BLOCK I DROP HAMMER BUILDING INVESTIGATION REPORT–AUGUST 2021 LOCKHEED MARTIN MIDDLE RIVER COMPLEX 2323 EASTERN BOULEVARD MIDDLE RIVER, MARYLAND

Prepared for:
Lockheed Martin Corporation

Prepared by:
Tetra Tech, Inc.

February 2022

Approved by:
Lockheed Martin, Inc.

Revision: 0

Michael Martin, P.G.
Regional Manager

Joshua Mullis
Project Manager

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ACRONYMS

ACM	asbestos-containing material
AF	attenuation factor
bgs	below ground surface
BZ	breathing zone
COC	chemical(s) of concern
DHB	Drop Hammer Building
Earth Tech	Earth Tech, Inc.
FV	floor vent
GC	gas chromatograph
GPR	ground-penetrating radar
HASP	health and safety plan
IA	indoor air
in Hg	inches of mercury
LMCPI	LMC Properties, Inc.
Lockheed Martin	Lockheed Martin Corporation
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
$\mu g/m^3$	microgram(s) per cubic meter
MDE	Maryland Department of the Environment
MRC	Middle River Complex
MS	mass spectrometer
OHM	other hazardous materials
OSHA	Occupational Safety and Health Administration
PCE	tetrachloroethene
PEL	permissible exposure limit
ppbv	part(s) per billion by volume

QA	quality assurance
QC	quality control
RSL	regional screening level
SL	screening level
SV	sub-slab vapor
TCE	trichloroethene
Tetra Tech	Tetra Tech, Inc.
TO-15	toxic organic-15
UCHASE	utility corridor chase
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VI	vapor intrusion
VMP	vapor monitoring point
VOC(s)	volatile organic compound(s)
WV	wall vent

SECTION 1
INTRODUCTION AND SITE DESCRIPTION

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc., (Tetra Tech) has prepared this report documenting the additional activities completed to provide more substantive data for evaluating potential vapor intrusion within the Drop Hammer Building (DHB) at the Lockheed Martin Middle River Complex (MRC) in Middle River, Maryland (Figure 1-1).

The Drop Hammer Building is in the western portion of Block I, west of Building A and south of the Maintenance Building. This report briefly focuses on the historical processes that may have used chlorinated volatile organic compounds (VOCs) such as trichloroethene (TCE) in the Drop Hammer Building, presents the data available from investigations conducted inside the building prior to this investigation, and assesses the findings of this vapor intrusion investigation.

The Middle River Complex is at 2323 Eastern Boulevard in Middle River, Maryland, approximately 11.5 miles northeast of downtown Baltimore, Maryland. The complex is part of the Chesapeake Industrial Park and comprises approximately 161 acres, including 12 main buildings, an active industrial area, perimeter parking lots, an athletic field, a vacant concrete lot, a trailer- and parts-storage lot, and numerous grassy areas along its perimeter. Middle River Complex is bounded by Eastern Boulevard (Route 150) to the north, Dark Head Cove to the south, Cow Pen Creek to the west, and Wilson Point Road and Martin State Airport to the east. Commercial, industrial, and residential establishments surround the complex. Figure 1-2 presents the current layout of the Middle River Complex and Figure 1-3 shows the Drop Hammer Building area of the site.

Middle River Complex is owned by LMC Properties, Inc., (LMCPI), a subsidiary of Lockheed Martin Corporation (Lockheed Martin). Currently, the primary activities of LMC Properties, Inc., are facility and building management and maintenance. The main site tenant, MRA Systems, LLC, a subsidiary of Singapore Technologies Engineering, Ltd., designs, manufactures, fabricates, tests, overhauls, repairs, and maintains aeronautical structures, parts, and components for military and commercial applications. Lockheed Martin Rotary and Mission Systems (formerly Mission

Systems & Training), a Lockheed Martin business segment, conducts engineering and fabricates, assembles, tests, and otherwise supports vertical-launch systems. Lockheed Martin recently announced that the Rotary and Mission Systems operations will transition to other location(s) in 2022–2023.

This report summarizes the results obtained from the fourth round of sampling following the methodology set forth in the *Block I Drop Hammer Building Assessment Work Plan* (Tetra Tech, 2020a) and its addendum (Tetra Tech, 2020c). The objectives of the August 2021 sampling round (Round 4) were to determine if possibly present contaminants (primarily chlorinated solvents) from former operations are impacting indoor air (IA) in the Drop Hammer Building, and to confirm and further define sub-slab vapor (SV) concentrations detected at the Drop Hammer Building during previous investigations in May 2020, August 2020, and February 2021 (Tetra Tech, 2020b, 2021a, 2021b). Four existing Vapor Pins® were sampled for soil vapor. Four locations were also sampled for breathing zone indoor air. Samples collected from Vapor Pin® and indoor air monitoring points were submitted to the laboratory and analyzed for possibly present site-related volatile organic compounds (VOCs).

This report is organized into the following sections:

Section 2—Drop Hammer Building History, Use, and Previous Investigations: Briefly summarizes the historical use of the Drop Hammer Building.

Section 3—Investigation Approach and Field Methodology: Summarizes the investigation approach used for the installation and subsequent sampling of the vapor pin monitoring points and the sampling of indoor air collected during this investigation.

Section 4—Results: Summarizes the laboratory results obtained from sampling sub-slab vapor and indoor air within the Drop Hammer Building.

Section 5—Data Summary and Recommendations: Presents a summary of Drop Hammer Building sampling results, and recommendations for future actions.

Section 6—References: Lists the references used in this report.

Tables, figures, and appendices are at the end of the report body following Section 6.

SECTION 2
DROP HAMMER BUILDING HISTORY, USE, AND PREVIOUS INVESTIGATIONS

This section presents the results of all historical document research and environmental investigations associated with the Drop Hammer Building (DHB). Figure 2-1 is a historical (1941) layout plan of the DHB first floor that represents its original construction. Limited historical facility drawings, site plans, and/or records are available to document the former layout(s) of the building and its various uses over time, and do not cover all operational changes that have occurred within the building. Interviews with current and past employees have provided useful information about the site's operational history and infrastructure, but a full understanding of the historical operations as it pertains to chlorinated solvent use has not been determined.

