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March 13, 2020

VIA PRIVATE CARRIER

Brian Dietz
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 Pen Creek Wetland Restoration 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 documents wetland restoration as assessed in 2019, after sediment remediation was completed at the end of 2017. Cow Pen Creek is located adjacent to the Lockheed Martin Middle River Complex in Middle River, Maryland.

If possible, we respectfully request to receive MDE's document review comments by May 15, 2020.

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

Sincerely,

Thomas D. Blackman
Project Lead, Environmental Remediation

cc: (via email without enclosure)
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Mark Mank, MDE
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COW PEN CREEK
WETLAND RESTORATION MONITORING REPORT
2323 EASTERN BOULEVARD
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

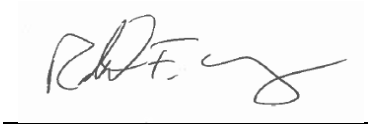
Prepared for:
Lockheed Martin Corporation

Prepared by:
Tetra Tech, Inc.

March 2020

Revision: 0

Michael Martin, P.G.
Regional Manager



Bob Murphy
Project Manager

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ACRONYMS AND ABBREVIATIONS

FAC	facultative species
ft^2	square feet
GIS	geographic information system
GPS	global positioning system
IRT	Interagency Review Team
Lockheed Martin	Lockheed Martin Corporation
MAA	Maryland Aviation Administration
MDE	Maryland Department of the Environment
MRC	Middle River Complex
NOAA	National Oceanic and Atmospheric Administration
Tetra Tech	Tetra Tech, Inc.
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture

SECTION 1
INTRODUCTION

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech Inc. (Tetra Tech) has prepared the following monitoring report for 2019 that documents wetland restoration after sediment remediation was completed at the end of 2017. Cow Pen Creek is located adjacent to the Lockheed Martin Middle River Complex (MRC) in Middle River, Maryland (Figure 1-1).

1.1 PURPOSE OF THE WETLAND RESTORATION, MONITORING, AND MAINTENANCE

As part of the sediment remedy at the Middle River Complex, the upper portion of Cow Pen Creek, including both the stream channel and adjacent floodplain area, was excavated to remove contaminated sediment. Following excavation, the areas were restored per the approved project design (Tetra Tech, 2016). The restoration included reconstruction of the main channel and floodplains, placement of new channel substrate, streambank stabilization and vegetation, wetlands restoration, and revegetation of areas disturbed by sediment removal. The overall goal of restoration and mitigation was to replace the extent, function, and value for Cow Pen Creek wetlands and waters impacted by the remediation project. Documentation of the sediment removal action is provided in the *Season Two Cow Pen Creek Sediment Remedy Completion Report* (Tetra Tech, 2018a).

During remediation, approximately 1.5 acres of channel substrate were removed and replaced with clean material. During substrate removal and creek reconstruction, approximately four acres of vegetated habitat, comprised of forested, scrub/shrub, and emergent (herbaceous) wetlands along Cow Pen Creek were disturbed. This monitoring report focuses on wetland restoration. The approved work plan (Tetra Tech, 2017) does not contain established metrics to measure the success of the wetland restoration, so Tetra Tech will compare data collected annually during creek monitoring to determine whether the wetlands are improving. Ground coverage, plant species, and the goals and objectives established in the *Maryland Nontidal Wetland Mitigation Guidance* (Maryland Department of the Environment [MDE], 2011) will be compared annually,

and at the end of the five-year monitoring period in 2022. Specific goals to attain by 2022 include the following:

a) Greater than 85% of the wetland mitigation site will be vegetated (either by planted or naturally revegetated plants) by native wetland species like those found in the nontidal wetland lost, or by a species composition acceptable to the Nontidal Wetlands and Waterways Division. Vegetative communities not acceptable to the Division would include those communities dominated by common reed (*Phragmites australis*) or other nuisance vegetation, or communities that are dominated by facultative upland or upland species.

b) The entire wetland restoration or creation area must have sufficient hydrology to support a prevalence of wetland vegetation. The (United States) Army Corps of Engineers (USACE) and United States Environmental Protection Agency (USEPA) define wetlands as "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

c) For this determination, wetland vegetation is that which is readily observable in the field and can easily be used to help identify the extent of the wetland area. The area will be evaluated to determine the extent of the wetland and that the entire area meets the definition of a wetland using the appropriate regional supplement to the Corps of Engineers Wetland Delineation Manual (USACE, 2010).

d) The entire wetland restoration or creation area must meet the Hydric Soil Technical Standard developed by the National Technical Committee for Hydric Soils for saturated conditions and aerobic conditions (United States Department of Agriculture [USDA], 2015).

e) The site will provide the functional goals and objectives established in the Maryland Nontidal Wetland Mitigation Guidance (Appendix F in MDE, 2011).

