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Subject: **Independent Review of Remedial Action Summary Reports**
Lockheed Martin Tallevast Site (Former American Beryllium Company Site)
1600 Tallevast Road
Tallevast, Manatee County, Florida
E Sciences Project Number 1-1440-004

Dear Mrs. Ward and Mrs. Washington:

E Sciences, Incorporated (E Sciences) is pleased to submit this letter outlining the findings and resulting opinions from our review of Remedial Action Summary Reports and related regulatory correspondence for the Lockheed Martin Tallevast (former American Beryllium Company) site ("the Site"). These services were provided in accordance with our Proposal Number 1-1440-P04 dated July 21, 2020.

INTRODUCTION

E Sciences' understanding of the project is based on litigation support that we previously provided as part of an administrative challenge on the site assessment report [and therefore remedial action plan (RAP) and Addenda that were prepared regarding the contamination caused by the former operation of the American Beryllium Company facility at the property located at 1600 Tallevast Road. Since that time, the RAP and supporting RAP Addenda (RAPA) were approved by Florida Department of Environmental Protection (FDEP) and Lockheed Martin has proceeded with remediation implementation. We were requested to provide support to FOCUS to compile information and opinions about the ongoing remediation progress and reporting.

SCOPE OF REVIEW

E Sciences reviewed Site-related regulatory documents related to the remediation progress and regulatory communications that we downloaded from the FDEP online document management system, OCULUS. Specifically, we reviewed the plume and capture zone configurations and system modifications for each year of remedial progress, minutes from remedial action status update meetings, FDEP's letters issued in response to the Remedial Action Summary Reports (RASRs) and Lockheed Martin's responses to those letters. Select additional regulatory documents were reviewed as needed to further our understanding of the information contained in the RASRs.

OVERVIEW

Lockheed Martin Corporation began construction of the groundwater remediation system in March 2011. The groundwater treatment system includes 77 vertical extraction wells, four extraction trenches, five injection wells, and three infiltration galleries connected using more than three miles of conveyance piping to a central 14,200-square foot treatment process area. The system startup and testing activities began in February of 2013 and full-time operation of the system was initiated on November 18, 2013. The first RASR document submitted to FDEP was dated October 28, 2014. That report provided a summary of system operation and maintenance for the groundwater treatment system, persulfate pilot study monitoring, groundwater water level monitoring, effectiveness monitoring, private well monitoring, and wetlands monitoring performed during the period from November 18, 2013 to August 31, 2014. Annual reports dated October 27, 2015, October 28, 2016, October 26, 2017, October 29, 2018, October 29, 2019, and October 27, 2020, with similar content as the 2014 RASR, were subsequently submitted to FDEP. FDEP responded to each report documenting their review and outlined comments on the RASR, if any. If comments were issued, Lockheed Martin would prepare a response and FDEP would issue a letter accepting that response and requiring no additional information be submitted.

FINDINGS

In general, we found the presentation of information to demonstrate the progress of the remediation in the regulatory reports to be oversimplified and dismissive of important factors. We acknowledge that the remediation system itself is complex and the assessment data is vast, so a detailed review of the information is time consuming and challenging. While we did not review all of the information, it is our opinion that there are some relevant issues that should be highlighted with the prospect that the regulatory agency will review and use a more critical eye in the future. The deficiencies we identified are presented below and more information for each is provided in the later sections of this document.

