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South Carolina Department of Health and Environmental Control (SCDHEC)
Assessment Section, UST Management Division
Bureau of Land and Waste Management
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Columbia, South Carolina 29201

Subject: **2018 Third Quarter Monitoring Report**
Plantation Pipe Line Company
Lewis Drive Remediation Site
Belton, South Carolina
Site ID #18693, "Kinder Morgan Belton Pipeline Release"

Dear Ms. Coleman,

On behalf of Plantation Pipe Line Company (Plantation), CH2M HILL Engineers, Inc. (CH2M), now part of Jacobs Engineering Group Inc. (Jacobs), is submitting the attached 2018 Third Quarter Monitoring Report for the Lewis Drive Remediation Site in Belton, South Carolina. This report summarizes the work performed at the site between July 1, 2018, and September 30, 2018. If you have any questions or concerns, please call me at 919-760-1777 or Mr. Jerry Aycock/Plantation at 770-751-4165.

Regards,

William M. Waldron, P.E.
Program Manager

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Plantation Pipe Line Company
Lewis Drive Remediation Site
Belton, South Carolina
Site ID Number 18693
“Kinder Morgan Belton Pipeline Release”

2018 Third Quarter Monitoring Report

Final

January 21, 2019

Plantation Pipe Line Company

Lewis Drive Remediation Site, Belton, South Carolina

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The material and data presented in this report were prepared consistent with current and generally accepted consulting principles and practices. This work was supervised by the following Jacobs licensed professional.

Jonathan Grimes, P.G.
South Carolina Registered Professional Geologist No. 2235

January 21, 2019
Date

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Acronyms and Abbreviations

µg/L	microgram(s) per liter
1,2-DCA	1,2-dichloroethane
BCPZ	Brown's Creek Protection Zone
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAP	Corrective Action Plan
CCPZ	Cupboard Creek Protection Zone
CH2M	CH2M HILL Engineers, Inc., now part of Jacobs Engineering Group Inc.
COC	chain-of-custody
DO	dissolved oxygen
DOT	Department of Transportation
EPA	U.S. Environmental Protection Agency
HSA	hollow-stem auger
ID	identification
Jacobs	Jacobs Engineering Group Inc.
LLC	limited liability company
mg/L	milligram(s) per liter
MTBE	methyl tertiary butyl ether
O&M	operation and maintenance
PID	photoionization detector
Plantation	Plantation Pipe Line Company
QAPP	Quality Assurance Project Plan
SCDHEC	South Carolina Department of Health and Environmental Control
scfm	standard cubic feet per minute
scfm/ft	standard cubic feet per minute per foot
TSL	Target Screening Level
UST	underground storage tank

1. Introduction

On behalf of Plantation Pipe Line Company (Plantation), CH2M HILL Engineers, Inc. (CH2M), now a wholly owned subsidiary of Jacobs Engineering Group Inc. (Jacobs), is submitting this 2018 Third Quarter Monitoring Report for the Lewis Drive Remediation Site in Belton, South Carolina. This report summarizes the work performed at the site between July 1, 2018, and September 30, 2018.

On December 8, 2014, a release of an estimated 8,800 barrels (369,600 gallons) of gasoline and a small amount of diesel fuel (Plantation, 2015) was discovered from Plantation's 26-inch product pipeline near Lewis Drive in Belton, South Carolina (Figure 1). The release point is located on the pipeline right-of-way between Lewis Drive, a rural two-lane undivided asphalt road to the south, and a hayfield to the north. The release location and site features (including the location of monitoring wells, recovery sumps, temporary wells [piezometers], recovery trenches, recovery wells, and vertical and horizontal air sparging wells) are shown on Figure 1.

This site has been designated by the South Carolina Department of Health and Environmental Control (SCDHEC) as Site Number 18693 "Kinder Morgan Belton Pipeline Release." This Third Quarter Monitoring Report was prepared in accordance with the Corrective Action Plan (CAP) (CH2M, 2016b), CAP Addendum, Revision 1 (CH2M, 2017a), CAP Addendum, Revision 2 (CH2M, 2017d), Comprehensive Site Assessment Report (CH2M, 2016a), and project Quality Assurance Project Plan (QAPP), Revision 4 (CH2M-Jacobs, 2018b). Correspondence between Plantation and SCDHEC during this reporting period is summarized below:

- July 24, 2018 – Plantation submitted its response to SCDHEC comments in SCDHEC's Letter titled "Reviews of Requests for Injection Wells, Pumping of Monitoring Wells and Monthly Status Reports" dated June 26, 2018 (CH2M-Jacobs, 2018f).
- July 27, 2018 – Plantation submitted the *Monthly Status Update, Plantation Pipe Line Company, Lewis Drive Remediation, Site ID Number 18693, "Kinder Morgan Belton Pipeline Release,"* June 2018 (CH2M-Jacobs, 2018h).
- September 26, 2018 – Plantation submitted the *2018 Second Quarter Monitoring Report, Lewis Drive Remediation Site, Plantation Pipe Line Company, Belton, South Carolina. Site ID Number 18693, "Kinder Morgan Belton Pipeline Release"* (CH2M-Jacobs, 2018j).

