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Ms. Bobbi Coleman
South Carolina Department of Health and Environmental Control (SCDHEC)
Assessment Section, UST Management Division
Bureau of Land and Waste Management
2600 Bull Street
Columbia, SC 29201

Subject: *Shallow Bedrock Zone – Biosparging Pilot Study Plan*
Lewis Drive Remediation
Plantation Pipe Line Company
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) has prepared this letter to document the approach for pilot testing the recently constructed bedrock biosparging wells at the Lewis Drive site. This correspondence augments the discussion of bedrock biosparging that was included in the Corrective Action Plan (September 2016) and Corrective Action Plan Addendum (March 2017). The primary objective of pilot testing is to evaluate full-scale design parameters for bedrock biosparging, particularly injection pressure, flow rate, propagation of air in the subsurface (i.e., influence), and spacing between wells.

As presented in the Corrective Action Plan, bedrock biosparging was proposed for the area of the site with shallow bedrock and a thin saturated zone (the Shallow Bedrock Zone of the site). Spacing of 100 feet between bedrock biosparge wells was assumed as the design basis. The wells will be installed in phases, with spacing to be verified based on data from the pilot testing. The field data will include measurement of dissolved oxygen (DO) and observation of air bubbling in surrounding wells and potentially the surface when wet. This data will be used to evaluate distribution of air in the fractured bedrock and overlying saprolite (both saturated and unsaturated zones). The biosparge wells will be tested individually and as a group to assess relative performance, in terms of zone of influence.

To facilitate the first phase of bedrock sparging, a licensed driller installed three bedrock biosparging wells (VBS-01, 02, and 03) in March 2017 under the Underground Injection Control (UIC) permit-to-construct #SCHE03020469M. The permit-to-operate these three wells was received shortly after installation was complete and well construction records were provided to SCDHEC in a subsequent Monthly Status Report. As detailed in the Corrective Action Plan, the wells were installed by coring into rock until water-producing fractures were encountered, then the well was constructed using a two-foot long, 2-inch ID, 0.006-inch slotted well screen, with 40/70 filter sand installed around the screen. The

annular space above the sand pack was sealed with hydrated bentonite pellets (5 ft thick), with cement-bentonite grout to surface. The average as-built injection interval for the three wells was 31 to 33 feet below ground surface (ft bgs). The wells were later connected via field piping to the biosparging system. The three bedrock biosparging locations are shown on **Figure 1**.

The bedrock biosparging pilot study will be conducted in a series of two phases, as follows:

Phase 1 – Individual Biosparge Well Testing

During Phase 1, air will be injected into VBS-01, VBS-02, and VBS-03, with the objective of evaluating influence zones for individual biosparge wells.

- The first test will be conducted at VBS-02, using the other two bedrock biosparging wells as monitoring points.
- The target initial flow rate will be 5 standard cubic feet per minute (scfm). Sparging at 5 scfm will continue for approximately 4 - 6 hours, then the flow rate will be increased to 15 scfm and maintained for the remainder of the day (4 hours or more). Based on observations in the field, sparging may continue overnight.
- CH2M will periodically measure water table elevations and dissolved oxygen levels in nearby monitoring points and recovery wells per **Table 1**. As shown in **Figure 1**, there are at least 20 monitoring points in the vicinity of the bedrock biosparging wells, including piezometers, recovery sumps, recovery wells, and monitoring wells. A down-well transducer will also be installed in one piezometer to continuously monitor water levels.
- Following the flow increase to 15 scfm, depending on observations in the field, the target flow rate may be increased to 25-30 scfm. However, if excessive water table displacement occurs, the lower flowrate will be decreased to maintain reasonable displacement. CH2M will continue to monitor site conditions per **Table 1** for the remainder of the test.
- CH2M will repeat the process outlined above for VBS-01 and VBS-03.
- The first phase of testing is expected to last up to 5 to 8 days.

Phase 2 – Combined Biosparge Well Testing

During Phase 2, air will be injected into VBS-01, VBS-02, and VBS-03 simultaneously, with the objective of evaluating the overall zone of influence for multiple wells, assuming air flow through interconnecting bedrock fractures. The target flow rate will be based on observations during Phase 1. Dissolved oxygen, air bubbling in wells, and water levels will be periodically checked in other wells, as summarized in **Table 1**. Phase 2 is expected to last from 2 to up to 4 days.

