Via Email: chris.ralston@maryland.gov

September 26, 2019

Mr. Christopher Ralston
Maryland Department of the Environment
Remediation Division, Oil Control Program
1800 Washington Blvd., Suite 620
Baltimore, Maryland 21230

RE: Proposal for Monitored Natural Attenuation Study - Addendum
Inactive Exxon Facility #28077
14258 Jarrettsville Pike
Phoenix, Baltimore County, Maryland
MDE Case # 2006-0303-BA2
Kleinfelder Project No.: 20193011.001A

Dear Mr. Ralston

On July 25, 2019, Kleinfelder on behalf of ExxonMobil submitted a Natural Attenuation Evaluation Report (Report) to the Maryland Department of the Environment (MDE) for the above-referenced site. The Recommendations section (Section 6) of the Report contained a Jackson and Kleinfelder, and a subsequent email the same day, MDE requested additional information about the Work Plan. This document serves as an Addendum to the report and provides requested information to supplement the Work Plan in Section 6 of the Report.

6.1 Additional Testing and Analysis

Targeted natural attenuation sampling for field parameters, electron donors / acceptor indicators, microbial nutrients, and microbial indicators is recommended to be conducted in the discrete area of negative ORP and residual gasoline constituents at depth beneath 3501 Hampshire Glen Court. These data will serve to validate that biodegradation is occurring in this discrete portion of the aquifer and will serve as a baseline dataset prior to enhanced biosparge testing of this area, which is recommended in the following sections. The following monitoring wells are recommended for additional full-suite biodegradation evaluation testing: MW-183, MW-184, MW-91C, and MW-185 (**Figure 5**).

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"Pre-sparge Baseline" full-suite biodegradation testing will include the following parameters (see **Table 5**):

- Gasoline constituents (benzene, toluene, ethylbenzene, xylenes [BTEX], and five fuel oxygenates [Oxy5] including methyl tertiary butyl ether [MTBE]);
- Field conditions (pH, temperature)
- Electron donor/acceptor indicators (oxidation reduction potential [ORP], dissolved oxygen [DO], ferrous iron, nitrate, sulfate, methane, CO_2);
- Microbial nutrient (orthophosphate); and,
- Microbial indicators (full petroleum QuantArray analysis).

Microbial QuantArray analysis will be performed on aqueous samples rather than via BioTraps®. This will allow for collection of relevant data without requiring suspension of active recovery wells MW-183 and MW-184.

6.2 Targeted Biosparge Testing

A biosparge pilot test is proposed to evaluate the ability to stimulate and/or enhance aerobic biodegradation within the deep zone beneath 3501 Hampshire Glen Court. The current groundwater remediation system is configured to distribute compressed air to multiple recovery wells containing pneumatic groundwater recovery pumps. The engineering concept would use the existing air compressor and airlines to sparge air into an existing well at a relatively low flowrate. This is expected to increase the dissolved oxygen in the formation and stimulate or enhance aerobic biodegradation. The objectives of the biosparge pilot test are to:

1) Evaluate the ability to deliver air to groundwater using existing apparatus and infrastructure;
2) Evaluate the ability to oxygenate the aquifer proximate to and downgradient of the biosparge well; and,
3) Monitor for evidence of enhanced biodegradation as a consequence of oxygen delivery into the aquifer.

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6.2.1 Pilot Test Layout and Configuration

MW-91C, located in the middle of 3501 Hampshire Glen Court (**Figure 5**), is identified as the candidate biosparge pilot test well for the following reasons:

- Exhibits negative ORP (-112 mV), indicating biodegradation that can be enhanced with additional dissolved oxygen;
- Exhibits residual concentrations of MtBE (16 µg/L [March 13, 2019]) that can be further reduced;
    - Central to the discrete 'pocket' of negative ORP and within the northeast line of MtBE plume migration along strike;
    - Has a demonstrated water-bearing fracture at approximately 145 feet below top of casing (ft-toc) that may facilitate delivery of oxygenated water into the formation (Kleinfelder, August 15, 2011);
    - Recently deactivated as a recovery well with necessary air delivery apparatus, but without having to take an active recovery well off line;
    - Downgradient monitoring wells (MW-185 and MW-177) also exhibit negative ORP and residual MtBE, making for applicable and relevant monitoring locations;
    - Downgradient migration of dissolved oxygen may be enhanced with newly activated recovery well MW-138D located farther downgradient.

6.2.1.1 Methodology and Sequence

The steps of the testing methodology are outlined sequentially below:

1) Collect the Pre-sparge Baseline Data as shown in Table 5.

2) Initiate air-sparge in MW-91C - target the prominent water-bearing fracture in MW-91C, previously identified by borehole geophysical and hydraulic testing at approximately 145 ft-toc (Kleinfelder, August 15, 2011). Place air discharge 5 feet below the fracture (target depth = 150 ft-toc).

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3) Deploy transducers in MW-91 and MW-185 - log temperature, pH, ORP, specific conductivity, and depth to water continuously for the duration of the test.

