255	6574.27			4	59.5-79.5	84.5
IW-7S	1543151	488280	6574.94	Injection	--	4	35-55	60
IW-7D	1543174	488265	6574.02			4	57-77	82
IW-8S	1543110	488289	6574.20	Injection	--	4	33-53	58
IW-8D	1543129	488274	6574.53			4	55-75	80
IW-9S	1543064	488298	6573.36	Injection	--	4	33-53	58
IW-9D	1543088	488283	6574.23			4	52-72	77
IW-10S	1543018	488307	6573.72	Injection	--	4	33-53	58
IW-10D	1543043	488292	6573.46			4	56-76	81
IW-11S	1542974	488317	6573.56	Injection	--	4	35-55	60
IW-11D	1542998	488302	6574.14			4	53-73	78
IW-12S	1542929	488327	6574.11	Injection	--	4	40-60	65
IW-12D	1542953	488312	6573.76			4	60-80	85
IW-13S	1542883	488337	6573.36	Injection	--	4	40-60	65
IW-13D	1542908	488321	6573.43			4	59-79	84
IW-14S	1542839	488346	6573.10	Injection	--	4	44-64	69
IW-14D	1542863	488330	6573.04			4	65-85	90
IW-15S	1542796	488355	6573.76	Injection	--	4	42-62	67
IW-15D	1542818	488340	6573.22			4	62-82	87
IW-16S	1542752	488365	6573.94	Injection	--	4	42-62	67
IW-16D	1542775	488350	6573.98			4	64-84	89
IW-17S	1542709	488373	6573.48	Injection	--	4	44-64	69
IW-17D	1542731	488359	6573.69			4	72-92	97
EW-1	1543400	488270	6577.04	Extraction	50	4	50-90	95
EW-2	1543288	488294	6576.75	Extraction	50	4	49-89	94
EW-3	1543180	488316	6576.58	Extraction	50	4	50-90	95

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Well ID	Easting (meters)	Northing (meters)	TOC Elevation (ft amsl)	Well Purpose	Approximate Distance from IW (feet)	Diameter (inches)	Constructed Screened Interval (ft bgs)	Constructed Total Depth (ft bgs)
EW-4	1543072	488339	6575.81	Extraction	50	4	50-90	95
EW-5	1542963	488361	6575.63	Extraction	50	4	50-90	95
EW-6	1542855	488383	6575.58	Extraction	50	4	50-90	95
EW-7	1542749	488405	6576.05	Extraction	50	4	50-90	95
S36	NA	NA	6576.84	Existing Well/Dose Response	22	NA	50-90	NA
TDR-1S	1543397	488249	6576.86	Dose Response	30	2	44-54	59
TDR-1D	1543397	488249	6576.86		30	2	68-78	83
TDR-2S	1543240	488240	6576.07	Dose Response	22	2	52-62	67
TDR-2D	1543240	488239	6576.28		22	2	70-80	85
TDR-3S	1543130	488284	6576.15	Dose Response	10	2	44-54	59
TDR-3D	1543130	488284	6576.16		10	2	59-69	74
TDR-4S	1543060	488258	6575.12	Monitoring	25	2	45.5-55.5	60.5
TDR-4D	1543060	488259	6575.12		25	2	60.5-70.5	75.5
TDR-5S	1542852	488302	6574.71	Monitoring	24	2	44-54	59
TDR-5D	1542852	488303	6574.71		24	2	62-82	87
PMW-1S	1543104	488249	6575.81	Monitoring	44	2	43-53	58
PMW-1D	1543104	488249	6575.81		44	2	58-68	73
PMW-2S	1542957	488282	6575.31	Monitoring	44	2	46-56	61
PMW-2D	1542957	488282	6575.35		44	2	61-71	76
PMW-3S	1542781	488318	6575.07	Monitoring	44	2	58-68	73
PMW-3D	1542780	488318	6575.05		44	2	77-87	92
S1	NA	NA	6575.62	Existing Well/Monitoring	30	2	60-85	85
S2	NA	NA	6574.57	Existing Well/Monitoring	160	3	90-100	100
S4	NA	NA	6576.59	Existing Well/Monitoring	50	5	50-110	110
S14	NA	NA	6576.60	Existing Well/Monitoring	300	NA	50-90	96
S15	NA	NA	6576.52	Existing Well/Monitoring	250	NA	50-90	92
S18	NA	NA	6575.43	Existing Well/Monitoring	125	NA	60-100	103
S26	NA	NA	6574.26	Existing Well/Monitoring	430	NA	60-100	103
S27	NA	NA	6575.02	Existing Well/Monitoring	430	NA	60-100	103
S28	NA	NA	6573.38	Existing Well/Monitoring	125	NA	50-90	94

Notes:

Table 1 is a summary of well construction specifications for shallow injection wells (IW-S), deep injection wells (IW-D), extraction wells (EW), existing S wells in the immediate transect area, transect dose response wells (TDR), and performance monitoring wells (PMW).

amsl = above mean sea level
ft = feet
bgs = below ground surface
EW = Extraction Well
IW = Injection Well
MW = Monitoring Well
PMW = Performance Monitoring Well
TDR = Transect Dose Response Monitoring Well
TOC = Top Of Casing
NA = not available

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Parameter[1]	Unit	Site Standard - Alluvium	Method	Key Analyte List[2]
Analytical				
Uranium (U)	mg/L	0.16	E200.8	X
Uranium Precision		--	E200.8	X
Radium-226 (^{226}Ra) + Radium-228 (^{228}Ra)	pCi/L	5	E903.0	--
Thorium-230 (^{230}Th)	pCi/L	0.3	E908.0	--
Molybdenum (Mo)	mg/L	0.10	E200.8	--
Selenium (Se)	mg/L	0.32	E200.8	--
Vandadium (V)	mg/L	0.02	E200.8	--
Chloride	mg/L	250	E300.0	--
Total Dissolved Solids (TDS) @ 180°C	mg/L	2734	A2540 C	--
Sulfate (SO_4^{2-})	mg/L	1500	E200.0	--
Nitrate (NO_3^-)	mg/L	12	E300.0	--
Calcium (Ca)	mg/L	--	E200.7	X
Magnesium (Mg)	mg/L	--	E200.7	--
Potassium (K)	mg/L	--	E200.7	--
Sodium (Na)	mg/L	--	E200.7	--
Arsenic (As)[3]	mg/L	--	SW6020	X
Alkalinity (as $CaCO_3$)	mg/L	--	A2320 B	--
pH	s.u.	--	A 4500 H B	--
Phosphorous, Dissolved as P	mg/L	--	E365.1	X
Phosphorous, Total as P	mg/L	--	E365.1	X
Phosphorous, Orthophosphate as P	mg/L	--	E365.1	X
Field Parameters				
Water Level	ft btoc	--	water-level meter	--
Temperature	°C	--	field probe	--
Oxidation Reduction Potential (ORP)	mV	--	field probe	--
Conductivity	µmhos/cm	--	field probe	--
Dissolved Oxygen	mg/L	--	field probe	--

Notes:

Table 2 summarizes the parameters measured during sampling events, which included the chemical species as shown above and field parameters such as temperature, oxidation reduction potential, conductivity, and dissolved oxygen.

[1]All parameters are dissolved unless stated otherwise.

[2]Performance monitoring events used the "List M Dissolved - Short List" (Key Analyte List). Baseline monitoring events used the full analytical parameter "List M".

[3]The groundwater standard per the New Mexico Administrative Code (NMAC) 20.6.2.3103 for arsenic is 0.1 mg/L.

°C = degrees Celsius

ft btoc = feet below top of casing

mg/L = milligrams per liter

mV = millivolts

pCi/L = picoCuries per liter

s.u. = standard unit

µmhos/cm = micromhos per centimeter

X = analyte included in the "Key" analyte list

-- = analyte not included in the "Key" analyte list

Table 3: Well Sampling Summary
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Well	Baseline Monitoring	Injection Monitoring	Performance Monitoring					
			1 Week Post-Injection	3 Week Post-Injection	6 Week Post-Injection	3 Month Post-Injection	6 Month Post-Injection	9 Month Post-Injection
TDR-1S	4/16/2015	7/7/2015	8/3/2015	8/25/2015	9/15/2015	10/27/2015	1/26/2016	4/26/2016
TDR-2S	4/16/2015	7/15/2015	8/4/2015	8/25/2015	9/15/2015	10/27/2015	1/25/2016	4/26/2016
TDR-3S	4/16/2015	7/15/2015	8/4/2015	8/25/2015	9/15/2015	10/28/2015	1/26/2016	4/26/2016
TDR-4S	4/17/2015	--	8/5/2015	8/25/2015	9/15/2015	10/27/2015	1/26/2016	4/26/2016
TDR-5S	4/17/2015	--	8/5/2015	8/26/2015	9/15/2015	10/28/2015	1/27/2016	4/27/2016
TDR-1D	4/16/2015	--	8/3/2015	8/25/2015	9/15/2015	10/27/2015	1/26/2016	4/26/2016
TDR-2D	4/16/2015	7/22/2015	8/4/2015	8/25/2015	9/15/2015	10/27/2015	1/25/2016	4/26/2016
TDR-3D	4/16/2015	7/22/2015	8/4/2015	8/25/2015	9/15/2015	10/28/2015	1/26/2016	4/26/2016
TDR-4D	4/17/2015	--	8/5/2015	8/25/2015	9/15/2015	10/27/2015	1/26/2016	4/26/2016
TDR-5D	4/17/2015	--	8/5/2015	8/26/2015	9/15/2015	10/28/2015	1/27/2016	4/27/2016
PMW-1S	4/16/2015	--	--	8/25/2015	9/16/2015	10/27/2015	1/26/2016	--
PMW-2S	4/17/2015	--	--	8/26/2015	9/16/2015	10/28/2015	1/26/2016	4/27/2016
PMW-3S	4/17/2015	--	--	8/26/2015	9/15/2015	10/28/2015	1/27/2016	--
PMW-1D	4/16/2015	--	--	8/25/2015	9/16/2015	10/27/2015	1/26/2016	--
PMW-2D	4/17/2015	--	--	8/26/2015	9/16/2015	10/28/2015	1/26/2016	4/27/2016
PMW-3D	4/17/2015	--	--	8/26/2015	9/15/2015	10/28/2015	1/27/2016	--
S1	4/10/2015	--	--	8/26/2015	9/15/2015	10/27/2015	1/26/2016	4/27/2016
S3	4/10/2015	--	--	--	--	--	1/28/2016	--
S4	--	--	--	--	--	--	1/28/2016	--
S-14	4/11/2015	--	--	--	--	--	--	--
S-15	4/11/2015	--	--	--	--	--	--	--
S18	4/11/2015	--	--	--	--	--	1/28/2016	--
S-26	4/10/2015	--	--	--	--	--	--	--
S-27	4/10/2015	--	--	--	--	--	--	--
S-28	4/9/2015	--	--	--	--	--	--	--
S36	4/10/2015	6/30/2015	8/4/2015	8/26/2015	9/15/2015	10/28/2015	1/27/2016	--
SE6	1/28/2015	--	--	--	--	--	1/28/2016	--
SA	4/17/2015	--	--	--	--	--	1/28/2016	--
SMW-1	1/28/2015	--	--	--	--	--	--	--
SMW-3D	1/28/2015	--	--	--	--	--	--	--
SMW-4D	1/28/2015	--	--	--	--	--	--	--
IW-1S	4/15/2015	--	--	--	--	--	--	--
IW-1D	4/15/2015	--	--	--	--	--	--	--
IW-3S	4/14/2015	--	--	--	--	--	--	--
IW-3D	4/15/2015	--	--	--	--	--	--	4/28/2016
IW-6S	4/13/2015	--	--	--	--	--	--	--
IW-7D	4/14/2015	--	--	--	--	--	--	--
IW-9D	--	7/22/2015	--	--	--	--	--	--
IW-10S	4/12/2015	--	--	--	--	--	--	--
IW-10D	4/13/2015	6/26/2015	--	--	--	--	--	--
IW-11D	4/12/2015	--	--	--	--	--	1/29/2016	4/28/2016
IW-12S	4/12/2015	--	--	--	--	--	--	--
IW-13D	4/10/2015	--	--	--	--	--	--	--
IW-15S	4/11/2015	--	--	--	--	--	--	--
IW-15D	4/10/2015	7/1/15 and 7/7/15	--	--	--	--	--	--
IW-17S	4/11/2015	--	--	--	--	--	--	--
IW-17D	4/11/2015	--	--	--	--	--	--	--
EW-1	--	--	--	--	--	10/29/2015	--	4/27/2016
EW-4	--	--	--	--	--	10/29/2015	--	4/27/2016
EW-7	--	--	--	--	--	10/29/2015	--	4/27/2016
Total Samples	**45**	**10**	**11**	**18**	**18**	**21**	**24**	**18**

Note:

Table 3 summarizes the monitoring program during the Expanded TPP Pilot Test. Baseline samples were collected in April 2015. Active injections were administered in June and July 2015 and limited sampling was conducted during this period. Performance monitoring sampling began in August 2015 (at 1 week post-injection) and continued through April 2016 (at 9 months post-injection). For wells that were part of the monitoring program, the sampling dates are included for each event.

-- = not sampled

Table 4: Analytical Data
Expanded TPP Pilot Test in the Alluvial Aquifer Summary Report
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ARCADIS Design & Consultancy for natural and built assets

		Location	EW-1	EW-1	EW-4	EW-4	EW-7	EW-7	IW-1D	IW-1S	IW-3D	IW-3D	IW-3S	IW-6S
		Sample ID	EW-1 102915	EW-1 (042716)	EW-4 102915	EW-4 (042716)	EW-7 102915	EW-7 (042716)	IW-1D (041515)	IW-1S (041515)	IW-3D (041515)	IW-3D (042816)	IW-3S (041415)	IW-6S (041315)
		Sample Date	10/29/2015	4/27/2016	10/29/2015	4/27/2016	10/29/2015	4/27/2016	4/15/2015	4/15/2015	4/15/2015	4/28/2016	4/14/2015	4/13/2015
Chemical Name	Units	Fraction												
Orthophosphate (As P)	mg/l	T	**0.016 H**	**0.017 H**	**0.023 H**	**0.029 H**	**0.019 H**	**0.024 H**	0.2 U	0.2 U	0.2 U	**1460**	0.2 U	NA
Phosphorus as P	mg/l	T	**0.015**	**0.018**	**0.024**	**0.017**	**0.014**	**0.011**	**0.02**	**0.011**	**0.019**	**3290**	**0.013**	0.01 U
Phosphorus as P	mg/l	Dslvd	**0.012**	**0.013**	**0.018**	**0.018**	**0.013**	**0.012**	NA	NA	NA	**2220**	NA	NA
Phosphorus as PO4	mg/l	T	**0.05**	**0.06**	**0.07**	**0.05**	**0.04**	**0.03**	**0.06**	**0.03**	**0.06**	**10088**	**0.04**	0.03 U
Arsenic	mg/l	Dslvd	0.001 U	**0.001**	0.001 U	**0.025**	0.001 U	**0.008**	0.001 U	0.001 U	**0.001**	**0.133**	0.001 U	0.001 U
Calcium	mg/l	Dslvd	**266**	**559**	**446**	**391**	**431**	**379**	**247**	**292**	**230**	**1440**	**282**	**287**
Uranium	mg/l	Dslvd	**2.41**	**8.40**[b]	**4.93**	**7.66** [b]	**1.84**	**1.55**	**0.583**	**0.097**	**1.77**	**5.4** [b]	**0.198**	**0.21**
Uranium Precision	mg/l	Dslvd	**0.389**	**1.36**	**0.796**	**1.24**	**0.298**	**0.251**	**0.094**	**0.0157**	**0.285**	**0.872**	**0.032**	**0.034**
Uranium, Activity	pci/l	Dslvd	**1630**	**5.69**	**3340**	**5.18**	**1250**	**1.05**	**394**	**65.7**	**1200**	**3660**	**134**	**143**
Uranium, Activity Precision	pci/l	Dslvd	**263**	**0.918**	**539**	**0.836**	**202**	**0.170**	**63.7**	**10.6**	**193**	**590**	**21.7**	**23**
Fluorescein	mg/l	T	0.000015 U	0.000002 U	0.000015 U	**0.043**	0.000015 U	0.000002 U	NA	NA	NA	0.000002 U	NA	NA
Rhodamine WT	mg/l	T	0.000015 U	**1.17**	0.000015 U	0.000015 U	0.000015 U	0.000015 U	NA	NA	NA	**5.86**	NA	NA

Notes

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ARCADIS Design & Consultancy for natural and built assets

Location			IW-7D	IW-9D	IW-10S	IW-10D	IW-10D	IW-11D	IW-11D	IW-11D	IW-11D	IW-12S	IW-13D	IW-15D
Sample ID			IW-7D (041415)	IW9D07222018	IW-10S (041215)	IW-10D (041315)	IW-10D (062615	IW-11D (041215)	IW-11D (012916)	IW-11D (042816)	IW-11D (042816)P	IW-12S (041215)	IW-13D (041015)	IW-15D (041015)
Sample Date			4/14/2015	7/22/2015	4/12/2015	4/13/2015	6/26/2015	4/12/2015	1/29/2016	4/28/2016	4/28/2016	4/12/2015	4/10/2015	4/10/2015
Chemical Name	Units	Fraction												
Orthophosphate (As P)	mg/l	T	NA	NA	NA	NA	25 U	NA	**968**	**584**	**688**	NA	NA	NA
Phosphorus as P	mg/l	T	**0.009**	**1000**	**0.007**	**0.02**	**1.3**	**0.019**	**2020**	**654**	**3290**	**0.013**	**0.018**	**0.011**
Phosphorus as P	mg/l	Dslvd	NA	NA	NA	NA	NA	NA	**1030**	**656**	**2260**	NA	NA	NA
Phosphorus as PO4	mg/l	T	**0.03**	**3066**	**0.02**	**0.06**	**3.99**	**0.06**	**6194**	**2005**	**10088**	**0.04**	**0.06**	**0.03**
Arsenic	mg/l	Dslvd	0.001 U	NA	0.001 U	0.001 U	**0.0043**	0.001 U	**0.157**	**0.089**	NA	0.001 U	0.001 U	0.001 U
Calcium	mg/l	Dslvd	**252**	NA	**294**	**253**	**300**	**244**	**607**	**460**	NA	**387**	**295**	**263**
Uranium	mg/l	Dslvd	**1.44**	NA	**0.278**	**1.07**	**0.78**	**2.01**	**0.135**	**0.149**	NA	**1.59**	**1.67**	**1.62**
Uranium Precision	mg/l	Dslvd	**0.233**	NA	**0.0449**	**0.173**	NA	**0.325**	**0.0218**	**0.0241**	NA	**0.256**	**0.269**	**0.261**
Uranium, Activity	pci/l	Dslvd	**977**	NA	**188**	**726**	NA	**1360**	**91.5**	**101**	NA	**1080**	**1130**	**1090**
Uranium, Activity Precision	pci/l	Dslvd	**158**	NA	**30.4**	**117**	NA	**220**	**14.8**	**16.3**	NA	**174**	**182**	**176**
Fluorescein	mg/l	T	NA	NA	NA	NA	**0.202**	NA	0.000002 U	0.000002 U	NA	NA	NA	NA
Rhodamine WT	mg/l	T	NA	NA	NA	NA	0.000015 U	NA	**49.2**	**29.3**	NA	NA	NA	NA

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Table 4: Analytical Data
Expanded TPP Pilot Test in the Alluvial Aquifer Summary Report
Grants Reclamation Project
Grants, New Mexico

ARCADIS Design & Consultancy for natural and built assets

		Location	IW-15D	IW-15D	IW-15S	IW-17D	IW-17S	PMW-1D	PMW-1D	PMW-1D	PMW-1D	PMW-1D	PMW-1S
		Sample ID	IW-15D (070115)	IW-15D (070715)	IW-15S (041115)	IW-17D (041115)	IW-17S (041115)	PMW-1D (041615)	PMW-1D (082515)	PMW-1D 091615	PMW-1D 102715	PMW-1D (012616)	PMW-1S (041615)
		Sample Date	7/1/2015	7/7/2015	4/11/2015	4/11/2015	4/11/2015	4/16/2015	8/25/2015	9/16/2015	10/27/2015	1/26/2016	4/16/2015
Chemical Name	Units	Fraction											
Orthophosphate (As P)	mg/l	T	NA	NA	NA	NA	NA	0.2 U	**0.027**	NA	**0.025**	**0.028**	0.2 U
Phosphorus as P	mg/l	T	NA	**0.27**	**0.011**	**0.008**	0.005 U	**0.015**	**0.116**	NA	**0.062**	**0.065**	**0.015**
Phosphorus as P	mg/l	Dslvd	NA	NA	NA	NA	NA	NA	**0.012**	**0.013**	**0.014**	**0.015**	NA
Phosphorus as PO4	mg/l	T	NA	**0.83**	**0.03**	**0.02**	0.02 U	**0.05**	**0.36**	NA	**0.19**	**0.20**	**0.05**
Arsenic	mg/l	Dslvd	**0.003**	NA	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.001**	0.001 U
Calcium	mg/l	Dslvd	**360**	NA	**266**	**243**	**261**	**253**	**258**	**246**	**286**	**254**	**269**
Uranium	mg/l	Dslvd	**2.2** [b]	NA	**0.904**	**0.68**	**0.444**	**0.877**	**1.05** [b]	**0.967**	**0.838**	**0.931** [b]	**0.0958**
Uranium Precision	mg/l	Dslvd	NA	NA	**0.146**	**0.11**	**0.0716**	**0.142**	**0.169**	**0.156**	**0.135**	**0.15**	**0.0155**
Uranium, Activity	pci/l	Dslvd	NA	NA	**612**	**460**	**301**	**594**	**708**	**655**	**567**	**630**	**64.8**
Uranium, Activity Precision	pci/l	Dslvd	NA	NA	**98.8**	**74.3**	**48.5**	**95.9**	**114**	**106**	**91.6**	**102**	**10.5**
Fluorescein	mg/l	T	**0.000367**	NA	NA	NA	NA	NA	0.000002 U	NA	NA	**0.00736**	NA
Rhodamine WT	mg/l	T	0.000015 U	NA	NA	NA	NA	NA	0.000015 U	NA	NA	**0.0409**	NA

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Grants Reclamation Project
Grants, New Mexico

ARCADIS Design & Consultancy for natural and built assets

		Location	PMW-1S	PMW-1S	PMW-1S	PMW-1S	PMW-2D	PMW-2D	PMW-2D	PMW-2D	PMW-2D	PMW-2D	PMW-2S
		Sample ID	PMW-1S (082515)	PMW-1S 091615	PMW-1S 102715	PMW-1S (012616)	PMW-2D (041715)	PMW-2D (082615)	PMW-2D 091615	PMW-2D 102815	PMW-2D (012616)	PMW-2D (042716)	PMW-2S (041715)
		Sample Date	8/25/2015	9/16/2015	10/27/2015	1/26/2016	4/17/2015	8/26/2015	9/16/2015	10/28/2015	1/26/2016	4/27/2016	4/17/2015
Chemical Name	**Units**	**Fraction**											
Orthophosphate (As P)	mg/l	T	**0.023**	NA	**0.023**	**0.025**	0.2 U	**0.014**	NA	**0.017**	**0.03**	**0.014**	0.2 U
Phosphorus as P	mg/l	T	**0.281**	NA	**0.313**	**0.088**	**0.011**	**0.046**	NA	**0.115**	**0.024**	**0.02**	**0.013**
Phosphorus as P	mg/l	Dslvd	**0.011**	**0.012**	**0.013**	**0.019**	NA	**0.023**	**0.021**	**0.019**	**0.018**	**0.017**	NA
Phosphorus as PO4	mg/l	T	**0.86**	NA	**0.96**	**0.27**	**0.03**	**0.14**	NA	**0.35**	**0.07**	**0.06**	**0.04**
Arsenic	mg/l	Dslvd	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.002**	0.001 U	**0.002**	**0.01**	0.001 U
Calcium	mg/l	Dslvd	**287**	**265**	**297**	**310**	**248**	**368**	**390**	**350**	**359**	**301**	**254**
Uranium	mg/l	Dslvd	**0.101** [b]	**0.116** [b]	**0.121** [b]	**0.118**	**1.26**	**2.39** [b]	**2.63** [b]	**2.3**	**3.07** [b]	**1.85**	**0.423**
Uranium Precision	mg/l	Dslvd	**0.0163**	0.08 UD	**0.0195**	**0.019**	**0.203**	**0.386**	**0.38 D**	**0.37**	**0.496**	**0.299**	**0.0682**
Uranium, Activity	pci/l	Dslvd	**68.2**	**78.3**	**81.9**	**79.7**	**853**	**1620**	**1780**	**1550**	**2080**	**1260**	**286**
Uranium, Activity Precision	pci/l	Dslvd	**11**	60 U	**13.2**	**12.9**	**138**	**261**	**260**	**251**	**336**	**203**	**46.2**
Fluorescein	mg/l	T	0.000002 U	NA	0.000002 U	**0.000213**	NA	0.000002 U	NA	**0.000108**	**0.000036**	**0.00422**	NA
Rhodamine WT	mg/l	T	0.000015 U	NA	0.000002 U	**0.00139**	NA	**0.000155**	NA	**0.0027**	**0.000898**	**0.128**	NA

Notes

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ARCADIS Design & Consultancy for natural and built assets