2. Work Activities

The following remedial activities were performed during the third quarter 2018 in accordance with the CAP (CH2M, 2016b), CAP Addendum, Revision 1 (CH2M, 2017a), CAP Addendum, Revision 2 (CH2M, 2017d), and project QAPP, Revision 4 (CH2M-Jacobs, 2018b):

- Performed continuous, free product recovery from canisters and petroleum-absorbent socks in 18 wells at the site. Canisters were emptied monthly, recording the volume of product collected from each well. Product recovered from the absorbent socks was measured by weighing the absorbent socks before and after placement in each well.
- Conducted three groundwater sampling events and three surface water sampling events. This included sitewide gauging and inspections of surface water features at Brown's Creek and Cupboard Creek.
- Recorded changes in groundwater levels and barometric pressures in eight monitoring wells using In Situ Rugged Troll 100 data loggers. Six monitoring well locations (MW-02, MW-12, MW-25, MW-29, MW-39, and MW-40) contained water level data loggers and two monitoring well locations (MW-01 and MW-10) contained barometric pressure loggers.
- Operated vertical air sparging wells in the areas of Brown's Creek and Cupboard Creek (Figure 1).
- Operated stream aerators in Brown's Creek.
- Operated three horizontal air sparging wells in the Hayfield Zone (Figure 1).
- Performed routine operation and maintenance (O&M) on the air sparging system.
- Installed four new monitoring wells: MW-51, MW-52 (upgradient of MW-38), MW-53, and MW-54 (north and west of MW-30) (Figure 1) (CH2M-Jacobs, 2018d).
- Installed 13 additional air sparging wells: 5 vertical air sparging wells south and southwest of MW-17 to address impacts to the north of the Cupboard Creek air sparge curtain, and 8 vertical air sparging wells southwest to northeast of MW-11 (Figure 1) (CH2M-Jacobs, 2018e) to address impacts in the shallow bedrock zone just upgradient of the Brown's Creek air sparge curtain.
- Abandoned 22 1-inch-diameter wells (piezometers) and 1 recovery well (RW-13) that no longer provide useful information.
- Transported and disposed soil cuttings generated during the installation of the 13 air sparging wells and 4 monitoring wells (one 25 cubic yard roll-off). Purge water, free product recovered from canisters, and well development water are stored in the onsite tanks at the site. No liquids were removed from the site during this reporting period.

3. Work Procedures

3.1 Gauging Events

Monitoring wells, surface water locations, piezometers, and product recovery features (recovery sumps, trenches, and wells) were gauged monthly during this reporting period. During gauging events, dissolved oxygen (DO) measurements were recorded for select wells using an in-well YSI ProODO meter. Observations made during this reporting period are summarized in Table 1 and discussed in Section 3.2. Field forms and notes for this reporting period are included in Appendix A.

3.2 Product Recovery

In accordance with the SCDHEC-approved *Interim Free Product Recovery Plan – Revision 3* (CH2M, 2017c), free product recovery was focused on the Brown's Creek Protection Zone (BCPZ) and Cupboard Creek Protection Zone (CCPZ) during this reporting period. Free product is not being collected in the Hayfield Zone of the site since it was agreed to use an air sparge system to see how it would address free product. Product recovery was performed continuously in these two zones in recovery wells, sumps, and trenches (Table 2). In February 2018, in accordance with the *Free-Product Recovery Plan – Revision 4* (CH2M-Jacobs, 2018a), skimmers and absorbent socks (where sufficient water column was not available to install a canister) were placed in recovery features containing product to allow for improved product recovery and quantification of recovery from each location. During each monthly monitoring event, the field team recorded the product recovered from each recovery device (Table 2). The amount of recovered product from the canisters was tracked by measuring the fluid volume from the skimmers in a stainless-steel measuring cup and placing the fluid in a metal 5-gallon bucket. The amount of recovered product from the absorbent socks was measured by weighing the absorbent socks before and after deployment into the recovery feature. Recovered fluids from the skimmers were placed into the onsite poly tanks for temporary storage, separation, and eventual offsite disposal. Used absorbent socks were placed in a Department of Transportation (DOT)-approved 55-gallon steel drum for offsite disposal.

