Date: December 7, 2018

To: Bill Halliburton, Trust Administrator

From: Jeff Lux, Trustee Project Manager

Subject: Pilot Test Frac Tank Management and Testing Summary

Introduction

In December 2015, Environmental Properties Management LLC (EPM) submitted a *Facility Decommissioning Plan* (D-Plan) to the US Nuclear Regulatory Commission (NRC) and the Oklahoma Department of Environmental Quality (DEQ). The D-Plan included the design of groundwater remediation infrastructure and water treatment facilities that will recover and remediate groundwater impacted by uranium, nitrate, and fluoride. The groundwater remediation infrastructure included groundwater extraction trenches excavated in sandstone and fine-grained unconsolidated soils, and treated water injection trenches excavated in sandstone.

A Pilot Test was conducted in 2017 and 2018 to evaluate the anticipated performance of the groundwater extraction and treated water injection trenches, and to obtain performance data that could be used to optimize the design and reduce capital remediation costs. One groundwater extraction trench (GETR-BA1-01) was constructed in fine-grained silts and clays in the "transition zone" in Burial Area #1 (BA1). Treated water injection trenches GWI-BA1-01, GWI-UP2-01, GWI-UP1-01, and GWI-UP1-02 were constructed in sandstone in BA1 and the Uranium Pond #1 (UP1) and Uranium Pond #2 (UP2) areas.

Due to the unconsolidated nature of the transition zone material in which GETR-BA1-01 was constructed, a biopolymer slurry was used to maintain a positive hydraulic head on the trench during construction to keep the trench open and stable during excavation and gravel backfilling activities. Six fractionation (frac) tanks were mobilized to the site to mix and store the slurry used to maintain a positive hydraulic head on GETR-BA1-01 during construction. Following trench construction, two of the frac tanks were used to temporarily store fluid generated during GETR-BA1-01 aquifer pumping test, two of the tanks were used to hold potable water for injection testing activities, and the remaining two tanks were demobilized from the site.

Following GETR-BA1-01 construction and pump testing, but prior to the start of injection testing, a total of two grab samples were collected from the four frac tanks that remained on site. These samples were collected on December 4, 2017 and were intended to consist of one sample of the potable water used for injection testing, and one sample of the fluids generated during the GETR-BA1-01 pumping test. The sample identifiers (IDs) listed on the chain of custody for these two samples were "Potable Frac Tanks" and "GETR Frac Tanks". Upon receipt of the laboratory report it was determined that one of the frac tanks had been mislabeled in the field and both samples had been collected from frac tanks containing potable water.

Two additional frac tank samples were collected on February 8, 2018, in conjunction with the 2018 Q1 groundwater sampling, to characterize the fluids generated during the GETR-BA1-01 pumping test. During this sampling event, one sample was collected from each of the tanks

containing pumping test fluids and the sample IDs listed on the chain of custody corresponded to the serial numbers of the two frac tanks, SV26342L and SV29597L.

During an NRC inspection conducted November 27-28, 2018, inspectors noted that the spreadsheet containing the tabulated data for frac tank samples collected in December 2017 and February 2018 did not contain the same sample IDs as the chain of custody forms. In addition, the Pilot Test report submitted in June 2018 did not explain what materials these samples represented (i.e., potable water or GETR-BA1-01 pumping test fluids).

NRC requested a document explaining:

a. When frac tanks arrived at the site and why radiological surveys were not conducted on the incoming frac tanks
b. What was stored in the frac tanks and when
c. Which frac tanks were sampled and what fluid was sampled
d. When and to where frac tanks were relocated
e. What data was obtained prior to the disposition of the fluid in the frac tanks
f. When frac tanks were demobilized and what radiological release surveys were performed

This information is provided in the following paragraphs.

Mobilization and Filling of Frac Tanks

Six frac tanks were mobilized to the site on September 29, 2017 in preparation for GETR-BA1-01 excavation activities. All six tanks were placed in a staging area located south of BA1 and outside (i.e., above) the limits of the 100-year floodplain elevation. Prior to transportation to the site, the frac tanks were pressure-washed by the vendor using a chlorine-based solution. The vendor routinely pressure-washes its frac tanks prior to delivery. Because the frac tanks had been cleaned prior to delivery to the site, no radiological surveys were performed on the incoming frac tanks prior to their staging and use.

All six frac tanks were initially filled with potable water for biopolymer slurry mixing. Potable water was obtained from the Logan County Rural Water District #2, either from a hydrant located at the intersection of Highways 33 and 74, or from an onsite hydrant. On September 29th and 30th, water was transported to the frac tanks by water truck and each tank was filled with approximately 16,000 to 20,000 gallons of potable water. Because both hydrants provide potable drinking water, the water was not sampled for laboratory analysis of uranium prior to its use.