2.1 HISTORICAL USE OF DROP HAMMER BUILDING

The DHB was constructed along with Building A and is one of the original buildings at the Middle River Complex (MRC). According to a historical drawing (Figure 2-1), the building contained up to 26 drop hammers with vibration isolation trenching, as well as two salt baths likely used for heat-treating the metal prior to shaping. The drop hammers consisted of a lead die aligned with a hammer that was raised and then dropped on malleable metal to forge the metal resting on the anvil. Anecdotal reports from a former employee indicate that approximately eight drop hammers were in operation during the late 1990s; this accounts for the difference seen in the 1941 drawing and the features currently remaining visible in the floor of the building. All remaining drop hammers were removed in 2006, and the resulting pits were filled with concrete. A second series of trenches in the southern portion of the building are around what was reportedly a large air compressor. Currently, most of the building is used for storage.

A foundry was constructed as an addition on the western side of the DHB in the mid-1950s. This foundry was reportedly used to melt lead to forge dies for the drop hammers, and was later moved to the southwestern corner of the main building when the building addition was used for tool storage. A small-arms shooting range was also located in the DHB basement, but access to that area is restricted. No drawings or other documentation associated with the shooting range were identified, and no as-built drawings are available for the building addition.

2.2 SITE INTERVIEWS

Interviews were conducted with current and former LMC Properties, Inc., (LMCPI) and EMCOR (the onsite maintenance contractor) employees to research historical operations, sumps, and infrastructure relationships at the DHB, and to identify operational history that may help identify possible chemical use (e.g., the use of chlorinated solvents such as trichloroethene [TCE]) at the site). A DHB site walk was conducted to view the building's infrastructure, and a summary of the findings obtained from historical research and interviews is below.

- The DHB (Figure 2-1) and foundry historically manufactured and used lead dies which were stored outside the southern end of the building. Plating dip-tanks were reportedly used during historical operations, but no drawings were identified showing these tanks. If dip tanks were historically present, then associated solvents (such as TCE) would be of concern with respect to possible vapor intrusion (VI). The original building has a basement under a portion of its western side that included storage areas and an indoor firing range. An addition to the western extent of the DBH was added after its original construction.

- Molten lead was used in sand molds to produce drop hammers; pots containing molten lead were used to fill these molds with lead and Kirksite, a moderately strong zinc-base alloy that was developed primarily as an alloy for forming tools.

- A concrete-walled underground storage tank (UST), anecdotally reported as possibly containing TCE, was formerly located on the northern end of the building, and two aboveground tanks containing salt baths were formerly located near the center portion of the building. Additionally, two USTs of unknown use were reportedly formerly located on the southern end of the building. The term "dipping tanks" appears to have been used to describe both the USTs and/or the former aboveground salt baths. As the only aboveground tanks in the DHB were used as salt baths (as stated by EMCOR personnel), they may have been reported as dipping tanks in previous reports. (Note that the term "dipping tanks" is no longer used to describe the former UST areas to prevent further confusion of former site conditions.) A figure showing these features (and sampling results) is in Section 4 of this document.

2.3 2008 ENVIRONMENTAL INVESTIGATIONS

From January to May 2008, Earth Tech, Inc., (Earth Tech) carried out a comprehensive hazardous materials survey of 42 MRC buildings and structures, totaling approximately two million square feet (Earth Tech, 2008). This survey sought to identify asbestos-containing material (ACM) and other hazardous materials (OHM) in Lockheed Martin-owned structures that would require management before building demolition. In January 2008, a U-shaped concrete trench with steel covers was identified in the southeastern portion of the former DHB around an area historically holding a large air compressor (and coinciding with samples collected during the hazardous material survey [Earth Tech, 2008]). The purpose of the trench is unknown, but it possibly could have acted as a containment structure or could have been used for vibration isolation. Liquid and sediment in this drainage trench was sampled in late January 2008, and TCE was detected in both the liquid (DH-LM-001) and sediment/solid (DH-SM-001) samples, at concentrations of 4.25 micrograms per liter (µg/L) and 6.24 micrograms per kilogram (µg/kg), respectively. While not directly comparable for drainage liquid and sediment accumulated in a trench, the Maryland Department of the Environment (MDE) generic numeric groundwater and non-residential soil cleanup standards for TCE are 5 µg/L and 1,900 µg/kg, respectively (MDE, 2018). The U-shaped trench area was targeted for soil boring sampling during an opportunistic sampling program completed by Tetra Tech in February 2008 (Tetra Tech, 2008).

On February 26, 2008, Tetra Tech cored the concrete, advanced borings, and collected three soil samples (DHB-1, DHB-2, and DHB-3) in areas surrounding the trench (Tetra Tech, 2008). The trench was approximately 5-6 feet deep, and contained standing water of unknown origin. Eight borings were attempted, but five were abandoned due to the presence of a second concrete layer encountered beneath the main floor slab. Borings were advanced to a terminal depth of approximately two feet deeper than the estimated bottom of the trench (approximately eight feet below grade). Because the second subsurface concrete layer was encountered, soil samples were only able to be retrieved from three borings. No water was encountered during boring advancement. Methylene chloride (2.3-3.3*J* µg/kg) and naphthalene (2.4*J* µg/kg) were the only volatile organic compounds (VOCs) detected in soil samples DHB-1 through DHB-3, well below available MDE generic numeric (non-residential) soil cleanup standards of 320 milligrams per kilogram (mg/kg) and 17 mg/kg. TCE was not detected in any sample collected (Tetra Tech, 2008).