3.3 Surface Water

Inspections of surface water features were performed monthly. The inspection route used is illustrated on Figures 1, 2A, and 2B. The air sparging system, including the stream aerators, was operating during this reporting period.

Surface water samples were collected at locations shown on Figure 2A. Surface water samples were collected in July and September 2018 during this reporting period. Additionally, SW-13 (only) was sampled in August 2018 due to what was believed to be an anomalous exceedance of benzene from the June 2018 monitoring event.

Surface water samples were scheduled to be collected from 17 locations during this reporting period. However, locations SW-05 and SW-06 in Cupboard Creek were not sampled due to insufficient water; and in September 2018, location SW-07 in Cupboard Creek was not sampled due to insufficient surface water.

Samples were collected in accordance with the project QAPP, Revision 4 (CH2M-Jacobs, 2018b), and were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX), naphthalene, and methyl tertiary butyl ether (MTBE) using U.S. Environmental Protection Agency (EPA) Method 8260B (see Table 3). The samples were packed in wet ice and transported by FedEx under standard chain-of-custody (COC) procedures to Pace Analytical in Mount Juliet, Tennessee (formerly known as ESC Lab Sciences). Field notes are included in Appendix A. Laboratory reports for surface water samples and COC records for this reporting period are included in Appendix B. Laboratory results are summarized in Table 3.

3.4 Groundwater Sampling Events

Three groundwater sampling events were performed during this reporting period on July 12 and 13, 2018 (Event 1, final monthly), August 2, 2018 (Event 2), and September 11 through 13, 2018 (Event 3, quarterly). Event 2 comprised the collection of groundwater samples from five select wells that were purged of three to five well volumes, as approved in the SCDHEC correspondence dated July 24, 2018 (CH2M, 2018f). The air sparging system, including the stream aerators, was operating during this reporting period. Prior to each sampling event, a comprehensive round of groundwater gauging was conducted using an oil-water interface probe to measure the depth to water and test for the presence and thickness (if present) of product. The oil-water interface probe was decontaminated before each use and before the final measurement. Decontamination was performed in accordance with the SCDHEC *Programmatic Quality Assurance Program Plan, Revision 3.1* (Programmatic QAPP) or project QAPP, Revision 4 (CH2M-Jacobs, 2018b) as applicable. Groundwater elevation and product thickness data are summarized in Table 4. Gauging sheets and field notes for this reporting period are included in Appendix A. Figures 2A and 2B show groundwater elevations in the residuum and bedrock aquifers, respectively. Figure 3 presents product thickness data for the site.

Monitoring wells without free product were sampled using either a HydraSleeve, a peristaltic pump using low-flow purge, or a submersible pump (Event 2 only). Purge logs for wells that were sampled with the non-HydraSleeve method are provided in Appendix A. The height of the water column in the well determined if a well was sampled using a HydraSleeve or peristaltic pump according to the following:

- Water column greater than 3 feet: A HydraSleeve was used to collect an undisturbed groundwater sample from the well, in accordance with the project QAPP, Revision 4 (CH2M 2018b). A HydraSleeve was installed to the midpoint of the screened interval and immediately recovered. The water in the HydraSleeve was then used to fill the sample containers.
- Water column less than 3 feet but greater than 0.5 foot: A peristaltic pump was used to purge the well, while field parameters (including DO concentrations) were measured using a YSI 6920 V2-2 Multi-Parameter Water Quality Sonde meter to confirm stabilization of the groundwater, in accordance with the Programmatic QAPP (South Carolina UST Management Division, 2016). After the water quality parameters stabilized, a sample was collected from the well using the straw method in accordance with the Programmatic QAPP. Upon stabilization, the field parameters were recorded on a separate purge log. DO measurements are summarized in Table 5.
- Water column less than 0.5 foot: The well was reported and documented in the field logbook as insufficient water, was not sampled, and DO measurements were not collected.

Samples were labeled, packed with wet ice, and transported by FedEx under standard COC procedures to Pace Analytical in Mount Juliet, Tennessee. Samples were analyzed for BTEX, 1,2-dichloroethane (1,2-DCA), MTBE, and naphthalene using EPA Method 8260B. Field notes and purge logs are included in Appendix A. Laboratory reports for groundwater samples and COC records are included in Appendix B. Laboratory results are summarized in Table 6.