Pilot Test Trench Construction

Once the six frac tanks were filled with potable water, the construction subcontractor mixed a biopolymer with the water and circulated the mixture until all six frac tanks contained the slurry required for GETR-BA1-01 trench construction.

During GETR-BA1-01 excavation, slurry was gravity fed from the frac tanks into the excavated trench to maintain a fluid level that was near the top of the trench. Maintaining a positive hydraulic head within the trench (relative to the groundwater surface elevation) prevented sidewall collapse and groundwater infiltration, while the (high) viscosity of the slurry minimized infiltration into the surrounding soils. After the entire trench was excavated, groundwater extraction infrastructure (extraction sumps and drain pipe, in-trench monitor wells, temporary slurry breaking wells, etc.) were placed in the trench and the trench was backfilled with silica gravel. As backfilling activities proceeded, slurry displaced by the gravel was pumped back into the frac tanks while a positive head (relative to the groundwater surface elevation) was maintained within the trench. Slurry was pumped from the trench at a rate that prevented an overflow of slurry from the trench. When the top of the gravel placed in the trench reached approximately 3 feet below grade, a geotextile fabric was placed over the gravel and the trench was backfilled with soil previously excavated from the trench.

At the conclusion of GETR-BA1-01 construction activities, all six frac tanks were at least partially filled with biopolymer slurry that had been pumped from the trench. Per slurry manufacturer recommendations, LEB-H™ breaking enzyme was introduced to the frac tanks through the manway located in the top of each tank. Breaking enzyme was also introduced to the trench through the two extraction sumps, the cleanout pipe, and two slurry breaking wells. Using pumps installed near the base of the extraction sumps, cleanout, and temporary wells, the slurry and breaking enzyme were circulated from the bottom of the trench to the surface of the gravel backfill layer to distribute the breaking enzyme throughout the gravel backfill. To prevent infiltration of contaminated groundwater during trench construction, a positive head differential between the trench and surrounding groundwater table was maintained throughout the slurry/enzyme circulation process. The slurry and breaking enzyme were continuously circulated, and viscosity and pH measurements, obtained from samples of the recirculated trench slurry, were recorded three times per day throughout the process. Circulation of the slurry/enzyme continued until pH and viscosity measurements were within 10% of baseline measurements recorded for groundwater samples collected from the monitor wells located near the trench prior to excavation.

Between October 30th and November 3rd, the broken slurry in the frac tanks was transported to the dry detention basin located near UP1 for disposal. The broken slurry was pumped into the basin, which was later used for the disposition of excess sandstone excavated from GWI-UP1-01 and GWI-UP1-02. Because a positive head had been maintained in GETR-BA1-01 throughout

construction activities, contamination of the broken slurry by groundwater in the surrounding soil would have been negligible. Consequently, samples of the broken slurry were not collected for laboratory analysis prior to disposition in the detention basin.

Extraction and Injection Trench Pilot Testing

Following the slurry breaking and disposal activities described above, two frac tanks were demobilized from the site by the tank vendor. Two of the four remaining tanks (serial numbers SV26342L and SV29597L) were repurposed for the storage of groundwater to be generated during GETR-BA1-01 pump testing. Pump testing was conducted at GETR-BA1-01 from November 13th through November 28th; each frac tank was more than half full of groundwater at the conclusion of pump testing activities.

The two frac tanks that did not contain the fluid generated during pump testing were filled with potable water for injection testing at GWI-BA1-01. Following pump testing, but prior to the start of injection testing, grab samples were collected from two frac tanks on December 4th, with the intention of collecting one sample of potable water, and one sample of the fluid generated during the pump tests. The sample IDs listed on the chain of custody for these samples were "Potable Frac Tanks" and "GETR Frac Tanks".

An injection test was conducted at GWI-BA1-01 from December 7th through December 19th. As described above, water trucks continuously delivered potable water to the two potable water frac tanks throughout injection testing. The frac tanks were emptied during the injection test to facilitate mobilization to the next injection test location (described below).

The two empty frac tanks were transferred to the UP2 area and filled with potable water. The injection test for GWI-UP2-01 was conducted from January 5th through January 22nd. The frac tanks were emptied during injection testing, transferred to the UP1 area, and filled with potable water. The injection test for GWI-UP1-01 and GWI-UP1-02 was conducted from January 24th through February 8th. Upon completion of the injection testing, the two frac tanks used for potable water storage were demobilized from the site. Because these frac tanks had been filled with potable water and emptied numerous times, no release survey was performed prior to demobilization.