The proposed injection rates described above and monitoring frequencies (Table 1) are subject to change based on field observations. The density of fractures present in the vicinity of each bedrock biosparging well may limit the volume of air that can be injected.

Table 1. Bedrock Biosparge Pilot Test Monitoring Schedule

Lewis Drive Remediation Site

Monitoring Point¹	Screen Interval (ft bgs)²	Monitoring Parameter^{3,4}	Monitoring Frequency
Surface Conditions	N/A	Visual Observations	Hourly during testing
VBS-01	34.5 – 36.5	DTW, DO	Every two hours, when not in use
VBS-02	27.0 – 29.0	DTW, DO	Every two hours, when not in use
VBS-03	32.2 – 34.2	DTW, DO	Every two hours, when not in use
MW-01	3.0 – 13.0	DTW, DO	Twice per day during testing
MW-01B	18.5 – 38.5	DTW, DO	Twice per day during testing
MW-22	6.0 – 11.0	DTW, DO	Twice per day during testing
MW-44	5.0 – 10.0	DTW, DO	Twice per day during testing
MW-44B	16.1 - 37.1	DTW, DO	Twice per day during testing
TW-4R	2.5 – 5.5	DTW, DO	Twice per day during testing
TW-5R	2.8 – 8.9	DTW, DO	Twice per day during testing
TW-14R ⁵	2.5 – 6.3	DTW, DO	Twice per day during testing
TW-15R	2.0 – 4.9	DTW, DO	Twice per day during testing
TW-21	4.0 – 9.4	DTW, DO	Twice per day during testing
TW-81	2.0 – 7.0	DTW, DO	Twice per day during testing
TW-82	2.0 – 10.2	DTW, DO	Twice per day during testing
TW-83	2.0 – 17.1	DTW, DO	Twice per day during testing
TW-84	3.5 – 13.7	DTW, DO	Twice per day during testing
TW-86	2.0 – 6.2	DTW, DO	Twice per day during testing
TW-87	2.0 – 7.1	DTW, DO	Twice per day during testing
RS-19	2.0 – 14.0	DTW, DO	Twice per day during testing
RW-1	2.0 – 17.0	DTW, DO	Twice per day during testing
RW-2	13.0 – 23.0	DTW, DO	Twice per day during testing
RW-3	16.2 – 31.2	DTW, DO	Twice per day during testing

Notes:

DTW = depth to water, measured with an interface probe

DO = dissolved oxygen, measured with an optical DO probe (YSI ProODO)

N/A = not applicable

¹ Temporary wells (TW) are nominal one-inch diameter. Monitoring wells (MW) are nominal two-inch diameter. Recovery wells (RW) and recovery sumps (RS) are nominal four-inch diameter. All are Schedule 40 PVC.

² Screen intervals for bedrock biosparging wells are the sealed injection interval below the packer. Screen intervals for bedrock monitoring wells are open borehole construction.

³ Visual observations will be performed at the surface in the area of bedrock biosparging. Evidence of biosparging at the surface is typically air bubbling through the soil matrix, and/or buoyant diffusion of air through ponded water. A water source will be procured for the test to facilitate these observations, as needed.

⁴ DO measurements will only be performed if gasoline product is not detected with the interface probe, as pure-phase product will damage the DO probe.

⁵ An in-situ TROLL 500 will be installed in TW-14R to continuously monitor water table fluctuations.

After the pilot has been completed, results will be presented in a brief Technical Memorandum (TM) for SCDHEC's review. This TM will provide conclusions about the pilot effectiveness and impact on the full-scale design for bedrock biosparging.

If you have any further questions or concerns, please call me at (919) 760-1777, Mr. Scott Powell/CH2M at (678) 530-4457, or Mr. Jerry Aycock/Plantation at (770) 751-4165.

Regards,

CH2M HILL Engineers, Inc.