Chemical Name	Units	Fraction	PMW-2S PMW-2S (082615) 8/26/2015	PMW-2S PMW-2S 091615 9/16/2015	PMW-2S PMW-2S 102815 10/28/2015	PMW-2S PMW-2S (012616) 1/26/2016	PMW-2S PMW-2S (042716) 4/27/2016	PMW-3D PMW-3D (041715) 4/17/2015	PMW-3D PMW-3D (082615) 8/26/2015	PMW-3D PMW-3D 091515 9/15/2015	PMW-3D PMW-3D 102815 10/28/2015	PMW-3D PMW-3D (012716) 1/27/2016	PMW-3S PMW-3S (041715) 4/17/2015
Orthophosphate (As P)	mg/l	T	**0.031**	NA	**0.029**	**0.031**	**0.029**	0.2 U	**0.027**	NA	**0.028**	**0.022**	0.2 U
Phosphorus as P	mg/l	T	**0.106**	NA	**0.056**	**0.032**	**0.027**	**0.006**	**0.026**	NA	**0.026**	**0.021**	**0.012**
Phosphorus as P	mg/l	Dslvd	**0.018**	**0.017**	**0.018**	**0.019**	**0.019**	NA	**0.014**	**0.016**	**0.016**	**0.018**	NA
Phosphorus as PO4	mg/l	T	**0.33**	NA	**0.17**	**0.10**	**0.08**	**0.02**	**0.08**	NA	**0.08**	**0.06**	**0.04**
Arsenic	mg/l	Dslvd	0.001 U	0.001 U	0.001 U	0.001 U	**0.004**	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Calcium	mg/l	Dslvd	**229**	**255**	**266**	**268**	**304**	**251**	**260**	**261**	**258**	**254**	**272**
Uranium	mg/l	Dslvd	**0.335**	**0.254**	**0.233**	**0.235**	**0.324** [b]	**0.496**	**0.597** [b]	**0.769**	**0.732**	**0.703**	**1.3**
Uranium Precision	mg/l	Dslvd	**0.0541**	**0.0409**	**0.0376**	**0.0379**	**0.0524**	**0.08**	**0.0964**	**0.124**	**0.118**	**0.114**	**0.21**
Uranium, Activity	pci/l	Dslvd	**227**	**172**	**158**	**159**	**220**	**336**	**404**	**521**	**495**	**476**	**879**
Uranium, Activity Precision	pci/l	Dslvd	**36.6**	**27.7**	**25.4**	**25.7**	**35.5**	**54.2**	**65.3**	**84**	**80**	**76.9**	**142**
Fluorescein	mg/l	T	0.000002 U	NA	0.000015 U	**0.000152**	**0.00301**	NA	NA	NA	NA	0.000002 U	NA
Rhodamine WT	mg/l	T	0.000015 U	NA	**0.000151**	**0.00109**	**0.343**	NA	NA	NA	NA	0.000015 U	NA

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ARCADIS Design & Consultancy for natural and built assets

		Location	PMW-3S	PMW-3S	PMW-3S	PMW-3S	S1	S1	S1	S1	S1	S1	S14	S15	S18	S18
		Sample ID	PMW-3S (082615)	PMW-3S 091515	PMW-3S 102815	PMW-3S (012716)	S-1 (041015)	S1 (082615)	S1 091515	S1 102715	S1 (012616)	S1 (042716)	S-14 (041115)	S-15 (041115)	S-18 (041115)	S18 (012816)
		Sample Date	8/26/2015	9/15/2015	10/28/2015	1/27/2016	4/10/2015	8/26/2015	9/15/2015	10/27/2015	1/26/2016	4/27/2016	4/11/2015	4/11/2015	4/11/2015	1/28/2016
Chemical Name	Units	Fraction														
Orthophosphate (As P)	mg/l	T	**0.025**	NA	**0.027**	**0.021**	NA	**0.039 H**	NA	**0.04**	**0.038 H**	**0.036 H**	NA	NA	NA	**0.021 H**
Phosphorus as P	mg/l	T	**0.314**	NA	**0.439**	**0.067**	NA	**0.034**	NA	**0.048**	**0.036**	**0.029**	NA	NA	NA	**0.023**
Phosphorus as P	mg/l	Dslvd	**0.013**	**0.014**	**0.014**	**0.018**	**0.01**	**0.024**	**0.013**	**0.022**	**0.023**	**0.02**	**0.007**	**0.008**	**0.009**	**0.020**
Phosphorus as PO4	mg/l	T	**0.96**	NA	**1.35**	**0.21**	NA	**0.10**	NA	**0.15**	**0.11**	**0.09**	NA	NA	NA	**0.07**
Arsenic	mg/l	Dslvd	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Calcium	mg/l	Dslvd	**317**	**334**	**339**	**417**	**265**	**261**	**273**	**294**	**240**	**261**	**261**	**265**	**250**	**243**
Uranium	mg/l	Dslvd	**1.8** [b]	**2.12** [b]	**2.05**	**2.45** [b]	**0.352**	**0.314**	**0.38** [b]	**0.358**	**0.298**	**0.175**	**0.378**	**0.166**	**0.675**	**0.617**
Uranium Precision	mg/l	Dslvd	**0.291**	**0.343**	**0.331**	**0.395**	**0.0569**	**0.0507**	**0.0613**	**0.0578**	**0.0482**	**0.0282**	**0.0610**	**0.0268**	**0.109**	**0.0996**
Uranium, Activity	pci/l	Dslvd	**1220**	**1440**	**1390**	**1660**	**239**	**213**	**257**	**242**	**202**	**118**	**256**	**112**	**457**	**418**
Uranium, Activity Precision	pci/l	Dslvd	**197**	**232**	**224**	**268**	**38.5**	**34.4**	**41.5**	**39.1**	**32.6**	**19.1**	**41.3**	**18.1**	**73.8**	**67.4**
Fluorescein	mg/l	T	NA	0.000002 U	**0.0011**	**0.0302**	NA	0.000002 U	NA	NA	**0.0134**	**0.000622**	NA	NA	NA	NA
Rhodamine WT	mg/l	T	NA	**0.124**	**0.335**	**0.0424**	NA	0.000015 U	NA	NA	**0.0325**	**0.00686**	NA	NA	NA	NA

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		Location	S26	S27	S28	S3	S3	S3	S36	S36	S36	S36	S36	S36	S36	S36
		Sample ID	S-26 (041015)	S-27 (041015)	S-28 (040915)	S-3 (041015)	S3 (07-29-2015)	S3 (012816)	S-36 (041015)	S36 (063015)	S36 (080415)	8/4/2015	S36 (082615)	S36 091515	S36 102815	S36 (012716)
		Sample Date	4/10/2015	4/10/2015	4/9/2015	4/10/2015	7/29/2015	1/28/2016	4/10/2015	6/30/2015	8/4/2015	S36-DUP (080415)	8/26/2015	9/15/2015	10/28/2015	1/27/2016
Chemical Name	Units	Fraction														
Orthophosphate (As P)	mg/l	T	NA	NA	NA	NA	NA	**0.045 H**	NA	10 U	0.2 U	0.2 U	**0.217 H**	NA	**0.191 H**	**0.103**
Phosphorus as P	mg/l	T	**0.009**	NA	NA	NA	NA	**0.04**	**0.01 D**	0.050 U	**0.012**	**0.009**	**0.27**	NA	**0.221**	**0.095**
Phosphorus as P	mg/l	Dslvd	NA	**0.011**	**0.009**	**0.018**	NA	**0.032**	NA	0.20 U	NA	NA	**0.291**	**0.168**	**0.215**	**0.107**
Phosphorus as PO4	mg/l	T	**0.03**	NA	NA	NA	NA	**0.12**	**0.03 D**	0.15 U	**0.04**	**0.03**	**0.83**	NA	**0.68**	**0.29**
Arsenic	mg/l	Dslvd	0.001 U	0.001 U	0.001 U	**0.002**	NA	**0.001**	0.001 U	0.0020 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Calcium	mg/l	Dslvd	**265**	**266**	**245**	**630**	NA	**596**	**266**	**250**	**250**	**266**	**306**	**367**	**410**	**433**
Uranium	mg/l	Dslvd	**0.170**	**0.795**	**1.01**	**13.1 D**	**14.8 D**	**17.7**	**0.952**	**0.15**	**0.345** [b]	**0.348** [b]	**1.04** [b]	**1.98** [b]	**2.22** [b]	**2.58** [b]
Uranium Precision	mg/l	Dslvd	**0.0275**	**0.128**	**0.163**	**2.1 D**	**2.40 D**	**2.86**	**0.154**	NA	**0.0557**	**0.0562**	**0.167**	**0.32**	**0.358**	**0.416**
Uranium, Activity	pci/l	Dslvd	**115**	**538**	**683**	**8900 D**	**10100 D**	**12000**	**644**	NA	**234**	**236**	**701**	**1340**	**1500**	**1750**
Uranium, Activity Precision	pci/l	Dslvd	**18.6**	**86.8**	**110**	**1430**	**1620 D**	**1940**	**104**	NA	**37.7**	**38.0**	**113**	**216**	**242**	**282**
Fluorescein	mg/l	T	NA	NA	NA	NA	NA	NA	NA	0.000002 U	**0.000088**	NA	NA	NA	NA	NA
Rhodamine WT	mg/l	T	NA	NA	NA	NA	NA	NA	NA	0.000015 U	**0.0125**	NA	NA	NA	NA	NA

Notes

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1. Total phosphorus as PO_4 results were calculated based on the total phosphorus P analytical results.

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Expanded TPP Pilot Test in the Alluvial Aquifer Summary Report
Grants Reclamation Project
Grants, New Mexico

ARCADIS Design & Consultancy for natural and built assets

Chemical Name	Units	Fraction	S4	S4	SA	SA	SA	SE6	SE6	SMW-1	SMW-3D	SMW-4D	TDR-1D	TDR-1D	TDR-1D
Sample ID			S4 (07-16-2015)	S4 (012816)	SA (041715)	SA (06-11-2015)	SA (012816)	SE6 (012815)	SE6 (012816)	SMW-1 (012815)	SMW-3D (012815)	SMW-4D (012815)	TDR-1D (041615)	TDR-1D (080315)	TDR-1D (082515)
Sample Date			7/16/2015	1/28/2016	4/17/2015	6/11/2015	1/28/2016	1/28/2015	1/28/2016	1/28/2015	1/28/2015	1/28/2015	4/16/2015	8/3/2015	8/25/2015
Orthophosphate (As P)	mg/l	T	NA	**0.016**	2 U	NA	**0.271**	0.5 U	**0.021**	NA	NA	NA	0.5 U	0.2 U	**0.032**
Phosphorus as P	mg/l	T	NA	**0.012**	**1.33**	NA	**0.323**	**0.643**	**0.592**	**34**	**7.4**	**7**	**0.028**	**0.089**	**0.093**
Phosphorus as P	mg/l	Dslvd	NA	**0.01**	NA	NA	**0.331**	**0.02**	**0.015**	**14.3**	**6.3**	**5.4**	NA	NA	**0.02**
Phosphorus as PO4	mg/l	T	**#VALUE!**	**0.04**	**4.08**	**#VALUE!**	**0.99**	**1.97**	**1.82**	**104**	**23**	**21**	**0.09**	**0.27**	**0.29**
Arsenic	mg/l	Dslvd	NA	0.001 U	**0.036**	NA	**0.005**	**0.004**	**0.002**	**0.02**	**0.015**	**0.015**	**0.001**	**0.001**	0.001 U
Calcium	mg/l	Dslvd	**251**	**294**	**10**	**12.9**	**78**	**547**	**275**	**274**	**282**	**285**	**292**	**268**	**257**
Uranium	mg/l	Dslvd	**0.412**	**0.301**	**42**	**45.4**	**9.07**	**31.6**	**15.4**	**0.46**	**0.197**	**0.0556**	**9.9**	**6.23**	**6.45**
Uranium Precision	mg/l	Dslvd	**0.0664**	**0.0485**	**6.7**	**7.33**	**1.46**	**5.09**	**2.48**	**0.0743**	**0.0318**	**0.00897**	**1.59**	**1.01**	**1.04**
Uranium, Activity	pci/l	Dslvd	**279**	**204**	**28000**	**30800**	**6140**	**21400**	**10400**	**312**	**134**	**37.6**	**6700**	**4220**	**4370**
Uranium, Activity Precision	pci/l	Dslvd	**45**	**32.9**	**4600**	**4970**	**991**	**3450**	**1680**	**50.3**	**21.5**	**6.1**	**1080**	**681**	**705**
Fluorescein	mg/l	T	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.000002 U	0.000002 U
Rhodamine WT	mg/l	T	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.000015 U	0.000015 U

Notes

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1. Total phoshporus as PO_4 results were calculated based on the total phosphorus P analytical results.

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Grants, New Mexico

Location			TDR-1D	TDR-1D	TDR-1D	TDR-1D	TDR-1S	TDR-1S	TDR-1S	TDR-1S	TDR-1S	TDR-1S	TDR-1S	TDR-1S
Sample ID			TDR-1D 091515	TDR-1D 102715	TDR-1D (012616)	TDR-1D (042616)	TDR-1S (041615)	TDR-1S (070715)	TDR-1S (080315)	TDR-1S (082515)	TDR-1S 091515	TDR-1S 102715	TDR-1S (012616)	TDR-1S (042616)
Sample Date			9/15/2015	10/27/2015	1/26/2016	4/26/2016	4/16/2015	7/7/2015	8/3/2015	8/25/2015	9/15/2015	10/27/2015	1/26/2016	4/26/2016
Chemical Name	Units	Fraction												
Orthophosphate (As P)	mg/l	T	NA	**0.029**	**0.032**	**0.032**	0.2 U	25 U	0.2 U	**0.029**	NA	**0.029**	**0.026**	**0.039**
Phosphorus as P	mg/l	T	NA	**0.079**	**0.037**	**0.058**	**0.016**	0.05	**0.028**	**0.083**	NA	**0.192**	**0.04**	**0.083**
Phosphorus as P	mg/l	Dslvd	**0.024**	**0.025**	**0.021**	**0.045**	NA	0.2 U	NA	**0.026**	**0.022**	**0.018**	0.005 U	**0.041**
Phosphorus as PO4	mg/l	T	NA	**0.24**	**0.11**	**0.18**	**0.05**	**0.15**	**0.09**	**0.25**	NA	**0.59**	**0.12**	**0.25**
Arsenic	mg/l	Dslvd	0.001 U	0.001 U	**0.001**	**0.014**	0.001 U	0.002 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.003**	0.001 U
Calcium	mg/l	Dslvd	**253**	**273**	**289**	**235**	**285**	**300**	**296**	**297**	**298**	**289**	**291**	**97**
Uranium	mg/l	Dslvd	**7.8** [b]	**6.9**	**6.49**	**3.04**	**0.127**	**0.087**	**0.0747**	**0.0647**	**0.0789**	**0.0744**	**0.0631**	**0.0716**
Uranium Precision	mg/l	Dslvd	**1.25**	**1.11**	**1.05**	**0.49**	**0.0205**	NA	**0.0121**	**0.0104**	**0.0127**	**0.012**	**0.0102**	**0.0115**
Uranium, Activity	pci/l	Dslvd	**5200**	**4670**	**4390**	**2060**	**86.2**	NA	**50.6**	**43.8**	**53.4**	**50.4**	**42.7**	**48.4**
Uranium, Activity Precision	pci/l	Dslvd	**850**	**755**	**709**	**332**	**13.9**	NA	**8.2**	**7.1**	**8.6**	**8.1**	**6.9**	**7.8**
Fluorescein	mg/l	T	0.000002 U	0.000002 U	0.000002 U	0.000002 U	NA	0.000002 U	**0.0268**	**0.0011**	**0.000216**	**0.000071**	**0.000019**	**0.000918**
Rhodamine WT	mg/l	T	0.000015 U	0.000002 U	0.000015 U	0.000015 U	NA	0.000015 U	**0.000168**	0.000015 U	0.000015 U	0.000002 U	0.000015 U	**0.00086**

Notes

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		Location Sample ID Sample Date	TDR-2D TDR-2D (041615) 4/16/2015	TDR-2D TDR-2D-07222015 7/22/2015	TDR-2D TDR-2D (080415) 8/4/2015	TDR-2D TDR-2D (082515) 8/25/2015	TDR-2D TDR-2D 091515 9/15/2015	TDR-2D TDR-2D 102715 10/27/2015	TDR-2D TDR-2D (012516) 1/25/2016	TDR-2D TDR-2D (042616) 4/26/2016	TDR-2S TDR-2S (041615) 4/16/2015	TDR-2S TDR-2S (071515) 7/15/2015	TDR-2S TDR-2S (080415) 8/4/2015
Chemical Name	Units	Fraction											
Orthophosphate (As P)	mg/l	T	0.2 U	NA	0.2 U	**0.04**	NA	**10.4**	**26.9**	**5.7**	0.2 U	12 U	0.2 U
Phosphorus as P	mg/l	T	**0.015**	**0.05**	**0.035**	**0.042**	NA	**10.8**	**25.6**	**5.6**	**0.014**	**0.17**	**0.577**
Phosphorus as P	mg/l	Dslvd	NA	NA	NA	**0.022**	**7.73**	**11.1**	**24.6**	**5.4**	NA	0.2 U	
Phosphorus as PO4	mg/l	T	**0.05**	**0.15**	**0.11**	**0.13**	NA	**33**	**78**	**17**	**0.04**	**0.52**	**1.77**
Arsenic	mg/l	Dslvd	**0.001**	NA	**0.001**	0.001 U	**0.043**	**0.051**	**0.167**	**0.085**	0.001 U	0.002 U	**0.003**
Calcium	mg/l	Dslvd	**274**	NA	**323**	**293**	**232**	**189**	**225**	**239**	**266**	**270**	**282**
Uranium	mg/l	Dslvd	**2.28**	NA	**2.05**	**0.327**	**1.73** [b]	**1.25**	**0.409**	**2.2** [b]	**0.209**	**0.23**	**0.176**
Uranium Precision	mg/l	Dslvd	**0.368**	NA	**0.330**	**0.0528**	**0.279**	**0.202**	**0.066**	**0.355**	**0.0337**	NA	**0.0284**
Uranium, Activity	pci/l	Dslvd	**1540**	NA	**1390**	**222**	**1170**	**846**	**277**	**1490**	**141**	NA	**119**
Uranium, Activity Precision	pci/l	Dslvd	**249**	NA	**224**	**35.8**	**189**	**137**	**44.7**	**240**	**22.8**	NA	**19.2**
Fluorescein	mg/l	T	NA	NA	0.000002 U	0.000002 U	0.000002 U	0.000002 U	0.000002 U	0.000002 U	NA	0.000002 U	0.000002 U
Rhodamine WT	mg/l	T	NA	NA	**0.387**	**1.71**	**1.38**	**2.2**	**0.923**	**0.971**	NA	0.000015 U	0.000015 U

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Grants, New Mexico

ARCADIS Design & Consultancy for natural and built assets

		Location	TDR-2S	TDR-2S	TDR-2S	TDR-2S	TDR-2S	TDR-3D	TDR-3D	TDR-3D	TDR-3D	TDR-3D	TDR-3D	TDR-3D
		Sample ID	TDR-2S (082515)	TDR-2S 091515	TDR-2S 102715	TDR-2S (012516)	TDR-2S (042616)	TDR-3D (041615)	TDR-3D-07222018	TDR-3D (080415)	TDR-3D (082515)	TDR-3D 091515	TDR-3D 102815	TDR-3D (012616)
		Sample Date	8/25/2015	9/15/2015	10/27/2015	1/25/2016	4/26/2016	4/16/2015	7/22/2015	8/4/2015	8/25/2015	9/15/2015	10/28/2015	1/26/2016
Chemical Name	**Units**	**Fraction**												
Orthophosphate (As P)	mg/l	T	**0.221**	NA	**0.104**	**0.064**	**0.052**	0.2 U	NA	**0.4**	**0.629**	NA	**0.217**	**0.14**
Phosphorus as P	mg/l	T	**0.349**	NA	**0.153**	**0.067**	**0.068**	**0.02**	**0.25**	**0.523**	**0.703**	NA	**0.303**	**0.163**
Phosphorus as P	mg/l	Dslvd	**0.343**	**0.225**	**0.107**	**0.054**	**0.054**	NA	NA	NA	**0.626**	**0.26**	**0.207**	**0.13**
Phosphorus as PO4	mg/l	T	**1.07**	NA	**0.47**	**0.21**	**0.21**	**0.06**	**0.77**	**1.60**	**2.16**	NA	**0.93**	**0.50**
Arsenic	mg/l	Dslvd	**0.002**	**0.002**	0.001 U	0.001 U	**0.004**	0.001 U	NA	**0.004**	**0.002**	**0.002**	**0.001**	**0.002**
Calcium	mg/l	Dslvd	**277**	**292**	**325**	**321**	**291**	**260**	NA	**253**	**270**	**262**	**277**	**272**
Uranium	mg/l	Dslvd	**0.233** [b]	**0.26** [b]	**0.239**	**0.236**	**0.184**	**0.816**	NA	**0.615**	**0.893** [b]	**0.946** [b]	**0.634**	**0.645**
Uranium Precision	mg/l	Dslvd	**0.0375**	**0.042**	**0.0385**	**0.038**	**0.0297**	**0.132**	NA	**0.0993**	**0.144**	**0.153**	**0.102**	**0.104**
Uranium, Activity	pci/l	Dslvd	**157**	**176**	**162**	**160**	**124**	**552**	NA	**417**	**604**	**641**	**429**	**437**
Uranium, Activity Precision	pci/l	Dslvd	**25.4**	**28.4**	**26.1**	**25.8**	**20.1**	**89.2**	NA	**67.2**	**97.6**	**103**	**69.2**	**70.5**
Fluorescein	mg/l	T	0.000002 U	**0.000411**	**0.0282**	**0.0596**	**0.00103**	NA	NA	**0.0258**	**0.00683**	**0.00973**	**0.0197**	**0.0147**
Rhodamine WT	mg/l	T	0.000015 U	**0.00774**	**0.0522**	**0.142**	**0.0459**	NA	NA	**0.429**	**0.27**	**0.139**	**0.0333**	**0.0235**

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		Location	TDR-3D	TDR-3S	TDR-3S	TDR-3S	TDR-3S	TDR-3S	TDR-3S	TDR-3S	TDR-3S	TDR-4D	TDR-4D	TDR-4D
		Sample ID	TDR-3D (042616)	TDR-3S (041615)	TDR-3S (071515)	TDR-3S (080415)	TDR-3S (082515)	TDR-3S 091515	TDR-3S 102815	TDR-3S (012616)	TDR-3S (042616)	TDR-4D (041715)	TDR-4D (080515)	TDR-4D (082515)
		Sample Date	4/26/2016	4/16/2015	7/15/2015	8/4/2015	8/25/2015	9/15/2015	10/28/2015	1/26/2016	4/26/2016	4/17/2015	8/5/2015	8/25/2015
Chemical Name	Units	Fraction												
Orthophosphate (As P)	mg/l	T	**0.12**	0.2 U	25 U	0.2 U	**0.039**	NA	**0.208**	**0.273**	**1.4**	0.2 U	0.2 U	**0.028**
Phosphorus as P	mg/l	T	**0.127**	**0.018**	**0.53**[a]	**0.051**	**0.112**	NA	**0.349**	**0.294**	**1.66**	**0.017**	**0.071**	**0.41**
Phosphorus as P	mg/l	Dslvd	**0.121**	NA	**0.24**	NA	**0.026**	**0.041**	**0.203**	**0.235**	**1.59**	NA	NA	**0.016**
Phosphorus as PO4	mg/l	T	**0.39**	**0.06**	**1.63**	**0.16**	**0.34**	NA	**1.07**	**0.90**	**5.09**	**0.05**	**0.22**	**1.26**
Arsenic	mg/l	Dslvd	**0.008**	0.001 U	0.002 U	0.001	0.001 U	0.001 U	**0.002**	**0.003**	**0.017**	0.001 U	0.001 U	0.001 U
Calcium	mg/l	Dslvd	**268**	**263**	**340**	**389**	**291**	**307**	**198**	**224**	**244**	**250**	**264**	**265**
Uranium	mg/l	Dslvd	**0.514**	**0.196**	**0.17**	**0.283** [b]	**0.273**	**0.301** [b]	**0.101**	**0.0979**	**0.0474**	**1.4**	**1.34**	**1.22**
Uranium Precision	mg/l	Dslvd	**0.083**	**0.0316**	NA	**0.0457**	**0.044**	**0.0486**	**0.0163**	**0.0158**	**0.00764**	**0.226**	**0.217**	**0.197**
Uranium, Activity	pci/l	Dslvd	**348**	**132**	NA	**192**	**185**	**204**	**68.4**	**66.3**	**32.1**	**948**	**910**	**825**
Uranium, Activity Precision	pci/l	Dslvd	**56.2**	**21.4**	NA	**31.0**	**29.8**	**32.9**	**11**	**10.7**	**5.1**	**153**	**147**	**133**
Fluorescein	mg/l	T	0.000002 U	NA	**0.000569**	**0.101**	**0.0842**	**0.444**	**0.36**	**0.0842**	0.000002 U	NA	0.000002 U	0.000002 U
Rhodamine WT	mg/l	T	**0.0714**	NA	0.000015 U	**0.655**	**0.257**	**0.0477**	**0.0132**	**0.0297**	**0.321**	NA	0.000015 U	0.000015 U

Notes

Table 4 presents the analytical data for the key analytes (see Table 2) from the injection wells, extraction wells, dose-response wells, and performance monitoring wells that were sampled as part of the baseline and performance monitoring programs for the Expanded TPP Pilot Test (see Table 3 for complete list of wells sampled).
Analytical results where the the dissolved uranium concentrations are believed to be influenced by changing groundwater flow directions are noted with a superscript (see notes below).