3.5 Air Sparging System Operation and Maintenance

Air sparging was initiated on March 6, 2017, and has evolved since to achieve design flow rates. These changes have been agreed to during discussions with SCDHEC. Routine O&M activities were performed during this reporting period. O&M logs for July through September 2018 are provided in Appendix C. Air sparging activities are summarized by remediation area below. When air sparging rates were increased in zones of the site, air monitoring was performed with a photoionization detector (PID) and visual observations were made in the areas where flow rates were adjusted.

- BCPZ: Air sparging in the BCPZ was performed using 26 vertical air sparging wells screened from 13 to 71.5 feet below ground surface (bgs). The flow rates in these wells averaged 9.52 standard cubic feet per minute (scfm) per sparge well during the reporting period. Additionally, air was injected into two submersible diffusion aerators installed in Brown's Creek. The flow rates in these aerators averaged 14.35 scfm each during this reporting period.

- CCPZ: Air sparging in the CCPZ was performed using a curtain of 19 vertical air sparging wells screened from 9.5 to 31.20 feet bgs. The flow rates in these wells averaged 10.32 scfm per sparge well during this reporting period.
- Hayfield Zone: Air sparging in the Hayfield Zone was performed using three horizontal wells, HAS-01, HAS-02, and HAS-03, which have screen lengths of approximately 752, 715, and 377 feet, respectively. The flow rates in each of the three horizontal wells (HAS-1, HAS-2, and HAS-3) were maintained at approximately 0.60 scfm per foot of screen (scfm/ft) during this reporting period, resulting in the following approximate flows per well: 0.58, 0.58, and 0.63 scfm per foot, respectively.

Water levels were measured in the BCPZ, CCPZ, and Hayfield Zone to document the influence of the air sparging system on the residuum aquifer. Water level data loggers (In Situ Rugged Troll 100) have measured groundwater elevations continuously at various locations around the site. During this reporting period, data loggers were positioned in MW-02, MW-12, MW-25, MW-29, MW-39, and MW-40, and two barometric pressure loggers were positioned in MW-01 and MW-10.

3.6 Additional Activities

The following additional activities were performed during this reporting period:

- Biosparging system expansions – Additional air sparging wells were installed to reduce dissolved hydrocarbon concentrations in areas of CCPZ and BCPZ. Thirteen additional vertical air sparging wells were installed to the top of bedrock (VAS-47 through VAS-59) between August 14 and September 7, 2018, using a combination of a CME 750 hollow-stem auger (HSA) drill rig and Geoprobe 8040 with HSA capability. Well construction details are presented in Table 7. Five of these wells were installed to extend the remedial zone of influence of the CCPZ air sparging curtain to the northwest across Lewis Drive downgradient of monitoring well MW-17 (Figure 1). The remaining eight wells were installed to extend the remedial zone of influence of the BCPZ air sparging curtain southwest toward monitoring well MW-11 (Figure 1) into the shallow bedrock zone. Plantation proposed the expansion of the existing air sparging system in correspondence dated May 4, 2018 (CH2M-Jacobs, 2018e). SCDHEC approved the installation of these wells in a letter dated June 26, 2018 (SCDHEC, 2018b). These wells will be connected to the sparging system in December 2018.

    - Four residuum monitoring wells (MW-51, MW-52, MW-53, and MW-54) were installed for additional delineation in the Hayfield Zone. The wells were installed using a CME 750 HSA drill rig. MW-53 and MW-54 were installed on August 28 and 30, 2018, respectively, to expand the monitoring network north and west of MW-30. MW-51 and MW-52 were installed between September 4 and 5, 2018, upgradient of MW-38. The wells were installed in accordance with SCDHEC Well Standards R. 61-71 (SCDHEC, 2016) and the SCDHEC Monitoring Well Approval Form Number MW-11508 (SCDHEC, 2018a). Well construction details are presented in Table 7. The boring logs and well completion diagrams for these monitoring wells are provided in Appendix D. Well completion forms (Form 1903) were sent to SCDHEC in a separate submittal by AGE Drilling Services, LLC. Additionally, a soil sample was collected from each newly installed monitoring well boring in accordance with the project QAPP, Revision 4 (CH2M-Jacobs, 2018b). These soil samples were labeled, packed with wet ice, and transported by FedEx under standard COC procedures to Pace Analytical in Mount Juliet, Tennessee for BTEX analysis by Method SW-846 8260B. All samples were nondetect (see Table 8). Laboratory reports for soil samples and COC records are included in Appendix B.