Environmental studies for a possible upgradient source of chlorinated solvents (primarily TCE) have been conducted near or within Building A and Building A basement, and in areas heading west toward Cow Pen Creek. However, no groundwater samples directly beneath the DHB have been collected. A detailed presentation of investigations in the area west of Building A and Building A basement, and in adjacent areas, can be found in the *Deeper Western Groundwater Investigation Report* (Tetra Tech, 2018a). Groundwater data from 2021 indicate elevated levels of TCE in nearby monitoring wells upgradient of DHB, including wells MW120B (1,200 µg/L) screened in the lower permeable zone (well MW119B, similarly located, was not sampled in 2021, although a sampling result of 184 µg/L was found in 2020), and in a downgradient monitoring well MW90B and its duplicate (290/310 µg/L) also screened in the lower permeable zone. However, only trace TCE concentrations (0.55 µg/L and 0.64 µg/L) were detected in wells screened in the higher permeable zone (MW120A and MW64A, respectively). The lower (deeper) permeable zone and higher (shallower) permeable zone are separated by a clay confining layer ranging from 15-20 feet in thickness, as evidenced by the lithologic log of MW120A/B (located just north of the DHB), where the confining clay unit begins at approximately 13.5 feet below ground surface (bgs) and ends approximately 37 feet bgs. Note that although VOC concentrations in the lower permeable zone are elevated, the subsurface clay layer separates this zone from the upper permeable zone (where only trace VOC concentrations are detected), which is the groundwater zone of greater concern for VI into DHB.

Prior to the May 2020 Drop Hammer Building Assessment, no environmental investigations have been conducted except for one limited investigation completed in February 2008 during an opportunistic sampling project (Tetra Tech, 2008), and sampling conducted as part of a hazardous materials survey of the larger MRC manufacturing buildings conducted in January-May 2008 (Earth Tech, 2008).

2.4 MAY 2020 DROP HAMMER BUILDING ASSESSMENT

A field investigation at the DHB was conducted in May 2020 following the methodology set forth in the *Block I Drop Hammer Building Assessment Work Plan* (Tetra Tech, 2020a). The objectives of that assessment were to investigate the northern and southern portion of the DHB where TCE use may have occurred during historical operations and to evaluate if TCE-impacted groundwater under the building may be influencing sub-slab vapor (SV) or IA in the DHB. The results of this investigation (denoted Round 1) were reported in the *Block I Drop Hammer Building Assessment Report* (Tetra Tech, 2020b).

IA screening was completed in the field using the FROG-5000™ device, and TCE was detected above the device's threshold screening level (SL) of 5 micrograms per cubic meter air ($\mu g/m^3$), equivalent to 1 part per billion by volume (ppbv), at two locations. (The MDE SL and USEPA regional screening level (RSL) for industrial IA exposure to TCE is 8.8 $\mu g/m^3$.) These two locations were subsequently sampled over eight hours using one-liter Summa® canisters. IA was sampled in the breathing zone above the floor vent near column A6/A7 (IA-A6A7-DHB) and the floor vent near column D3 (IA-D3-DHB); refer to Figure 2-1 for column locations. These two samples (plus one duplicate) were sent to the laboratory for analysis of volatile organic compounds (VOCs), and were nondetect for TCE. However, 10 VOCs were detected in sample IA-D3-DHB, and eight VOCs were detected in sample IA-A6A7-DHB (and its duplicate), including carbon tetrachloride and tetrachloroethene (PCE). All detected concentrations were well below Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) and MDE SLs for industrial receptor exposures to IA. Round 1 (May 2020) IA sampling results are compared to available screening criteria in Table 2-1, and IA sampling results for TCE are shown on Figure 2-2. The MDE SLs are equivalent to the USEPA RSL corresponding to a target cancer risk of 10^{-5} or a hazard quotient of 1.0.

Six vapor monitoring points (VMPs) were installed in the DHB, including five locations on the main floor and one in the basement. As shown on Table 2-2, TCE was detected at all six SV monitoring points, at concentrations ranging from 16 $\mu g/m^3$ (VMP-192) to 62,000 $\mu g/m^3$ (VMP-189), and exceeded the SV SL (293 $\mu g/m^3$) at four locations on the northern end of the building (Figure 2-2). SV screening values were derived in accordance with the methods discussed in USEPA's *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* (USEPA, 2015), and were calculated by dividing MDE IA SLs by a conservative attenuation factor (AF) of 0.03. The AF represents the adjustment applied to IA screening levels to account for concentration reductions due to diffusive, advective, and/or other attenuating (dilution) mechanisms as vapor migrates from the sub-slab to IA. The recommended AF in the 2015 USEPA guidance resulted in higher SV screening values than those used for sampling rounds before August 2012, when an earlier AF of 0.1 was used. USEPA further acknowledges that applying the AF of 0.03 to industrial buildings is conservative (i.e., more protective of human health and the environment), because the value was developed based on residential VI studies and does not account for industrial buildings that generally have thicker building slabs and stronger heating/ventilation/air-conditioning systems than residential homes.

Based on the results of the Round 1 investigation, additional Vapor Pin® installation and monitoring was recommended to further delineate and verify the contaminant concentrations observed. Additionally, a more comprehensive IA sampling event was recommended to assess the entire DHB.

2.5 AUGUST 2020 DROP HAMMER BUILDING INVESTIGATION

The Round 2 investigation was conducted in August 2020 (Tetra Tech, 2021a). Seven additional vapor monitoring points were installed in the DHB prior to the Round 2 investigation, including four locations on the main floor (VMP-194, VMP-195, VMP-196, and VMP-197) and three in the basement (VMP-198, VMP-199, and VMP-200). The seven new and six existing vapor monitoring points were sampled for VOCs. IA was sampled for VOCs in the breathing zone at eleven sampling locations throughout the DHB. TCE was detected in IA at low concentrations (0.5 µg/L–2.1 µg/L) at three sampling locations (refer to Figure 2-2). As shown in Table 2-3, 13 VOCs, including trace concentrations (0.25 µg/L–0.86 µg/L) of PCE at seven locations, were detected in at least one of the samples; all detected concentrations were below applicable IA SLs. As shown on Figure 2-2 and Table 2-4, TCE was detected at all 13 VMPs, and exceeded the SV SL (293 $\mu g/m^3$) at seven locations, including five locations on the northern end of the building and two locations in the basement.