4) During Sparge Test (Table 5) – collect/analyze groundwater samples monthly (for 6 months) from monitoring wells MW-91, MW-185, MW-176, MW-177, MW-168, and MW-138D - analyze for BTEX and Oxy5 per Method 8260B and measure field parameters (depth to water, DO, ORP, pH, temperature, and ferrous iron test kit).

5) After 6 months – shut off air-sparge

6) Post-Sparge (once) - Collect full-suite biodegradation parameters from MW-91C, MW-183, MW-184 & MW-185 (**Table 5**).

7) Post Sparge (daily for 5 days) - collect groundwater samples for biosparge well MW-91C and monitoring wells MW-91, MW-185, MW-176, MW-177, and MW-168, and analyze for BTEX + Oxy5 analyses and measure field parameter readings (DO, ORP, pH, temperature, and ferrous iron test kit) and depth to groundwater in MW-91, MW-91C, MW-185, MW-176, MW-177, MW-168 and MW-138D (**Table 5**).

8) Provide report of results with recommendations to MDE.

If, after five days of post-sparge monitoring, the results suggest a continuation of either sparging and/or sampling would be beneficial, Kleinfelder will contact the MDE and send related proposal by email.

6.2.2 Equipment and Apparatus

The existing pneumatic line will be extended into monitoring well MW-91C and will be connected to a ¾-inch schedule 80 (SCH 80) polyvinyl chloride (PVC) pipe. The ¾-inch SCH 80 PVC will extend to a diffuser using a variety of couplings and adapters to a target depth of 150 ft-toc,

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which is 5 feet below the target fracture. The dedicated airline will be temporarily connected to the air delivery line within the well vault, and the air line to the pneumatic pump would be disconnected from the air line in the vault, and pneumatic pump retrieved. The existing regulator would be used to adjust the air delivery pressure and flow. The air line within the well vault, leading to the diffuser, would be fitted with a rotameter to allow an estimate of the volume of air/oxygen injected into groundwater during the pilot test.

6.2.3 Reporting

Within 45 days of receiving the post-sparging analytical data (including any additional data proposed and approved after the initial 5-day period), the results of additional testing, sampling, and biosparge pilot testing will be compiled, analyzed, and summarized in a report to MDE with conclusions and recommendations for the potential application of biosparging to supplement the current remedial approach for the Site. Should results show the ability to distribute dissolved oxygen within groundwater with lagging biodegradation response, prolonged biosparge testing may also be recommended.

Kleinfelder will initiate the sampling described above upon approval by the MDE.

LIMITATIONS

Kleinfelder performed the services for this project under the Enabling Agreement with Procurement, a division of ExxonMobil Global Services Company (signed on July 22, 2016). Kleinfelder states that the services preformed are consistent with professional standard of care defined as that level of services provided by similar professionals under like circumstances. This report is based on the regulatory standards in effect on the date of the report. It has been produced for the primary benefit of ExxonMobil Global Services Company and its affiliates.

If you have any questions regarding this request, please contact the undersigned at 410.850.0404.

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Sincerely,

KLEINFELDER

Stacey Schiding
Project Manager

Mark J. Schaaf, CPG
Project Director

FIGURES

5 Wells Proposed for Inclusion in Biosparge Pilot Study

TABLES

5 Biosparge Pilot Test Sampling Matrix

cc: Mr. Joseph Ogren – ExxonMobil Environmental & Property Solutions Company (file)
Mr. Andrew Miller – Maryland Department of the Environment
Ms. Ellen Jackson – Maryland Department of the Environment
Stephanie Cobb Williams, Esq. – Office of the Attorney General
Carlos Bollar, Esq. – Archer & Greiner, P.C.