- Soil cuttings generated during installation of the monitoring and sparging wells were placed in a roll-off dumpster and transported for disposal by A&D Environmental to the Republic Services Union County Regional Landfill in Enoree, South Carolina. See Appendix B for the remediation-derived waste laboratory report, and Appendix E for the manifest and waste profile.

- Twenty-two 1-inch-diameter temporary wells (piezometers) were abandoned at the end of August 2018. These wells were installed early during emergency response activities to delineate free product impacts at the site. The data collected from the 1-inch piezometers is not representative of

actual product thickness in the subsurface due to capillary action. Also, the 1-inch piezometers are redundant with the existing 2-inch monitoring well network currently being used for groundwater elevation and product thickness measurements. RW-13 was also abandoned because of high pressure within the well due to air sparging that resulted in a safety concern involving gauging or product recovery from this well. The abandoned locations are shown on Figure 1. All wells were abandoned in accordance with SCDHEC Well Standards R. 61-71 (SCDHEC, 2016). SCDHEC approval for abandonment of piezometers was provided in a letter dated June 26, 2018 (SCDHEC, 2018b). SCDHEC 1903 Forms for the well abandonments were submitted to SCDHEC in a letter dated October 15, 2018 (CH2M-Jacobs, 2018k).

4. Discussion of Results

4.1 Product Recovery

During this third quarter 2018 reporting period, only 2.44 gallons of product were recovered at the site. Overall, there was a decrease each month in the volume being recovered as noted in Table 2. The average amount recovered per recovery feature during this reporting period was 0.05 gallon.

Table 2 shows the dates and quantities of product that was recovered. Table 9 shows the dates and quantities of product that was shipped offsite for disposal. Field notes for this reporting period are included in Appendix A.

4.2 Surface Water

No new signs of distressed vegetation, hydrocarbon sheens, or odors were observed during the surface water inspections for this reporting period. Observations made during this reporting period are summarized in Table 1. Field notes for this reporting period are included in Appendix A.

During this reporting period, dissolved hydrocarbons were detected in surface water at 4 of the 15 locations sampled, SW-01, SW-02, SW-12, and SW-14 (Table 3). However, no analytes exceeded the surface water standard for protection of human health for consumption of water and organisms (SCDHEC, 2014).

Surface water sample results are summarized in Table 3. Trends for surface water sampling locations SW-01, SW-02, SW-04, SW-12, SW-13, and SW-14 are presented in Appendix F. Construction details for the stream gauges are presented in Table 10. Field notes for this reporting period are included in Appendix A. Analytical data sheets and COC records are included in Appendix B.

4.3 Groundwater Flow and Product Distribution

Water level data from the September 2018 gauging event were used to create potentiometric surface maps for the site (Figures 2A and 2B). Groundwater flow in both the residuum (Figure 2A) and bedrock (Figure 2B) mimics the topography of the site and generally flows from topographic highs to topographic lows. Cupboard Creek flows intermittently, indicating the primary direction of groundwater flow is northeast toward Brown's Creek. The September 2018 water table configurations and direction of groundwater flow are consistent with previous findings.

Stream elevations are tabulated in Table 4 and are presented with groundwater elevations on Figure 2A. Construction details for recovery and nonrecovery features are presented in Table 7.

Product thicknesses continue to be minimal throughout the site. Measurable thicknesses in September 2018 ranged from 0.01 foot at RS-05 and RW-02 to 0.3 foot at MW-20. Measurable product thicknesses were only observed at 9 features out of the 161 features monitored. Free product levels are presented alongside well gauging data in Table 4.

In September 2018, no recovery wells/features within the BCPZ or the CCPZ contained measurable product.

Gauging sheets for this reporting period are included in Appendix A. Hydrographs for nonrecovery (monitoring wells and piezometers) and recovery features representative of general product thickness trends are presented in Appendix G.

4.4 Dissolved Oxygen Distribution

Overall during this reporting period, the average DO concentration has stabilized in the residuum wells and increased in the bedrock wells. In residuum wells, the average DO concentration ranged from 6.65 milligrams per liter (mg/L) in July 2018 to 7.04 mg/L in September 2018. In bedrock wells, the average DO concentration increased from 1.00 mg/L in July 2018 to 3.11 mg/L in September 2018. DO measurements in groundwater are provided in Table 5. Field notes for this reporting period are included in Appendix A.

4.4.1 Brown's Creek Protection Zone

The average DO levels in the BCPZ were stable with 3.88 mg/L in July 2018 to 4.03 mg/L in September 2018.