1.2 OBJECTIVES

The restoration area is shown on Figure 1-1. The specific objectives of wetland monitoring are to:

- observe and report conditions monitored in Cow Pen Creek wetlands and vegetation along and in Cow Pen Creek
- maintain vegetation within Cow Pen Creek, as needed

SECTION 2
EXISTING SITE CONDITIONS AND BACKGROUND

The Lockheed Martin Middle River Complex (MRC), 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 site is approximately 161 acres and includes 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 2-1).

Lockheed Martin started the removal of contaminated sediment from Dark Head Cove and Cow Pen Creek in 2014. Portions of Dark Head Cove and the lower reaches of Cow Pen Creek were conventionally dredged, and the sediment surface was restored by placing a six-inch-thick sand layer (residual management layer). During the remedial action in the upstream portion of Cow Pen Creek, approximately four acres of vegetated habitat including wetlands were damaged or removed. Wetlands are an important habitat for a variety of organisms, including ecologically important fish and invertebrate species (Brinson and Rheinhardt, 1996). In addition, wetlands provide an excellent food source for several waterfowl species, particularly in the freshwater and oligohaline portions of the Middle River and Chesapeake Bay. In response to the temporary loss of these ecosystems, and in compliance with a United States Army Corps of Engineers (USACE) permit and Maryland Department of the Environment (MDE) Tidal Wetlands License, Lockheed Martin implemented a wetland restoration project in 2017-2018. After sediment removal and stream reconstruction was completed, wetland areas were planted along both banks of Cow Pen Creek (see Figure 1-1).

Existing functions and values (e.g., habitat, physical and chemical conditions, scenic, recreational, and other values) in the floodplain of Cow Pen Creek were restored to the extent

practicable following the removal of contaminated soil. The restoration plan was developed to replace specific functions and values by designing features to provide habitat and moderate flood flow, to stabilize the shoreline and retain sediment, to remove toxicants, and to provide aesthetic and recreational values. Features were restored and toxicants were reduced by replanting emergent vegetation to restore/improve fisheries habitat, and replanting floodplain forest/shrub vegetation to moderate flood-flow, stabilize shorelines, and retain sediment. Other features, including replanting of riparian vegetation, were designed to restore visual/aesthetic appeal of the stream corridor. Stream restoration features are detailed in Cow Pen Creek design documents (Tetra Tech, 2016).

Under the approved work plan, wetland vegetation was first monitored in 2018 and will continue annually (including the results reported herein [in subsequent sections] for 2019), during the forested/scrub-shrub system growing season between May 1 and September 30, and during the growing season for emergent systems between June 15 and September 30. Subsequent maintenance activities will be conducted twice annually, in the spring (between May 1 and May 30 of each year), and in the fall (between September 15 and October 31 of each year).

SECTION 3
WETLAND MONITORING AND DATA COLLECTION IN 2019

3.1 ACTIVITIES PERFORMED

Tetra Tech conducted its second annual (2019) monitoring of restored wetlands of Cow Pen Creek on September 27, 2019. The wetland vegetation survey and data collection were conducted in accordance with the methods specified in the approved *Cow Pen Creek Wetland Restoration Monitoring Work Plan* (Tetra Tech, 2017).

Plots were randomly selected using a geographic information system (GIS) and a map of the restored area, using site parameters (i.e., the total plot area) to ensure sampling plots fell completely within the target habitat type (see Figure 3-1). The following observations or counts were made in each plot: (1) the dominant plant species were identified, (2) the percentage of dominant species survival was estimated, (3) the percentage of ground cover was estimated, (4) woody-stem plants were counted, (5) the percentage of invasive plants was estimated, and (6) the percent of invasive groundcover was estimated (Table 3-1).

Developing vegetation and the designed habitat types were assessed using at least the minimum number of sampling plots recommended in the Interagency Review Team (IRT) protocol; therefore, four 400 square foot (ft^2) randomly located sampling plots were monitored in the scrub-shrub habitat, while four 400 ft^2 plots in forest-dominated habitats, and two three-foot by three-foot sample plots, were randomly assessed in the herbaceous dominated community (Table 3-1). Additionally, one 400 ft^2 plot was sampled at the edge of the forested-emergent wetland boundary, as well as another upland 400 ft^2 sampling location. Figure 3-1 shows the location of the wetland sampling plots surveyed during the 2019 monitoring.

