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November 6, 2018

**VIA PRIVATE CARRIER**

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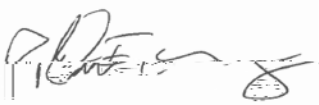
Subject: Transmittal of the Cow Pen Creek and Dark Head Cove SAV Restoration and Monitoring Report  
Lockheed Martin Corporation; Middle River Complex  
2323 Eastern Boulevard, Middle River, Baltimore County, Maryland

Dear Mr. Rushlow:

For your review please find enclosed two hard copies with a CD of the above-referenced document. This report describes the methods used to source native submerged-aquatic vegetation seed, and dispersal of that seed, and includes the results from the initial site monitoring (via diver survey), per the methods outlined in *Cow Pen Creek and Dark Head Cove SAV Restoration and Monitoring Work Plan*. This report also provides an early assessment of restoration success and, as part of an adaptive management strategy, recommendations for future

COW PEN CREEK AND DARK HEAD COVE  
SAV RESTORATION AND MONITORING REPORT  
LOCKHEED MARTIN MIDDLE RIVER COMPLEX  
2323 EASTERN BOULEVARD  
MIDDLE RIVER, MARYLAND

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## TABLE OF CONTENTS

Section	Page
Table of Contents .....	i
List of FIGURES.....	ii
List of TABLES .....	ii
Acronyms and Abbreviations.....	iii
Section 1 Introduction .....	1-1
1.1 Background.....	1-1
1.2 Objectives .....	1-3
Section 2 SAV Restoration Activities.....	2-1
2.1 Seed Collection .....	2-1
2.2 Seed Storage and Germination Testing.....	2-2
2.3 Seed Dispersal.....	2-3
Section 3 Monitoring.....	3-1
Section 4 Conclusions and Recommendations .....	4-1
Section 5 References .....	5-1

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## TABLE OF CONTENTS (CONTINUED)

### LIST OF FIGURES

- Figure 1 Middle River Complex location, bordered by Cow Pen Creek to the west and Dark Head Cove to the south
- Figure 2 SAV density in Dark Head Cove and Middle River (2015 survey)
- Figure 3 Map of collection locations (red stars) overlaid the VIMS 2016 survey map
- Figure 4 Vallisneria seed pods at different stages of development; full developed pod is on far right
- Figure 5 Collecting seed pods in Middle River
- Figure 6 Sieving seeds from remaining detritus
- Figure 7 Seed stored in one-liter containers
- Figure 8 Constructing Exclosure in Cow Pen Creek
- Figure 9 Location of Exclosures in Middle River Complex area
- Figure 10 Seed dispersal within Exclosure in Dark Head Cove
- Figure 11 Seeds, held in water, prior to dispersal
- Figure 12 Location of seed distribution in April 2018
- Figure 13 Location of monitoring transects within Cow Pen Creek and Dark Head Cove

### LIST OF TABLES

- Table 1 Species composition from 2015 survey of Dark Head Cove and Cow Pen Creek
- Table 2 Plant counts in Dark Head Cove and Cow Pen Creek during the August 2018 survey



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# SECTION 1 INTRODUCTION

This report describes the methods used to source native submerged-aquatic vegetation seed, and dispersal of that seed, and includes the results from the initial site monitoring (via diver survey), per the methods outlined in Cow Pen Creek and Dark Head Cove SAV Restoration and Monitoring Work Plan (Tetra Tech, 2017). This report also provides an early assessment of restoration success and, as part of an adaptive management strategy, recommendations for future efforts.

