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February 10, 2016 **<u>VIA PRIVATE CARRIER</u>**

Mr. James R. Carroll
Program Administrator
Land Restoration Program
Land Management Administration
Maryland Department of the Environment
1800 Washington Boulevard, Suite 625
Baltimore, Maryland 21230

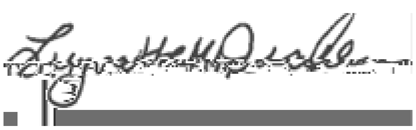
Subject: Transmittal of the Groundwater Remediation O&M Manual, Appendix A1—Block E Tracer Testing Work Plan
Lockheed Martin Corporation; Middle River Complex
2323 Eastern Boulevard, Middle River, Baltimore County, Maryland

Dear Mr. Carroll:

For your information, please find enclosed two hard copies with CD of the above-referenced document. The enclosed work plan presents the protocols to perform tracer testing in Block E of the Lockheed Martin Corporation Middle River Complex. If possible, we respectfully request to receive MDE's comments by February 23, 2016.

Please let me know if you have any questions. My office phone is (301) 548-2227.

Sincerely,



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Groundwater Remediation O&M Manual, Appendix A1—Block E Tracer Testing Work Plan Middle River Complex, Middle River, Maryland

Prepared for:

Lockheed Martin Corporation

TABLE OF CONTENTS

LIST OF TABLES

FIGURES

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ACRONYMS

CB	catch basin
DO	dissolved oxygen
°F	degrees Fahrenheit
gph	gallon

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Section 1
Background

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc. (Tetra Tech) has prepared the following work plan to perform tracer testing in Block E of the Lockheed Martin Corporation Middle River Complex (MRC) at 2323 Eastern Boulevard in Middle River, Maryland. This work plan is an addition to Appendix A of the *Groundwater Remediation System Operations and Maintenance Manual* (O&M manual) for the Lockheed Martin Middle River Complex (Tetra Tech, 2014). Refer to the appropriate sections of the operations and maintenance manual for background information, remediation system process-equipment and controls descriptions, and for specific operation and maintenance procedures.

The groundwater response action at the Middle River Complex implements enhanced anaerobic bioremediation-processes in three areas that have high concentrations of trichloroethene (TCE) in groundwater: the southeastern trichloroethene area (Block E), the southwestern trichloroethene area (Block G), and the northern trichloroethene area (Block I). Amendments are injected into the subsurface using rows of semi-permanent injection wells connected (via underground conveyance piping) to injection equipment in each of the three TCE areas (Appendix C of the operations and maintenance manual, Drawings C-2, C-3, C-4). Field tracer-testing was performed at Blocks G and I before system startup b

- verify the performance and design of injection wells
- determine injection effects on the aquifer
- determine if injected material is being transported via flow through utilities or utility bedding, and if such transport is occurring, determine how to prevent it from occurring during enhanced anaerobic bioremediation
- test and confirm the full functionality of the injection system, including the process equipment, controls, and communications

This work plan provides the rationale, methodology, data collection requirements, and safety protocols for tracer testing.

Tracer testing will involve the following:

- using the same processing equipment and controls as will be used in the enhanced anaerobic bioremediation work
- communications testing and de-bugging
- performing tracer tests using treated pH-adjusted, chlorine- and oxygen-free potable water with added sodium-bromide tracer
- reporting results

Section 2
General Approach and Methodology

Tracer testing in Block E will entail the following general components:

a) The injection equipment module will be placed in the Block E test area as shown on Figure 2-1. The final module location will be predicated on site conditions at the time of the container move.

b) The underground injection lines, potable-water line, and power supply will be connected to the equipment container.

c) Baseline performance-monitoring sampling will be performed, including bromide sampling.

d) Process equipment, controls, and communications will be configured and tested.

e) Test injections will be performed using water (with chlorine and dissolved oxygen removed), tracer, and pH buffer (sodium bicarbonate). The following general procedure will be used:

    The system will be configured to simultaneously inject fluid with tracer into several selected injection wells; two well sets will be tested in Block E.

    Injection rates will be set as indicated in Section 3.

    Groundwater-table mounding and pressure heads in the injection interval will be measured, and injection rates adjusted as necessary.

    Stormwater utilities and outfalls will be visually examined and monitored.

    Samples will be collected to detect the tracer in monitoring wells, stormwater utilities, and outfalls.

Note that some parameter values (such as achievable injection rates and injection wellhead

2.1 LOGISTICS AND EQUIPMENT

Tracer test equipment and logistics are selected to ensure safety during field procedures and to minimize risk while achieving the stated test objectives. The following steps summarize tracer test general logistics and equipment:

1) Injection equipment module designed to perform full-scale injection events will be used for tracer injection. The injection module will be moved from Block I to Block E. The equipment module will be positioned approximately as shown in Figure 2-1.