1. Total phoshporus as PO_4 results were calculated based on the total phosphorus P analytical results.

[a] Where two results reported, the higher result was used.

[b] Observed increase in uranium concentration from the previous event is likely due to changing groundwater flow directions.

Detections are boldfaced

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Dslvd = dissolved
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NA = not analyzed
P = phosphorus
PO_4 = phosphate
pci/l = picoCuries per liter
T = total
U = below the method detection limit; detection limit shown

ARCADIS Design & Consultancy for natural and built assets

		Location	TDR-4D	TDR-4D	TDR-4D	TDR-4D	TDR-4S	TDR-4S	TDR-4S	TDR-4S	TDR-4S	TDR-4S	TDR-4S
		Sample ID	TDR-4D 091515	TDR-4D 102715	TDR-4D (012616)	TDR-4D (042616)	TDR-4S (041715)	TDR-4S (080515)	TDR-4S-DUP (080515)	TDR-4S (082515)	TDR-4S 091515	TDR-4S 102715	TDR-4S (012616)
		Sample Date	9/15/2015	10/27/2015	1/26/2016	4/26/2016	4/17/2015	8/5/2015	8/5/2015	8/25/2015	9/15/2015	10/27/2015	1/26/2016
Chemical Name	Units	Fraction											
Orthophosphate (As P)	mg/l	T	NA	**0.027**	**0.033**	**0.029**	0.2 U	0.2 U	0.2 U	**0.022**	NA	**0.023**	**0.024**
Phosphorus as P	mg/l	T	NA	**0.221**	**0.059**	**0.139**	**0.016**	**0.09**	**0.052**	**0.256**	NA	**0.212**	**0.054**
Phosphorus as P	mg/l	Dslvd	**0.017**	**0.015**	**0.018**	**0.02**	NA	NA	NA	**0.012**	**0.012**	**0.013**	**0.017**
Phosphorus as PO4	mg/l	T	NA	**0.68**	**0.18**	**0.43**	**0.05**	**0.28**	**0.16**	**0.78**	NA	**0.65**	**0.17**
Arsenic	mg/l	Dslvd	0.001 U	0.001 U	**0.001**	**0.012**	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Calcium	mg/l	Dslvd	**268**	**269**	**275**	**269**	**254**	**341**	**343**	**312**	**270**	**312**	**314**
Uranium	mg/l	Dslvd	**1.46** [b]	**1.36**	**1.2**	**1.59** [b]	**0.168**	**0.0944**	**0.0954**	**0.118** [b]	**0.254** [b]	**0.135**	**0.131**
Uranium Precision	mg/l	Dslvd	**0.235**	**0.219**	**0.194**	**0.257**	**0.0271**	**0.0152**	**0.0154**	**0.019**	**0.0411**	**0.0218**	**0.0211**
Uranium, Activity	pci/l	Dslvd	**988**	**918**	**814**	**1080**	**114**	**63.9**	**64.6**	**79.8**	**172**	**91.6**	**88.7**
Uranium, Activity Precision	pci/l	Dslvd	**159**	**148**	**131**	**174**	**18.4**	**10.3**	**10.4**	**12.9**	**27.8**	**14.8**	**14.3**
Fluorescein	mg/l	T	NA	**0.00189**	NA	**0.00049**	NA	NA	NA	0.000002 U	0.000002 U	0.000002 U	NA
Rhodamine WT	mg/l	T	NA	**0.0739**	NA	**0.00742**	NA	NA	NA	0.000015 U	0.000015 U	**0.00505**	NA

Notes

Table 4 presents the analytical data for the key analytes (see Table 2) from the injection wells, extraction wells, dose-response wells, and performance monitoring wells that were sampled as part of the baseline and performance monitoring programs for the Expanded TPP Pilot Test (see Table 3 for complete list of wells sampled).
Analytical results where the the dissolved uranium concentrations are believed to be influenced by changing groundwater flow directions are noted with a superscript (see notes below).

1. Total phoshporus as PO_4 results were calculated based on the total phosphorus P analytical results.

[a] Where two results reported, the higher result was used.

[b] Observed increase in uranium concentration from the previous event is likely due to changing groundwater flow directions.

Detections are boldfaced

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mg/l = milligrams per liter
NA = not analyzed
P = phosphorus
PO_4 = phosphate
pci/l = picoCuries per liter
T = total
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Table 4: Analytical Data
Expanded TPP Pilot Test in the Alluvial Aquifer Summary Report
Grants Reclamation Project
Grants, New Mexico

ARCADIS Design & Consultancy for natural and built assets

Location			TDR-4S	TDR-5D	TDR-5D	TDR-5D	TDR-5D	TDR-5D	TDR-5D	TDR-5D	TDR-5S	TDR-5S	TDR-5S
Sample ID			TDR-4S (042616)	TDR-5D (041715)	TDR-5D (080515)	TDR-5D (082615)	TDR-5D 091515	TDR-5D 102815	TDR-5D (012716)	TDR-5D (042716)	TDR-5S (041715)	TDR-5S (080515)	TDR-5S-DUP (080515)
Sample Date			4/26/2016	4/17/2015	8/5/2015	8/26/2015	9/15/2015	10/28/2015	1/27/2016	4/27/2016	4/17/2015	8/5/2015	8/5/2015
Chemical Name	Units	Fraction											
Orthophosphate (As P)	mg/l	T	**0.023**	0.2 U	0.2 U	**0.036**	NA	**0.03**	**0.024**	**0.029**	0.2 U	0.2 U	0.2 U
Phosphorus as P	mg/l	T	**0.052**	**0.016**	**0.054**	**0.224**	NA	**0.337**	**0.081**	**0.038**	**0.013**	**0.045**	**0.025**
Phosphorus as P	mg/l	Dslvd	**0.016**	NA	NA	**0.024**	**0.017**	**0.017**	**0.018**	**0.019**	NA	NA	NA
Phosphorus as PO4	mg/l	T	**0.16**	**0.05**	**0.17**	**0.69**	NA	**1.03**	**0.25**	**0.12**	**0.04**	**0.14**	**0.08**
Arsenic	mg/l	Dslvd	**0.002**	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.009**	0.001 U	0.001 U	0.001 U
Calcium	mg/l	Dslvd	**305**	**247**	**275**	**254**	**249**	**247**	**263**	**251**	**251**	**297**	**298**
Uranium	mg/l	Dslvd	**0.0866**	**1.54**	**1.84** [b]	**2.5** [b]	**2.42**	**2.17**	**2.18**	**1.8**	**0.356**	**0.154**	**0.152**
Uranium Precision	mg/l	Dslvd	**0.014**	**0.249**	**0.297**	**0.41**	**0.391**	**0.35**	**0.352**	**0.291**	**0.0575**	**0.0249**	**0.0245**
Uranium, Activity	pci/l	Dslvd	**58.6**	**1040**	**1250**	**1700**	**1640**	**1470**	**1480**	**1220**	**241**	**104**	**103**
Uranium, Activity Precision	pci/l	Dslvd	**9.4**	**169**	**201**	**280**	**265**	**237**	**238**	**197**	**38.9**	**16.8**	**16.6**
Fluorescein	mg/l	T	**0.00231**	NA	0.000002 U	0.000002 U	NA	NA	**0.000092**	**0.000043**	NA	0.000002 U	NA
Rhodamine WT	mg/l	T	**0.0099**	NA	0.000015 U	0.000015 U	NA	NA	0.000015 U	0.000015 U	NA	0.000015 U	NA

Notes

Table 4 presents the analytical data for the key analytes (see Table 2) from the injection wells, extraction wells, dose-response wells, and performance monitoring wells that were sampled as part of the baseline and performance monitoring programs for the Expanded TPP Pilot Test (see Table 3 for complete list of wells sampled).
Analytical results where the the dissolved uranium concentrations are believed to be influenced by changing groundwater flow directions are noted with a superscript (see notes below).

1. Total phoshporus as PO_4 results were calculated based on the total phosphorus P analytical results.

[a] Where two results reported, the higher result was used.

[b] Observed increase in uranium concentration from the previous event is likely due to changing groundwater flow directions.

Detections are boldfaced

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mg/l = milligrams per liter
NA = not analyzed
P = phosphorus
PO_4 = phosphate
pci/l = picoCuries per liter
T = total
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Chemical Name	Units	Fraction	TDR-5S	TDR-5S	TDR-5S	TDR-5S	TDR-5S
Sample ID			TDR-5S (082615)	TDR-5S 091515	TDR-5S 102815	TDR-5S (012716)	TDR-5S (042716)
Sample Date			8/26/2015	9/15/2015	10/28/2015	1/27/2016	4/27/2016
Orthophosphate (As P)	mg/l	T	**0.184**	NA	**0.046**	**0.039**	**0.045**
Phosphorus as P	mg/l	T	**0.419**	NA	**0.181**	**0.16**	**0.192**
Phosphorus as P	mg/l	Dslvd	**0.204**	**0.058**	**0.041**	**0.012**	**0.043**
Phosphorus as PO4	mg/l	T	**1.28**	NA	**0.55**	**0.49**	**0.59**
Arsenic	mg/l	Dslvd	0.001 U	0.001 U	0.001 U	0.001 U	**0.002**
Calcium	mg/l	Dslvd	**298**	**300**	**297**	**320**	**298**
Uranium	mg/l	Dslvd	**0.218** [b]	**0.337** [b]	**0.185**	**0.371** [b]	**0.212**
Uranium Precision	mg/l	Dslvd	**0.0352**	**0.0544**	**0.0299**	**0.0599**	**0.0342**
Uranium, Activity	pci/l	Dslvd	**147**	**228**	**125**	**251**	**143**
Uranium, Activity Precision	pci/l	Dslvd	**23.8**	**36.8**	**20.2**	**40.5**	**23.1**
Fluorescein	mg/l	T	0.000002 U	0.000002 U	0.000015 U	**0.0104**	**0.000156**
Rhodamine WT	mg/l	T	0.000015 U	0.000015 U	0.000015 U	0.000015 U	0.000015 U

Notes

Table 4 presents the analytical data for the key analytes (see Table 2) from the injection wells, extraction wells, dose-response wells, and performance monitoring w
that were sampled as part of the baseline and performance monitoring programs for the Expanded TPP Pilot Test (see Table 3 for complete list of wells sampled).
Analytical results where the the dissolved uranium concentrations are believed to be influenced by changing groundwater flow directions are noted with a superscrip

1. Total phoshporus as PO_4 results were calculated based on the total phosphorus P analytical results.

[a] Where two results reported, the higher result was used.

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Detections are boldfaced

D = sample diluted during analysis
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H = analysis performed outside recommended holding time
mg/l = milligrams per liter
NA = not analyzed
P = phosphorus
PO_4 = phosphate
pci/l = picoCuries per liter
T = total
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Table 5: Injectate Analytical Data
Expanded TPP Pilot Test in the Alluvial Aquifer Summary Report
Grants Reclamation Project
Grants, New Mexico

ARCADIS Design & Consultancy for natural and built assets

Location		INJ	INJ	INJ-S	INJ-D	INJ-D
Injection Interval		Shallow	Deep	Shallow	Deep	Deep
Sample Date		7/7/2015	7/9/2015	6/26/2015	7/15/2015	7/28/2015
Sample Type		N	N	N	N	N
Sample ID		INJ (070715)	INJ (070915)	INJ-S (062615)	INJ-D (071515)	INJ-D (072815)
Chemical Name	**Units**					
Orthophosphate (As P)	mg/l	NA	NA	25 U	250 U	100 U
Phosphorus as P	mg/l	**480**	**800**	**210**	**270**	**300**
Phosphorus as PO4	mg/l	**1472**	**2453**	**644**	**828**	**920**
Phosphorus as P, Dissolved	mg/l	NA	NA	**150**	**170**	**330**
Arsenic, Dissolved	mg/l	NA	NA	**0.027**	**0.02**	**0.04**
Calcium, Dissolved	mg/l	NA	NA	**240**	**560**	**130**
Uranium, Dissolved	mg/l	NA	NA	**1.9**	**4.3**	**1.3**
Fluorescein	mg/l	NA	NA	**2.07**	**0.000564**	NA
Rhodamine WT	mg/l	NA	NA	0.000015 U	**55.2**	NA

Notes

Table 5 presents the analytical results for sampled collected from the injectate solution as part of the injection monitoring program. The samples were analyzed for only key parameters. The injected solution contained a mixture of tripolyphosphate and a fluorescent tracer in site groundwater to allow visual monitoring of breakthrough at dose response wells. Fluorescein tracer dye was used in the shallow injection wells and rhodamine WT tracer dye was used in the deep injection wells. Phosphate concentrations in the injectate ranged from 644 to 2453 mg/l as phosphate. Concentrations of fluorescent tracer and phoshporus at the perfomance monitoring and dose response wells during subsequent monitoring events were normalized to the average injectate concentrations to evaluate the distribution of the injectate solution in the subsurface.

Detections are boldfaced

mg/l = milligrams per liter

NA = not analyzed

P = phosphorus

PO4 = phosphate

U = below the method detection limit; detection limit shown

ARCADIS Design & Consultancy for natural and built assets

Well ID	TPP solution injected (gallons)	Fresh Water Injected (gallons)
IW-1S	41,868	4,257
IW-2S	37,094	1,475
IW-3S	30,248	129
IW-4S	29,865	313
IW-5S	26,199	10
IW-6S	21,989	3,289
IW-7S	29,787	11
IW-8S	21,459	3,428
IW-9S	32,331	5,212
IW-10S	38,969	3,074
IW-11S	44,546	3,007
IW-12S	38,881	5,095
IW-13S	36,728	3,269
IW-14S	36,629	4,330
IW-15S	29,902	2,249
IW-16S	39,113	3,141
IW-17S	38,364	5,361
Total Shallow Injections	**573,972**	**47,650**
IW-1D	34,397	4,604
IW-2D	32,340	3,777
IW-3D	25,569	522
IW-4D	32,177	1,320
IW-5D	41,785	2,790
IW-6D	36,013	5,698
IW-7D	46,646	7,266
IW-8D	40,607	3,653
IW-9D	31,608	586
IW-10D	24,411	399
IW-11D	35,341	2,072
IW-12D	40,865	3,775
IW-13D	35,760	1,168
IW-14D	42,532	5,812
IW-15D	35,939	3,516
IW-16D	41,588	3,237
IW-17D	40,705	5,515
Total Deep Injections	**618,283**	**55,710**
Total TPP Solution Injected	***1,192,255***	***103,360***

Notes:

Table 6 summarizes the total injected volume of water (including both TPP-amended groundwater and clean groundwater flushes) at each of the shallow and deep injection wells. Total injection volumes at each well ranged from approximately 21,000 gallons to 42,000 gallons, depending on the specific capacity (i.e., the injectibility) of each well. Injection volumes were calculated to achieve a target radius of influence of approximately 22 feet.

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Well ID	TOC Elevation ft amsl	Baseline		1-Week PI		3-Weeks PI		6-Weeks PI		3-Months PI		6-Months PI		9-Months PI	
		5/27/2015		8/3/2015		8/24/2015		9/14-9/15/2015		10/26/2015		1/25/2016		4/25/2016	
		Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)
S36	6576.84	37.57	6539.27	39.29	6537.55	38.98	6537.86	38.01	6538.83	38.13	6538.71	37.93	6538.91	38.68	6538.16
TDR-1S	6576.86	35.19	6541.67	34.59	6542.27	34.02	6542.84	33.09	6543.77	33.70	6543.16	NM	NM	NM	NM
TDR-1D	6576.86	35.33	6541.53	34.71	6542.15	34.03	6542.83	33.11	6543.75	33.67	6543.19	NM	NM	NM	NM
TDR-2S	6576.07	35.25	6540.82	37.28	6538.79	36.36	6539.71	35.65	6540.42	36.28	6539.79	35.72	6540.35	36.62	6539.45
TDR-2D	6576.28	35.62	6540.66	37.47	6538.81	36.8	6539.48	35.86	6540.42	36.46	6539.82	35.89	6540.39	36.60	6539.68
TDR-3S	6576.15	35.17	6540.98	37.26	6538.89	36.61	6539.54	35.57	6540.58	36.20	6539.95	35.69	6540.46	36.65	6539.50
TDR-3D	6576.16	35.20	6540.96	37.28	6538.88	36.59	6539.57	35.56	6540.60	36.22	6539.94	35.67	6540.49	36.65	6539.51
TDR-4S	6575.12	34.48	6540.64	36.38	6538.74	35.83	6539.29	34.85	6540.27	35.31	6539.81	34.07	6541.05	35.66	6539.46
TDR-4D	6575.12	34.50	6540.62	36.4	6538.72	35.83	6539.29	34.85	6540.27	35.32	6539.80	34.88	6540.24	35.66	6539.46
TDR-5S	6574.71	34.33	6540.38	36.01	6538.70	35.6	6539.11	34.7	6540.01	34.86	6539.85	34.60	6540.11	35.25	6539.46
TDR-5D	6574.71	34.37	6540.34	36.02	6538.69	35.6	6539.11	34.7	6540.01	34.86	6539.85	34.60	6540.11	35.25	6539.46
PMW-2D	6575.35	NM	NM	NM	NM	NM	NM	35.29	6540.06	35.59	6539.76	35.22	6540.13	35.96	6539.39
PMW-3S	6575.07	34.84	6540.23	36.39	6538.68	36.04	6539.03	35.18	6539.89	35.24	6539.83	35.01	6540.06	35.66	6539.41
PMW-3D	6575.05	34.83	6540.22	36.38	6538.67	36.02	6539.03	35.15	6539.90	35.20	6539.85	34.97	6540.08	35.62	6539.43
S1	6575.62	34.00	6541.62	36.04	6539.58	35.45	6540.17	34.53	6541.09	35.03	6540.59	34.51	6541.11	35.38	6540.24
S2	6574.57	34.45	6540.12	36.02	6538.55	35.57	6539.00	34.75	6539.82	35.02	6539.55	34.56	6540.01	34.85	6539.72
S4	6576.59	34.95	6541.64	36.8	6539.79	36.34	6540.25	35.49	6541.10	35.90	6540.69	35.43	6541.16	36.06	6540.53
S14	6576.60	36.53	6540.07	37.56	6539.04	37.37	6539.23	36.76	6539.84	36.67	6539.93	36.33	6540.27	36.65	6539.95
S26	6574.26	34.52	6539.74	35.23	6539.03	35.02	6539.24	34.58	6539.68	34.33	6539.93	NM	NM	NM	NM
S27	6575.02	35.31	6539.71	35.95	6539.07	35.81	6539.21	35.31	6539.71	35.05	6539.97	NM	NM	NM	NM
SQ	6580.08	37.31	6542.77	45.57	6534.51	39.35	6540.73	38.07	6542.01	44.61	6535.47	43.26	6536.82	40.82	6539.26
SD4	6579.51	38.10	6541.41	40.38	6539.13	39.02	6540.49	38.11	6541.40	39.46	6540.05	38.32	6541.19	38.60	6540.91
SB	6580.83	38.35	6542.48	53.46	6527.37	39.93	6540.90	38.64	6542.19	40.56	6540.27	39.79	6541.04	41.88	6538.95
SE6	6579.16	38.61	6540.55	41.47	6537.69	40	6539.16	38.89	6540.27	40.31	6538.85	39.38	6539.78	41.04	6538.12
SA	6579.17	38.59	6540.58	80.53	6498.64	40.3	6538.87	39.01	6540.16	27.37	6551.80	84.28	6494.89	74.01	6505.16
S3	6575.36	34.99	6540.37	37.62	6537.74	36.75	6538.61	35.8	6539.56	NM	NM	36.20	6539.16	37.45	6537.91
S39	6574.98	35.09	6539.89	36.89	6538.09	36.59	6538.39	35.59	6539.39	35.66	6539.32	35.59	6539.39	36.70	6538.28
SMW-6	6575.19	NM	NM	NM	NM	NM	NM	34.22	6540.97	34.27	6540.92	NM	NM	NM	NM
S15	6576.52	NM	NM	NM	NM	NM	NM	35.91	6540.61	35.82	6540.70	NM	NM	NM	NM
S18	6575.43	NM	NM	NM	NM	NM	NM	35.07	6540.36	35.31	6540.12	34.9	6540.53	35.25	6540.18
S28	6573.38	NM	NM	NM	NM	NM	NM	34.43	6538.95	34.33	6539.05	34.06	6539.32	34.48	6538.90
S37	6573.24	NM	NM	NM	NM	NM	NM	33.91	6539.33	NM	NM	NM	NM	NM	NM
B25	6574.59	NM	NM	NM	NM	NM	NM	34.51	6540.08	35.00	6539.59	NM	NM	NM	NM
ST	6579.01	NM	NM	NM	NM	NM	NM	38.54	6540.47	52.02	6526.99	35.31	6543.70	52.39	6526.62

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Well ID	TOC Elevation ft amsl	5/27/2015		8/3/2015		8/24/2015		9/14-9/15/2015		10/26/2015		1/25/2016		4/25/2016	
		Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)
S5	6579.73	NM	NM	NM	NM	NM	NM	38.75	6540.98	40.29	6539.44	39.8	6539.93	42.29	6537.44
SN	6580.28	NM	NM	NM	NM	NM	NM	37.27	6543.01	37.75	6542.53	NM	NM	NM	NM
SS	6581.40	NM	NM	NM	NM	NM	NM	40.01	6541.39	41.70	6539.70	40.51	6540.89	41.46	6539.94
S6	6580.35	NM	NM	NM	NM	NM	NM	37.87	6542.48	39.09	6541.26	38.82	6541.53	40.89	6539.46
SP	6579.74	NM	NM	NM	NM	NM	NM	37.67	6542.07	38.21	6541.53	NM	NM	38.95	6540.79
SM	6580.08	NM	NM	NM	NM	NM	NM	36.89	6543.19	37.16	6542.92	NM	NM	NM	NM
SO	6579.93	NM	NM	NM	NM	NM	NM	38.25	6541.68	38.50	6541.43	NM	NM	38.91	6541.02
EW-1	6574.28	NM	NM	NM	NM	NM	NM	NM	NM	36.95	6537.33	36.2	6538.08	36.80	6537.48
EW-3	6573.50	NM	NM	NM	NM	NM	NM	NM	NM	36.85	6536.65	NM	NM	NM	NM
EW-4	6572.72	NM	NM	NM	NM	NM	NM	NM	NM	36.10	6536.62	35.60	6537.12	36.47	6536.25
EW-5	6572.22	NM	NM	NM	NM	NM	NM	NM	NM	35.91	6536.31	NM	NM	NM	NM
EW-6	6571.84	NM	NM	NM	NM	NM	NM	NM	NM	35.63	6536.21	NM	NM	NM	NM
EW-7	6572.41	NM	NM	NM	NM	NM	NM	NM	NM	36.22	6536.19	36.01	6536.40	36.83	6535.58

Notes

Table 7 presents depth to water measurements for high-spatial resolution monitoring events that were collected coincident with performance monitoring sampling events. Additionally, weekly depth to water measurements were collected by Homestake Mining Company at key locations near the TPP transect to closely monitor groundwater elevations near the transect. Potentiometric surface maps were constructed using this data and revealed that groundwater flow directions have changed frequently over the treatment and monitoring periods (See Figures 5A and 5B).

amsl = above mean sea level

ft = feet

bgs = below ground surface

btoc = below top of casing

NA = not available

NM = not measured

PI = post-injection

TOC = top of casing

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Parameter	Units	Shallow (IW-S)	Deep (IW-D)	Total
Injected Volumes				
TPP Dosed Water	gallons	573,972	618,283	1,192,255
Clean Water Flush	gallons	47,650	55,710	103,360
Total Injected Volume	gallons	621,622	673,993	1,295,615
Total Phosphorus as PO_4				
Target Injectate Concentration	mg/l	2,000	2,000	2,000
Average Injected Concentration	mg/l	1,100	1,400	1,300
Approximate Pounds Delivered	lbs	5,300	7,200	13,000
Target In-Situ Concentration	mg/l	1,000	1,000	1,000
Average Achieved In-Situ Concentration	mg/l	--	5,300	5,300

Notes

Table 8 summarizes the total injected volumes along the transect in the shallow injection wells, the deep injections wells, and the total for the transect. A total of 1,192,255 gallons of TPP-amended groundwater was injected along the transect, and 103,360 gallons of unamended groundwater was injected as part of a clean water flush to clear the injection system piping. In total, 1,295,615 gallons of water were injected into the shallow and deep injection wells, most of which was amended with TPP.