## 1.1 BACKGROUND

The Lockheed Martin Middle River Complex, which is part of the Chesapeake Industrial Park, is located at 2323 Eastern Boulevard in Middle River, Maryland, approximately 11.5 miles northeast of downtown Baltimore. The complex consists of approximately 161 acres and twelve main buildings. The property also includes an active industrial area and yard, perimeter parking lots, an

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of the Middle River and Chesapeake Bay (Bergstrom et al. 2006). Submerged aquatic vegetation is considered a sensitive aquatic habitat in Maryland and is protected as a habitat area of particular concern by the National Marine Fisheries Service under the Magnuson-Stevens Act, legislation that regulates impacts to essential fish habitat. To mitigate impacts to submerged aquatic vegetation, and in accordance with Maryland Department of the Environment Tidal Wetlands License No. 15-1119 and United States Army Corps of Engineers Authorization No. 2016-61958-M02, the 6.5-acre impact area was to be re-seeded with native submerged aquatic vegetation and monitored for a period of five years. In response to the temporary loss of these ecosystem services, and in compliance with the United States Army Corps of Engineers (USACE) permit and Maryland Department of the Environment (MDE) Tidal Wetlands License, Lockheed Martin implemented a large-scale submerged aquatic vegetation restoration project in 2017-2018.

Baseline Survey (2015)—Tetra Tech conducted a survey of submerged aquatic vegetation coverage and species composition in Dark Head Cove and Cow Pen Creek in July 2015 to document existing conditions. The baseline survey documented seven species in the project area (Table 1), dominated by coontail (*Ceratophyllum demersum*) and Eurasian milfoil (*Myriophyllum spicatum*). Milfoil is a non-native species, so it would be inappropriate to restore the population of this species. Coontail, a native species, is difficult to work with for restoration because its reproductive nut is difficult to harvest. Furthermore, coontail is a rootless plant that would likely recolonize impacted areas from floating plants elsewhere in Middle River. Wild celery is an excellent plant for waterfowl and provides habitat for a variety of finfish and other aquatic organisms. Additionally, wild celery produces a readily harvestable seed pod that can be collected in large numbers for use in restoration (Moore and Jarvis, 2007). Therefore, the baseline survey recommended reintroducing wild celery via seed dispersal into suitable areas within Dark Head Cove and Cow Pen Creek; methods for seed dispersal were outlined in the work plan (Tetra Tech, 2017). Note that the 2015 baseline survey revealed that submerged aquatic vegetation had not

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## 1.2 OBJECTIVES

The specific objectives for the submerged aquatic vegetation restoration and monitoring effort include:

- x locating and collecting enough native wild celery seed from local (within 30 miles) populations, to provide a minimum 100,000 viable seeds per acre
- x providing viable seed that demonstrates at least 80% germination during testing
- x dispersing seeds over the impact area, so that they are distributed at a minimum of 100,000 seeds per acre
- x installing and successfully maintaining grazing exclosures
- x achieving a 10–15% rake cover (density) in Cow Pen Creek and a 5–10% rake cover (density) in Dark Head Cove (not completed during this initial monitoring event) by 2022
- x implementing a robust post-seeding monitoring program using divers (in 2018 and 2019) and boat-accessible rake surveys (in 2020-2022) (Tetra Tech, 2017)



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## SECTION 2 SAV RESTORATION ACTIVITIES

The preferred sources of *Sagittaria arifolia* (wild celery) seed were local populations genotypically adapted to the local environment and therefore had the highest likelihood for successful restoration (Moore and Jarvis, 2007). The Middle River and surrounding tributaries support several beds of freshwater and oligohaline submerged aquatic vegetation (SAV) species, some of which are mixed species while others are mono-specific stands. Since SAV beds are dynamic and vary in size and distribution, mapping data from the previous three years (2014-2016) was used to locate persistent beds from which seeds could be collected. The Virginia Institute of Marine Science (VIMS) conducts annual aerial surveys of the entire Chesapeake Bay region, including tidal tributaries and coastal bays; this survey maps the density, extent, and composition of SAV beds in these areas. Survey results are digitized and available online for public use. These maps were used to determine the likely locations of beds (in 2017) that were monitored for seed development (Figure 3).