2) The pH adjustment tank (T-2) in the equipment module will be filled with 330 gallons of treated (deoxygenated and dechlorinated) potable water, and the design quantity of sodium bromide tracer will be added. Sodium bromide is a common nontoxic tracer for groundwater studies. Refer to Appendix E of the operations and maintenance (O&M) manual (Tetra Tech, 2014) for the sodium-bromide safety data sheet (SDS). The rationale for the selection of the bromide tracer-concentration is in Section 2.2.

3) The design quantity of buffer (sodium bicarbonate) will be added to tank T-2. Sodium bicarbonate is a common nontoxic chemical often used as a gentle pH-buffering agent. Appendix E of the O&M manual (Tetra Tech, 2014) contains the SDS for sodium bicarbonate. The mixing pump in T-2 will be activated for approximately 4-8 hours to dissolve the added chemicals.

4) Operation of the injection system will be started per the start-up procedures described in Section 3.1 of the O&M manual (Tetra Tech, 2014). Injection system equipment will be configured as described in Section 3.1.3 of the O&M manual (Tetra Tech, 2014). Injection well configurations for each specific test area are described in Section 3 below.

5) Before starting the injection test at each location, data-logging liquid-level transducers will be placed in selected wells to automatically measure liquid levels. Following each test in each area, the data will be downloaded and used to determine the injections' effects on groundwater levels in the injection area. Two injection events at two sets of selected wells are proposed for Block E.

6) During injection, stormwater utilities and the outfall in the injection areas will be visually inspected upon arrival at the site and at the end of the day to note any change in flow or water characteristics. The active injection wellheads and all wells near the injection wells will also be checked for leaks and daylighting of tracer fluid.

7) The presence of bromide tracer will be determined by collecting analytical samples from monitoring wells at each injection location and from various stormwater utility lo

period. Additionally, monitoring via remote computer access will be performed daily when the operator is not present at the site.

2.2 TRACER DOSAGE

Proposed sodium-bromide tracer quantities will be selected based on baseline bromide levels measured at various Middle River Complex (MRC) locations before the tracer test. A lower concentration of bromide tracer can generally be used if low baseline-bromide levels are found in the groundwater. Sodium-bromide tracer was successfully used during the November 2011 injection test (Tetra Tech, 2011). Background bromide levels measured in MRC groundwater before the November 2011 pilot injection-test range from below 0.05 milligrams per liter (mg/L) to 0.34 mg/L. Approximately 10 pounds (lbs) of sodium bromide tracer were introduced in each injection well test location during the November 2011 test. Therefore, elevated bromide concentrations might persist near the 2011 injection well test locations.

The dosages and injection rates proposed in this work plan may be changed in response to groundwater mounding, and daylighting or leakage of tracer as the testing proceeds.

For design purposes, bromide tracer quantities for each injection well are assumed to be approximately the same as the quantities used during the 2014 tracer tests in Blocks G and I (approximately 10 lbs of sodium bromide per injection well). This will result in a concentration of approximately 200 to 250 mg/L of bromide in the injected solution.

The duration of tracer injection (as compared to the overall injection duration) can be varied; for example, the entire design quantity of tracer (10 lbs per well) can be injected at the beginning of the injection process and then “chased” by fluid without tracer, until the entire design volume has been injected. The advantage of this approach is that it uses higher tracer concentrations, making differentiation of the tracer from background levels easier. However, tracer can be missed in sampling locations if sampling frequency is insufficient. This approach is better suited to locations with relatively high background tracer-concentrations.

In contrast, the same tracer quantity (10 lbs per well) can be injected uniformly during the entire injection process. The advantage of this approach is that it reduces the likelihood of missing the tracer due to insufficient sampling frequency. However, differentiating tracer concentrations from background levels can be more difficult to discern (as compared to the previous approach). This approach is better suited to locations with relatively low background tracer concentrations. A combination of these two approaches will be used; tracer injection time is estimated to be approximately 75% of the entire injection time, corresponding to tracer injection concentration of 500 mg/L (similar to the 2011 injection test). A final decision regarding injection protocol will be made and discussed during a regular Lockheed Martin Corporation (Lockheed Martin) conference call after the pre-test background-

Section 3
Block E Tracer Testing

This section describes the layout for the tracer test, field procedures, and monitoring that will be performed for the tracer test in the Block E area of the Middle River Complex (MRC).

3.1 FIXED-BASE LABORATORY SAMPLING

Baseline groundwater samples will be collected from the following wells before tracer testing begins: SEMW-1I, SEMW-2I, SEMW-3I, SEMW-4I, SEMW-5S, SEMW-5I, SEMW-6I, IWE-25, IWE-28, MW-72B, MW-74A, and MW-74B. The baseline testing parameters for Block E are summarized in Table 3-1. Appendix B of the operations and maintenance (O&M) manual (Tetra Tech, Inc. [Tetra Tech], 2014) contains procedures for baseline sampling. Groundwater samples from the following wells near the tracer injection areas will also be analyzed for bromide: SEMW-1I, SEMW-2I, SEMW-3I, SEMW-6I, and MW-72B. Additionally, bromide samples will be collected from three catch basins (MH-10/IL-3, IL-2, IL-1) and one outfall (Outfall 8). Bromide levels will be measured several times during the tracer test. A baseline sample will be collected before tracer testing begins, and several samples will be collected at various times during the tracer test. A static sample will be collected after the tracer test is complete. Bromide sampling locations and sampling frequency are summarized in Table 3-2. Bromide sampling procedure and analytical laboratory requirements are described in Section 2-3.