Additionally, the achieved injected concentration of total phosphorus as phosphate (average of 1,300 mg/L) was approximately half of the targeted concentration of 2,000 mg/L. Achieved in-situ concentrations were approximately five times higher than the targeted in-situ concentrations.

lbs = pounds
mg/l = milligrams per liter
PO_4 = phosphate
TPP = Sodium Tripolyphosphate
-- = not applicable

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Injection Zone Transect	Days Post Injection	Hydraulic Conductivity (ft/d)	Length of Transect (ft)	Thickness of Transect (ft)	Area of Transect (ft^2)	Hydraulic gradient (ft/ft)	Baseline Uranium Concentration (mg/L)	Estimated Treated Uranium Concentration (mg/L)	Untreated Mass Discharge		Treated Mass Discharge		U Removal Rate	Total U Removed (lbs)
									(mg/d)	(lbs/d)	(mg/d)	(lbs/d)	(lbs/d)	
IW-S	273	10	750	20	15000	0.03	0.53	0.036	67536	0.15	4587	0.01	0.14	38
IW-D	273	10	750	20	15000	0.03	1.34	0.09	170752	0.38	11468	0.03	0.35	96
													Total	**134**

Notes

Table 9 presents the estimated mass discharge of uranium through both the shallow and deep injection wells. Uranium removal rates are estimated at 0.14 lbs/d in the shallow wells and 0.35 lbs/d in the deep wells. This corresponds to a total removal of 134 pounds of uranium over 9 months of passive treatment at the Expanded TPP transect.

ft = feet

ft/d = feet per day

ft/ft = feet per foot

ft^2 = square feet

lbs = pounds

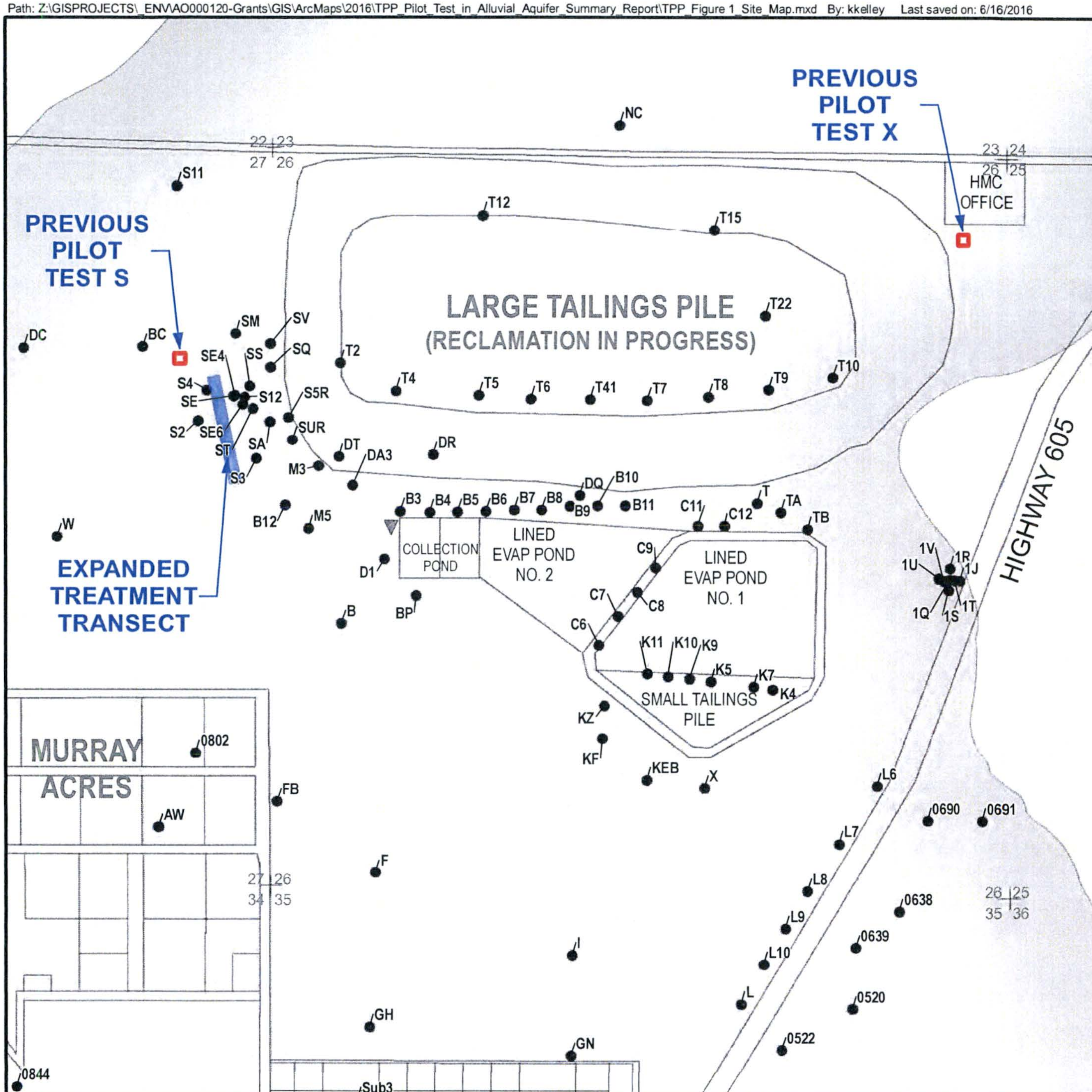
lbs/d = pounds per day

mg/L = milligrams per liter

mg/d = milligrams per day

FIGURES

Path: Z:\GISPROJECTS_ENV\AO000120-Grants\GIS\ArcMaps\2016\TPP_Pilot_Test_in_Alluvial_Aquifer_Summary_Report\TPP_Figure 1_Site_Map.mxd By: kkelley Last saved on: 6/16/2016



LEGEND:

- Alluvial Aquifer Well
- Previous Pilot Test Location
- Pilot TPP Injection Transect and Reactive Barrier
- Alluvial Aquifer

N

0 500 1,000 Feet

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Alluvial Aquifer Summary Report

SITE MAP

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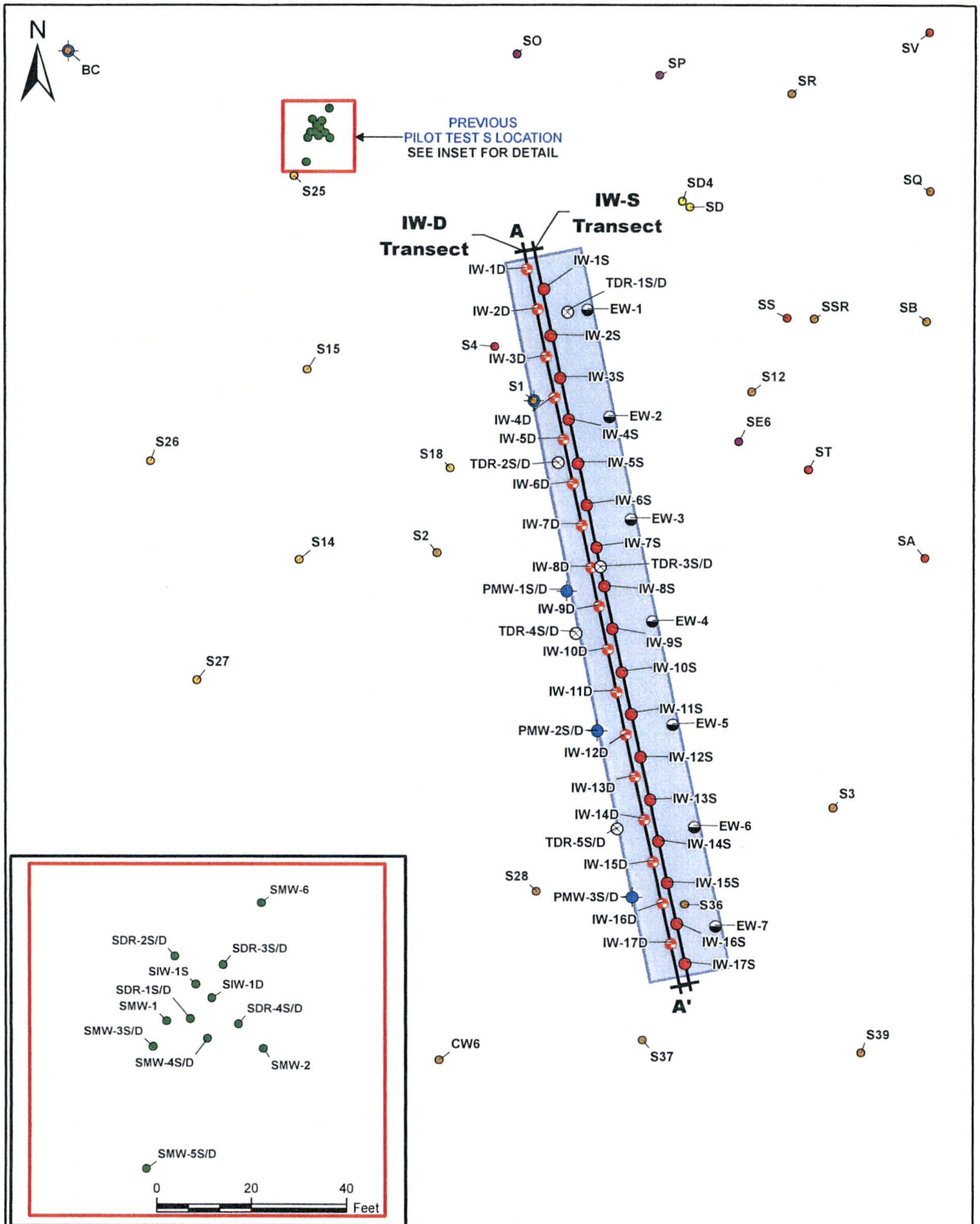
FIGURE 1

Path: Z:\GISPROJECTS_ENV\AO000120-Grants\GIS\ArcMaps\2016\TPP_Pilot_Test_in_Alluvial_Aquifer_Summary_Report\TPP_Figure_2_Injection_Transect_Location_and_CrossSection_Layout.mxd By: kkelley Last saved on: 6/16/2016



LEGEND:

- Injection Well
- Point of Compliance Well
- Reversal Well
- Monitoring Well
- Pilot Test Area S Well
- Reverse Osmosis Collection Well
- Existing Well
- Deep Injection Well
- Shallow Injection Well
- Extraction Well
- Performance Monitoring Well
- Transect Dose Response Well
- Cross-Section Location
- Previous Pilot Test Location
- Pilot TPP Injection Transect and Reactive Barrier

0 100 200
Feet

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TPP INJECTION TRANSECT LOCATION AND CROSS-SECTION LAYOUT MAP

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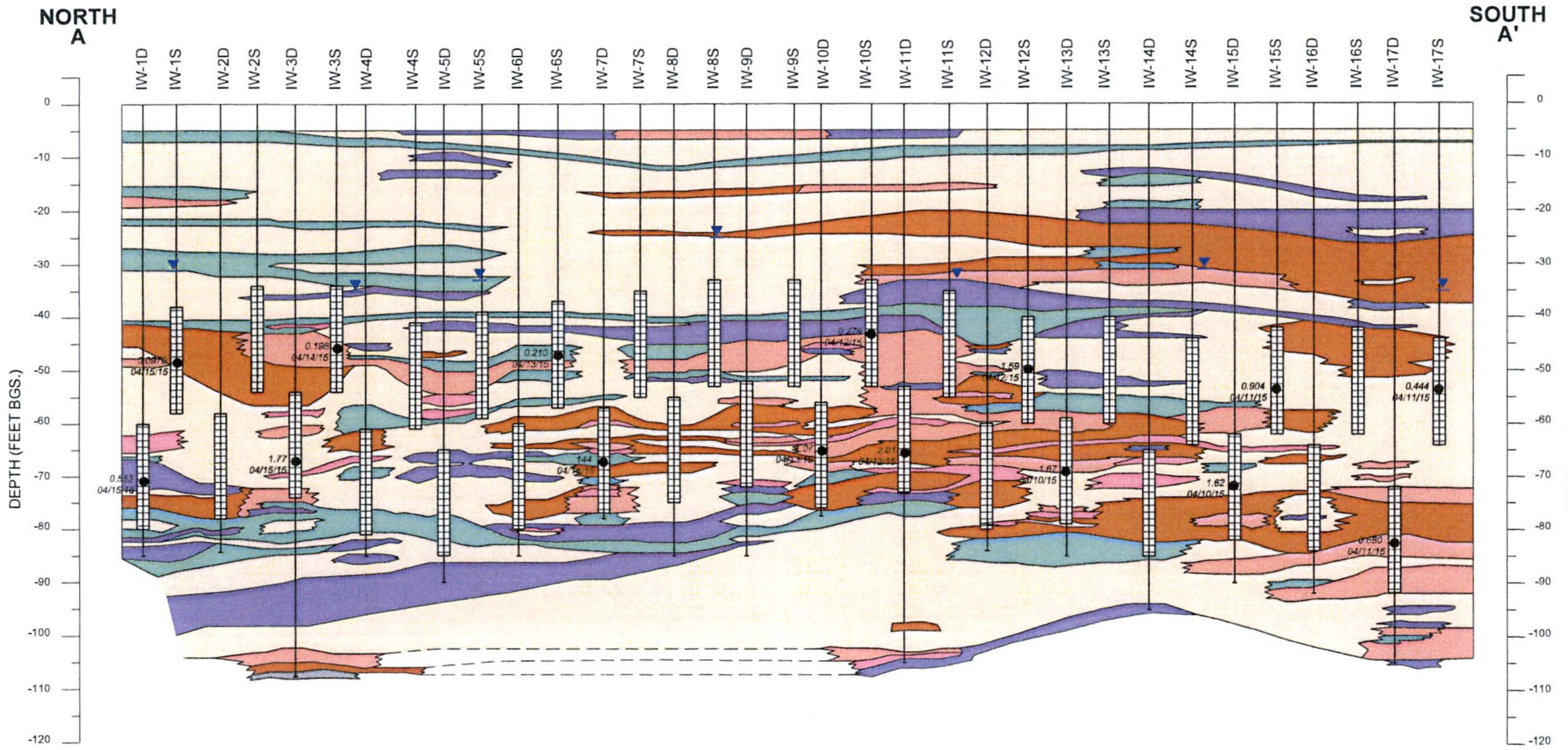
FIGURE 2



LEGEND:

- FINES (SILTS AND CLAYS) WITH NO TO SOME (10-50%) SAND GRAVEL
- SAND WITH SOME (21-50%) FINES
- FINE TO MEDIUM SAND WITH NO TO LITTLE (0-20%) FINES
- MEDIUM TO COARSE SAND WITH NO LITTLE (0-20%) FINES
- SAND WITH LITTLE TO SOME (10-50%) GRAVEL
- GRAVEL
- BEDROCK

WELL SCREEN

1.07 04/13/15 — CONCENTRATION OF URANIUM (mg/L) AND DATE SAMPLED

DEPTH TO WATER TABLE (FEET BGS.)

NOTES:

BGS = BELOW GROUND SURFACE
mg/L = MILLIGRAMS PER LITER

0 60' 120'
GRAPHIC SCALE
HORIZONTAL SCALE

0 20' 40'
GRAPHIC SCALE
VERTICAL SCALE

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GEOLOGIC CROSS-SECTION A - A'

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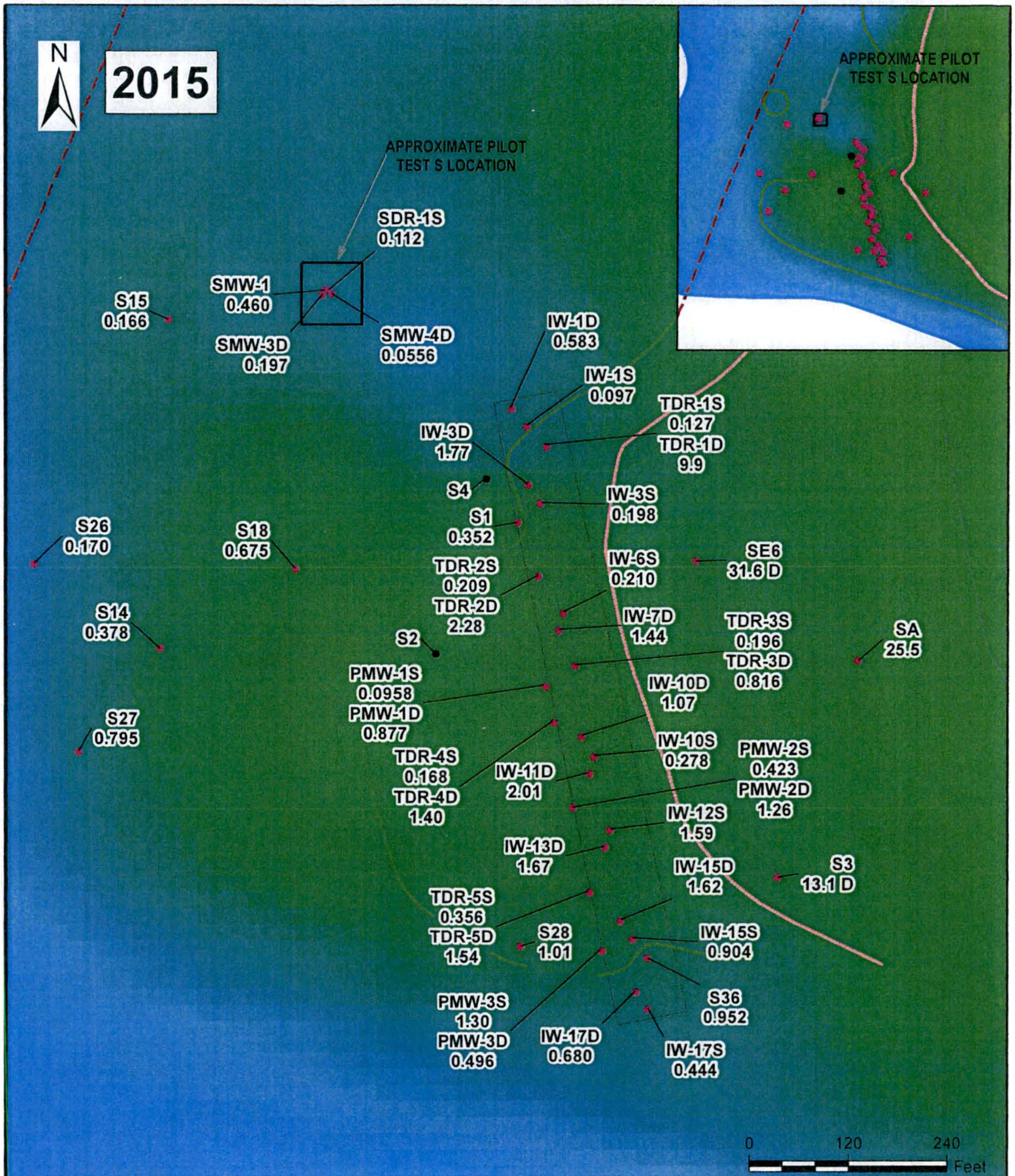
FIGURE 3

CITY: SYRACUSE, NY DIV/GROUP: ENV/IMDV DB: G.STOWELL PM: G.SUAREZ LYR: ON=*;OFF=*REF*

Path: Z:\GISPROJECTS_ENV\AO000120-Grants\GIS\ArcMaps\2016\TPP_Pilot_Test_in_Alluvial_Aquifer_Summary_Report\TPP_Figure_4_Baseline_Uranium_Concentrations_Near_TPP_Injection_Transect.mxd By: DHolmes Last saved on: 10/3/2016



LEGEND:

- 2015 Uranium Data

2015 Dissolved Uranium Concentration Contours (mg/L)

- 0.16
- 1
- 10
- Approximate Pilot Test Location
- Fault
- Alluvial Aquifer
- TTP Injection Transect and Reactive Barrier

DISSOLVED URANIUM

- 10.0 mg/L
- 1.0 mg/L
- 0.10 mg/L
- 0.010 mg/L
- 0.0010 mg/L

0869 ← Well ID
0.276 ← Dissolved Uranium (mg/L)

Notes:
1). Color shading represents estimated background dissolved uranium concentrations at the site from 2010 through 2015. The contour lines represent the locally observed dissolved uranium concentrations around the transect during baseline sampling in April 2015.

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BASELINE URANIUM CONCENTRATIONS NEAR THE TPP INJECTION TRANSECT

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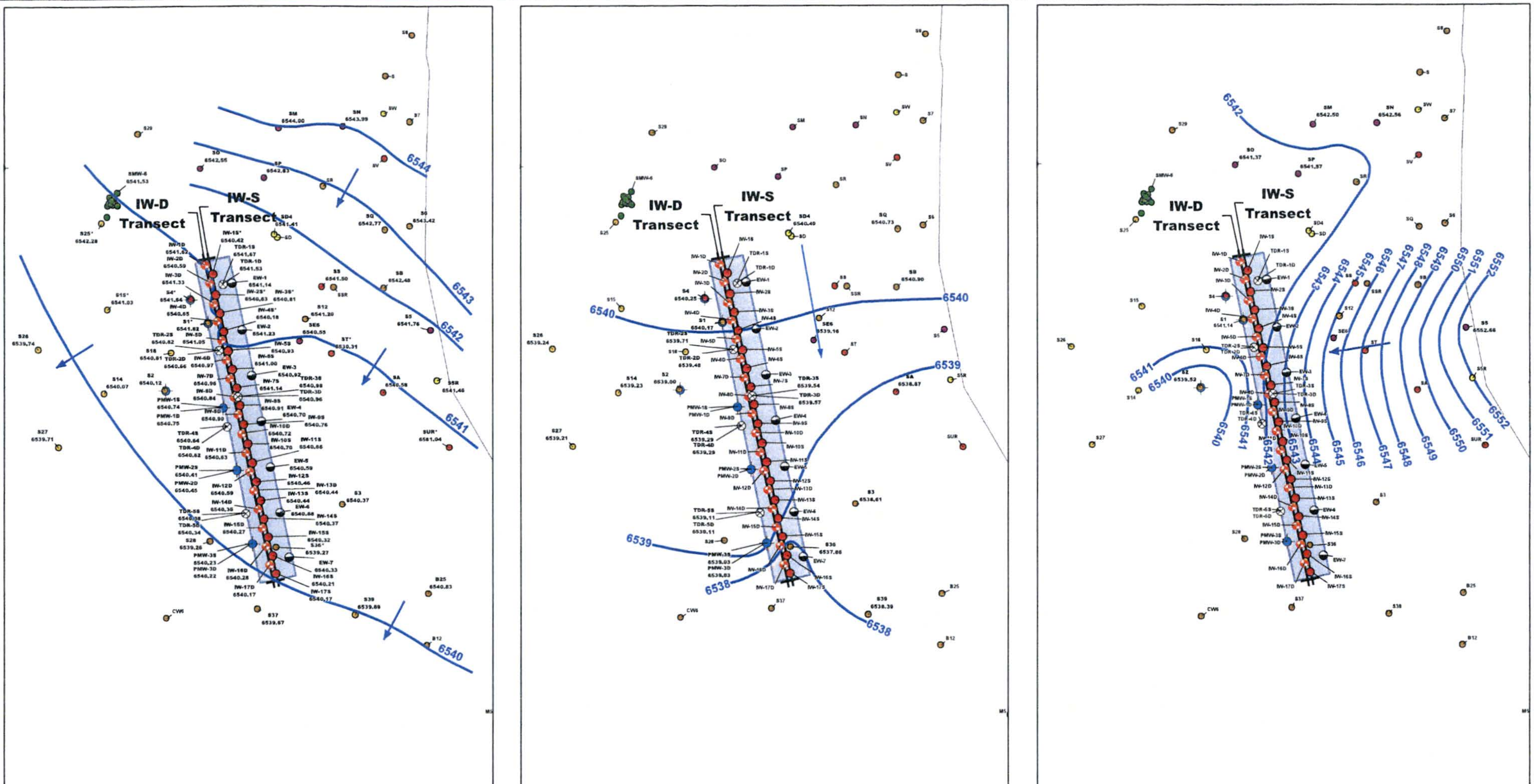
FIGURE 4

mg/L = milligrams per liter

Path: Z:\GISPROJECTS_ENV\AO000120-Grants\GIS\ArcMaps\2016\TPP_Pilot_Test_in_Alluvial_Aquifer_Summary_Report\TPP_Figure_5A_Potentiometric_Contour_Map.mxd By: kkelley Last saved on: 7/1/2016



MAY 27, 2015 (-64 DPI) | AUGUST 24, 2015 (25 DPI) | AUGUST 31, 2015 (32 DPI)

LEGEND:

- Injection Well
- Point of Compliance Well
- Reversal Well
- Monitoring Well
- Pilot Test Area S Well
- Reverse Osmosis Collection Well
- Existing Well
- Deep Injection Well
- Shallow Injection Well
- Extraction Well
- Proposed Performance Monitoring Well
- Proposed Transect Dose Response Well
- Pilot TPP Injection Transect and Reactive Barrier
- DPI = Days Post Injection
- = steep drawdown; contours not to scale
- = Direction of Groundwater Flow

Note:
* = Location not used to construct potentiometric contours

N

0 220 440 Feet

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Potentiometric Contour Maps from May and August 2015