4.4.2 Cupboard Creek Protection Zone

The average DO concentrations in the CCPZ increased from 2.26 mg/L in July 2018 to 3.74 mg/L in September 2018.

4.4.3 Hayfield Zone

The average DO concentrations in the Hayfield Zone were stable at 7.90 mg/L in July 2018 to 8.36 mg/L in September 2018.

4.4.4 Shallow Bedrock Zone

DO levels in this zone increased from 1.14 mg/L in July 2018 to 3.13 mg/L in September 2018 indicating that the air sparging systems are having an effect on the shallow bedrock zone, which will increase the natural attenuation capabilities of the shallow bedrock zone.

4.5 Groundwater Monitoring Results

Groundwater monitoring results for this reporting period indicate that there are significant decreases in dissolved concentrations of hydrocarbons in the BCPZ, CCPZ, and Hayfield Zone, and stable trends in the shallow bedrock zone, in bedrock wells, as well as other locations outside the direct influence of the air sparging systems. Table 6 presents analytical results for all groundwater samples that have been collected at the site since July 2015. Laboratory analytical reports for the sampling events for this reporting period are provided in Appendix B. Groundwater analytical results are screened against the risk-based screening levels listed in the Programmatic QAPP, Table D1 (South Carolina UST Management Division, 2016), referred to as Target Screening Levels (TSLs), and are provided at the top of Table 6. The September 2018 results are shown on Figures 4A and 4B and summarized in the following sections. Trend plots for select groundwater monitoring wells are shown in Appendix H. If the monitoring well is directly influenced by the air sparging system, there will be a gray shaded area on the trend charts. Trends were not created for monitoring wells that have been nondetect since sampling began. Field notes and purge logs for this reporting period are included in Appendix A.

4.5.1 Brown's Creek Protection Zone

Dissolved concentrations continue to show an overall decreasing trend in the residuum aquifer of the BCPZ. For example, in monitoring wells MW-34, MW-40, and MW-42, benzene concentrations have decreased by one to three orders of magnitude to below 30 micrograms per liter (µg/L) at MW-34 and MW-40 and to below detection levels at MW-42. Concentrations of BTEX constituents, which were stable in MW-12 between September 2017 and March 2018, have shown a decrease since June 2018, and all constituents were below TSLs in September 2018.

Benzene concentrations show a slight increase in MW-12B and a decrease in MW-15B. Benzene was nondetect in all other bedrock monitoring wells in September 2018.

Benzene was detected above TSLs in 5 of 15 residuum monitoring wells in the BCPZ (MW-15, MW-28, MW-34, MW-38, and MW-40), ranging from 14.6 µg/L to 157 µg/L. MTBE was detected above its TSL in MW-15, MW-34, MW-39, and MW-40, ranging from 72.2 µg/L to 209 µg/L. Constituents in cross-gradient monitoring wells MW-37 (to the north) and MW-35 (to the south) have been nondetect, except for MTBE, which is below its TSL since system startup. Constituent concentrations in monitoring wells MW-24, MW-25, MW-41, MW-42, MW-43, and MW-49 continue to remain below TSLs since early 2018.

4.5.2 Cupboard Creek Protection Zone

Since air sparging was initiated, dissolved concentrations in the CCPZ have stabilized. MW-19 has not been able to be sampled on a regular frequency due to insufficient water; however, it was sampled during the July and September 2018 events with no detections above TSLs. Since MW-46 was installed in September 2017, BTEX concentrations had been increasing but seem to have stabilized based on the August and September 2018 monitoring events.

MW-20 has not been able to be sampled for a considerable period of time due to the presence of free product. However, it was sampled in July 2018 with exceedances for BTEX and MTBE concentrations. Benzene was also detected above its TSL (5 µg/L) during this reporting period in two other residuum monitoring wells in the CCPZ: MW-23 at 17.9 µg/L (August 2018), and MW-46 at 1,510 µg/L (September 2018). MTBE was detected above its TSL (40 µg/L) in MW-46 at 311 µg/L (September 2018). Downgradient monitoring wells MW-26 and MW-29 were nondetect for all constituents since February 2018 and January 2016 respectively.

No constituents were detected above TSLs in bedrock monitoring wells in the CCPZ.

4.5.3 Hayfield Zone

A decreasing trend is very evident in the residuum aquifer in the Hayfield Zone, with reduced concentrations of detected constituents and reduced number of constituents exceeding TSLs. For example, of the 29 monitoring wells sampled in the Hayfield Zone, the constituents at 22 locations are below their respective TSLs. Since the initialization of the horizontal sparging wells in 2017, these concentrations have decreased by three orders of magnitude.

