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October 31, 2019

VIA PRIVATE CARRIER

Brian Dietz
Interim Program Administrator
Land Restoration Program
Land and Materials Administration
Maryland Department of the Environment
1800 Washington Boulevard, Suite 625
Baltimore, Maryland 21230

Subject: Transmittal of the Cow Creek and Dark Head Cove 2019 SAV Monitoring Report
Lockheed Martin Corporation – Middle River Complex
2323 Eastern Boulevard, Middle River, Baltimore County, Maryland

Dear Mr. Dietz,

For your review please find enclosed two hard copies with a CD of the above-referenced document. This report addresses the 2019 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 assessment of restoration progress and, as part of an adaptive management strategy, recommendations for future efforts. If possible, we respectfully request to receive MDE's document review comments by December 16, 2019.

Please let me know if you have any questions. My office phone is (301) 548-2209.

Sincerely,

A handwritten signature in black ink, appearing to read "Tom D. Blackman", with a long horizontal flourish extending to the right.

Thomas D. Blackman
Project Lead, Environmental Remediation

cc: (via email without enclosure)
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**COW PEN CREEK AND DARK HEAD COVE 2019
SAV MONITORING REPORT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
2323 EASTERN BOULEVARD
MIDDLE RIVER, MARYLAND**

Prepared for:
Lockheed Martin Corporation

Prepared by:
Tetra Tech, Inc.

October 2019

Approved by:
Lockheed Martin, Inc.

Revision: 0



Michael Martin, P.G.
Regional Manager



Robert Murphy
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ACRONYMS AND ABBREVIATIONS

BRF	Biological Resources Facility
cm	centimeter(s)
DNR	Department of Natural Resources
Lockheed Martin	Lockheed Martin Corporation
m	meter(s)
m ²	square meter(s)
MDE	Maryland Department of the Environment
MRC	Middle River Complex
SAV	submerged aquatic vegetation
Tetra Tech	Tetra Tech, Inc.
USACE	United States Army Corps of Engineers
VIMS	Virginia Institute of Marine Science

SECTION 1 INTRODUCTION

This report describes 2019 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 assessment of restoration progress 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 athletic field, a concrete-covered vacant lot, a trailer and parts storage lot, and numerous grass-covered green spaces along the facility's perimeter. Locked chain-link fences surround all exterior lots and the main industrial area. The site is bounded by Eastern Boulevard (Route 150) to the north, Dark Head Cove to the south, Cow Pen Creek to the west, and Martin State Airport to the east (Figure 1).

Beginning in late 2014, Lockheed Martin initiated the removal of sediment in Dark Head Cove and Cow Pen Creek. These sediments were contaminated by historical operations in adjacent areas of the site. As part of this work, portions of Dark Head Cove and the lower reaches of Cow Pen Creek were dredged and restored by the placement of a six-inch-thick sand layer (residual management layer). During this sediment remedial action, approximately 6.5 acres of submerged aquatic vegetation (SAV) were damaged or removed. Submerged aquatic vegetation serves as critical habitat for a variety of aquatic organisms, including ecologically important fish and invertebrates (Smart et al., 1996). In addition, submerged aquatic vegetation serves as an excellent food source for several waterfowl species, particularly in the freshwater and oligohaline portions 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*). Eurasian milfoil is a non-native species, so it would be inappropriate to actively restore the population of this species, however, Eurasian milfoil is likely to re-establish in Dark Head Cove and Cow Pen Creek due to high densities in surrounding waterways. Coontail, a native species, is difficult to work with for restoration because its seed is difficult to harvest. Furthermore, coontail is a rootless plant that would likely recolonize impacted areas from floating plants originating from elsewhere in Middle River. Wild celery (*Vallisneria americana*) is an excellent plant for waterfowl and provides habitat for a variety of finfish and other aquatic organisms. Additionally, wild celery is a native plant that produces a readily harvestable seed pod that can be collected in large numbers for use in restoration (Moore and Jarvis, 2007). Therefore, the planting and monitoring plan 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). It should be noted that the 2015 baseline survey revealed that submerged aquatic vegetation had not established adjacent to the cove bulkhead (Figure 2) because surface water in that location exceeds suitable depths for SAV growth (> 2 m) in the Chesapeake Bay watershed (Batiuk, et al. 2000).