The August 2020 sampling results were similar to May 2020 sampling results, where TCE exceedances of SV criteria (ranging from 330 $\mu g/m^3$ to 98,000 $\mu g/m^3$) were observed in the northern portion of the building, as well as in the basement, with the highest detection at location VMP-195.

2.6 FEBRUARY 2021 DROP HAMMER BUILDING INVESTIGATION

The Round 3 investigation was completed in February 2021 (Tetra Tech, 2021b) to perform additional delineation and assess IA conditions during winter operations, when the DHB is typically more enclosed for the winter heating season, as opposed to the summer months when large overhead bay doors tend to be open during the day.

IA was sampled in the breathing zone at 12 sampling locations throughout the DHB. These 12 samples (plus one duplicate) were sent to the laboratory for analysis of VOCs. As shown in Table 2-5, 12 VOCs were detected in at least one of 13 samples; all detected concentrations were below applicable IA criteria. Note that concentrations of both TCE (at a range of 0.17 $\mu g/m^3$ to 0.79 $\mu g/m^3$), detected in IA at four locations (see Figure 2-3), and PCE (0.28 $\mu g/m^3$), detected at only one location (VMP-190), were well below their lowest IA SLs (8.8 $\mu g/m^3$ and 180 $\mu g/m^3$, respectively).

Four new vapor monitoring points were installed in the DHB, including three locations on the main floor and one location in the DHB addition (the former foundry area). The four new and 13 existing vapor monitoring points (including one duplicate) were sampled for VOCs and sent to the laboratory. Twenty VOCs were detected (Table 2-6); TCE was detected in SV at 16 of 17 vapor monitoring points, and exceeded the SV screening level (293 micrograms per cubic meter air [$\mu g/m^3$]) at four locations, including three locations on the northern end of the building and one location in the basement (refer to Figure 2-3 and Table 2-6). PCE was detected in SV below the SL (6,000 $\mu g/m^3$) at 10 locations, at concentrations ranging from 0.25 $\mu g/m^3$ to 7.3 $\mu g/m^3$ (Table 2-6). Chloroform also exceeded its SV SL (177 $\mu g/m^3$) at two locations (230 $\mu g/m^3$ at VMP-195, and 290 $\mu g/m^3$ at VMP-200); both chloroform exceedances occurred at the locations of SV TCE exceedances.

February 2021 sampling results were generally similar to May and August 2020 sampling results, where TCE exceedances of soil vapor criterion (ranging from 980 $\mu g/m^3$ to 30,000 $\mu g/m^3$) were observed in the northern portion of the building, as well as the basement, with the highest detection at location VMP-195. SV TCE concentrations were lower during the February 2021 sampling round as compared to the previous two sampling rounds, which were both conducted during warmer months. The maximum concentration of trichloroethene in February 2021 was

30,000 µg/m^3, as compared to 62,000 µg/m^3 in May 2020, and 98,000 µg/m^3 in August 2020. The concentrations of SV TCE have also decreased substantially at multiple monitoring points, as compared to those detected during the May 2020 sampling round. TCE at VMP-189 has decreased from 62,000 µg/m^3 (May 2020) to 37,000 µg/m^3 (August 2020), and to 22,000 µg/m^3 (February 2021). Similarly, at VMP-191, TCE has decreased from 4,800 µg/m^3 (May 2020), to 1.7 µg/m^3 (August 2020), with a subsequent ten-fold decrease to 0.17*J* µg/m^3 in February 2021.

SECTION 3
INVESTIGATION APPROACH AND FIELD METHODOLOGY

This report documents field activities completed to provide more substantive data to evaluate possible vapor intrusion (VI) into indoor air (IA) at the Drop Hammer Building (DHB) at the Lockheed Martin Corporation (Lockheed Martin) Middle River Complex (MRC) in Middle River, Maryland. The August 2021 sampling round was denoted Round 4 to distinguish it from the previous three (May 2020 [Round 1], August 2020 [Round 2], and February 2021 [Round 3]) sampling rounds. This report assesses IA and sub-slab vapor (SV) conditions during summer operations, when the large overhead bay doors of the DHB tend to be open during the day, as opposed to the winter when the building is more enclosed.

The scope of work associated with this field investigation includes:

- collecting four eight-hour IA samples and four sub-slab vapor (SV) samples using Summa® canisters at various locations in the DHB
- collect one IA and one SV duplicate sample for QA/QC purposes

In accordance with Addendum No. 2, only those IA sampling locations where trichloroethene (TCE) was detected in February 2021 (i.e., IA-190-DHB, IA-BATHROOM-DHB, and IA-B2-DHB on the main floor, and IA-BSTORE-DHB in the basement), and only those SV sampling locations where TCE was detected at concentrations exceeding the SV screening level (293 $\mu g/m^3$) in February 2021 (VMP-189, VMP-195, and VMP-197 on the main floor, and VMP-200 in the basement) were sampled in August 2021. IA and SV sampling locations are shown on Figure 3-1. Results from this investigation document sub-slab conditions under the main floor and basement of the DHB in August 2021, as well as breathing zone conditions of IA, and will assist future sampling activities and further contaminant delineation.

3.1 MOBILIZATION/DEMOBILIZATION

Tetra Tech provided notification to and coordinated access arrangements through Lockheed Martin security, EMCOR (site maintenance), and Singapore Technologies Engineering, Ltd., to gain access to the DHB. MRC tenants were informed of and updated about the field investigation at biweekly meetings conducted by LMC Properties, Inc. (LMCPI). LMCPI and Singapore Technologies Engineering, Ltd., were notified of investigation-associated field tasks and schedule, and approved the work and schedule before Tetra Tech mobilized to the field.

The field operations leader coordinated mobilization and demobilization (including equipment inventories, to ensure equipment availability), purchasing and leasing equipment, and staging equipment for efficient loading and transport to and from the site before and after each field activity. Before field operations began, Tetra Tech personnel reviewed the site-specific HASP and the respective “safe work” permits therein. Tetra Tech held mandatory daily health and safety tailgate meetings before all field events.

The utility-locating subcontractor (RETTEW) was included in the daily health and safety meeting when they were onsite. The Tetra Tech site health and safety officer documented pertinent topics covered and personnel in attendance.