Observations made at Cow Pen Creek, and data collected assessed the following parameters:

1. dominant vegetative species identification (all plots)
2. percent ground cover (all plots)
3. number of woody plant stems greater than 10 inches in height (total and number per acre–forest and scrub/shrub plots only)
4. percentage of dominant facultative species (FAC)[1] or wetter (all plots)
5. percent survival by planted species (all plots)
6. invasive/noxious species, including percent cover (all plots)

Other recorded data at each sampling plot included indicators of wetland hydrology and soil data (see Table 3-1). On-site monitoring also documented bare spots of more than 10 square feet, areas of erosion, and areas of failed vegetation relative to the sampling plots. A photo point was established adjacent to each sampled plot, and a photograph was taken of each developing wetland area. Photo and sampling points were located using global positioning system (GPS) instruments, and locations were plotted on aerial photographic maps. The directionality of each photograph taken, as well as the habitat type photographed, were also recorded. Additional photos are included in Appendix A.

Additional monitoring was conducted in August 2019 to assess and delineate the sitewide status of the developing wetlands based on habitat (i.e., forested, scrub-shrub, and emergent). The wetlands were further delineated based on tidal or non-tidal habitat types in order to determine the current status of the wetland restoration. Appendix B contains the technical memorandum summarizing the results of this survey, as well as the plan for revegetation of certain areas to account for the observed shortage of forested tidal wetlands.

3.2 RECORDED OBSERVATIONS

Sampling locations for 2019 (numbered 1–12) are shown on Figure 3-1. Table 3-1 provides a summary of the vegetation observed and recorded at each site, per the monitoring and data collection objectives outlined in Section 3-1. Note that no dead shrubs or trees were observed,

[1] Facultative species (FAC) are plant species that are equally likely to occur in wetland (estimated probability 34–66%) or non-wetland areas.

although some of the planted material may have died shortly after planting and subsequently decayed or was washed away, leaving no trace. Unless noted in descriptions, both herbaceous and woody plants are thriving and expanding in coverage.

3.2.1 2019 Wetland Plot Descriptions

Plot 1: This scrub-shrub wetland monitoring location is between stormwater Outfalls 002 and 003 (Figures 3-1 and 3-2). Ground cover is 100% with no bare spots, and the dominant herbaceous vegetation (with 95% coverage) is creeping bentgrass (*Agrostis stolonifera*), that was seeded according to the approved seed mix for wetland areas. Woody stem count in this plot was 4 and there appears to be 100% survival of planted woody material since no dead shrubs were observed (Table 3-1). Soil in the monitoring location was wet or saturated at the surface and is hydric based on colors and features (Table 3-2). Some small patches of common reed were observed near this location, but none were within the sampling plot.

Plot 2: This scrub-shrub wetland monitoring location is downstream of plot 1. Ground cover is 100% with no bare spots, and the dominant herbaceous vegetation (with 95% coverage) is creeping bentgrass that was seeded per the approved seed mix for wetland areas. Three plants with woody stems were observed in this plot, with an apparent 100% survival of planted woody material, as no dead shrubs were observed. Several common burdocks (*Arctium minus*) were observed in the area. Soil in the monitoring location was wet or saturated at the surface and is hydric based on colors and features.

Plot 3: This monitoring location (Figure 3-3) is upslope between plots 1 and 2 in an upland area that was selected to be representative of upland conditions across the entire study area. Soil at this location is not hydric and can be used to compare upland conditions to wetland conditions in the restoration area. The dominant vegetation in this plot is turf-type fescue. No woody stem plantings are within the plot, although tree seedlings from natural recruitment are present in the area.

Plot 4: This forested wetland sampling location is downstream and southeast of plot 3 (Figure 3-1). Ground cover is 100%, the dominant herbaceous vegetation is creeping bentgrass that was seeded according to the approved seed mix for wetland areas. Sedges (*Carex sp.*) are becoming

more numerous since the 2018 monitoring (Appendix C). Thirteen woody stem plants are in this plot, and survival appears to be 100%, as no dead shrubs or trees were observed. Some of the planted tree species observed include sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and sycamore *(Plantanus occidentalis)*, with black willow (*Salix nigra*) as the dominant tree species. Soil in the monitoring location was wet or saturated at the surface and is hydric based on colors and features. No invasive ground cover was observed within the plot.