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FIGURE

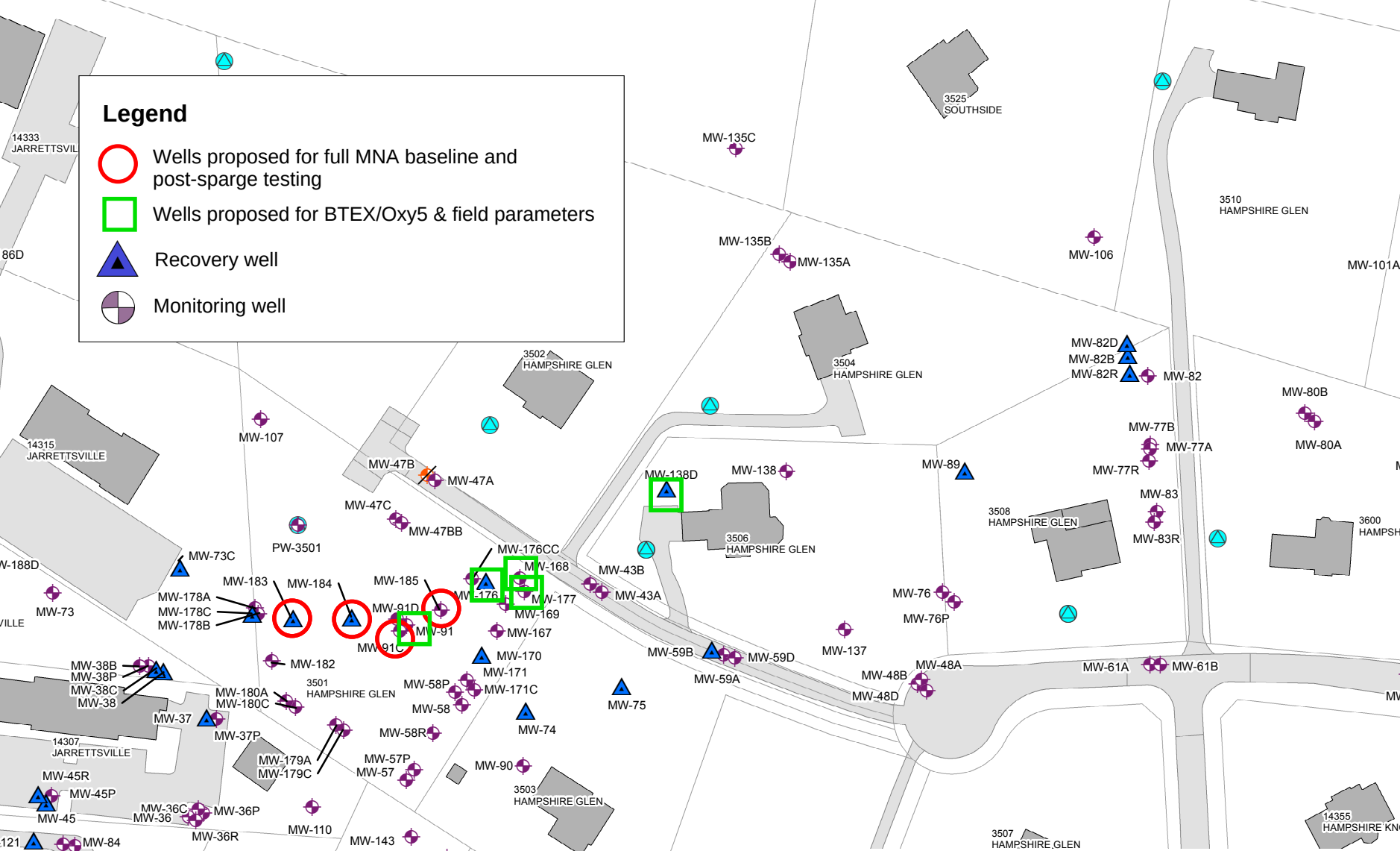

Figure 5 - Wells Proposed for Inclusion in Biosparge Pilot Study

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TABLES

Table 5 – Biosparge Pilot Test Sampling Matrix

	Gasoline Constituents	Field Parameters					Laboratory Analysis (Chemistry)						Laboratory Analysis (Microbial)		
		Conditions		Electron Donor / Acceptor Indicators								Microbial Nutrient	Microbial Indicators		
MW	**BTEX/ Oxy5**	**pH**	**Temp**	**ORP**	**D.O.**	**Ferrous Iron (test kit)**	**Nitrate**	**Sulfate**	**Ferrous Iron**	**Methane**	**CO_2**	**Orthophosphate**	**QuantArray (MtBE & TBA)**	**QuantArray (Full Petro)**	**Rationale**
Pre-Sparge Baseline (once)															
MW-183 [R]	X	X	X	X	X	X	X	X	X	X	X	X	X (aqueous)		Discrete area of negative ORP & dissolved residual petroleum constituents at depth
MW-184 [R]	X	X	X	X	X	X	X	X	X	X	X	X		X (aqueous)	
MW-185	X	X	X	X	X	X	X	X	X	X	X	X	X (aqueous)		
MW-91C	X	X	X	X	X	X	X	X	X	X	X	X		X (aqueous)	
MW-91	X	X	X	X	X	X									Adjacent to MW-91C
MW-138D [R]	X	X	X	X	X	X									Far downgradient well
MW-168	X	X	X	X	X	X									Downgradient from MW-91C
MW-176 [R]	X	X	X	X	X	X									
MW-177	X	X	X	X	X	X									
During Sparge Test (monthly for 6 mos.)															
MW-185	X	X	X	X	X	X									
MW-91	X	X	X	X	X	X									
MW-138D [R]	X	X	X	X	X	X									
MW-168	X	X	X	X	X	X									
MW-176 [R]	X	X	X	X	X	X									
MW-177	X	X	X	X	X	X									
Post-Sparge (once)															
MW-183 [R]							X	X	X	X	X	X	X (aqueous)		
MW-184 [R]							X	X	X	X	X	X		X (aqueous)	
MW-185							X	X	X	X	X	X	X (aqueous)		
MW-91C							X	X	X	X	X	X		X (aqueous)	
Post-Sparge (daily for 5 days)															
MW-185	X	X	X	X	X	X									
MW-91C	X	X	X	X	X	X									
MW-91	X	X	X	X	X	X									
MW-138D [R]	X	X	X	X	X	X									
MW-168	X	X	X	X	X	X									
MW-176 [R]	X	X	X	X	X	X									
MW-177	X	X	X	X	X	X									