- The original model used for the remediation design has been updated and was included in an appendix of the 2019 RASR. We understand that the updated model is intended to be more sophisticated and have incorporated more site-specific data collected during system operation and therefore more representative of actual conditions. The updated model predicts that an area of about 100 feet by 400 feet of the 1,4-dioxane plume in the northwest portion of the plume is not being recovered by the capture zone. The updated model predicts the 1,4-dioxane simulated contour extends nearly 1,000 feet southeast of the plume boundaries depicted in the RASR. Neither of these findings are reported in the RASR text. This is particularly important because it suggests that the 1,4-dioxane plume was not being contained and captured by the remediation system. It has been proven through actual test data that the plume is migrating to the southeast over time because the area was never properly assessed.
- The capture zones depicted in the RASR maps are drawn based upon "professional judgement" rather than the groundwater elevation data and potentiometric curves that are mapped. No acknowledgement or explanation of these discrepancies are included in the RASRs.
- The plume size has been increasing over time. Of particular concern is the contamination in the USAS which can result in an exposure pathway to residents. It was predicted in the 2009 RAPA to be 4.1 acres, but the actual size in 2018 was 13 acres.
- Private wells that were designated for monitoring as part of the RAP were found to be inoperable at the time Lockheed Martin attempted to collect samples. Lockheed Martin recommended that the private wells be removed from the monitoring program based upon a rationale that the monitoring in those areas could be replaced by monitoring wells in different depths and geologic zones. Therefore, removal of these private wells from monitoring is leaving these areas unassessed, under the guise that the data will be collected from other monitoring wells. Those private wells are no longer being monitored.
- Lockheed Martin has determined that geochemical conditions are limiting the extent of reductive dichlorination occurring. Based on this information, the remediation system should be adjusted to compensate for the actual subsurface conditions to augment the system performance and reduce remediation time to achieve cleanup goals predicted in the RAP.
- Lockheed Martin continues to recommend removal of monitoring wells from the monitoring program. Some of these monitoring wells have had 1,4-dioxane detections and should continue to be watched. Monitoring data of other wells has revealed an increase in 1,4-dioxane over time and potential contaminant increases may go undetected if sampling is discontinued in some of these monitoring wells.

Groundwater Model Update

The plume expansion over time provides evidence that the capture zone has not been sufficient to contain and recover the groundwater contamination. The capture zones presented in the 2009 RAP Addendum (RAPA) were based upon a computer model that showed the capture zones to be larger than the estimated plumes, thus providing FDEP with assurances that the extent of the groundwater contamination would be recovered by the proposed extraction system. This model was constructed using MODFLOW-2000 with five separate geologic strata: Upper Surficial Aquifer System (USAS), Lower Shallow Aquifer System (LSAS), upper Arcadia Formation (AF) Gravels, Salt and Pepper (S&P) Sands, and Lower AF Sands. These units were represented using one to three model layers each, for a total of eight of the 14 layers.

- The USAS was divided into two layers, an upper permeable layer, and a lower, less-permeable layer, representing the bottom five feet of the unit.
- The LSAS was divided into three layers due to varying hydraulic conductivities and vertical head differentials. Model layers 5 and 6 were initially assigned a lower hydraulic conductivity value than model layer 4.
- The upper AF Gravels, S&P Sands, and Lower AF Sands were represented by a single model layer.

No pumping sources other than those associated with the RAPA system were represented in the model.

TetraTech completed an updated model and it was included as Appendix J of the 2019 RASR. The objective of the updated model (referred to as a five-year report) was to summarize the current status of the model, describe the evolution of the model between 2009 and 2019, and present material to support the viability of the model as a system operation and management tool. The following changes were made in the updated groundwater flow model:

- This model incorporated influence of infiltration galleries and private wells on groundwater.
- Heterogeneous distribution of hydraulic conductivity was developed in model layers representing the USAS, upper LSAS, lower LSAS, and AF Gravels.
- The S&P Sands layer was divided into two layers, resulting in a new 15-layer model.
- Several wells that were previously represented in the lower LSAS were modified to be simulated as being in the upper LSAS.

The solute transport model was used to simulate trichloroethene (TCE) and 1,4-dioxane for the period of August 2014 through August 2018. Simulated water levels were evaluated with respect to predicted capture zones and the estimated distribution of TCE and 1,4-dioxane in excess of their

respective groundwater cleanup target levels (GCTLs) in each layer. The 1,4 dioxane compound was simulated because it had been detected over the widest area, was detected at relatively high concentrations in the USAS, LSAS, and AF Gravels and has a very low degradation rate. TCE was simulated because it had been detected over the second-widest area, and at relatively high concentrations in the USAS, LSAS, AF Gravels, and S&P Sands. Of additional importance is that TCE may have significant sorbed-phase mass that could desorb during remediation, limiting the rate of remediation. The updated model report states that "*All the simulated capture zones encompass the estimated August 2018 distribution of GCTLs in their respective units, except for a very small part of the 1,4-dioxane in the USAS in the northwest part of the Site*."