Plot 5: This forested wetland sampling location is downstream and southeast of plot 4 and in a narrow band of forested wetland along the stream (Figure 3-4). Ground cover is 100%, and the dominant herbaceous vegetation is creeping bentgrass, seeded per the approved seed mix for wetland areas. Like plot 4, sedges have become more numerous since the 2018 monitoring. Common beggar's tick (*Bidens frondosa*) is becoming common. Five plants with woody stems were observed at this site, and survival appears to be 100% as no dead shrubs or trees were observed. Planted tree species observed include sweet gum, red maple, and sycamore. Black willow is the dominant tree species and is numerous along the edge of the site, and more numerous as compared to that observed during the 2018 monitoring. Soil in the monitoring location was wet or saturated at the surface and is hydric based on colors and features. No invasive ground cover was observed within the plot.

Plot 6: This forested wetland sampling location is downstream of plot 5 where the stream starts to widen (Figure 3-5). Ground cover is 100%, the dominant herbaceous vegetation is the creeping bentgrass that was seeded according to the approved seed mix for wetland areas. A few soft rush (*Juncus effuses*) were present. Nine plants with woody stems were counted at this site, and survival appears to be 100% as no dead shrubs or trees were observed. Planted tree species observed include sweet gum, red maple, and sycamore, with some natural recruitment of seedlings of the same species. Black willow is the dominant tree species. Soil in the monitoring location was wet or saturated at the surface and is hydric based on colors and features. No invasive ground cover was observed within the plot.

Plot 7: This forested wetland plot is on the southeastern shore on the school side where the creek bends from running towards the east to a southeast direction (Figure 3-6). This area is frequently inundated at high tide. Only 10% of this area was covered with vegetation when observed in

September 2018, but as of September 2019, 90% of the area is covered by herbaceous vegetation, with hibiscus or rose mallow (*Hibiscus moschuetos*) and orange jewelweed (*Impatiens campensis*) being dominant. There is some natural recruitment of tree seedlings (including sycamore, red maple, and sweet gum) closer to the upland bank and existing upland tree line. Six woody stem plants were counted, including four hibiscus and two sycamore seedlings. About 90% of planted trees and shrubs did not survive, likely due to inundation. No invasive herbaceous or woody plants were observed within the plot. This area is proposed for replanting with more inundation tolerant trees. Bald cypress (*Taxodium distichum*) is one of the best candidates for this site and is on the Maryland Aviation Administration (MAA) list of approved species. Although we are slightly north of its natural range in Calvert County, bald cypress will likely thrive and reproduce at this site as conditions in plot 7 are similar to the hydrologic conditions in its native stands farther south in Maryland. This site will provide the constantly saturated seed bed that is needed for a successful high percentage germination of bald cypress.

Plot 8: This scrub-shrub wetland plot is located on the Lockheed Martin side of the creek where it starts to widen along a wider wetland and floodplain (Figure 3-7). The area is slightly lower than adjacent forested wetland. The soil is saturated at the surface, and the hole dug for soil sampling filled with water. The dominant herbaceous ground cover is creeping bentgrass (100% ground cover) along with cattail (*Typha latifolia*) in wetter spots. Sedge and rush are more numerous than last year. Woody stem count in this site was 12, and survival appears to be 100% as no dead shrubs or trees were observed. Hibiscus or rose mallow is becoming established as the dominant woody species, and other woody plants include sweet pepperbush (*Itea virginic*a) and sweet bay magnolia (*Magnolia virginiana*). No invasive ground cover was observed within the plot.

Plot 9: This forested wetland is halfway down the creek and within the project area on the Lockheed Martin side (Figure 3-8). Like most non-inundated sites, creeping bentgrass is the dominant herbaceous vegetation, with rush and sedge species becoming more numerous (100% ground cover). Five woody stem plants were counted at this site, and survival appears to be 100% as no dead shrubs or trees were observed. Planted trees including sweet gum, red maple, and sycamore. Black willow is the dominant tree species. Soil in the monitoring location was

saturated at the surface and is hydric based on colors and features. No invasive ground cover was observed within the plot.

Plot 10: This forested wetland is within the project area more than halfway downstream and on the Lockheed Martin side (Figure 3-9). Like plot 9, this area is low and on the inside bend of the creek. Ground cover here is 100%, with creeping bentgrass being the dominant herbaceous vegetation, and rush and sedge species becoming more numerous. Six woody stem plants were counted in this plot, and survival appears to be 100%, as no dead shrubs or trees were observed. Planted trees include sweet gum, red maple, and sycamore, with sweet gum and sycamore established as dominant species. Soil in the monitoring location was saturated at the surface and is hydric based on colors and features. No invasive ground cover was observed within the plot.