Data Evaluation and Reporting

In January 2018, upon receipt of the laboratory results for the frac tank water samples collected on December 4, 2017, it was observed that the uranium concentration for both samples was less than 1.0 microgram per liter (µg/L) uranium. Upon further investigation it was discovered that the temporary labels that had been affixed to the frac tanks were incorrect. Because the fluid in the frac tanks used for the GETR-BA1-01 pumping test had distinct characteristics (i.e., residual biopolymer slurry and evidence of biological activity), it was clear that those two frac tanks had

not been emptied and filled with potable water. Consequently, it was concluded that one of the two frac tanks containing potable water had been mistakenly sampled and the sample had been assigned the ID "GETR Frac Tanks". Hence, the two tank samples collected on December 4, 2017 both consisted of potable water; however, one of the samples was labeled as though it consisted of fluid generated during the GETR-BA1-01 pumping test.

Having determined that both samples collected on December 4, 2017 consisted of potable water, the samples that were named "Potable Frac Tanks" and "GETR Frac Tanks" were re-named as "Potable Frac Tank 1" and "Potable Frac Tank 2" in the data table submitted to the agency, as well as in the Pilot Test Report. The sample yielding a total uranium concentration of 0.77 (+/- 0.4) µg/L had been identified as "Potable Frac Tanks" on the chain of custody, and the sample yielding a total uranium concentration of 0.48 (+/- 0.3) µg/L had been identified as "GETR Frac Tanks" on the chain of custody.

A Notice of Deficiency (NOD) was generated on February 8, 2018 to document the tank labeling and sampling errors. Corrective Action included the collection of samples from the two tanks containing groundwater generated during the GETR-BA1-01 pump test. These samples were collected on February 8th, during the 1st Quarter 2018 groundwater sampling event. The IDs for these samples listed on the chain of custody were the serial numbers of the frac tanks – "SV26342L" and "SV29597L"; however, the IDs listed on the data tables provided in the agency data submission and the Pilot Test Report were "GETR Frac Tank 1" and "GETR Frac Tank 2". These IDs were used to describe the water that the samples represented, rather than the IDs listed on chain of custody forms.

Final Disposition of Fluid and Frac Tanks

Initially, the decision was made to retain the fluid generated during the GETR-BA1-01 pumping test until it could be treated by the BA1 water treatment facility, because the sample identified as "GETR Frac Tank 1" yielded 38.5 (+/- 1.90) µg/L total uranium, slightly higher than the uranium maximum contaminant level (MCL) of 30 µg/L, and "GETR Frac Tank 2" yielded 25.7 (+/- 1.27) µg/L total uranium, less than the method detection limit (MDL).

A supplemental sampling event was conducted in September 2018 to evaluate the potential for dissolved organics from the broken slurry to impact groundwater around GETR-BA1-01. In addition to the collection of groundwater samples, the project team desired more representative sampling of the fluid in the frac tanks than had been obtained from the initial grab samples (i.e., GETR Frac Tank 1 and GETR Frac Tank 2). Using a low-flow sampling procedure, samples were collected from each tank at approximately one foot below the top of fluid, at the middle of the fluid column, and at approximately one foot from the bottom of the tank.

At two of the sample locations, one filtered and one unfiltered sample was collected for analysis; the unfiltered sample IDs included the suffix "UF". Unfiltered samples were collected to evaluate the possibility that uranium had sorbed onto suspended solids, in which case analysis of only filtered samples may not capture all the uranium in the fluid.

There was no record that identified which frac tank (by serial number) was sampled as "GETR Frac Tank 1" or "GETR Frac Tank 2". Consequently, samples collected in September 2018 were assigned IDs consisting of the serial number of the frac tank, followed by the "location" designation (i.e., top, middle, or bottom), and "UF" if appropriate. The sample IDs and total uranium concentrations follow:

- SV26342L-TOP – 13.76 (+/- 0.68) µg/L
- SV26342L-MID – 13.56 (+/- 0.67) µg/L
- SV26342L-BOT – 13.96 (+/- 0.69) µg/L
- SV26342L-BOTUF – 14.16 (+/- 0.70) µg/L
- SV29597L-TOP – 28.33 (+/- 1.40) µg/L
- SV29597L-MID – 28.62 (+/- 1.42) µg/L
- SV29597L-MIDUF – 29.03 (+/- 1.43) µg/L
- SV29597L-BOT – 28.52 (+/- 1.41) µg/L

Considering the uncertainties associated with the analyses, the results for all four samples from each frac tank are essentially the same. In addition, the analytical results for all eight samples were less than the MCL. Consequently, the tanks were emptied by discharging the water to the ground surface in November 2018. The frac tanks will be washed prior to demobilization. Because the fluid in these frac tanks did contain low concentrations of licensed material, a release survey will be performed prior releasing these frac tanks to the vendor.

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