No investigative-derived waste was generated during this investigation.

3.2 INDOOR AIR SAMPLING

Five IA samples (four locations with one duplicate) were collected on August 4, 2021 (Figure 3-1) at locations where TCE was detected during the February 2021 sampling (Round 3). IA samples were analyzed for volatile organic compounds (VOCs) by Method Toxic Organics-15 (TO-15), and were collected at the breathing zone using one-liter preconditioned Summa® canisters equipped with integral controllers that controlled the rate of filling over the eight-hour sampling period. All IA and SV samples collected during this investigation were analyzed for the following chemicals of concern (COC):

- Benzene
- naphthalene

- carbon tetrachloride
- chlorodifluoromethane (Freon 22)
- chloroform
- Dichlorodifluoromethane
- 1,1-dichloroethane
- 1,2-dichloroethane
- 1,1-dichloroethene
- cis-1,2-dichloroethene
- trans-1,2-dichloroethene
- Ethylbenzene
- methyl-tertiary-butyl ether
- methylene chloride
- tetrachloroethene
- toluene
- 1,2,4-trichlorobenzene
- 1,1,1-trichloroethane
- 1,2,3-trimethylbenzene
- 1,2,4-trimethylbenzene
- 1,3,5-trimethylbenzene
- TCE
- 1,1,2-trichloroethane
- vinyl chloride
- xylenes (total)

Following receipt of the analytical data, data validation was performed by an independent chemist in accordance with United States Environmental Protection Agency (USEPA) Region 3 protocols. All data was validated for all quality assurance (QA)/quality control (QC) parameters including accuracy, precision, completeness, and comparability in accordance with USEPA guidance. IA sampling log sheets were used to record the times sampling started/stopped, the stop/start pressures within the canisters, canister/regulator numbers, and any other sample-specific information including a photograph of the sampling location; these log sheets are included as Appendix A.

3.3 VAPOR MONITORING POINT SAMPLING

Five SV samples (from four locations with one duplicate) were collected on August 4, 2021 (Figure 3-1) at SV sampling locations where TCE was detected at concentrations exceeding the SV screening level (293 µg/m^3) in February 2021. Each SV sample was collected over one hour using preconditioned Summa® canisters to ensure subsurface equilibration and avoid high negative pressure that might mobilize subsurface vapor and bias the results. Each sampling location was routinely inspected during the sampling period to ensure appropriate operation of sampling devices, sample integrity, and to document conditions within the area that might affect results. Samples were collected and analyzed for VOCs by USEPA Method TO-15 (USEPA, 1999). SV samples were collected in accordance with standard operating procedures developed by the USEPA Environmental Response Team for soil vapor sampling (USEPA, 1996), and methodologies developed by the USEPA Office of Research and Development (USEPA, 2004).

Individual evacuated Summa® canisters were used to collect all SV samples, in accordance with USEPA Method TO-15. These specially treated, stainless steel, one-liter canisters were equipped with in-line particulate filters and integral controllers that regulate the rate of filling during sampling. SV samples were collected through Teflon® tubing attached to the stainless-steel Vapor Pins®. Before sampling, the Teflon® tubing was purged of atmospheric air by attaching the tubing to a low-flow sampling pump set at a flow rate of approximately 200 cubic centimeters per minute to minimize mobilization of SV and prevent sample bias. One to three volumes (i.e., the volume of the sampling probe and tube) were purged to ensure that collected samples represented sub-slab conditions.

SV samples were collected by opening the valve on the canister, which allowed air to enter the canister at the rate set by the controller. Controllers were calibrated in the laboratory and shipped to the field with a sufficient flow rate that maintained the necessary vacuum pressure in the Summa® canister for the one-hour sampling interval. Summa® canisters were certified clean (less than 0.2 part per billion by volume (ppbv) of targeted compounds) by the laboratory before sending, in accordance with Section 8.4 of the TO 15 methodology (USEPA, 1999). SV sampling log sheets are in Appendix B.

After sampling had been completed, each canister was closed and sent to an offsite laboratory (Eurofins TestAmerica, Inc. in Knoxville, Tennessee) under proper chain of custody procedures.

3.4 DOCUMENTATION

Field documentation was recorded using an electronic form template and the FormConnect app on field iPads™. Daily field reports documented all pertinent information, including the date, time onsite/offsite, weather conditions, personnel onsite, a summary of field activities, health and safety topics discussed, and photographs of the daily activities. "Daily Activity Reports" are included as Appendix C.

Sample documentation consists of chain of custody reports and matrix-specific sampling log sheets. The chain of custody report is a standardized form that summarizes and documents pertinent sample information, such as sample identification and type, matrix, date and time of collection, preservation, and requested analysis. Sample custody procedures to document sample acquisition and integrity were properly followed. Signed chains of custody are provided along with the data validation reports and laboratory reports in Appendix D.

3.5 SAMPLE HANDLING

Proper custody procedures were followed throughout all phases of sample collection and handling. Chain of custody protocols were used throughout sample handling to establish the evidentiary integrity of sample containers. These protocols demonstrate that the samples were handled and transferred in a manner that would eliminate (or detect) possible tampering. Sample containers were released under signature from the laboratory and were accepted under signature by the sampler or individual responsible for maintaining custody until the sample containers were transferred to the sampling team.

Samples were released under signature from the sampling team and were accepted under signature by the laboratory. Transport containers returning to the laboratory were sealed with strapping tape and a tamper-resistant custody seal. The custody seal includes the signature of the individual releasing the transport container, along with the date and time.

3.6 DATA VALIDATION

Following receipt of the IA and SV analytical data, data were validated by an independent chemist in accordance with USEPA Region 3 protocols. Chemical data were supplied by the laboratory as hard-copy reports and electronic databases. All data were validated for all QA/QC parameters, including laboratory QA/QC and accuracy, precision, completeness, and comparability, in accordance with USEPA guidance. This review is based on the USEPA *National Functional Guidelines for Organic Superfund Methods Data Review* (USEPA, 2020), and the specifics of the analytical method used. Data validation reports, including complete chain of custody documentation, are in Appendix D. Chemical data tables are also in Appendix D.