SAV Restoration Activities (2017–2018) – Starting in August 2017, several existing *V. americana* beds in Middle River and its tributaries were monitored to assess the maturation of the seedpods. Reproductive shoots showed evidence of maturity by mid-August, at which point teams conducted multiple days of hand-harvesting to collect seedpods. Seedpods were transferred to a cooler on the boat filled with river water where they were kept until the conclusion of each collection day. Seed pods were transported to Tetra Tech’s Biological Resources Facility (BRF) in Owings Mills, Maryland. The BRF is equipped with a walk-in refrigerator where the seedpods were stored at $\leq 4^{\circ}\text{C}$. Approximately 4,000,000 to 4,500,000 seeds were collected. Viability tests (using tetrazolium oxide, Moore and Jarvis, 2007) were conducted on subset of seeds and it was determined that only 10% of the seeds were viable, for a total yield of 400,000 to 450,000 viable seeds. Prior to seed dispersal, exclosures were erected to prevent herbivory on the young plants by turtles, waterfowl, or other organisms, thereby allowing the plants to mature and reproduce into a more sustainable bed.

In the spring 2018 all seeds were dispersed throughout Cow Pen Creek and along the shoreline of Dark Head Cove. Seeds were dispersed by hand from a boat as it motored within Cow Pen Creek and along the Lockheed Martin property side of Dark Head Cove. As noted above, approximately 400,000 to 450,000 viable seeds were spread over the area, including within the exclosures, with an estimated density of approximately 90,500 to 102,000 viable seeds per acre. In consultation with the Maryland Department of Natural Resources, Tetra Tech made an in-field decision to spread seed over a reduced area (4.42 acres instead of 6.5 acres) due to greater than anticipated depths in some regions of Dark Head Cove. Some dredged regions were deeper than three meters, thereby precluding adequate survival of any seed spread in this environment (Batiuk et al., 2000). Rather than distribute seed in these areas, seed dispersal was concentrated in areas that would sustain wild celery habitat.

2018 Monitoring – The first monitoring event was conducted in August 2018, by Tetra Tech scientific divers, using SCUBA gear to inspect 13 transects and count plants within 0.25 m² quadrats along each transect (Tetra Tech, 2018). Eight transects were established in Dark Head Cove, extending up to five meters out from the bank. The depth or type of substrate (i.e., gravel and cobble) was not conducive to submerged aquatic vegetation (SAV) growth at any of the

assessed quadrat locations. Depth ranged from two meters at the bulkhead on Dark Head Cove to approximately four meters at the five-meter survey point. Results indicate that SAV was not well established within the transects in Dark Head Cove.

Five transects were surveyed in Cow Pen Creek, extending from bank to bank, and consisting of 10 survey points across each transect equidistant apart, per the work plan. The shallower depths and substrate in Cow Pen Creek were much more conducive to SAV establishment as compared to Dark Head Cove. Plant counts per square meter are shown in Table 2. SAV in Cow Pen Creek was more established. Higher numbers of SAV were counted in survey points near the banks as compared to survey points in the middle of Cow Pen Creek, likely due in part to the shallower water depths near the banks. Three species of SAV were noted: the planted wild celery, milfoil, and sago pondweed (*Stuckenia pectinata*). In addition to plants growing from planted seed, it appeared that natural recruitment of other SAV species was occurring in Cow Pen Creek. Overall, densities ranged from zero to 42 plants per square meter. This wide range demonstrates natural variability, as plants respond to the conditions within the system, and multiple species compete for available habitat.

1.2 OBJECTIVES

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

- locating and collecting enough native wild celery seed from local (within 30 miles) populations, to provide a minimum 100,000 viable seeds per acre (completed in 2017; optional for future events depending on restoration success)
- providing viable seed that demonstrates at least 80% germination during testing (did not meet objective in 2017/2018; optional for future events depending on restoration success)
- dispersing seeds over the area to be restored, so that they are distributed at a minimum of viable 100,000 seeds per acre (completed in 2018; optional for future events depending on restoration success)
- installing and successfully maintaining grazing exclosures (completed in 2018 and removed in 2019; optional for future events depending on restoration success)

-
- 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 the 2018 or 2019 monitoring event) by 2022
 - implementing a robust post-seeding monitoring program using divers (in 2018 and 2019) and boat-accessible rake surveys (in 2020-2022) (Tetra Tech, 2017)

SECTION 2 2019 MONITORING

The second monitoring event was conducted on August 8, 2019 by Tetra Tech scientific divers, using SCUBA gear to inspect 13 transects and count plants within 0.25 m² quadrats along each transect in areas where seed was dispersed (Figures 3 & 4). Water clarity in both Cow Pen Creek and Dark Head Cove was better than when monitoring was conducted in 2018. Visibility was greater than 50 centimeters (cm), and was 10-15 cm at depths of up to 3.2 m.