In the residuum, benzene, toluene, and naphthalene were detected above the TSLs in 2 of 22 monitoring wells in the Hayfield Zone (MW-07 and MW-16). Benzene concentrations exceeded the TSL in MW-36, and MTBE concentrations exceeded the TSL in MW-45. Concentrations are shown in the table below.

Well	Date	Units	Benzene	Toluene	MTBE	Naphthalene
MW-07	9/12/2018	µg/L	4,620	13,600	1 U	82.5
MW-16	9/13/2018	µg/L	150	2,100	21.5	635
MW-36	9/11/2018	µg/L	238	326	1 U	5 U
MW-45	9/13/2018	µg/L	1 U	1 U	46.3	5 U

Gray shading indicates the analyte exceeded Target Screening Levels
U = analyte was not detected above the reported sample quantitation limit

Four residuum monitoring wells in the Hayfield Zone were not sampled because of insufficient water (MW-13, MW-17, and MW-30) and the presence of product (MW-18). MW-18 is the only monitoring well in the Hayfield Zone with measurable product.

In the bedrock, benzene was detected above its TSL in 3 of 10 wells, ranging in concentration from 150 µg/L in MW-50B to 8,180 µg/L in MW-17B (September 2018). Concentrations of ethylbenzene, toluene, and MTBE exceeded the TSLs at MW-17B. MTBE also exceeded its TSL in MW-13B and MW-50B.

At locations outside the direct influence of the air sparging system, only two locations, MW-45 and MW-50B, showed concentration increases from June 2018 to September 2018. Additionally, constituents in MW-13B, MW-17B, and MW-36, which are also outside of the direct influence of the air sparge system, have remained stable. These wells will continue to be evaluated.

4.5.4 Shallow Bedrock Zone

In the residuum of the shallow bedrock zone, MW-11 was the only well that contained product (0.02 foot). The constituents in all other residuum wells in the shallow bedrock zone had concentrations below TSLs.

In bedrock, benzene was detected above its TSL in only one of three wells in the shallow bedrock zone at a concentration of 11.1 µg/L in MW-01B.

4.6 Air Sparging System Operating Efficiency and Performance Data

Between July 1, 2018, and September 30, 2018, the air sparging system operated a total of approximately 4,243 hours, with an operating uptime of 100 percent. Since two compressors were operating during this timeframe, system maintenance activities could be conducted with no system downtime. Air sparging flow rates for this reporting period in the stream aerators, horizontal wells, and vertical wells were at 96 percent, 80 percent, and 66 percent of design flow capacity, respectively.

5. Conclusions

The following conclusions are based on data analysis from the site work performed between July 1, 2018, and September 30, 2018:

- Since starting the air sparging system at the site on March 6, 2017 (vertical sparging systems in the BCPZ and CCPZ areas) and in May 2017 (horizontal sparging system in the Hayfield Zone), product thickness values have substantially declined in both recovery and nonrecovery features across the site. The number of locations with product thicknesses greater than 0.5 foot has decreased from seven locations in March 2018, to one location in June 2018, and no locations in September 2018. The locations that have measurable product thickness are not adjacent to any surface water bodies at the site.
- The volume of product recovered between July 2018 and September 2018 was 2.44 gallons, which is less than the previous quarter. Additionally, the quantity of product recovered during the reporting period decreased each month.
- Three surface water sampling events were performed during this quarter (July, August, and September 2018). The August 2018 sampling event included SW-13 only due to what was believed to be an anomalous exceedance of benzene from the June 2018 monitoring event. The benzene exceedance in June 2018 at SW-13 will continue to be monitored.
- The average DO concentration in residuum has remained stable, and the average DO concentration in bedrock wells has increased for this reporting period. This shows the effectiveness of the air sparging system at introducing oxygen into the subsurface. Air sparging will continue to be increased at the vertical and horizontal wells to design flow rates during the next quarter to meet the increasing biomass oxygen demand. The design flow rates have been met and sustained at the stream aerator locations.
- Groundwater monitoring results for this reporting period indicate that due to operation of the air sparging systems there are continued decreases in dissolved concentrations of hydrocarbons in the BCPZ, CCPZ, and Hayfield Zone, and stable trends in the shallow bedrock zone, in bedrock wells, and in other locations outside the direct influence of the air sparging system. Concentrations in MW-40 dropped significantly during the September 2018 event. Concentrations in MW-12, MW-19, MW-23, and MW-27 are now below TSLs.
- During this reporting period, the air sparging system had an operating uptime of 100 percent. Operating flows in the stream aerators, horizontal wells, and vertical wells were at 96 percent, 80 percent, and 66 percent of design flow capacity, respectively.