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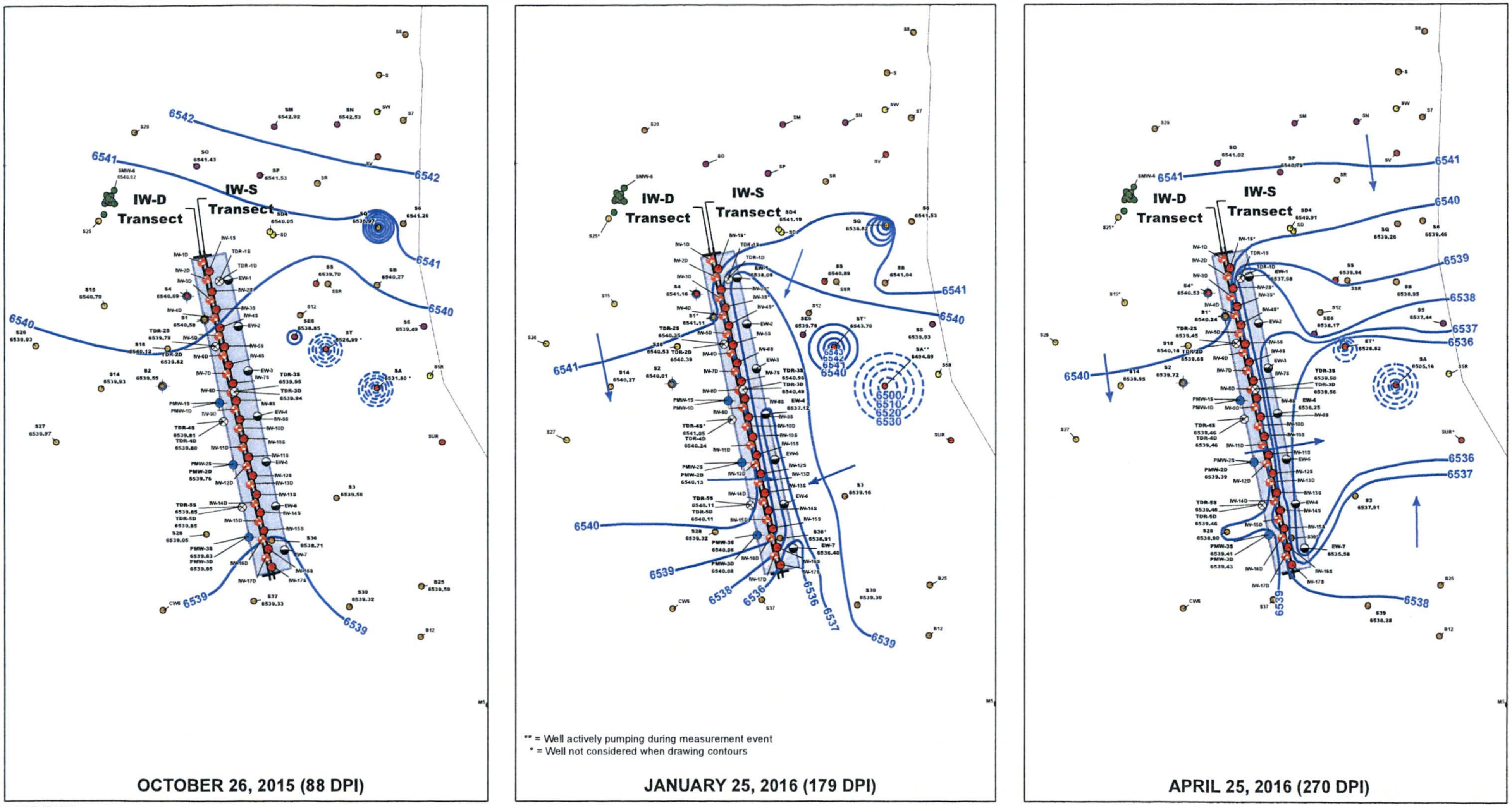
FIGURE **5A**

Path: Z:\GISPROJECTS_ENV\AO000120-Grants\GIS\ArcMaps\2016\TPP_Pilot_Test_in_Alluvial_Aquifer_Summary_Report\TPP_Figure_5B_Potentiometric_Contour_Map.mxd By: kkelley Last saved on: 7/1/2016



LEGEND:

- Injection Well
- Point of Compliance Well
- Reversal Well
- Monitoring Well
- Pilot Test Area S Well
- Reverse Osmosis Collection Well
- Existing Well
- Deep Injection Well
- Shallow Injection Well
- Extraction Well
- Proposed Performance Monitoring Well
- Proposed Transect Dose Response Well
- Pilot TPP Injection Transect and Reactive Barrier
- DPI = Days Post Injection
- = steep drawdown; contours not to scale
- = Direction of Groundwater Flow

Note:
* = Location not used to construct potentiometric contours

N

0 220 440 Feet

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Expanded TPP Pilot Test in the Alluvial Aquifer Summary Report

Potentiometric Contour Maps from October 2015 and January and April 2016

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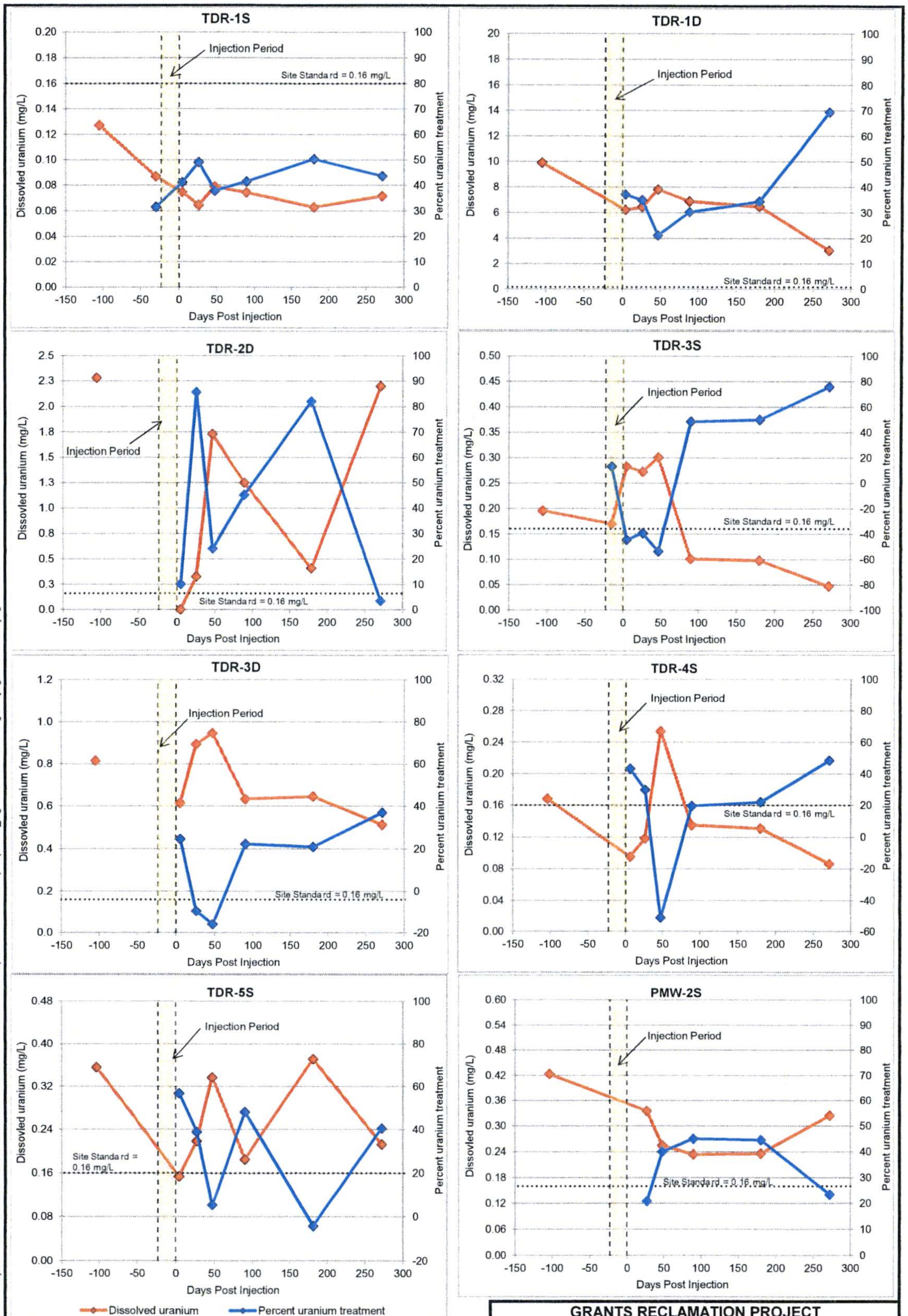
FIGURE **5B**



Notes:
1. mg/L = milligrams per liter
2. Uranium site standard = 0.16 mg/L

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Uranium Treatment at Select Performance Monitoring Locations

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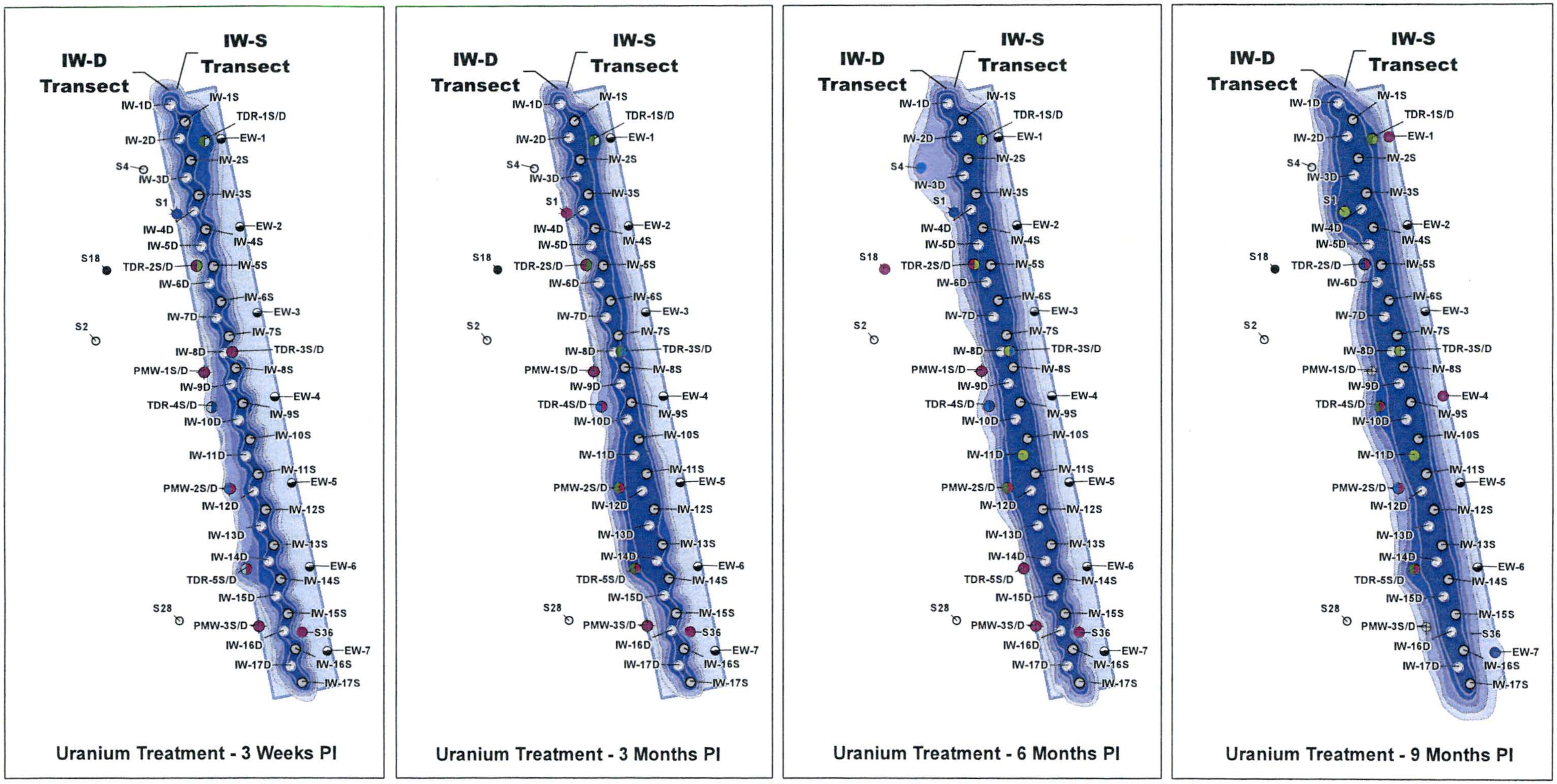
FIGURE **6A**

7/1/2016
A:\project\Barrick\KA000120 Grants Uranium Project - NM\Task 1 Alternative Groundwater Treatment\TPP FULL SCALE\Expanded TPP Summary Report\02_Figures\Raw materials-figures\[Figures 6 - 8.xlsx]Figure 6



LEGEND:

- Deep Injection Well
- Shallow Injection Well
- Extraction Well
- Proposed Performance Monitoring Well
- Proposed Transect Dose Response Well
- Injection Well
- Existing Well
- Pilot Test TPP Injection Transect And Reactive Barrier

Percent Uranium Treatment Contours

- > 10%
- > 20%
- > 30%
- > 40%
- > 50%

Percent Uranium Treatment

- < 10%
- 10% - < 20%
- 20% - < 30%
- 30% - < 40%
- 40% - < 50%
- > 50%

0 100 200 Feet

N

Notes:

1. For locations with nested wells, uranium treatment contours were drawn based on the results from the shallow well.
2. PI = Post Injection
3. For nested well locations, the left half of the circle represents uranium treatment in the shallow well, and the right half of the circle represents treatment in the deep well.

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Expanded TPP Pilot Test in the Alluvial Aquifer Summary Report

URANIUM TREATMENT THROUGH TIME

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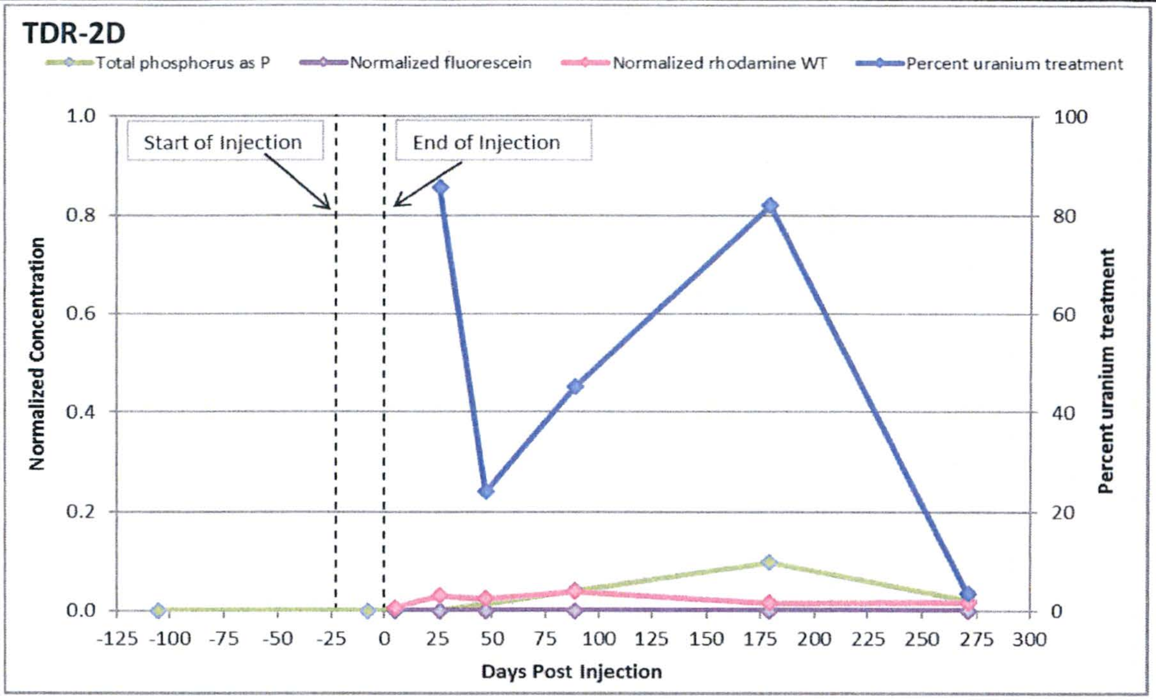
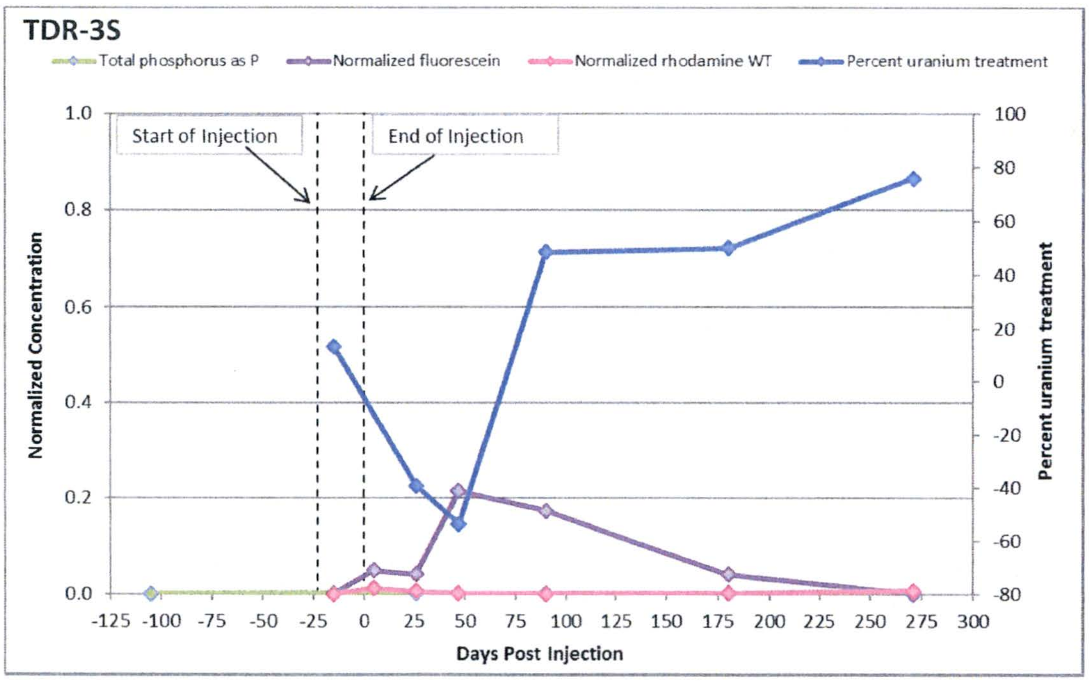
FIGURE 6B





Notes:
1. Measured amendment concentrations were normalized to injectate concentrations.

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NORMALIZED AMENDMENT CONCENTRATIONS

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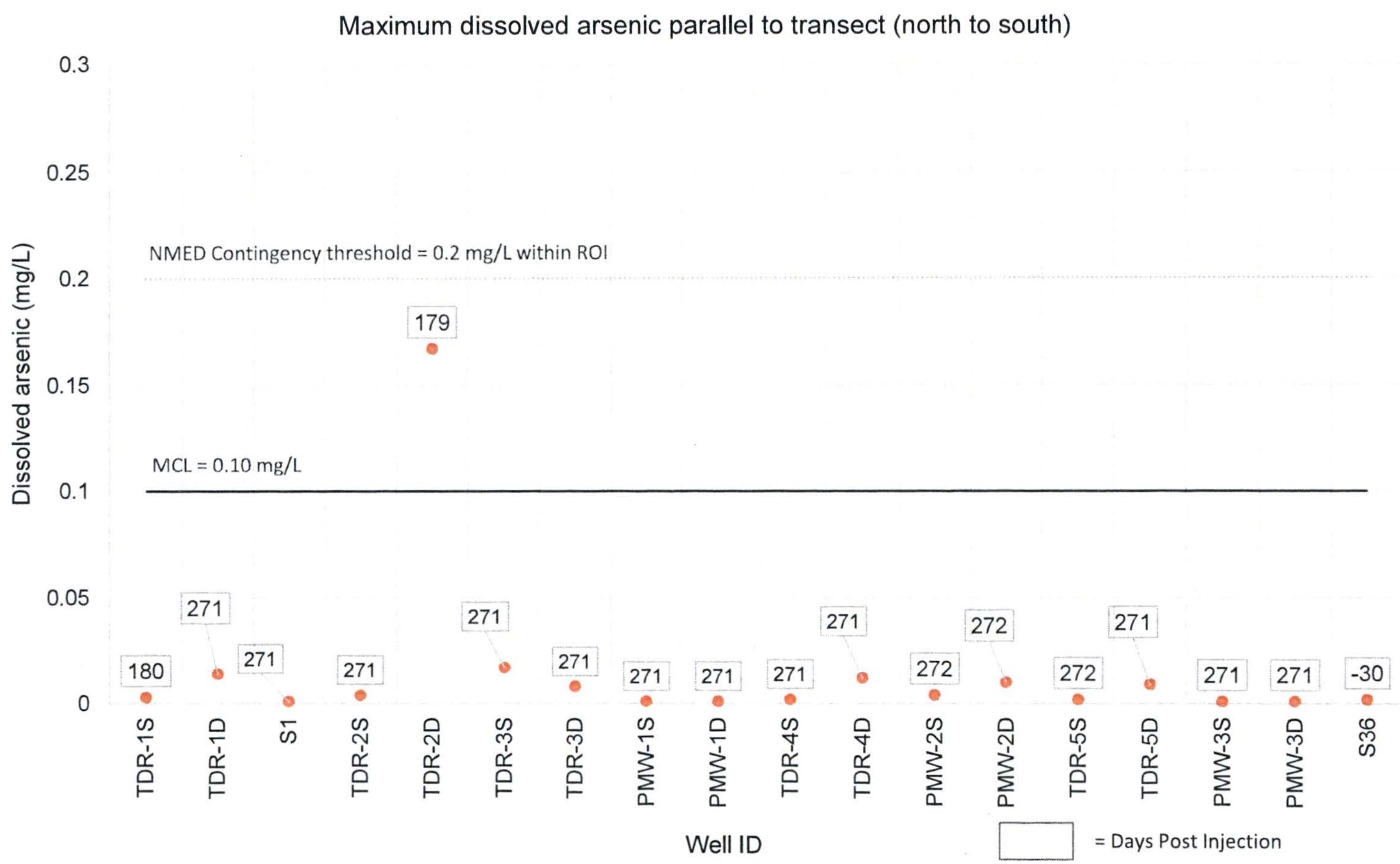
FIGURE
7

7/1/2016
A:\project\Barrick\AO000120 Grants Uranium Project - NM\Task 1 Alternative Groundwater Treatment\TPP FULL SCALE\Expanded TPP Summary Report\02_Figures\Raw materials-figures\[Figures 6 - 8.xlsx]Figure 6



Notes:
NMED = New Mexico Environment Department
MCL = maximum contaminant level
mg/L = milligrams per liter
ROI = radius of influence
Well ID = well identification

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Expanded TPP Pilot Test in the
Alluvial Aquifer Summary Report

ARSENIC PROFILE

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FIGURE
8

7/1/2016
Aproject\Barrick\AO000120 Grants Uranium Project - NM\Task 1 Alternative Groundwater Treatment\TPP FULL SCALE\Expanded TPP Summary Report\02_Figures\Raw materials-figures

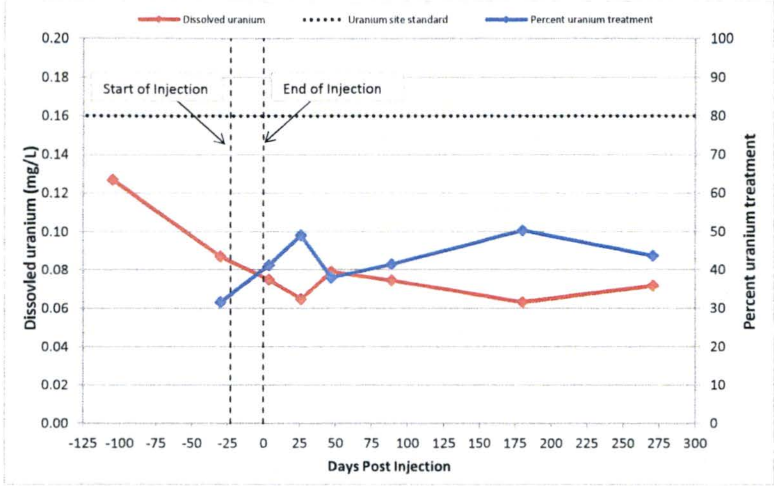
APPENDIX A

At-A-Glance Charts

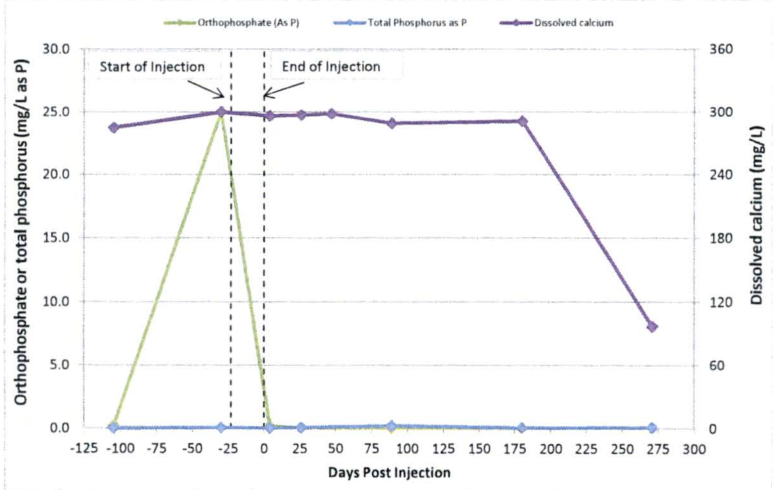
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-1S