The same eight transects were monitored in 2019 that were established in Dark Head Cove in 2018, extending up to five meters out from the bank. Three measurements were made on each transect at varying distances from the bank: 2 m, 3 m, and 5 m. The depth or type of substrate (i.e., gravel and cobble) was not conducive to SAV growth at any of the assessed quadrat locations. Depth ranged from 1 m at the bulkhead on Dark Head Cove to approximately 4 m at the endpoint. The same five transects that were surveyed in Cow Pen Creek in 2018 were monitored in 2019. Each transect extended from bank to bank and consisted of 10 survey points across each transect equidistant apart, per the work plan. The shallower depths and substrate in Cow Pen Creek were much more conducive to SAV establishment compared to Dark Head Cove. Plant counts per square meter are shown in Table 2.

Results indicate that SAV is not well established within the transects in Dark Head Cove. In 2018 it was noted that SAV was becoming established in areas of Dark Head Cove outside of the transect locations. In particular, in 2018 a large SAV bed had established along the bulkhead in the area between transects 4 and 5. However, this SAV was not present in Dark Head Cove in 2019.

SAV in Cow Pen Creek was substantially reduced in 2019 compared to the monitoring conducted in 2018. As noted in 2018, higher numbers of SAV were counted in survey points near the banks as compared to survey points in the middle of Cow Pen Creek, likely due in part to the shallower water depths near the banks, but overall the SAV was reduced in 2019 compared

to 2018. In 2018, three species of SAV were noted: the planted wild celery (*Vallisneria americana*), milfoil (*Myriophyllum spicatum*), and sago pondweed (*Stuckenia pectinata*), while in 2019 only two species were noted, the wild celery and horned pondweed (*Zannichellia palustris*). In addition to plants growing from planted seed, it appears that some natural recruitment of other SAV species is occurring in Cow Pen Creek based on the presence of horned pondweed. Overall, densities ranged from 0 - 2.8 plants per m² in 2019 whereas in 2018 the range was from 0 - 42.4 plants per m². This represents a substantial reduction in SAV in Cow Pen Creek. Tables 2 and 3 summarize the plant counts in 2018 and 2019. The two transects with the highest plant counts in 2018 (CPC-9 and CPC-10) were the only two transects with SAV in 2019.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

No objectives for plant density were established for the 2018 and 2019 diver-based surveys. However, the survey does provide data relevant to number of seedlings established after the dredging operations. Compared to 2018 observations, SAV has been substantially reduced in Cow Pen Creek. As anticipated, water depths and substrate in Dark Head Cove may not be conducive to SAV growth and establishment (Batiuk et al., 2000).

The 2019 results also indicate that SAV is reduced in areas in and around the monitoring locations. Visual assessments of SAV in other parts of Dark Head Cove indicate substantially reduced bed sizes and smaller plants compared to what has been observed in the past. Visual assessments completed on the donor beds used to collect SAV seeds in 2017 indicate that most beds are reduced in size and delayed in plant maturation. It was determined, in consultation Maryland Department of Natural Resources (DNR), that additional harvest of declining donor beds in 2019 may cause further reductions in population. As such, additional harvest was not performed and the potential for additional harvest and seeding in 2020/2021 will be evaluated during the 2020 monitoring event. Based on the results of the 2019 diver survey and visual assessments conducted on other SAV beds both locally and regionally, Lockheed Martin recommends:

- Reevaluating the need for an additional seeding in Cow Pen Creek and Dark Head Cove during the 2020 monitoring event;
- Conducting another diver survey in 2020 to more accurately assess the SAV in Dark Head Cove and Cow Pen Creek along transects;
- Conduct a visual assessment and potential rake survey of local SAV beds (i.e., Dark Head Cove on bank opposite Lockheed Martin property in 2020).