3.2 GROUNDWATER TABLE MEASUREMENTS

Groundwater levels will be monitored periodically via manual gauging of monitoring wells and via pressure transducers placed within several injection-G manual3(l)-12(e)4(vle)6(v) ted5w 1.76co Td [(B)7(r)3(o.

Groundwater levels at several locations will be continuously recorded using down-well pressure transducers. Transducers will be installed and will operate throughout the tracer injection testing in wells SEMW-1I, SEMW-3I, SEMW-6I, and MW-72B. Before the transducers are installed and prior to removal, water levels in each well will be measured using an electronic water-level meter. Transducers will collect data for the entire test duration. Transducers will be installed in each location approximately five to 10 feet below the static water level; recording frequency will be set to approximately five minutes. The transducers will be left in place while the wells are being sampled. During sampling, water levels in each well will be measured using an electronic water-level meter.

The transducers will be removed one week after the Block E tracer testing is finished to allow the groundwater table to recover to static conditions. Data from the transducers will be downloaded and assembled in a spreadsheet for analysis.

3.3 INJECTION SOLUTION PREPARATION

The following procedure will be used to prepare the injection solution in tank T-2 during the Block E tracer testing event:

1)lkwN4SDT(y)T26(s)-5(i)-6d [( )-1 14.0a-Tw -4.2 ToT2 1 Tf 7-2(n)-10(g)10(t)-2 330k

Metering pump MP-2 will be activated to begin injection of the

3.5 PARAMETER MONITORING

Injection system parameters inside the equipment container will be monitored and recorded at least twice daily during each site visit while tracer testing is underway. The on-site operator and, if necessary, a remote operator via an Internet connection, will monitor and control the operation of the injection system. The injection system will be accessed daily via remote connection. The procedures for remote monitoring and control of the system are described in Section 3.2.2 of the O&M manual (Tetra Tech, 2014). A summary of the process-equipment parameters inside the equipment module is in Table 3-3. Wellhead pressures for injection wells, changes in the groundwater table, bromide concentrations in wells, catch basins, and outfalls, observations of any liquid daylighting, and other visible potential effects of injection will be monitored and recorded. If daylighting is observed or significant tracer is measured in the catch basins or outfalls, the injection will be stopped, Lockheed Martin will be notified, and alternative injection protocol will be considered and initiated. A summary of these field parameters is in Table 3-4.

Table 3-1

Table 3-2
Block E Bromide Sampling Summary
Tracer Testing Work Plan
Lockheed Martin Middle River Complex, Middle River, Maryland
Page 2 of 2

Sampling Location	Sampling Events					
	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
MH-10/IL-3	Baseline	1st injection Week 1	1st injection Week 2	2nd injection Week 1	2nd injection Week 2	Static - Week 2 after 2nd injection
IL-2	Baseline	1st injection Week 1	1st injection Week 2	2nd injection Week 1	2nd injection Week 2	Static - Week 2 after 1st injection
IL-1	Baseline	1st injection Week 1	1st injection Week 2	2nd injection Week 1	2nd injection Week 2	Static - Week 2 after 2nd injection
Outfall 8	Baseline	1st injection Week 1	1st injection Week 2	2nd injection Week 1	2nd injection Week 2	Static - Week 2 after 2nd injection

Table 3-3
Block E Equipment Module Process Equipment Monitoring
Tracer Testing Work Plan
Lockheed Martin Middle River Complex, Middle River, Maryland

Parameter	Instrument or Formula	Expected Range/Adjustment	Units
Date/time of observation	clock	NA	NA
Injection wells connected	Manifold	**1st injection event:** IWE-3, IWE-4, IWE-5, IWE-22, IWE-23, IWE-24 **2nd injection event:** IWE-10, IWE-11, IWE-12	NA
Potable water inlet pressure	PG-1	50 to 100	psig
Pressure regulator PR-1 outlet pressure	PG-2	Adjust pressure in PG-2 between 10- 20 psig using PR-1.	psig
GAC-1 outlet pressure	PG-3	1-2 psig below PG-2. Check GAC-1 at over 3 psig difference from PG-2.	psig
Filter PF-1 outlet pressure	PG-4	0-2 psig below PG-3. PF-1 (replace filter bag) at over 3 psig difference from PG-3.	psig
Injection manifold pressure	PG-5	1-2 psig below PG-4. Check MC-1 at over 3 psig difference from PG-4.	

Table 3-4
Block E Field Parameters Monitoring
Tracer Testing Work Plan
Lockheed Martin Middle River Co4.3(T)/Top]ple ex, Ra-6.6(n)11.dde River CMia anl

Section 4

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