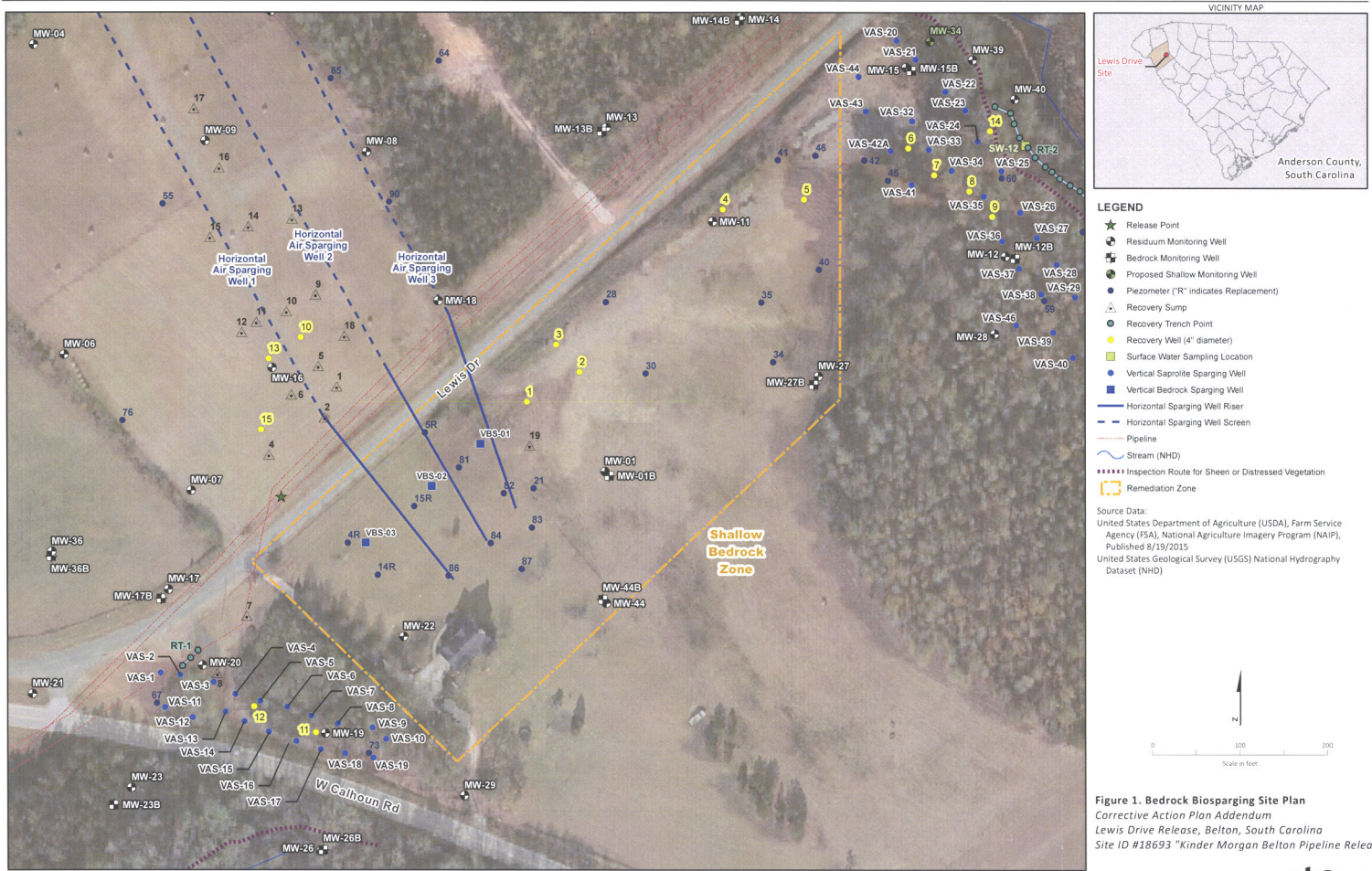
William M. Waldron, P.E.
Senior Project Manager

Attachments:

Figure 1 – Bedrock Biosparging Site Plan

- c: Jerry Aycock, Plantation (Digital, Jerry_Aycock@kindermorgan.com)
Mary Clair Lyons, Esq., Plantation (Digital, Mary_Lyons@kindermorgan.com)
Richard Morton, Esq., Womble Carlyle Sandridge & Rice, PLLC (Digital, rmorton@wcsr.com)
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Figure



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