SECTION 4 REFERENCES

- Batiuk, R.A., P.W. Bergstrom, W.M. Kemp, E.W. Koch, L. Murray, J.C. Stevenson, R. Bartleson, et al. (2000). "Chesapeake Bay submerged aquatic vegetation water quality and habitat-based requirements and restoration targets: A second technical synthesis." 130pp. Edgewater, MD: Chesapeake Research Consortium.
- Bergstrom, P. W., R. F. Murphy, et al., Eds. (2006). "Underwater grasses in Chesapeake Bay & Mid-Atlantic coastal waters: Guide to identifying submerged aquatic vegetation." College Park, MD, Maryland Sea Grant College.
- Moore, K.A., and J.C. Jarvis. 2007. Using seed to propagate and restore *Vallisneria americana* (wild celery) in the Chesapeake Bay, 10. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- Smart, R. M., R. D. Doyle, et al. (1996). "Establishing native submersed aquatic plant communities for fish habitat." American Fisheries Society Symposium 16: 347-356.
- Tetra Tech. 2017. *Cow Pen Creek and Dark Head Cove SAV Restoration and Monitoring Work Plan, Lockheed Martin Middle River Complex*. Lockheed Martin Middle River Complex, Middle River, Maryland. December.
- Tetra Tech, 2018. *Cow Pen Creek and Dark Head Cove SAV Restoration and Monitoring Report, Lockheed Martin Middle River Complex*. Lockheed Martin Middle River Complex, 2323 Eastern Boulevard, Middle River, Maryland.

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: Location of seed distribution in April 2018

Figure 4: Location of monitoring transects within Cow Pen Creek and Dark Head Cove

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 Cow Pen Creek (2015 survey), prior to dredging
Note sparse to non-existent beds off bulkhead where water depths will not support growth