Collectively, these data are acceptable for their intended use. For this validation, the following data qualifiers (i.e., flags) were applied to the chemical results presented in this report; these flags also appear on the chemical results tables in Section 4 and Appendix D:

U	Not detected. The analyte is considered not detected at the reported value.
J	The analyte is considered present in the sample. However, the value is estimated and might not be accurate or precise.
UJ	The analyte was analyzed for, but was not detected. The reported detection limit is approximate and may be inaccurate or imprecise.

SECTION 4
RESULTS

This section presents the results of the August 2021 sampling round (Round 4) of indoor air (IA) and sub-slab vapor (SV) at the Drop Hammer Building (DHB). Trichloroethene (TCE) results, in both IA and SV, are shown on Figure 4-1, while tetrachloroethene (PCE) results, in both IA and SV, are shown on Figure 4-2. These two volatile organic compounds (VOCs) are emphasized because they are primary chemicals of concern (COC) based on the sampling conducted to date.

4.1 EIGHT-HOUR INDOOR AIR SAMPLING

Five eight-hour IA samples (at four locations and with one duplicate) were collected via one-liter Summa® canisters on August 4, 2021 at locations within the DHB and DHB basement (Figure 4-1). Samples were collected at the breathing zone in preconditioned Summa® canisters (equipped with integral controllers that controlled the rate of filling) at all locations with the exception of the bathroom IA sample, where site conditions did not allow for a practical area to place the canister, so it was placed on the ground. IA samples were analyzed for volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15. The large overhead bay doors near columns A5/A6, and the bay door into the basement near column D11 were open for most of the entire eight-hour sampling period. The bay doors near columns A5/A6 tend to be open during warmer weather months.

Thirteen VOCs were detected in IA during the August 2021 sampling round (Table 4-1). TCE was detected at concentrations below the IA screening level of 8.8 micrograms per cubic meter ($\mu g/m^3$), with detected concentrations ranging from 0.55 $\mu g/m^3$ to 4.1 $\mu g/m^3$, and with the highest concentration detected at IA-190. PCE was detected at unusually high concentrations (as compared to earlier sampling rounds) at all sampling locations during the August 2021 round, with concentrations ranging from 1,100 $\mu g/m^3$ to 6,400 $\mu g/m^3$ (Table 4-1; Figure 4-2). These concentrations were above the Maryland Department of the Environment (MDE) IA screening level (SL) of 180 $\mu g/m^3$, but lower than the Occupational Safety and Health Administration

(OSHA) permissible exposure limit (PEL) of 678,000 µg/m^3. (The PEL is the legal limit for the maximum chemical concentration in air to which a United States worker may be exposed continuously for eight hours without any danger to health and safety. This OSHA PEL presumes active use of an industrial product containing PCE.) The highest PCE concentration was detected at IA-BATHROOM, located in the bathroom in the central portion of the building. With the exception of PCE and a single result of 1,1,2-Trichloroethane, all detected VOC concentrations were below their respective MDE SLs for industrial receptor exposure to IA (see Table 4-1), and all VOCs (including PCE) were detected at concentration below OSHA PELs.

Detected IA concentrations of PCE during the August 2021 sampling event are higher and more widely distributed than any of the previous four rounds of sampling, specifically:

- May 2020: one PCE detection of 0.88 µg/m^3 at indoor air location D3
- August 2020: seven PCE detections in IA, ranging from 0.25 µg/m^3 to 0.86 µg/m^3
- February 2021: one PCE detection of 0.28 µg/m^3 at IA-190

Such a marked change in PCE IA concentrations from February 2021 to August 2021 is likely an indication of changed operational activities at the DHB, or the introduction of a PCE-containing product into the building. SV results (see Section 4.2, below) suggest that IA exceedances of PCE are not related to VI.

The only other IA exceedance was for 1,1,2-trichloroethane, which slightly exceeded its industrial air screening level (0.88 µg/m^3) at IA-190, with a concentration of 1.3 µg/m^3. However, the duplicate analysis of this sample location produced a nondetectable result for 1,1,2-trichloroethane. 1,1,2-Trichloroethane was nondetect in IA during the first three sampling rounds.

4.2 SOIL VAPOR SAMPLING

Five sub-slab vapor (SV) samples were collected at four locations (including one duplicate) on August 4, 2021 and sent to the laboratory for TO-15 analysis for VOCs. Twenty-two VOCs were detected, with TCE exceeding its SV SL (293 µg/m^3) at all four locations (Table 4-2; Figure 4-1), and with the highest concentration (52,000 µg/m^3) at VMP-195 in the northern end of the building, and southeast of the possible historical location of an underground storage tank (UST) (Figure 4-1). TCE also exceeded its SV SL at VMP-197 (7,400 µg/m^3, with 8,100 µg/m^3 in the duplicate), which is located south (in the north-central area of DHB) of that possible former UST, and VMP-189 (14,000 µg/m^3), which is located south of the possible former UST. TCE also exceeded its SV SL at lone sampling location in the central portion of the DHB basement, VMP-200, with a concentration of 380 µg/m^3.

SV TCE results in August 2021 are similar to those detected in February 2021, with the exception of VMP-200, where the detected TCE concentration has decreased each sampling event since installation in August 2020. TCE at VMP-200 in August 2020 was 50,000 µg/m^3, decreasing to 22,000 µg/m^3 in February 2021, and decreasing again in August 2021 (380 µg/m^3).

Chloroform exceeded its target shallow SV concentration (177 µg/m^3) at VMP-195, with a concentration of 440 µg/m^3. All other VOCs, including PCE, were detected at concentrations below their chemical-specific target shallow SV criteria (Table 4-2).