Uranium



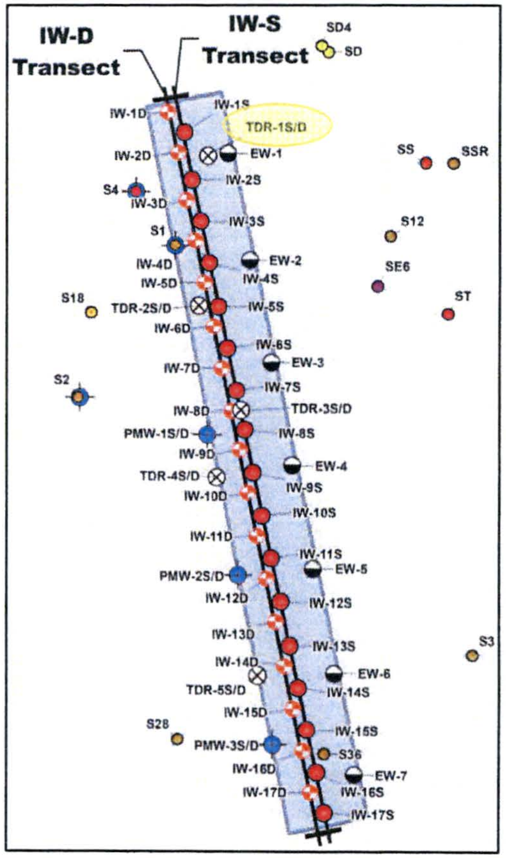
Amendment Signature



Well Construction Details:

Depth	Screened Interval	Diameter
54'	44-54'	2"

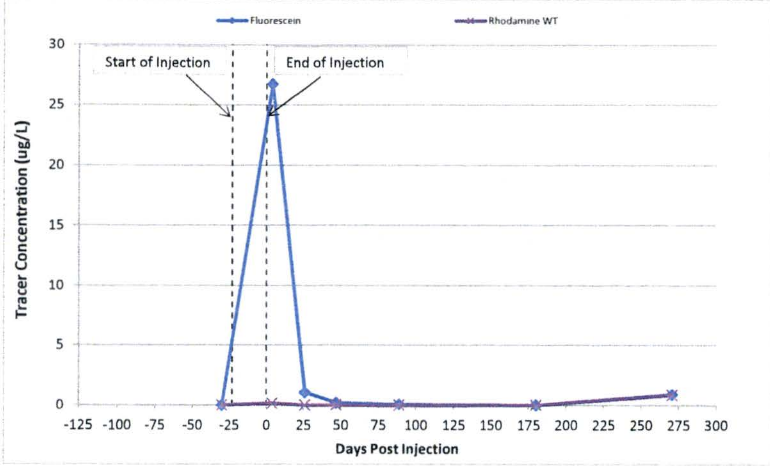
Well Location:



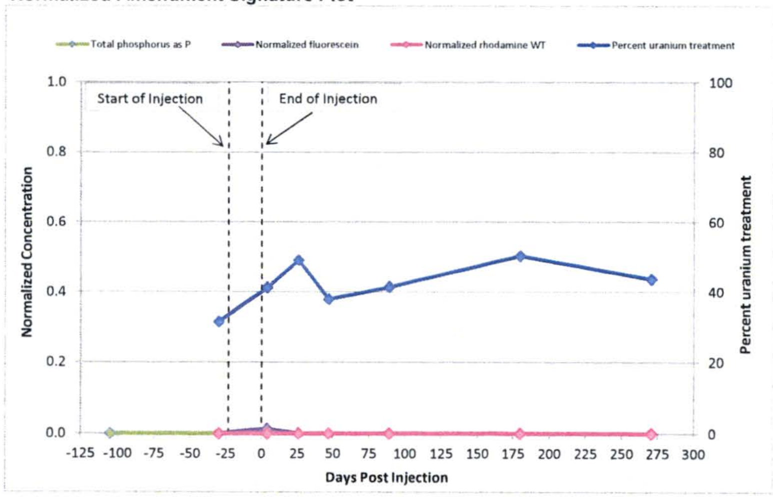
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-1S

Fluorescent Tracers



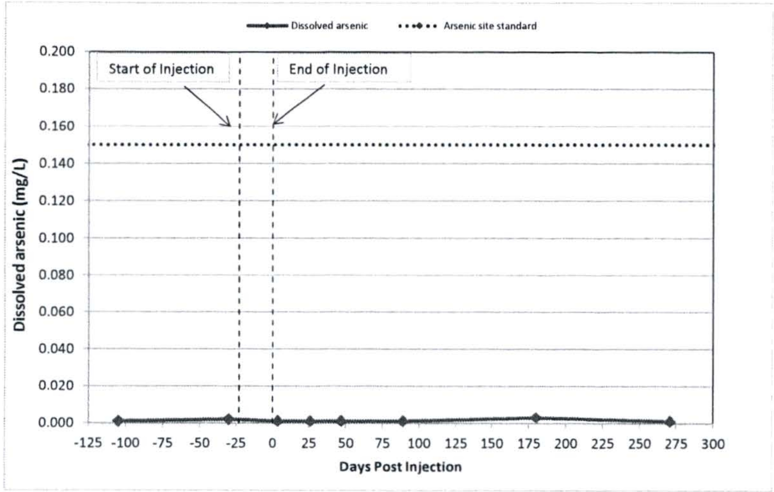
Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-1S

Arsenic

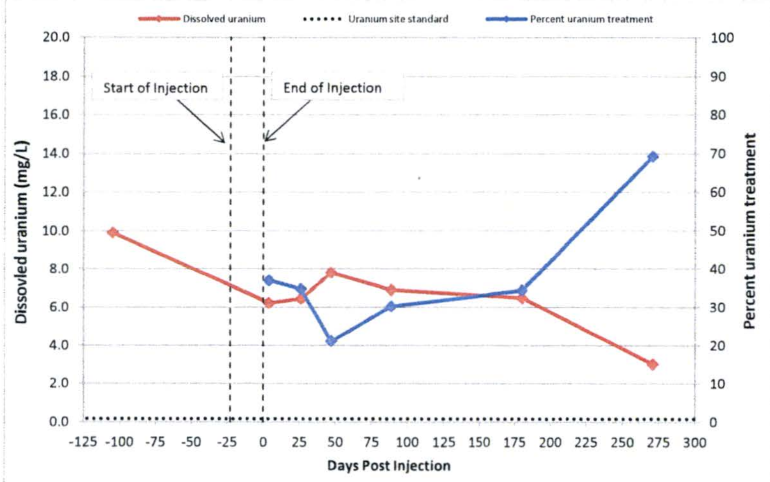


Notes

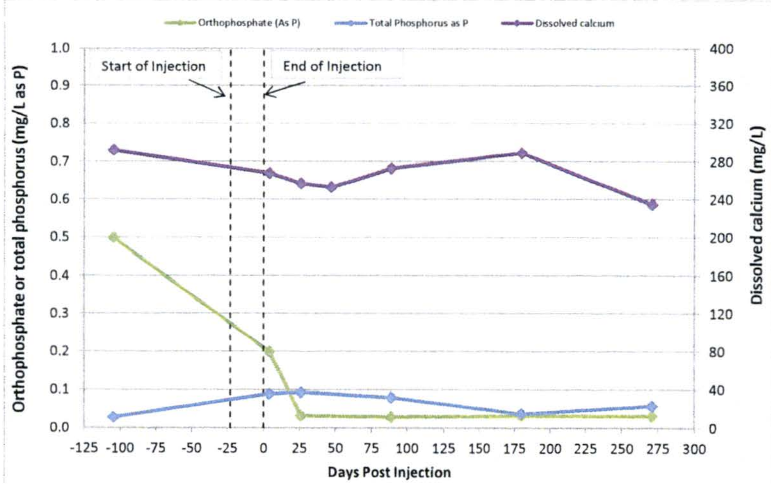
When an analyte was measured at or below its reporting limit (RL) or method dection limit (MDL), the analyte's RL or MDL is plotted.
Scales of the y-axes varies from well to well to facilitate visualization of the data.
mg/L = milligrams per liter
ug/L = micrograms per liter
P = phosphorus

Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-1D

Uranium



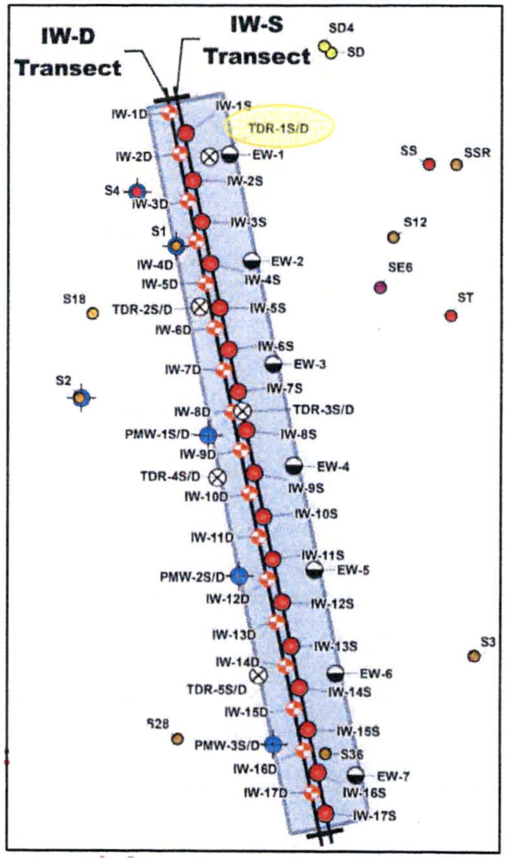
Amendment Signature



Well Construction Details:

Depth	Screened Interval	Diameter
78'	68-78'	2"

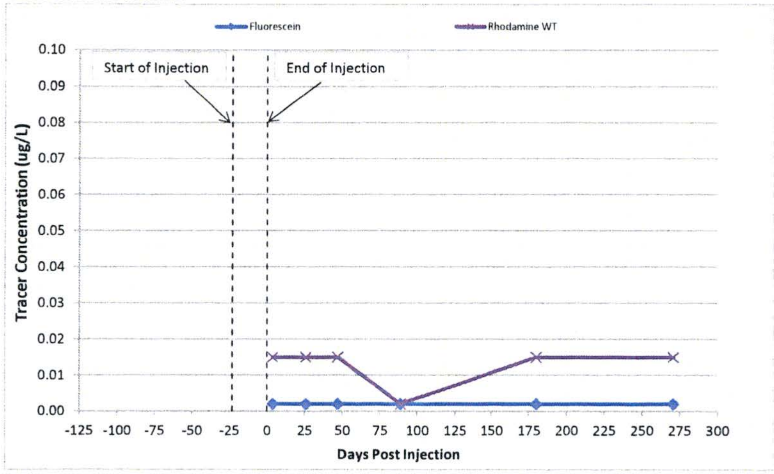
Well Location:



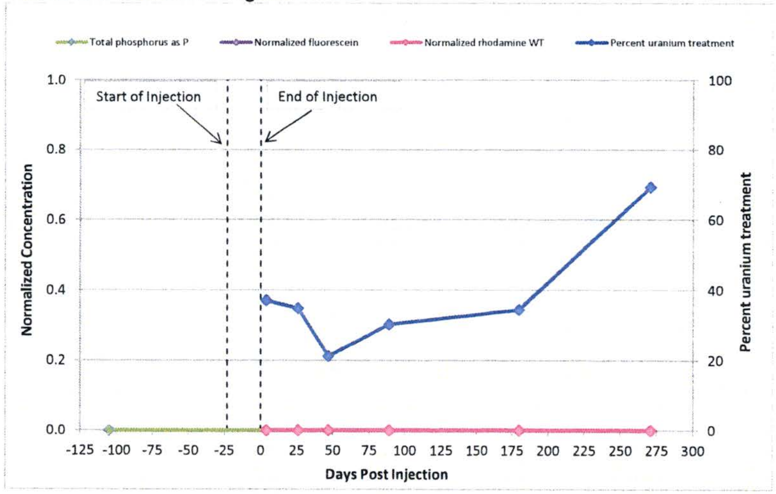
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-1D

Fluorescent Tracers

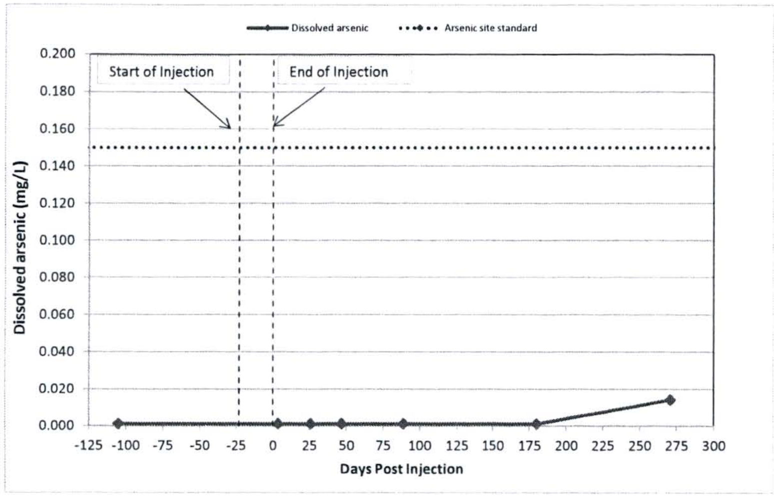


Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-1D

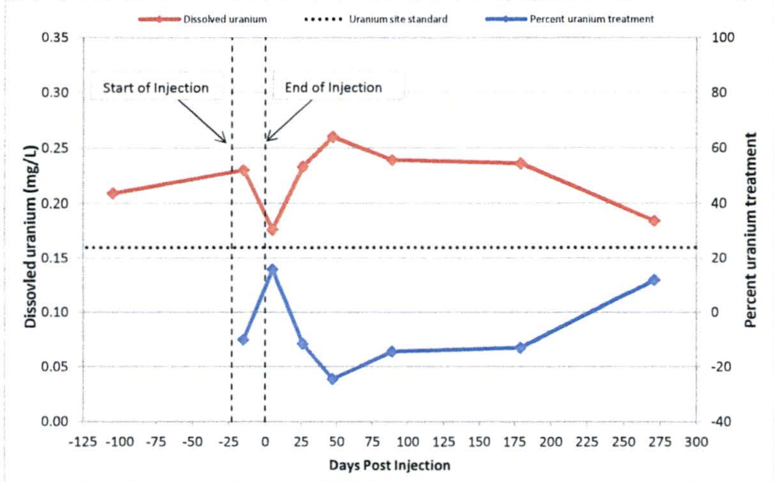
Arsenic



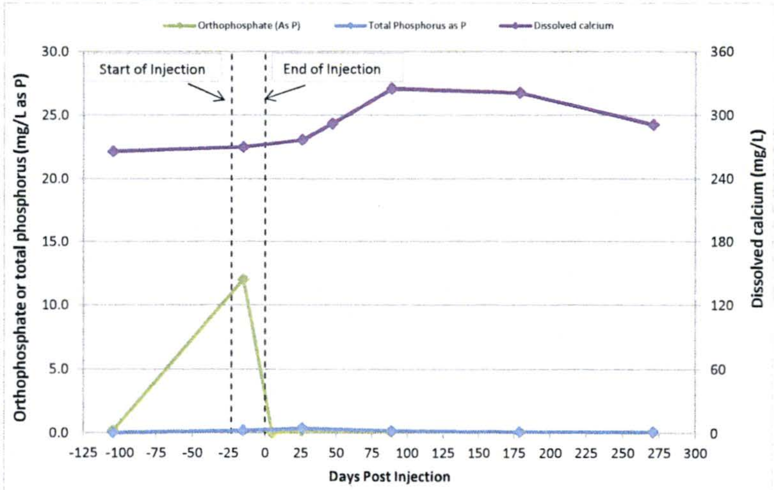
Notes
When an analyte was measured at or below its reporting limit (RL) or method dection limit (MDL), the analyte's RL or MDL is plotted.
Scales of the y-axes varies from well to well to facilitate visualization of the data.
mg/L = milligrams per liter
ug/L = micrograms per liter
P = phosphorus

Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-2S

Uranium



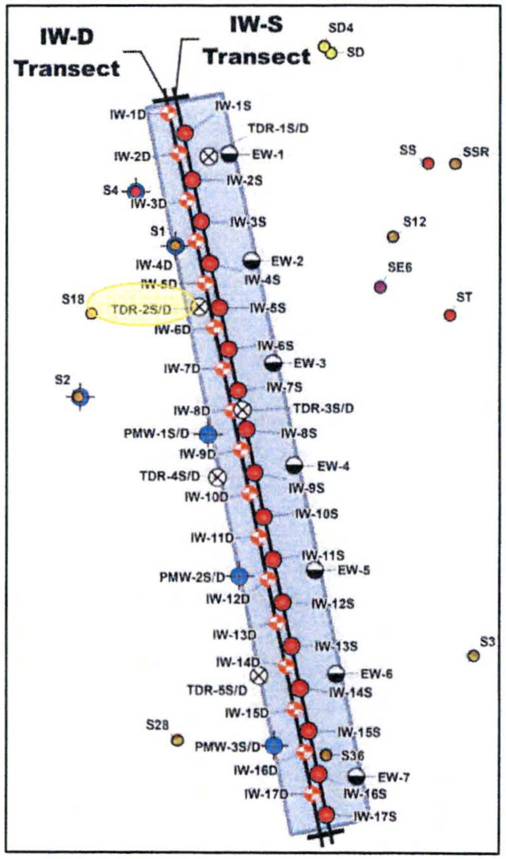
Amendment Sig ture



Well Construction Details:

Depth	Screened Interval	Diameter
62'	52-62'	2"

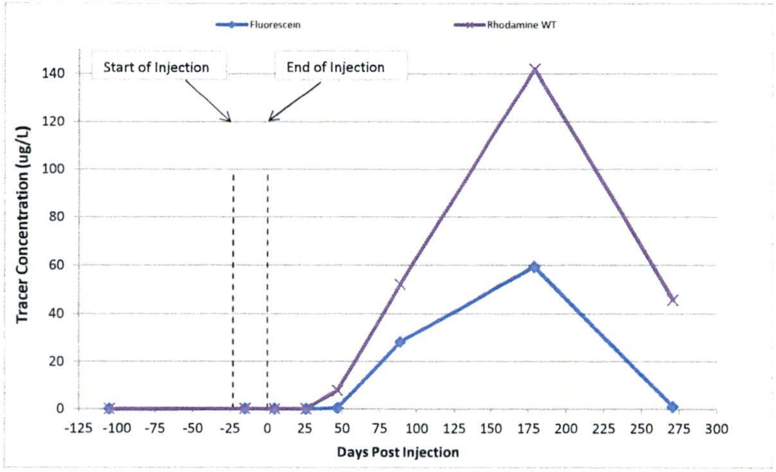
Well Location:



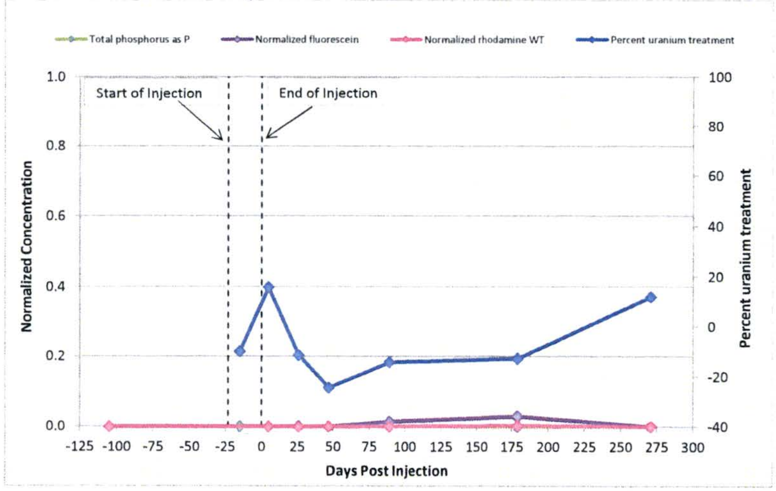
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-2S

Fluorescent Tracers

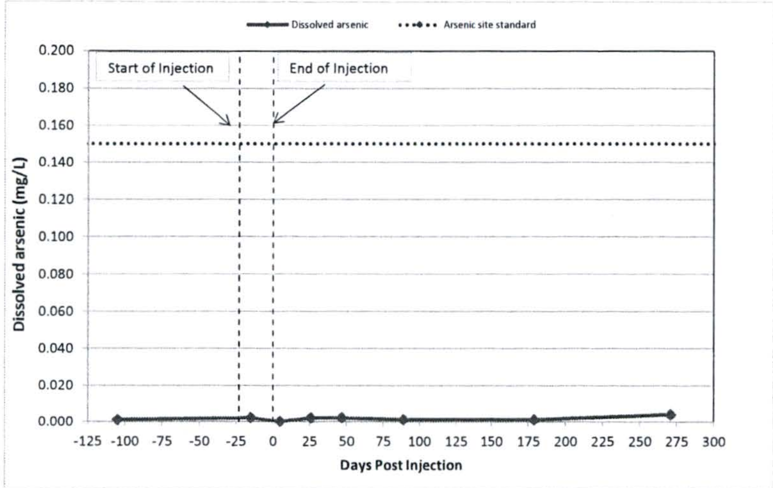


Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-2S

Arsenic

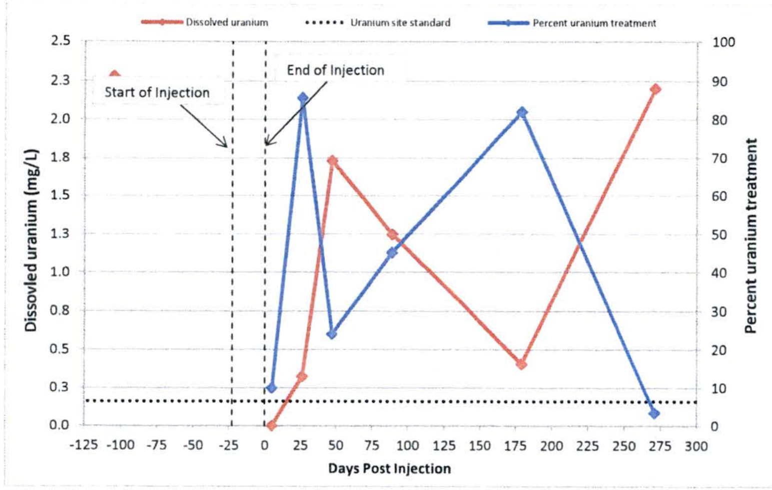


Notes

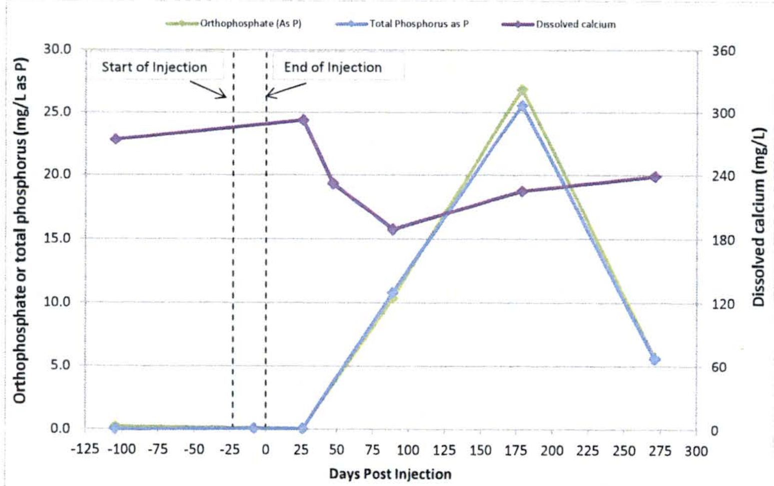
When an analyte was measured at or below its reporting limit (RL) or method dection limit (MDL), the analyte's RL or MDL is plotted.
Scales of the y-axes varies from well to well to facilitate visualization of the data.
mg/L = milligrams per liter
ug/L = micrograms per liter
P = phosphorus

Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-2D

Uranium



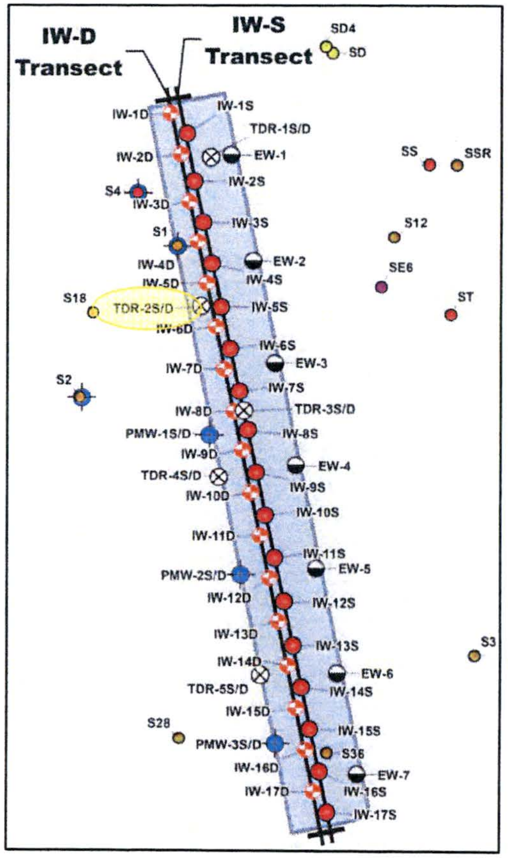
Amendment Signature



Well Construction Details:

Depth	Screened Interval	Diameter
80'	70-80'	2"