Wild celery typically enters the sexual reproductive phase (flower and seed production) in the middle of summer (McFarland, 2006), with female flowers reaching the water's surface, or just below, where they can be observed from a boat or via wading. The female flower is fertilized by pollen from male flowers, and seed maturation begins. The stalk of the flower will begin to coil after fertilization, drawing the seedpod downward where it will continue to develop under a





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## SECTION 3 MONITORING

The first monitoring event was conducted on August 8, 2018, by Tetra Tech scientific divers, using SCUBA gear to inspect 13 transects and count plants within 0.25 square meter quadrats along each transect (Figure 13). Water clarity in both Cow Pen Creek and Dark Head Cove was significantly reduced, likely due to rainfall before the dive. Visibility was below 50 centimeters (cm), and approaching 10 cm. Poor water clarity necessitated using touch to locate seedlings within the quadrats.

Eight transects were established in Dark Head Cove, extending up to five meters out from the bank. Three measurements were made on each transect: one at two meters from the bank, one at three meters from the bank, and the last approximately five meters from the bank. The depth or



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## SECTION 4 CONCLUSIONS AND RECOMMENDATIONS

No objectives for plant density were established for the first diver-based survey completed after the sediment remediation project. However, the survey does provide data relevant to number of seedlings established after the dredging operations. At this point, it seems that submerged aquatic vegetation (SAV) is becoming established in Cow Pen Creek from a combination of seeding and



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# FIGURES



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Figure 1 Middle River Complex location, bordered by Cow Pen Creek to the west and Dark Head Cove to the south

Figure 2 SAV density in Dark Head Cove and Middle River (2015 survey)

Figure 3 Map of collection locations (red stars) overlaid the VIMS 2016 survey map

Figure 4 Vallisneria seed pods at different stages of development; full developed pod is on far right

Figure 5 Collecting seed pods in Middle River

Figure 6 Sieving seeds from remaining detritus

Figure 7 Seed stored in one-liter containers

Figure 8 Constructing Exclosure in Cow Pen Creek

Figure 9 Location of Exclosures in Middle River Complex area

Figure 10 Seed dispersal within Exclosure in Dark Head Cove

Figure 11 Seeds, held in water, prior to dispersal

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Figure 1 Middle River Complex location, bordered by Cow Pen Creek to the west and Dark Head Cove to the south

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Figure 2 SAV density in Dark Head Cove and Cow Pen Creek (2015 survey)  
Note sparse to non-existent beds off bulkhead where water depths will not support growth

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Figure 3 Map of collection locations (red stars) overlaid the VIMS 2016 survey map

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Figure 4 Vallisneria seed pods at different stages of development; full developed pod is on far right

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Figure 5 Collecting seed pods in Middle River

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Figure 6 Sieving seeds from remaining detritus

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Figure 7 Seed stored in one-liter containers



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Figure 8 Constructing Exclosure in Cow Pen Creek

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Figure 9 Location of Enclosures in Middle River Complex area



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Figure 11 Seeds, held in water, prior to dispersal

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7HMD7HFK" / RFNKHHG0 DUMQ0 LGGØI5 LYHU&RP SØI "   
 Cow Pen Creek andwCrena0(H4(re).6(k)-.6(n)1-24 54C)5.4(re)1.0(w)-v6(n)1e79.9(a)3S.0(9n)1AV24 T6 6(R4(re).6(k)-s6(k)-t)[(C)1.0(w)-ra5(e)3tCCwCnw

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Figure 13 Location of monitoring transects within Cow Pen Creek and Dark Head Cove

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# TABLES

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Table 1 Species composition from 2015 survey of Dark Head Cove and Cow Pen Creek

Table 2 Plant counts in Dark Head Cove and Cow Pen Creek during the August 2018 survey



Table 1

Species composition from 2015 survey of Dark Head Cove and Cow Pen Creek

SPECIES	% COMPOSITION
<i>Ceratophyllum demersum</i> (Coontail)	49%
<i>Myriophyllum spicatum</i> (Eurasian milfoil)	42%
<i>Vallisneria spiralis</i> (wild celery)	4%
<i>Stuckenia pectinata</i> (Sago pondweed)	2%
<i>Potamogeton crispus</i> (Curly pondweed)	2%
<i>Potamogeton perfoliatus</i> (Redhead grass)	0.5%
<i>Zannichellia palustris</i> (horned pondweed)	0.5%