4.3 CONCEPTUAL SITE MODEL

This investigation was not specifically designed to determine precise TCE sources, or the complete nature and extent of contamination that may be present under the DHB. The DHB is one of the original operational buildings constructed at the MRC, and was constructed as a slab-on-grade building with a portion of the building underlain by a basement. Documented historical operations for which the building was designed and constructed are not associated with the use of chemicals that may be a concern from a VI perspective. However, anecdotal reports of possible TCE-containing historical USTs do exist, and the DHB's configuration and use have changed over time. If these TCE USTs were present and used, any release from the tanks could have impacted subsurface soil beneath the building, and VI of TCE could be hypothetically possible. However, many of the higher SV concentrations (except for VMP-189) are more proximate to the former aboveground salt baths, rather than the possible former USTs. However, as stated earlier, the term "dipping tanks" was apparently used to describe both the USTs and/or the former aboveground salt baths, so whether this area formerly contained solvents is unknown.

The DHB also partially overlies identified TCE impacts to groundwater, originating from sources to the north and east of DHB from (and likely beneath) Building A. TCE in groundwater in this area is migrating to the south and west. The nature and extent of this contamination, in combination with underlying hydrogeologic conditions, suggest possible VI from contaminated groundwater is unlikely, as the highest TCE concentrations (e.g., 1,200 micrograms per liter [µg/L] at well MW120B) are in deeper groundwater below a clay layer that separates the lower permeable zone from the upper permeable zone. TCE concentrations in wells screened in the upper permeable zone are several orders of magnitude lower (e.g., 0.55 µg/L and 0.64 µg/L, detected at wells MW120A and MW64A, respectively). Therefore, the concern for a significant contribution of VI into IA from underlying groundwater at the DHB is remote, although relatively low concentrations of TCE in groundwater from the shallower permeable zone could, under certain conditions such as a preferential flow path, have a measurable impact on vapor concentrations.

The objective of the February 2021 investigation was to further delineate SV concentrations and provide IA data during the winter season, when the facility is typically more enclosed, and sought to further evaluate the findings of the May and August 2020 investigations. During the May 2020 investigation, elevated TCE SV concentrations (410 $\mu g/m^3$ to 62,000 $\mu g/m^3$) were found under the DHB, but no impacts were noted for IA (as all results were below applicable screening criteria). The August 2020 investigation at the DHB provided additional delineation of the SV concentrations, and additional IA data that indicated IA at the DHB is not significantly impacted by SV via VI. February 2021 data results provide additional confirmation that TCE SV does not appear to be impacting IA, and that SV concentrations tend to be much lower during the colder winter months than during the summer months.

The objective of the August 2021 data was to provide VOC sampling results for exceedances of the SV SL, as well as any detections of VOCs in IA. Although PCE exceedances in IA were detected in August 2021, SV PCE concentrations were low; therefore, PCE IA exceedances are more likely due to the introduction of a PCE-containing substance into the DHB, or due to changes in DHB operations, rather than VI of SV. In addition, although TCE exceedances were detected in SV, no IA exceedances were detected. These lines of evidence, including the August 2021 results, provide additional confirmation that SV does not appear to be impacting IA at the DHB.

SECTION 5
DATA SUMMARY AND RECOMMENDATIONS

The investigation objectives were to:

- collect indoor air (IA) samples for laboratory analysis using Summa® canisters
- evaluate the distribution of sub-slab vapors emanating either from impacted groundwater present beneath the building or from potential historical release from building structures via installation of additional Vapor Pin® vapor monitoring points, selected based on sampling results from February 2021.

5.1 INDOOR AIR SAMPLING

Indoor air was sampled in the breathing zone at four sampling locations throughout the Drop Hammer Building. These four samples (plus one duplicate) were sent to the laboratory for analysis of volatile organic compounds (VOCs). Thirteen volatile organic compounds were detected in at least one of five samples; all detected concentrations were below applicable indoor air criteria. except for tetrachloroethene (PCE) and 1,1,2-trichloroethane.

Trichloroethene was detected at low concentrations at three of the four sampling locations, including IA-190-DHB, IA-BATHROOM-DHB, and IA-BSTORE-DHB. The large overhead bay doors near columns A5/A6 were open during the entire eight-hour sampling period; as these doors tend to be open during warmer weather months.

Tetrachloroethene was detected above its industrial air screening level (180 µg/m^3) at all four locations at concentrations ranging from 1,100 micrograms per cubic meter (µg/m^3) to 6,400 µg/m^3, but had not been detected at concentrations above its screening level in all past events, so its presence may be the result of changed operational activities at the Drop Hammer Building or introduction of a product into the building with tetrachloroethene. It does not appear to be related to vapor intrusion, and historical sampling results appear to indicate that these tetrachloroethene exceedances in indoor air are an isolated event. In addition, the detected indoor air concentrations of tetrachloroethene are below Occupation Safety and Health Administration (OSHA) time-weighted average permissible exposure limits (PELs). This conclusion (that indoor air concentrations of tetrachloroethene are not due to vapor intrusion) is supported by the lack of evidence of any significant vapor intrusion from trichloroethene, which is present at much higher concentrations in sub-slab vapor than tetrachloroethene, but would migrate into the building from sub-slab vapor along the same pathways.

1,1,2-Trichloroethane exceeded its industrial air screening level (0.88 $\mu g/m^3$) at IA-190, with a concentration of 1.3 $\mu g/m^3$. However, the duplicate analysis of this sample location produced a nondetectable result for 1,1,2-trichloroethane.

August 2021 indoor air sampling results were similar to those observed in Rounds 1, 2, and 3 (May 2020, August 2020, and February 2021, respectively), in that all volatiles were detected at concentrations below their applicable indoor air criteria, with the exception being the detected concentrations of tetrachloroethene which are not likely related to vapor intrusion. The indoor air criteria are industrial United States Environmental Protection Agency regional screening levels corresponding to a target cancer risk of 1×10^{-5} or a hazard quotient of 1.0. The Maryland Department of the Environment criteria are equivalent to the defined regional screening levels.

5.2 SOIL VAPOR SAMPLING

Four vapor monitoring points were sampled for volatile organic compounds (including one duplicate) and sent to the laboratory. Twenty-two volatile organic compounds were detected; trichloroethene exceeded its soil vapor screening level (293 $\mu g/m^3$) at all four locations. Three sampling locations are on the northern end of the building and one location is in the basement. However, note that although tetrachloroethene exceedances were detected in indoor air, no sub-slab vapor concentrations of tetrachloroethene exceeded the screening level. Tetrachloroethene exceedances in indoor air in August 2021 are, therefore, more likely due to an interior source rather than vapor intrusion.