The 2019 RASR references the updated model in the "Five Year Modeling Update" section of the report. This section does not provide any narrative about the results of the updated model or contents of the updated model report. However, the Summary and Recommendations section of the RASR states the following: "*The groundwater model has been updated and recalibrated on approximately a biannual basis, resulting in a 6-year flow model simulation of the period of October 2012 to August 2018. Statistical analysis of the simulation results indicates that the groundwater flow model is well calibrated. The model indicates that all zones with chemicals of concern concentrations in excess of their respective groundwater cleanup target level criteria will be captured through carefully planned and FDEP-approved adjustments to the Groundwater Recovery and Treatment System, as needed, as summarized below…*" The only adjustment outlined later in the report was to install a larger pump in EW-2104 and shutdown of eight extraction wells. The adjustments to the groundwater recovery and treatment system were reportedly implemented after the August 2018 model simulations had occurred. Therefore, we conclude that the "FDEP-approved adjustments" had not yet been incorporated into the model. This statement in the RASR is misleading by the implication that the model has incorporated proposed system improvements.

The updated model report states that all the simulated capture zones in the updated model report encompass the estimated August 2018 distribution of GCTLs in their respective units, except for a very small part of the 1,4-dioxane in the USAS in the northwest part of the Site. Also, the updated model depicts the 1,4-dioxane simulated contour to extend nearly 1,000 feet southeast of the observed 1,4-dioxane plume (TetraTech Figure 3-6B). Neither of these points were discussed in the 2019 RASR narrative.

It does not appear that the groundwater model is being used to determine the capture zones. The USAS capture zone that has been depicted in the RASRs over the years has not deviated much from that presented in the 2009 RAPA regardless of the groundwater simulations in the updated model or the potentiometric curves depicted in the figures. Based on the RASRs, the capture zones are not drawn based upon these factors but rather, they are "estimated using professional judgement." This and similar phrasing are used frequently throughout the reporting. The simulated water level in the USAS from August 2018 (Figure 2-11A) shows that the groundwater elevations decrease

from elevation 22 west of MW-114 to elevation 19 just southeast of PZ-USAS-19. These simulated water levels indicate that the groundwater recovery system is not influencing the groundwater contaminant plume in the southeast direction where plume migration beyond the predicted capture zone shown on Figure 2-13A has been both predicted by the model and observed. It is further important to note that the potentiometric curves on this figure do not support or match the "predicted capture zone" lines that have arbitrarily been imposed on this figure. In the 2009 RAPA the predicted capture zone, including a 100-foot buffer generally corresponded to a drawdown of one or more feet. In the case of the model, the capture zone encompasses areas that are depicted to have groundwater mounding based on groundwater elevation data. Mounding in the USAS within away from infiltration galleries should not be observed within the capture zone during groundwater remediation.

The large and dynamic shift of the plume size can be attributed to the underassessed 1,4-Dioxane plume, and therefore insufficient control of its leading edge. Lockheed Martin indicates that the increase in area of contaminant concentrations is primarily due to the detection of 1,4-Dioxane above the GCTL in samples collected from PZ-USAS-19. It is important to note that this piezometer was sampled for the first time on April 8, 2019. It was acknowledged in the 2019 RASR that this contaminated area is outside of the capture zone. We further note that there is no vertical delineation in this leading edge of the plume so the 1,4-dioxane plumes in the LSAS and AF Gravels may be grossly underestimated.

The updated model report indicates that the initial distribution of TCE and 1,4 dioxane used as initial conditions for simulating long-term cleanup was developed using data collected in the spring of 2009. The spatial extent of TCE and 1,4-dioxane in the USAS, LSAS, AF Gravels, and S&P Sands in 2018, after 5 years of RAP pumping, was compared to that predicted in 2009. The extent is somewhat greater in the USAS (TCE and 1,4-dioxane) and in the AF Gravels (1,4 dioxane) than that predicted in 2009. The extent of TCE in the AF Gravels and TCE and 1,4 dioxane in the LSAS and S&P Sands is reportedly similar to that predicted.