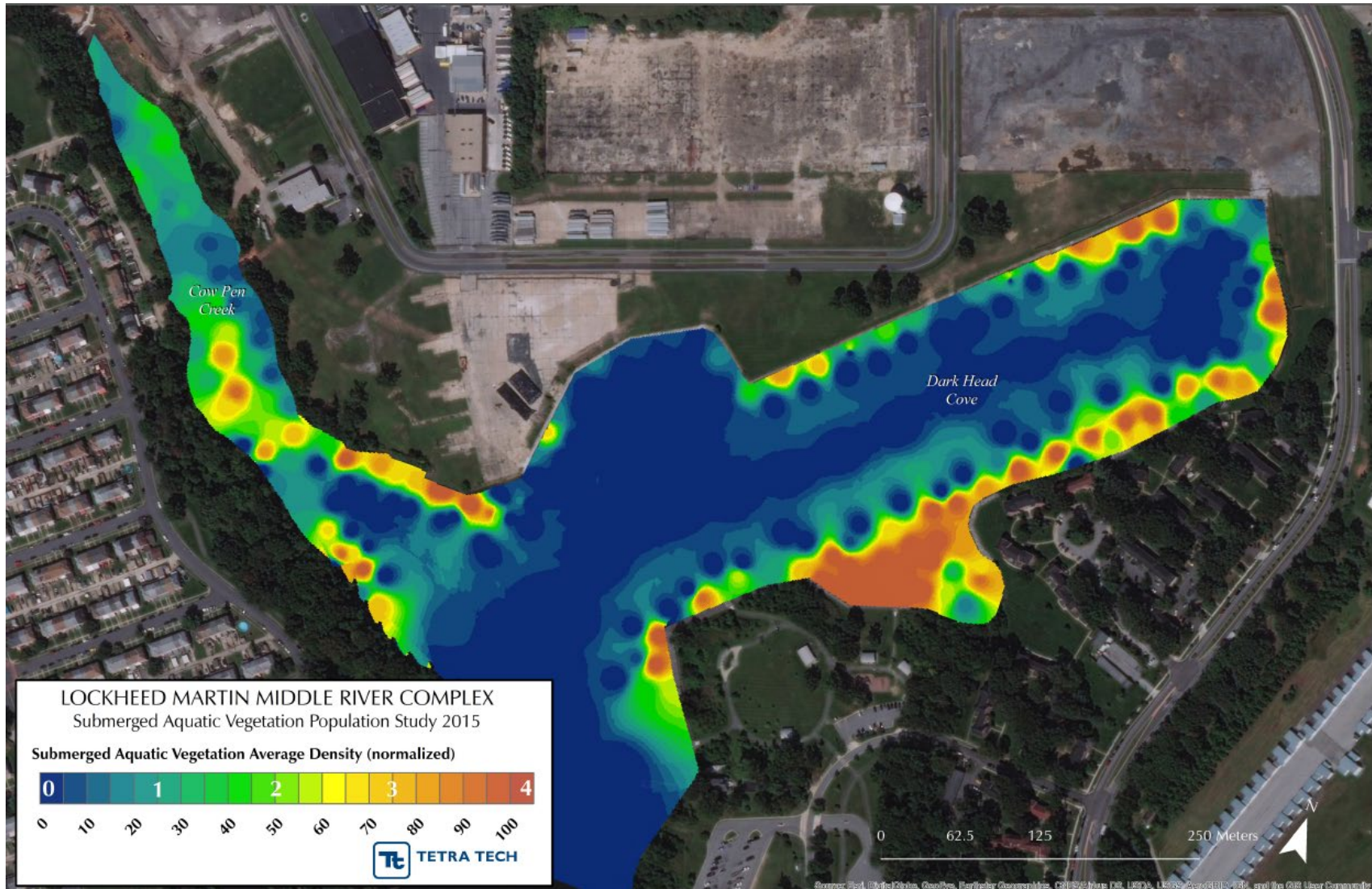
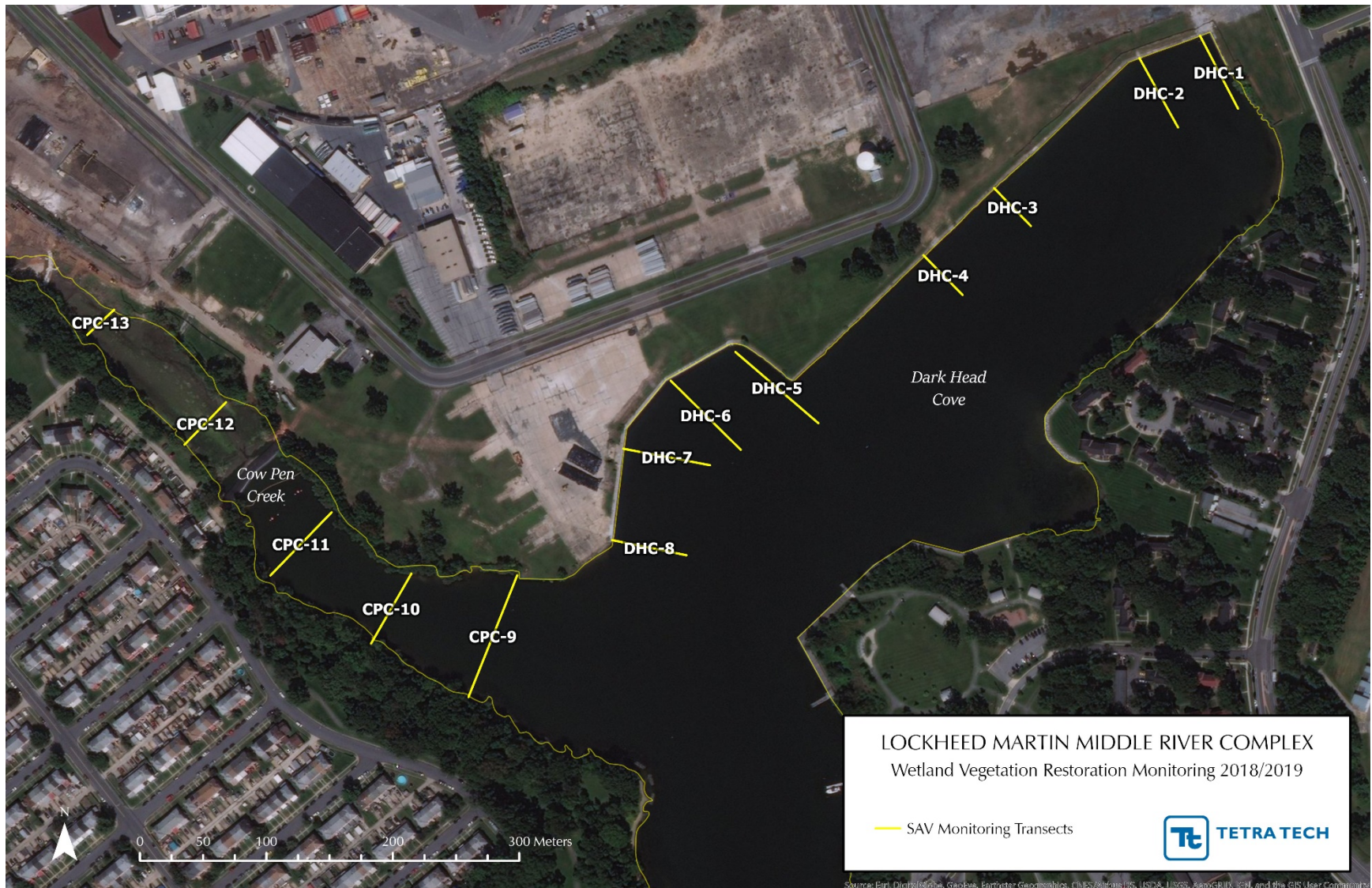