Sub-slab vapor screening values were derived in accordance with the methods discussed in USEPA's *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* (USEPA, 2015), and were calculated by dividing Maryland

Department of the Environment indoor air screening levels by a conservative (protective) attenuation factor (AF) of 0.03.

August 2021 sampling results were generally similar to May 2020, August 2020, and February 2021 sampling results, where trichloroethene exceedances of soil vapor criterion (293 $\mu g/m^3$) were observed in the northern portion of the building, as well as the basement, with the highest detection at location VMP-195. Sub-slab vapor concentrations of trichloroethene in Round 4 ranged from 380 $\mu g/m^3$ to 52,000 $\mu g/m^3$. The maximum concentration of trichloroethene in August 2021 was 52,000 $\mu g/m^3$, as compared to 30,000 $\mu g/m^3$ in February 2021, 62,000 $\mu g/m^3$ in May 2020, and 98,000 $\mu g/m^3$ in August 2020. The concentrations of trichloroethene have also decreased substantially at multiple monitoring points, as compared to those detected during the previous three sampling rounds. The trichloroethene concentration at VMP-189 has decreased from 62,000 $\mu g/m^3$ (May 2020) to 37,000 $\mu g/m^3$ (August 2020), 22,000 $\mu g/m^3$ (February 2021), and to 14,000 $\mu g/m^3$ in August 2021. Similarly, trichloroethene at VMP-200 in August 2020 (installed in August 2020) was 50,000 $\mu g/m^3$, decreasing to 22,000 $\mu g/m^3$ in February 2021, and decreasing again in August 2021 (380 $\mu g/m^3$).

5.3 RECOMMENDATIONS

As stated in *Addendum No. 2: Block I Drop Hammer Building Assessment Work Plan* (Tetra Tech, 2020e), the scope of the August 2021 (Round 4) investigation was dependent upon the results of the February 2021 (Round 3) investigation. In accordance with Addendum No. 2, only those indoor air sampling locations where trichloroethene was detected in February 2021 (i.e., IA-190-DHB, IA-BATHROOM-DHB, and IA-B2-DHB on the main floor, and IA-BSTORE-DHB in the basement), and only those soil vapor sampling locations where trichloroethene was detected at concentrations exceeding the soil vapor screening level (293 $\mu g/m^3$) in February 2021 (VMP-189, VMP-195, and VMP-197 on the main floor, and VMP-200 in the basement) were sampled in August 2021.

Based upon the results of the May 2020, August 2020, and February 2021 investigations, no additional vapor monitoring points were proposed for installation during the August 2021 investigation. This investigation determined the current distribution of vapor monitoring points is sufficient to define the extent of the sub-slab vapors beneath the Drop Hammer Building. Based on the results of the sub-slab vapor samples, and using a similar proactive approach to the mitigation proposed for constructing and expanding the sub-slab depressurization systems (SSDSs) in Building A and Building C, the recommendation to install and operate a sub-slab depressurization system in the Drop Hammer Building was recommended, and installation per the Maryland Department of the Environment (MDE)-approved 100% design (Tetra Tech, 2021c) has been completed.

Addendum No. 3: Block I Drop Hammer Building Assessment Work Plan will address sampling activities to be conducted in both February and August 2022 and 2023 (Tetra Tech, 2021d). It is proposed that eleven vapor monitoring points VMPs and nine indoor air locations will be sampled during each semi-annual monitoring event (plus duplicates) which will be conducted concurrently with the indoor air/soil vapor monitoring conducted semiannually (in the Building A basement) and annually (respectively) in Buildings A and C.

5.4 DROP HAMMER BUILDING SSDS INSTALLATION

The sub-slab depressurization system in the Drop Hammer Building was designed to provide vapor extraction and associated depressurization of a target area encompassing the defined extent of sub-slab vapors with volatile organic compound (specifically trichloroethene) concentrations above indoor air and soil vapor screening levels on the first floor and basement levels. Based on performance of the Building A and Building C systems, the expected radius of influence of approximately 30 feet for each extraction point, pulling an average of 25 standard cubic feet per minute of vapor from below the slab. Therefore, the Drop Hammer Building sub-slab depressurization system has two extraction points in the basement and five extraction points on the first floor to cover the target area. The system installation is currently completed (November 2021). Refer to the *100% Design Sub-Slab Depressurization Systems-Drop Hammer Building, Building A, Building C* (Tetra Tech 2021c) for indoor air and soil vapor sampling requirements related to the sub-slab depressurization system.

Initial volatile organic compound mass removal rates are expected to be less than 1 pound per day at startup. Removal rates are expected to decrease to less than 0.1 pounds per day after the first month of operation. These estimated removal rates are based on soil-vapor concentrations in existing vapor monitoring points, and concentration decline rates observed during initial operation of the Building A and Building C systems in 2008.

The system design was developed to install and connect the extraction points to a blower/fan to discharge vapor above the Drop Hammer Building roof line. During the initial month of operation, volatile organic compounds in vapor will be adsorbed using granular activated carbon. Vapor samples were collected during this time to confirm the expected low rate of volatile organic compounds extracted to allow direct discharge after the initial month. A construction completion report will be submitted under separate cover.

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FIGURES

TABLES

APPENDICES

Appendix A—Indoor Air Sampling Log Sheets

Appendix B—Soil Vapor Sampling Log Sheets

Appendix C—Daily Activity Reports

Appendix D—Validated and Full Data Reports and Chain(s) of Custody

APPENDIX A—INDOOR AIR SAMPLING LOG SHEETS

APPENDIX B—SOIL VAPOR SAMPLING LOG SHEETS

APPENDIX C—DAILY ACTIVITY REPORTS

APPENDIX D—VALIDATED AND FULL DATA REPORTS AND CHAIN(S) OF CUSTODY