Plume Size Prediction vs. Actual

During our previous review of the approved RAP Addendum dated July 14, 2009 (the RAPA) and earlier site assessment documents, it was our opinion that the extent of the contamination plume had not been adequately delineated to determine the required capture zones that would be sufficient to recover, treat and contain the vertical and horizontal extent of the groundwater contamination plume. The RAPA included 3-Year Simulation Results for the various contaminants of concern (COC) in different geologic strata to predict the plume configuration at the time of system implementation. This simulation data was used to determine the capture zones for five separate geologic strata. By the time the system was installed, the plume configuration predictions had

already proven to be inaccurate. This called into question the validity of either the model or the assessment data, or both at that time.

Lockheed Martin provided the following table that supplements the information provided in the February 12, 2020 response to FDEP's 2019 RASR comment review letter. The following table provides the July 2009 groundwater model predictions and actual plume sizes after five years of RAPA pumping in 2018:

Unit	**TCE Plume Area (acres)**	
	2009 RAPA Prediction	**2018 Actual**
USAS	4.1	13
LSAS	19	31
AFG	7.7	8.7
S&P Sands	1.4	0.8
Unit	**1,4 Dioxane Plume Area (acres)**	
	2009 RAPA Prediction	**2018 Actual**
USAS	10	38
LSAS	86	72
AFG	33	58
S&P Sands	4.8	2.3

This table demonstrates the inadequacy of the RAPA to predict the changes in the plume configuration and the efficacy of the remediation system to contain and recovery the groundwater plume.

Private Wells

In the 2014 RASR, Lockheed Martin reported that a total of eight private wells were scheduled to be sampled, but due to mechanical and electrical complications associated with two private wells, only six private wells were sampled. When FDEP's report review letter requested additional information regarding these wells, Lockheed Martin replied that it does not plan to repair or sample those two private wells located at 8005 15th St E. and 1201 Tallevast Road. Lockheed Martin cited that their rationale was that there were other monitoring wells that provide sufficient plume delineation in those two areas and that those two wells exhibited COC concentrations below GCTLs since at least 2009. Lockheed Martin proposed removing these two private wells from the groundwater sampling program. FDEP concurred. We believe that the following statements should be taken into consideration in determining the importance of sampling those two private wells as was previously committed.

- Lockheed Martin states that monitoring well MW-124 is located between the 8005 15th St East well and the AF Gravels contaminant plume. We note that the 8005 15th Street East well is Floridan well and MW-124 is an AF Gravels well.
- Lockheed Martin states that monitoring wells MW-129 and MW-153 are both located between the 1201 Tallevast Road private well and the AF Gravels contaminant plume. We note that 1201 Tallevast Road had a small detection of perchloroethylene (PCE) in 2011 and it was only sampled one more time in 2012. PCE was not detected at that time. We also note that MW-153 was not sampled after 2014. Tables indicate that MW-153 is screened from 97 to 107 feet and MW-129 is screened from 103 to 113 feet. 1201 Tallevast Road well is noted to be an AF Gravel well.

Populated Residential Area Abutting Contamination Source Property

An area of particular concern is the residential neighborhood located immediately south and east of the former ABC facility. This neighborhood is about 12 acres in size, abuts the source property and is the apparent downgradient direction of the shallow plume movement. There is a potential for exposure through vapor encroachment because the USAS has remained largely unassessed in this area of high concentration of residents.

During site assessment activities only one monitoring well (MW-25) was installed to assess the USAS on the residential properties (except for a site boundary well location) and it is located nearly 550 feet from the source property. Data tables indicate that the top of the USAS ranges from about five to ten feet below ground surface (bgs) in MW-25. The top of the well screen is set at 36.4 feet bgs, approximately 25 to 30 feet below the top of the water table. The upper strata of the USAS which would result in vapor encroachment is not being properly assessed. This well is sampled annually.