Figure 3: Location of seed distribution in April 2018



Figure 4 Location of monitoring transects within Cow Pen Creek and Dark Head Cove in 2018 and 2019



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

Table 3: Plant counts in Dark Head Cove and Cow Pen Creek during the August 2019 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 americana</i> (wild celery)	4%
<i>Stuckenia pectinata</i> (sago pondweed)	2%
<i>Potamogeton crispis</i> (curly pondweed)	2%
<i>Potamogeton perfoliatus</i> (redhead grass)	0.5%
<i>Zannichellia palustris</i> (horned pondweed)	0.5%

Table 2
Plant counts in Dark Head Cove and Cow Pen Creek during the August 2018 survey.
(up to ten quadrats measured per transect)

Transect	Number of Plants per Quadrat										Mean number of plants per m ²	Number of Species Present ^a
	1	2	3	4	5	6	7	8	9	10		
1-DHC	0	0	0	-	-	-	-	-	-	-	0	0
2-DHC	0	0	0	-	-	-	-	-	-	-	0	0
3-DHC	0	0	0	-	-	-	-	-	-	-	0	0
4-DHC	0	0	0	-	-	-	-	-	-	-	0	0
5-DHC	0	0	0	-	-	-	-	-	-	-	0	0
6-DHC	0	0	0	-	-	-	-	-	-	-	0	0
7-DHC	0	0	0	-	-	-	-	-	-	-	0	0
8-DHC	0	0	1	-	-	-	-	-	-	-	1.3	1
9-CPC	0	0	0	0	0	0	0	1	75	30	42.4	3
10-CPC	4	20	0	0	1	0	2	0	0	10	14.8	1
11-CPC	2	0	0	0	0	0	0	12	14	1	11.6	1
12-CPC	2	2	1	1	2	3	0	2	0	0	5.2	1
13-CPC	0	1	1	2	0	0	0	0	15	2	8.4	1

a – Transects 8-CPC, 10-CPC, 11-CPC, 12-CPC, and 13-CPC only had *Vallisneria americana*; Transect 9-CPC had three species including *Vallisneria americana*, *Myriophyllum spicatum*, and *Stuckenia pectinate*.

CPC – Cow Pen Creek

DHC – Dark Head Cove

m² – square meter(s)

Table 3
Plant counts in Dark Head Cove and Cow Pen Creek during the August 2019 survey.
(up to ten quadrats measured per transect)

Transect	Number of Plants per Quadrat										Mean number of plants per m ²	Number of Species Present ^a
	1	2	3	4	5	6	7	8	9	10		
1-DHC	0	0	0	-	-	-	-	-	-	-	0	0
2-DHC	0	0	0	-	-	-	-	-	-	-	0	0
3-DHC	0	0	0	-	-	-	-	-	-	-	0	0
4-DHC	0	0	0	-	-	-	-	-	-	-	0	0
5-DHC	0	0	0	-	-	-	-	-	-	-	0	0
6-DHC	0	0	0	-	-	-	-	-	-	-	0	0
7-DHC	0	0	0	-	-	-	-	-	-	-	0	0
8-DHC	0	0	0	-	-	-	-	-	-	-	0	0
9-CPC	0	0	0	0	0	0	0	0	0	7	2.8	2
10-CPC	2	0	0	0	0	0	0	0	0	4	2.4	1
11-CPC	0	0	0	0	0	0	0	0	0	0	0	0
12-CPC	0	0	0	0	0	0	0	0	0	0	0	0
13-CPC	0	0	0	0	0	0	0	0	0	0	0	0

a – Transect 9-CPC had two species including *Vallisneria americana* and *Zannichellia palustris*; Transect 10-CPC only had *Vallisneria americana*.

CPC – Cow Pen Creek

DHC – Dark Head Cove

m² – square meter(s)