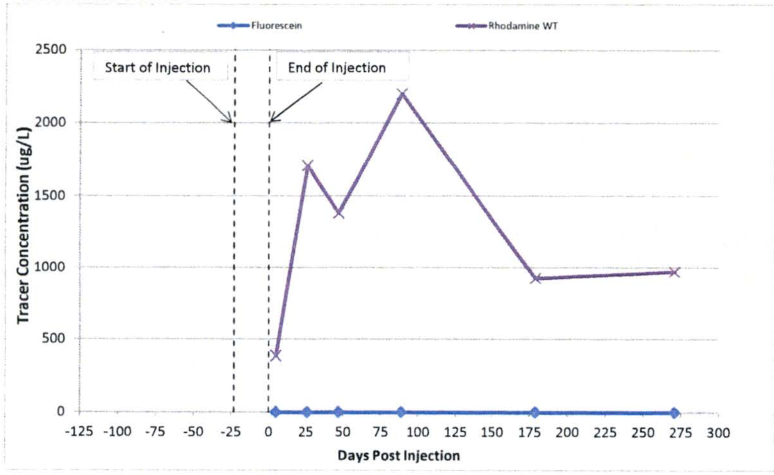
Well Location:



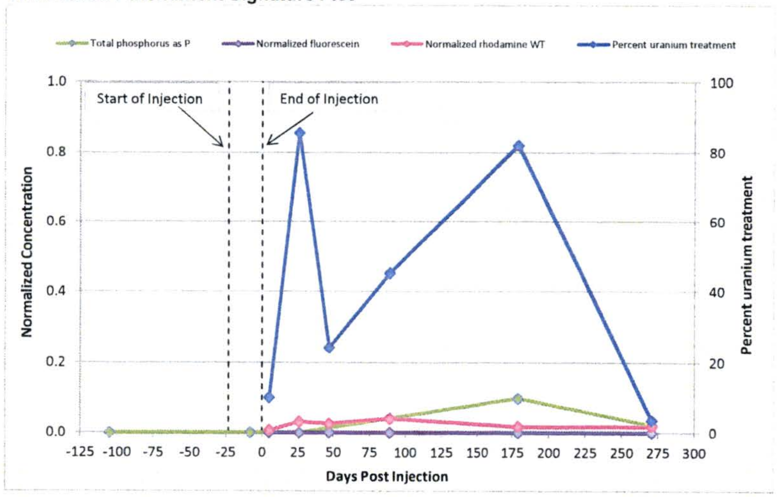
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-2D

Fluorescent Tracers

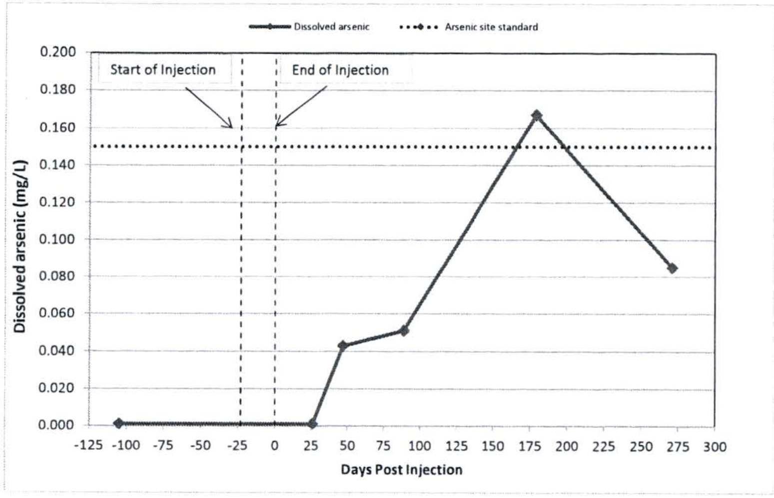


Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-2D

Arsenic



Notes

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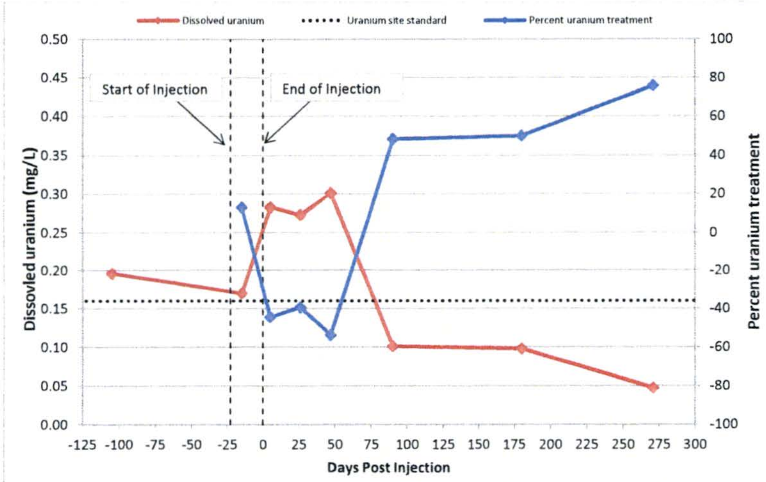
ug/L = micrograms per liter
P = phosphorus

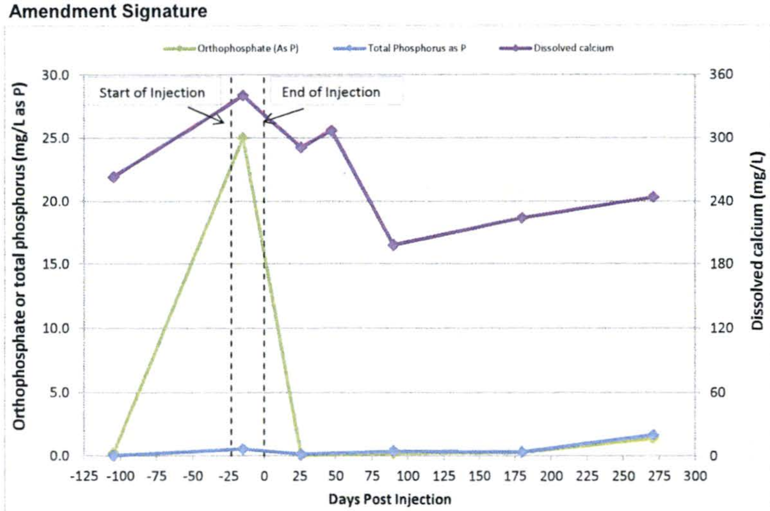
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-3S

Uranium



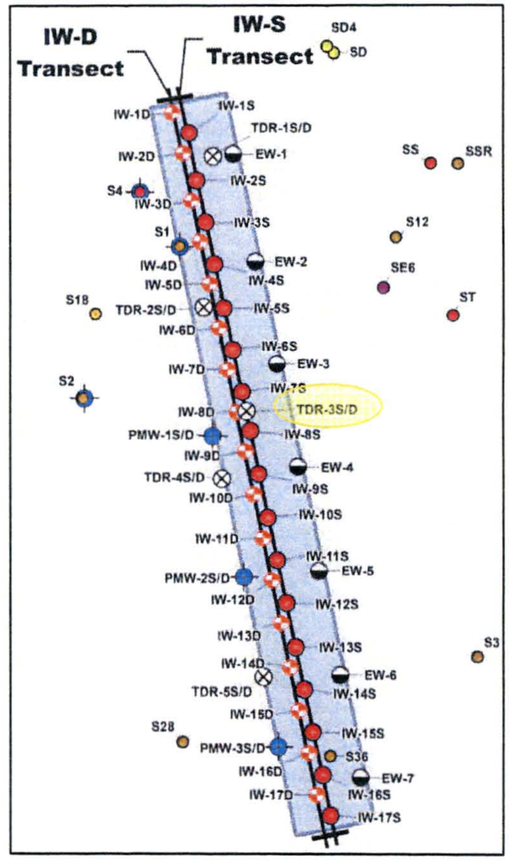
Amendment Signature



Well Construction Details:

Depth	Screened Interval	Diameter
54'	44-54'	2"

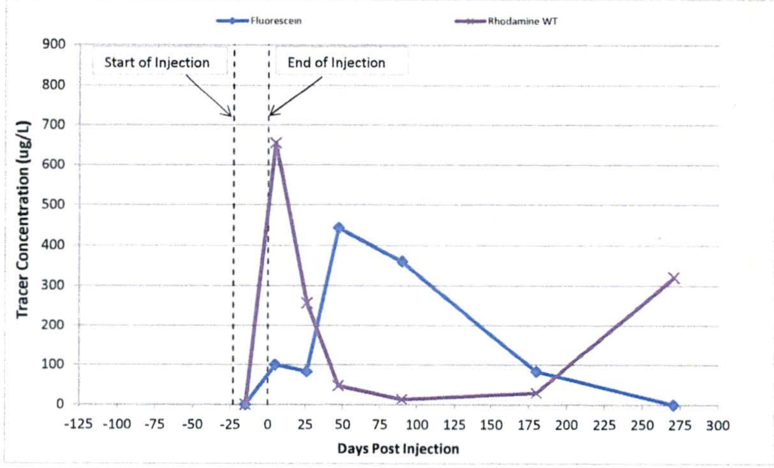
Well Location:



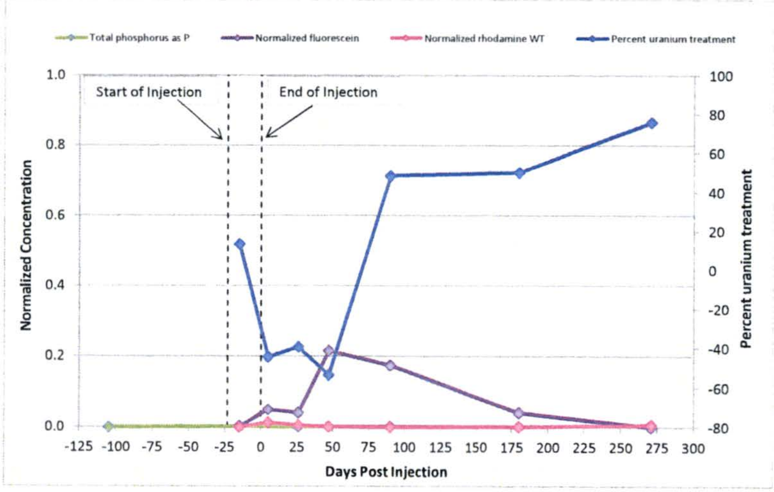
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-3S

Fluorescent Tracers

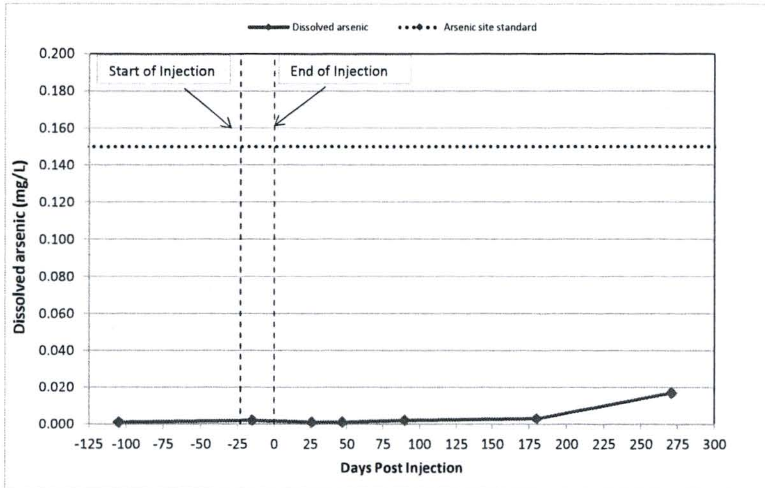


Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-3S

Arsenic



Notes

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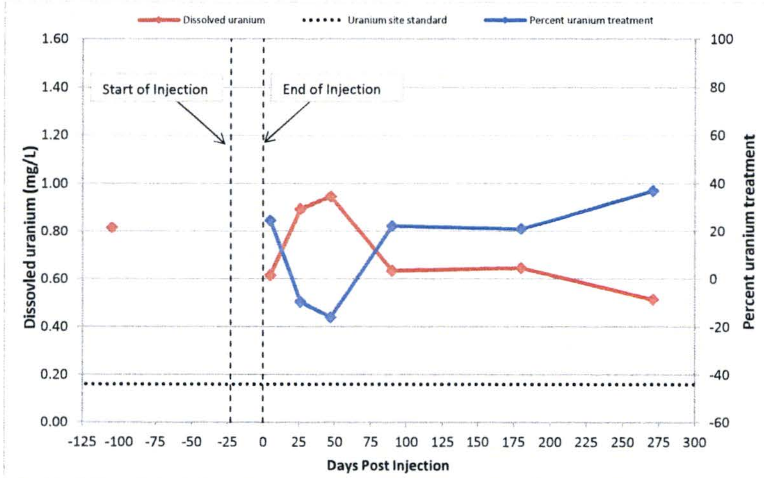
mg/L = milligrams per liter
ug/L = micrograms per liter
P = phosphorus

Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-3D

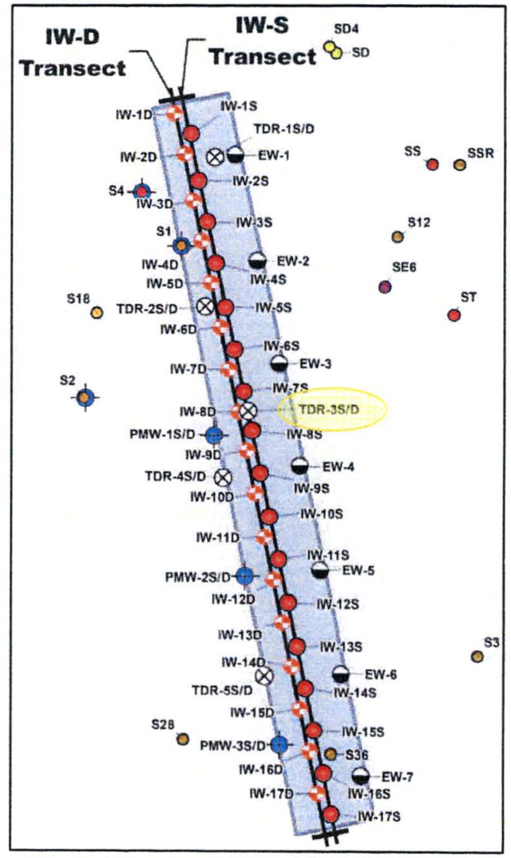
Uranium



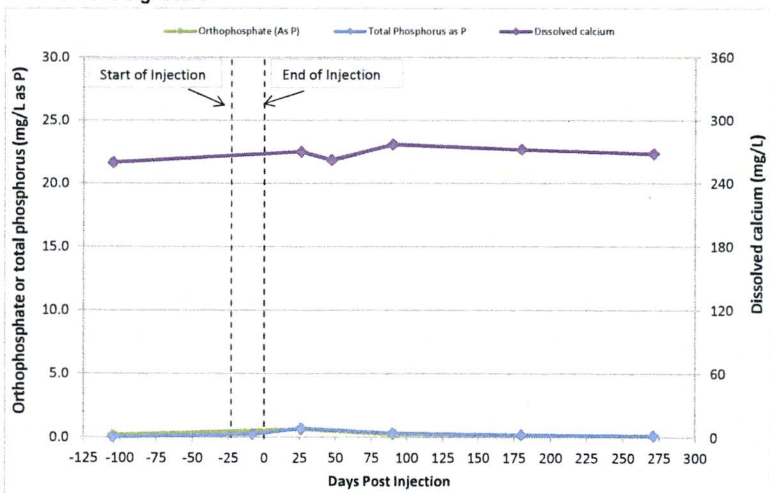
Well Construction Details:

Depth	Screened Interval	Diameter
69'	59-69'	2"

Well Location:



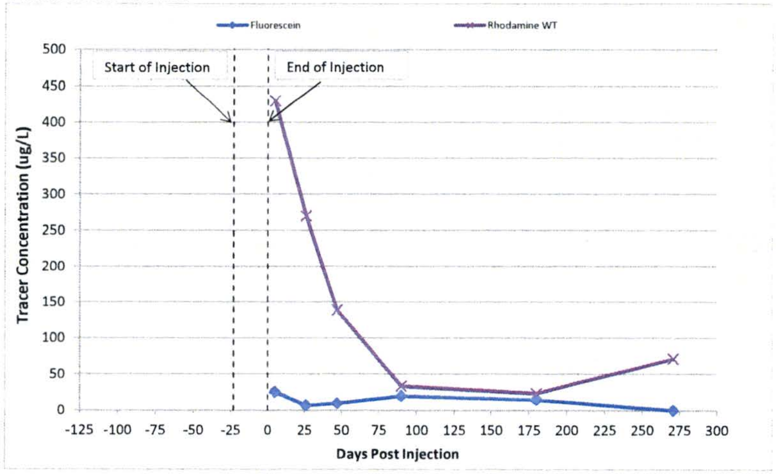
Amendment Signature



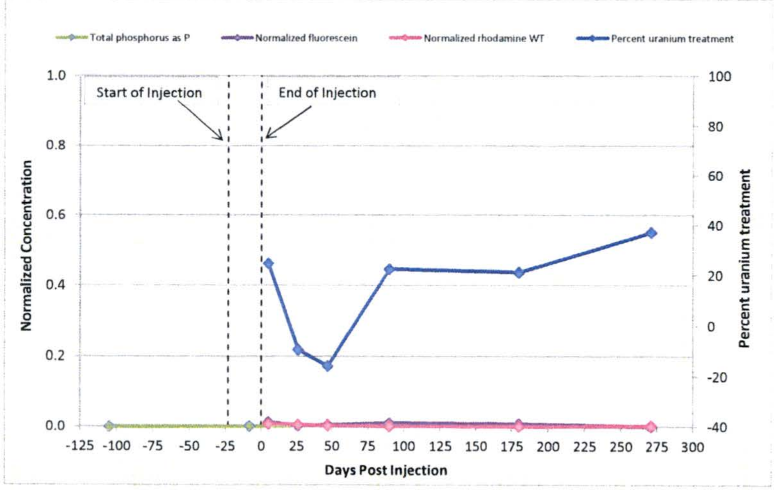
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-3D

Fluorescent Tracers



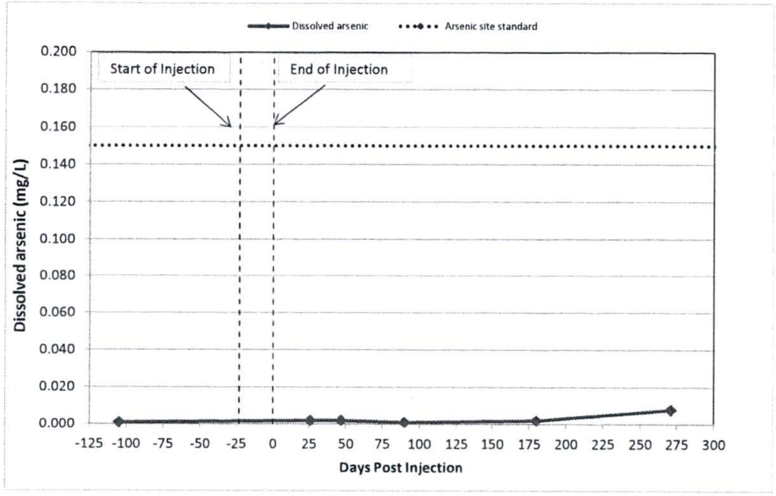
Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-3D

Arsenic



Notes

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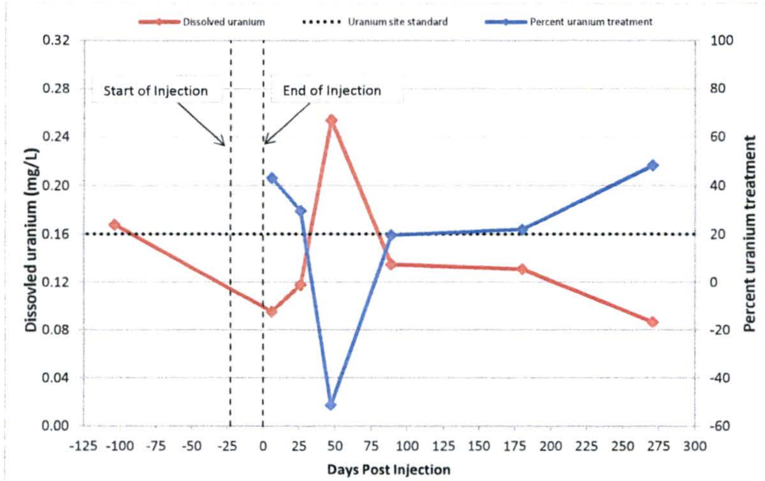
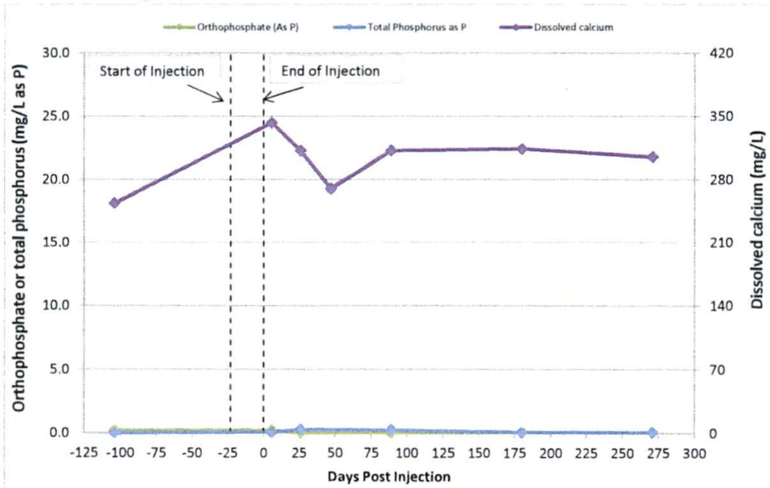
Scales of the y-axes varies from well to well to facilitate visualization of the data.
mg/L = milligrams per liter
ug/L = micrograms per liter
P = phosphorus

Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-4S

Uranium



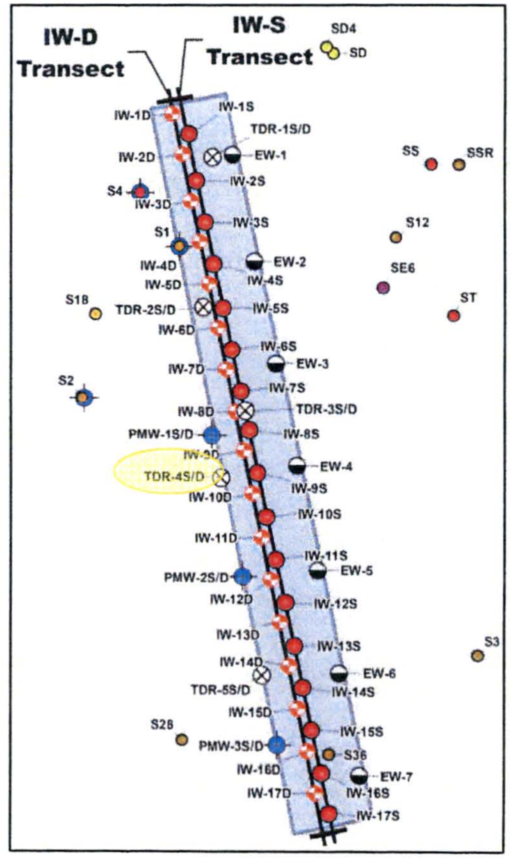
Amendment Signature



Well Construction Details:

Depth	Screened Interval	Diameter
55.5'	45.5-55.5'	2"

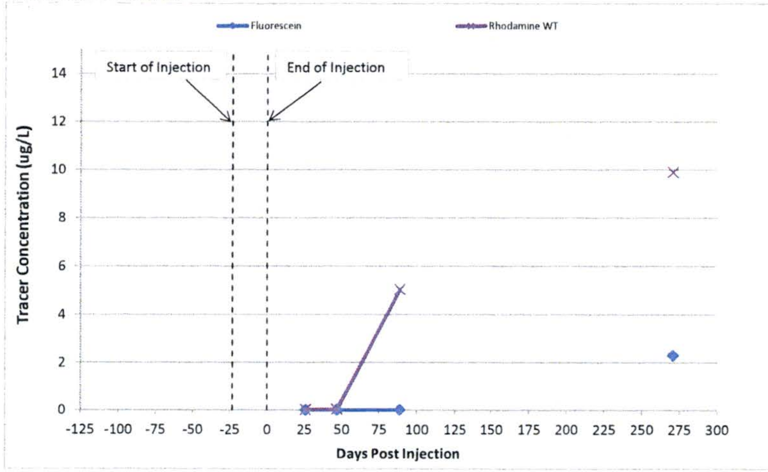
Well Location:



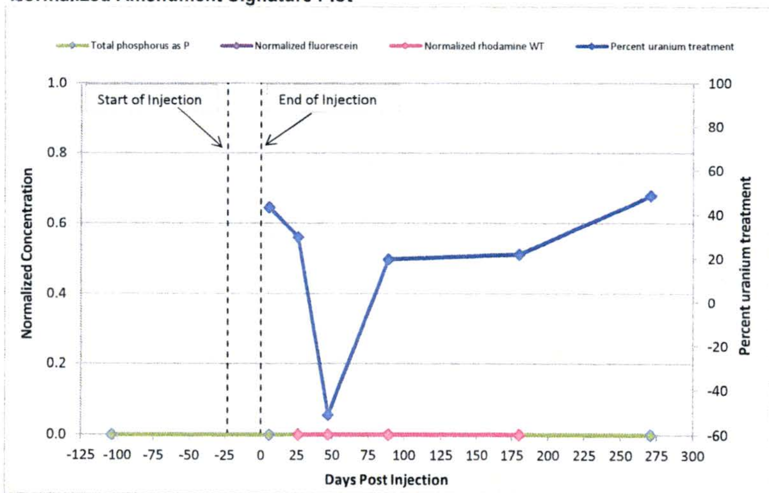
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-4S