In lieu of an assessment in the USAS in this neighborhood, an extraction well (EW-2035) was placed between MW-25 and the source property. The top of this extraction well screen is about 24 feet bgs and it is sampled twice per year. This dynamic sample is collected from a sampling port. Therefore, there is only one location (MW-25) in the USAS that is being periodically evaluated for the presence of surficial contamination from a static condition that would represent the groundwater quality in the USAS.

We acknowledge that contaminant concentrations measured in samples collected from MW-25 and EW-2035 have decreased over time. However, the nature of the transport of the contaminants and their affinity for adherence to soils makes the unassessed areas still a concern for potential vapor migration. This largely unassessed residential area abutting the source property could have volatile contaminants that are going undetected and may be a source of contaminants in the airspace of these homes and impacting the AF Gravels geologic zone. Lockheed Martin conducted a vapor

intrusion evaluation to a evaluate if volatile organic compounds were present in the soil vapor beneath or near sampled residences at concentrations that could migrate into the indoor air of the Tallevast residences at levels that could present a risk to the health of the occupants. The study reported that nine of 54 sampling locations demonstrated indoor air exceeded regional screening levels (RSLs) for one or more contaminants of concern. RSLs are considered by the USEPA to be protective of human health over a lifetime. The indoor air sample results were reported to be higher than that of the corresponding soil vapor samples. However, soil vapor samples were not collected beneath the buildings, but in the yards, near the structures, and it is unknown whether the placement of the shallow soil gas sample points outside of the houses would be expected to produce a higher result than if they had been conducted within the footprint of the house. It was also noted that the indoor air exceedances of RSLs for COCs did not "match up" with the areas of documented groundwater contamination based upon review of plume maps. We note that the plume maps were based upon data collected at a different time than the soil gas survey and as previously discussed are based upon inadequate assessment of the USAS.

We are also concerned that the deeper zones are not properly assessed in this residential area as well. The PCE and TCE plumes in the LSAS encroach into portions of the neighborhood but there are no deeper monitoring wells to delineate those plumes vertically.

Geochemical Data

The October 28, 2016 RASR included a discussion and analysis of geochemical data collected to evaluate reductive dechlorination as a remediation mechanism for this Site. In this report, Lockheed Martin indicates that oxygen reduction potential and pH values suggest a highly reducing anaerobic environment. However, the results of the laboratory analyses indicate that total organic carbon levels are below levels observed at sites where reductive dechlorination processes have been successful in achieving complete dechlorination of chlorinated ethenes. Results of the microbial sampling performed do not indicate that populations of naturally occurring microorganisms (Dehalococcoides, etc.) typically responsible for biotic dechlorinating processes exist at the site in magnitudes associated with complete reductive dechlorination. The slight increase in average concentrations of daughter products was acknowledged and it was therefore inferred that although the geochemical conditions do not support it, biotic or abiotic processes appear to be occurring. However, because the geochemical conditions to do not support reductive dichlorination and Dehaloccoides populations are not thriving at the Site, reductive dichlorination will be limited and not a substantial contributing factor to remediation under the current conditions.

Proposed RAP Modifications

The 2019 RASR indicated that following discussions with the FDEP, several actions were taken to evaluate and extend the USAS capture zone in the southeast quadrant of the Site. Those actions reportedly began in June 2019 and included the following:

- installation of nine transducers in USAS piezometers and monitoring wells located in the southeast quadrant of the Site to evaluate the capture zone;
- increase in extraction flow rate in extraction well EW-2103;
- temporary discontinuation of discharge to gallery RC-7002; and
- an engineering evaluation for upsizing the extraction well pump in EW-2104 to maximize the groundwater extraction from this well. Lockheed Martin proposed increasing the pumping to approximately 59,000 gallons of groundwater per day with an expected flow rate of 75 gallons per minute.