6. Future Activities

This section describes future activities planned for the site.

6.1 Groundwater and Surface Water Monitoring

- Continue gauging of monitoring wells and surface water sampling locations in accordance with the CAP Addendum, Revision 2 (CH2M, 2017d) submitted to SCDHEC on October 12, 2017.
- Sample monitoring wells and surface water sampling locations on a quarterly basis per Section 3 and Table 2 of the CAP Addendum, Revision 2 (CH2M, 2017d).
- Collect DO concentration measurements on a quarterly basis, per Section 3 and Table 2 of the CAP Addendum, Revision 2 (CH2M, 2017d).
- Submit quarterly reports per Section 3 and Table 2 of the CAP Addendum, Revision 2 (CH2M, 2017d).
- Continue routine visual inspection of Brown's Creek and Cupboard Creek as outlined in the CAP Addendum, Revision 2 (CH2M, 2017d).
- Include the newly installed monitoring wells (MW-51, MW-52, MW-53, and MW-54) as part of the quarterly gauging and sampling events.
- Install additional monitoring wells MW-55 (west of MW-36), MW-56, and MW-57 (southwest and west of MW-46, respectively), and advance one soil boring to the top of bedrock (east side of Brown's Creek near SW-02).
- Abandon the remaining 1-inch-diameter wells (piezometers) because these 1-inch piezometers are less representative of product thickness measurements and are redundant with the existing 2-inch monitoring well network, which is sufficient for groundwater elevation and product thickness measurements.
- Abandon monitoring wells MW-17 and MW-19 without replacement. These wells have consistently experienced insufficient groundwater for collecting groundwater samples, and additional downgradient and cross-gradient wells have since been installed in the vicinity that provide sufficient water for groundwater sampling purposes.
- Analyze concentration trends in the monitoring well network to identify areas for additional remediation, if necessary, and to optimize the monitoring well network.

6.2 Product Recovery

Continue continuous product recovery, with monthly collection, using skimmers and socks in accordance with the *Free-Product Recovery Plan, Revision 4* (CH2M-Jacobs, 2018c).

6.3 System Operation and Maintenance

- Complete ongoing efforts to expand the existing biosparging system and start air flow to new sparging wells.
- Continue routine O&M activities for the air sparging system as described in the CAP Addendum, Revision 2 (CH2M, 2017d).
- Continue air sparging in the BCPZ and CCPZ up to the maximum design flow rate of 15 scfm per well.
- Continue air sparging in the horizontal wells in the Hayfield Zone up to the maximum design flow rate of 0.75 scfm/ft.
- Continue operating the stream diffusion aerators at the design flow rate of 15 scfm in each location, according to the Sparging Operating Limits letter (CH2M, 2017b).

7. References

CH2M HILL Engineers, Inc. (CH2M). 2016a. *Comprehensive Site Assessment Report, Lewis Drive Release Site, Belton, South Carolina. Site ID Number 18693 ("Kinder Morgan Belton Pipeline Release").* July.

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CH2M HILL Engineers, Inc. (CH2M-Jacobs). 2018h. *Lewis Drive – June 2018 Monthly Status Update, Plantation Pipe Line Company, Belton, South Carolina. Site ID Number 18693, "Kinder Morgan Belton Pipeline Release."* July 27.

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Tables

Table 1. Field Observation Log

Plantation Pipe Line Company

Lewis Drive Remediation Site, Belton, South Carolina

Site ID #18693 "Kinder Morgan Belton Pipeline Release"

Date	**Inspect Wetlands South of Calhoun Road** (Any odor, sheen or distressed vegetation? Describe.)	**Inspect Brown's Creek Upstream and Downstream of the Culvert Under Lewis Drive** (Any odor, sheen or distressed vegetation? Describe.)
7/11/2018	No odors, sheens, or distressed vegetation observed in wetlands South of Calhoun Road.	No odors, sheens, or distressed vegetation observed in wetlands either upstream or downstream of Culvert under Lewis Drive.
8/1/2018	No odors, sheens, or distressed vegetation observed in wetlands South of Calhoun Road.	No odors, sheens, or distressed vegetation observed in wetlands either upstream or downstream of Culvert under Lewis Drive.
9/14/2018	No odors, sheens, or distressed vegetation observed in wetlands South of Calhoun Road.	No odors, sheens, or distressed vegetation observed in wetlands either upstream or downstream of Culvert under Lewis Drive.

Note:

ID = identification