Fluorescent Tracers

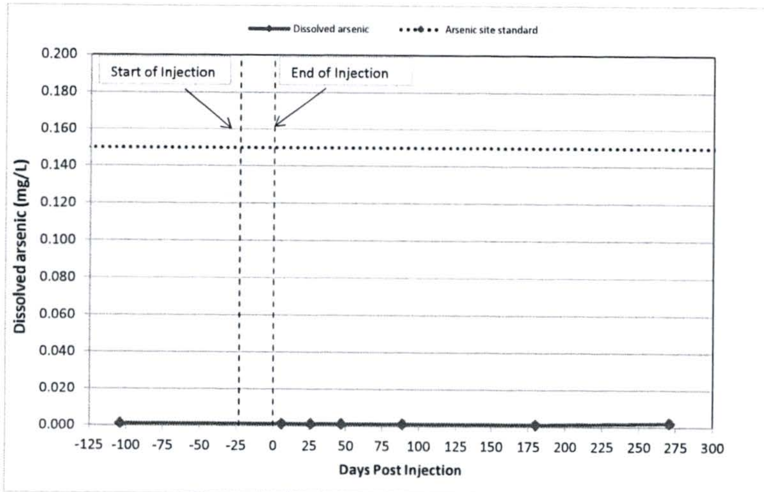


Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-4S

Arsenic



Notes

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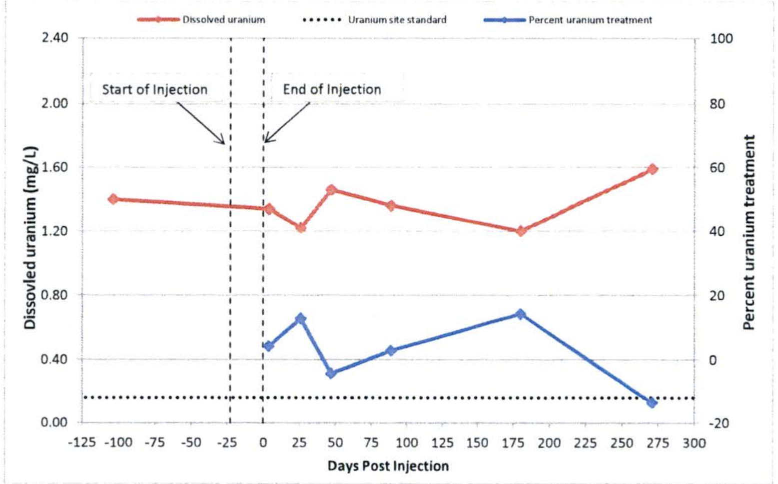
mg/L = milligrams per liter
ug/L = micrograms per liter
P = phosphorus

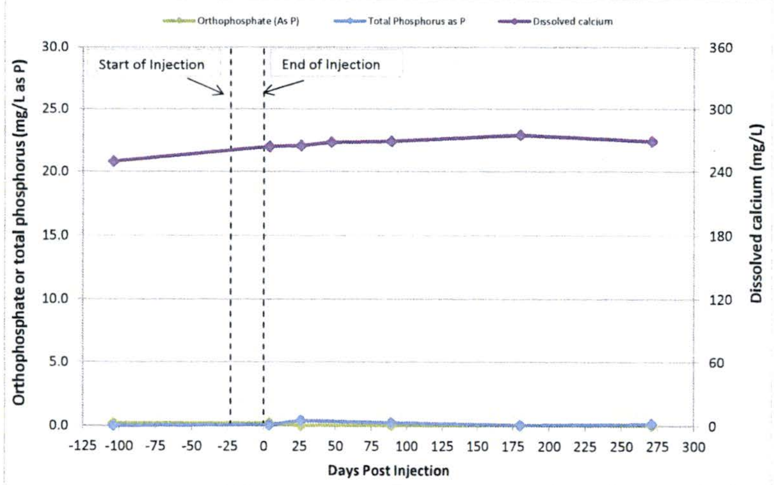
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-4D

Uranium



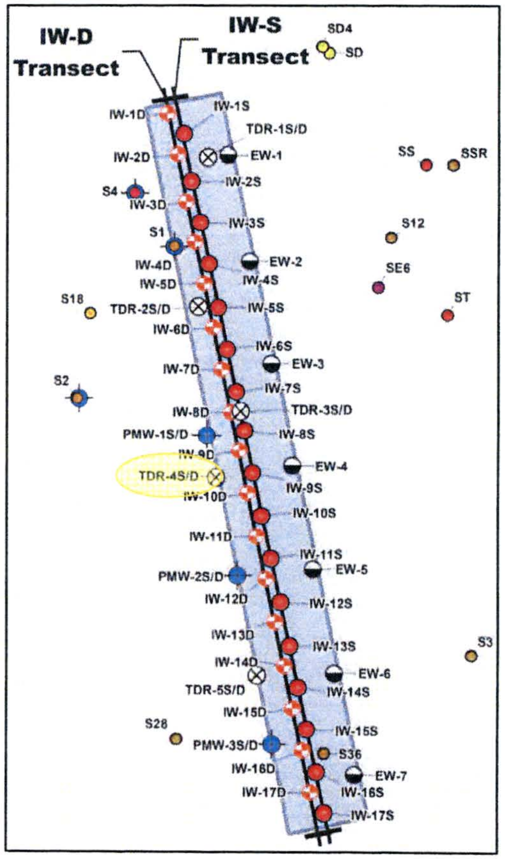
Amendment Signature



Well Construction Details:

Depth	Screened Interval	Diameter
70.5'	60.5-70.5'	2"

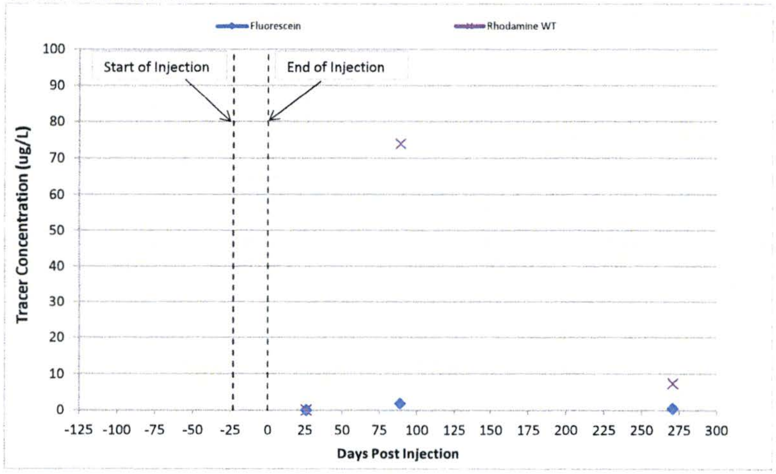
Well Location:



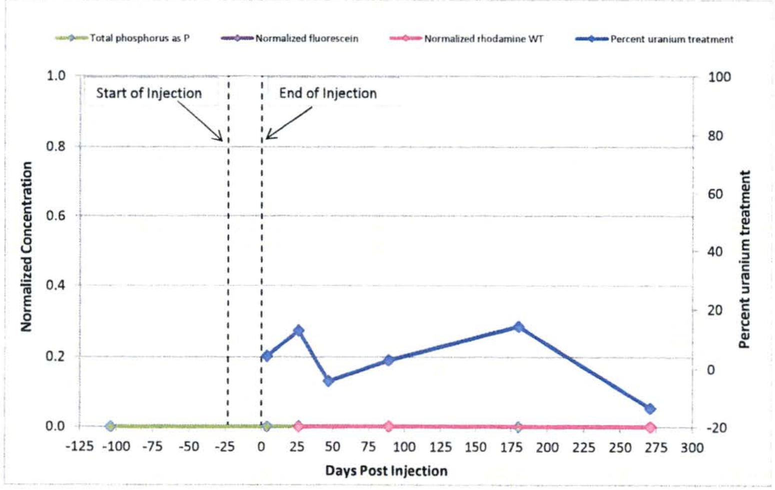
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-4D

Fluorescent Tracers

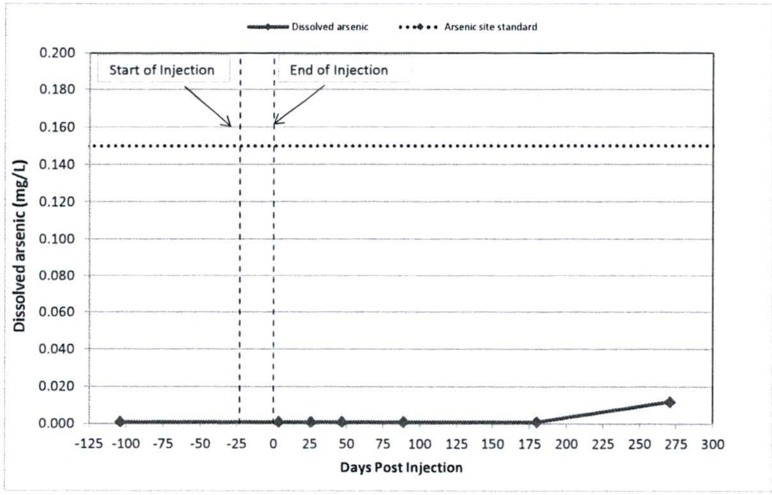


Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-4D

Arsenic



Notes
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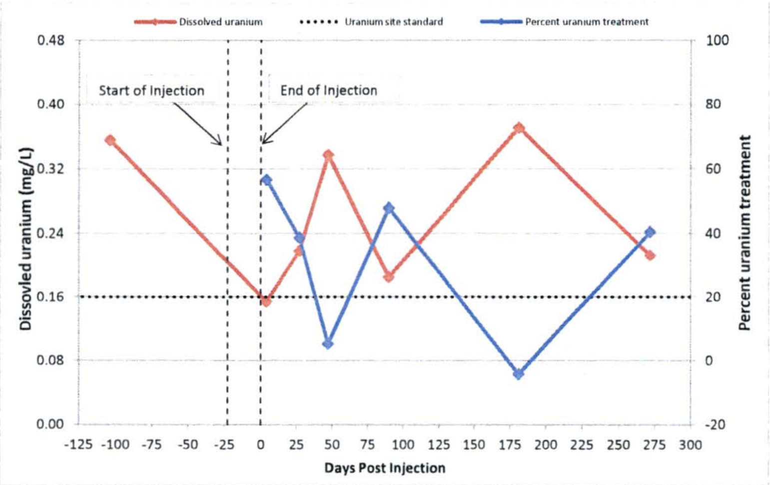
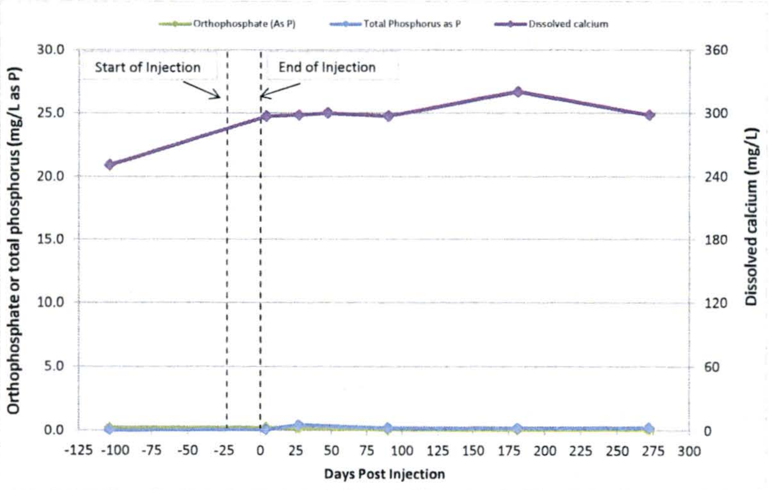
ug/L = micrograms per liter
P = phosphorus

Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-5S

Uranium



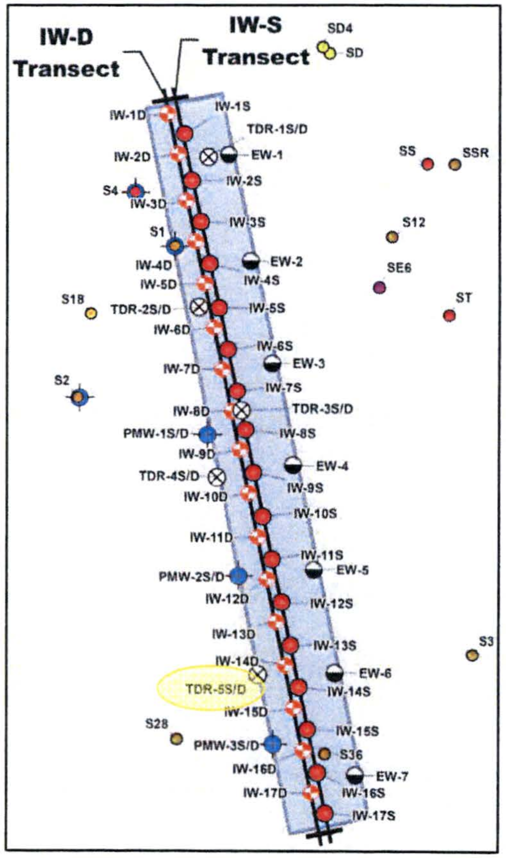
Amendment Signature



Well Construction Details:

Depth	Screened Interval	Diameter
54'	44-54'	2"

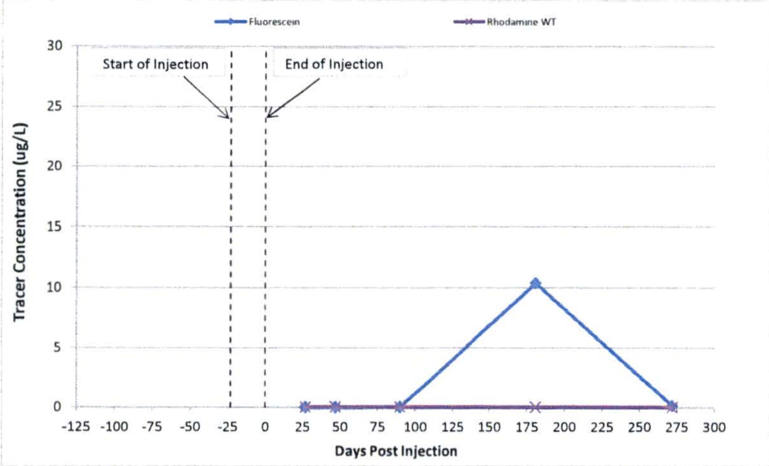
Well Location:



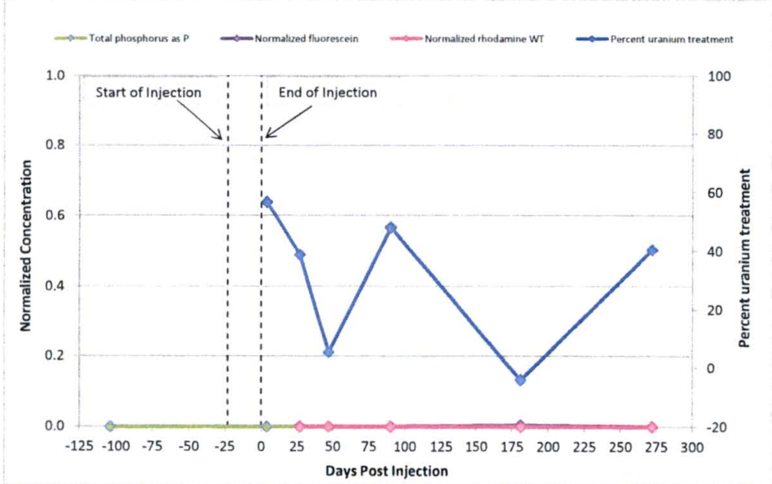
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-5S

Fluorescent Tracers

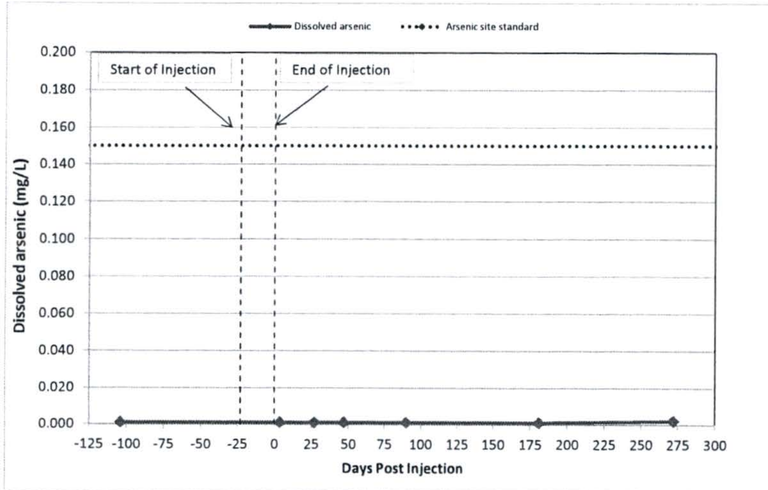


Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-5S

Arsenic



Notes

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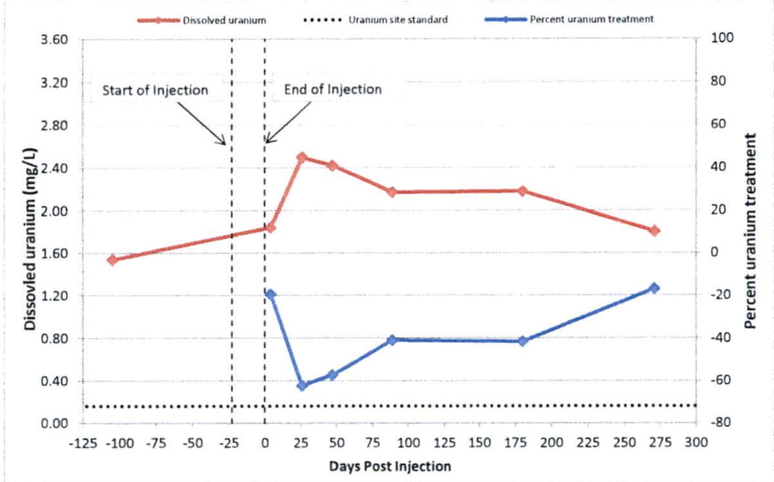
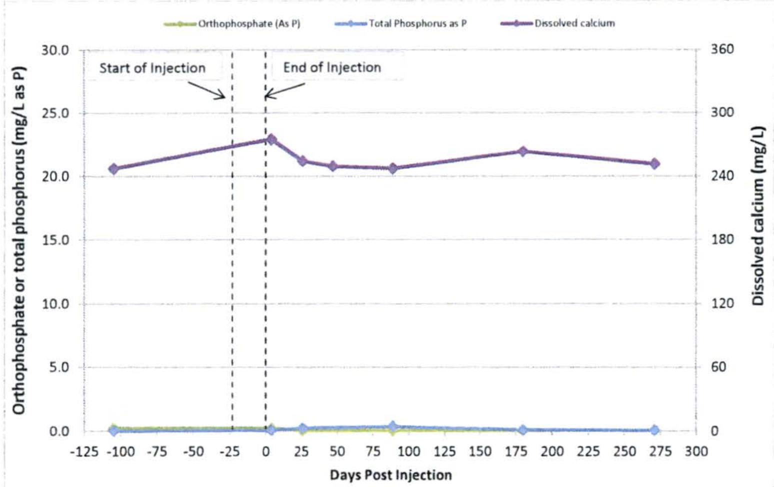
ug/L = micrograms per liter
P = phosphorus

Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-5D

Uranium



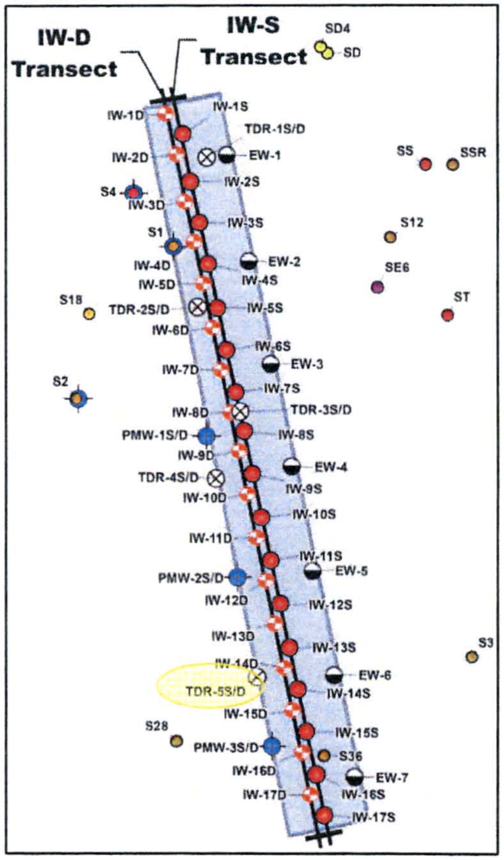
Amendment Signature



Well Construction Details:

Depth	Screened Interval	Diameter
82'	62-82'	2"

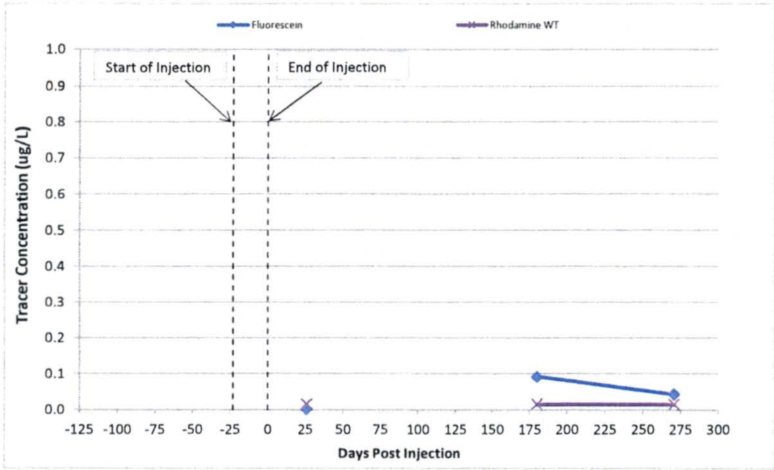
Well Location:



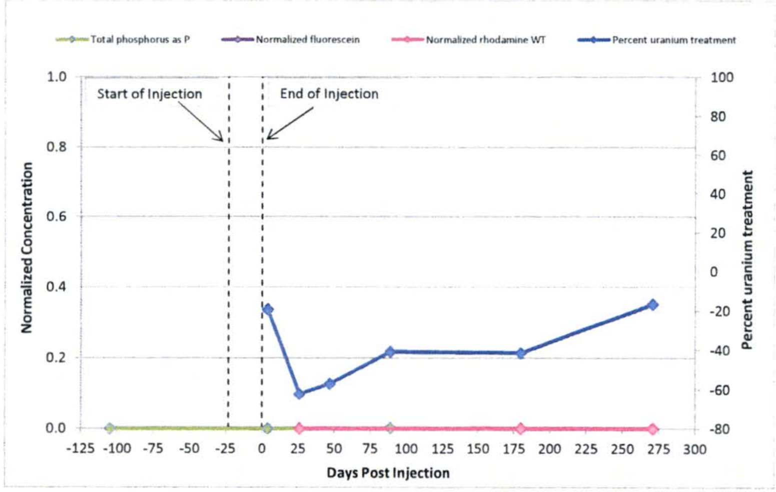
Expanded TPP Pilot Test At-A-Glance Charts

Well ID: TDR-5D

Fluorescent Tracers

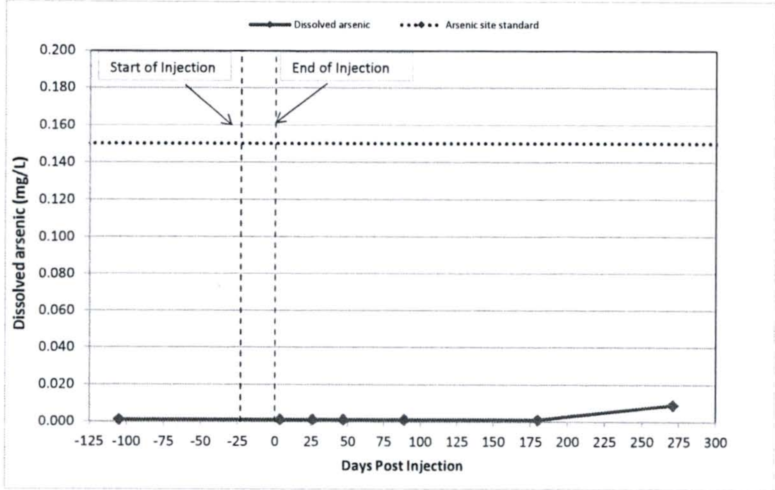


Normalized Amendment Signature Plot



Expanded TPP Pilot Test At-A-Glance Charts
Well ID: TDR-5D

Arsenic



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ug/L = micrograms per liter
P = phosphorus

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