FDEP accepted the 2019 recommended changes. The 2020 RASR recommended the following additional system changes:

- Increase the size of the vault piping and flow meters in extraction wells EW-2103 and EW-2104 from one to two inches in diameter to allow increased pumping flow in an effort to expand the capture area further in the southeast quadrant of the USAS.
- Discontinue operation of extraction wells EW-2013, EW-2021, EW-2034, EW-2101, and EW-2102 as COC concentrations are below GCTLs in those locations and begin extraction well post-active remediation monitoring. Following shutdown of the extraction wells, they will be inactive, but operated as needed to maintain their functionality and for groundwater sample collection purposes.
- Collect groundwater samples on a quarterly basis (beginning in November 2020) from the shut-down extraction wells and their associated monitoring wells for a minimum of one year. Results are to be reported in the 2021 RASR or under separate cover.

Lockheed Martin also recommended removal of the monitoring wells exhibiting COC concentrations below groundwater cleanup target levels for at least two consecutive sampling events from the sampling program. We agree that samples collected from these monitoring wells do reflect two consecutive sampling events without GCTL exceedances but note that several of them have had 1,4-dioxane detections over the years. One example is monitoring well MW-16D which has exhibited low concentrations of 1,4-dioxane in the seven of the eight previous sampling events. These concentrations ranged from 1.0 to 2.0 micrograms per liter, just below the GCTL of 3.2 micrograms per liter. This USAS monitoring well is located between two plumes and having a “non-detect” in this location has resulted in disconnection of these two plume areas.

FDEP issued an internal memorandum dated November 23, 2020 outlining that they agreed with the recommendations but issued the following comments:

- The lateral and down gradient extent of 1,4-dioxane in the USAS has not been adequately delineated. Additional monitoring wells should be installed as follows to better define and monitor the extent of 1,4-dioxane:
    - East and west of MW-114.
    - East, west, and Southeast of PA-USAS-19.
    - Following the installation of the additional monitoring wells, PZ-USAS-15, PZ-USAS-16, PZ-USAS-17, PZ-USAS-18, PZ-USAS-20, and the new wells should be sampled and the samples analyzed for 1,4-dioxane.
- There are several hot spots that the treatment system does not appear to be affecting and where contaminant concentrations remain quite a bit above the cleanup goals. FDEP advised that they should explore treatment methods other than pumping to enhance the cleanup progress in those areas. FDEP stated that they may want to set up a meeting to discuss this with AECOM.

OPINIONS

In summary, it is our opinion that the impact of the largely unassessed areas and overestimated capture zones, as indicated in our administrative challenge to the RAPA have been confirmed. We are very concerned that the reported data demonstrates that the remediation system has been inadequate to contain and control the contamination plumes. We are pleased that FDEP is requiring additional assessment and wishes to review additional remediation strategies for "hot spots". However, it is our opinion that the following additional items should also be addressed:

- The estimated plume configuration outlined in the 2018 groundwater model should be reviewed and updated with the additional groundwater monitoring data. We believe that FDEP should engage a modeling expert to review the model inputs and outputs.
- Vertical delineation of the contaminant plumes should also be required. This can be done using MIP or direct push as a screening tool, followed by installation of permanent monitoring wells.
- Groundwater assessment of the USAS and LSAS within the residential area abutting the ABC facility to the south and east would be prudent to protect the health and safety of the immediately affected community. Based upon those results, a properly conducted vapor intrusion study to include testing to determine if a vapor encroachment condition exists within the residents' homes should be conducted. This may also result in a need for additional vertical delineation.
- Augmentation of geochemical conditions should be considered to improve remedial efforts and reductive chlorination to reduce overall time to achieve cleanup goals.

- A review of the private well location and data should be conducted to ascertain if impacts to private citizen wells are going undetected.
- Monitoring wells with historic detections of 1,4-dioxane that are being removed from regular monitoring should be placed on a less frequent monitoring schedule, rather than being completely removed from the sampling program.
- FDEP should engage a third-party expert to review the "capture zone" shapes that have been incorporated into maps since the 2009 RAPA that are not consistent with the groundwater elevation contours or the groundwater models.

We appreciate the opportunity to offer our professional services to you. If you have any questions concerning our evaluation, please contact us at 954-484-8500.

Sincerely,
E SCIENCES, INCORPORATED

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