Plot 11: This plot is in the emergent wetland between forested wetland and open water (Figure 3-9). Marsh fleabane and cattail are the dominant herbaceous vegetation, with pickerel weed, rushes, and sedges also observed. No woody vegetation was observed in this plot, and vegetative coverage is 100%. This area is shallow so emergent vegetation may expand waterward over time.

Plot 12: This site is the farthest downstream and on one of the constructed benches designed to function as an emergent wetland (Figure 3-10). Vegetation is still sparse, with less than 25% coverage. Herbaceous plants are mostly pickerel weed with a smaller amount of green arrow-arum (*Peltandra virginica*). No invasive plants were observed within the plot.

3.2.2. Site Wide Observations 2019

Figure 3-11 shows observed tidal water levels in Baltimore Harbor at the National Oceanic and Atmospheric Administration (NOAA) Fort McHenry, Patapsco River station from September 23-30, 2019. Tide levels observed (green line) during the days preceding the monitoring were above predicted long-term levels (blue line). Therefore, study areas that seem to have been repeatedly inundated may have been affected by the volume of water associated with these higher than normal tides.

General observations from infrequently inundated areas are summarized below:

- Planted woody plants are in their second year and growing. No dead woody plants were observed. Many more tree seedlings from natural recruitment including sycamore, red maple, and sweet gum were observed.

- The dominant herbaceous vegetation is creeping bentgrass, as it was in 2018 (see Appendix C), but many more sedges and rushes, along with switchgrass (*Panicum virgatum*), beggar's tick, and other wetland species were observed in 2019. Recruitment of other wetland species may only account for 5% of herbaceous ground cover. These species will likely continue to increase in coverage with additional species occurring over time.

- Barnyard grass (*Echinochloa crus-galli*) is appearing in some areas and will be spot treated during maintenance of the site.

Observations from frequently inundated areas include:

- Less than 5% of planted woody plants survived frequent inundation, but herbaceous wetland vegetation is thriving in flooded areas.

- Less than 25% herbaceous vegetation is on benches at the downstream end of site.

SECTION 4
CONCLUSIONS AND RECOMMENDATIONS

4.1 FORESTED WETLAND

Although herbaceous vegetation is still dominated by creeping bentgrass in non-flooded and non-inundated areas of restored forested wetlands, other herbaceous wetland vegetation is increasing in coverage. Creeping bentgrass was part of the approved seed mix and became well established in 2018 (Appendix C). Dominance by creeping bentgrass was observed at eight of 12 surveyed plots (estimated coverage at 70–80%), but is changing as more perennial wetland grasses or forbs start to colonize the area. Trees and shrubs in these areas are healthy and growing. Downstream, where the channel widens, some areas designated as forested wetland are more characteristic of emergent wetland and are approximately 80% covered by emergent vegetation. In areas that appear to be more consistently inundated or flooded, planted trees and shrubs have not survived. Some natural recruitment of tree seedlings has occurred closer to the upland bank (see Figure 3-1).

As noted in Appendix B, the overall area currently delineated as forested wetlands is less than (short of) preconstruction conditions by approximately 17,000 square feet. This shortage is currently being evaluated for revegetation (see Appendix B).

4.2 SCRUB-SHRUB WETLAND

Two areas of scrub-shrub wetland were restored, one in the Baltimore Gas & Electric easement near the upstream portion of the site, and the other about halfway downstream. Areas of scrub-shrub wetlands that are not flooded are dominated by bentgrass and contain planted shrubs and trees. Part of the downstream scrub-shrub wetland closest to the stream channel was flooded with two to three inches of water and appeared to be regularly inundated with water at high tide. Most of the flooded area is dominated by emergent vegetation. Some of this area contain willows (*Salix sp.)*.

As noted in Appendix B, the area reconstructed as scrub-shrub wetland is currently meeting the preconstruction wetlands requirement of 4,792 square feet.

4.3 EMERGENT WETLAND

The site plan shows emergent wetlands along the downstream banks of the site (Figure 3-1). The monitoring team observed several patches of pickerel weed on the wetland benches, but overall vegetation coverage was less than 25%. Farther upstream, the shallow water along the shoreline was well vegetated with emergent vegetation.

As noted in Appendix B, the area reconstructed as emergent wetland currently exceeds the preconstruction emergent wetland area by approximately 1,300 square feet.

4.4 COMPARISON TO LONG-TERM MONITORING GOALS

Field monitoring and maintenance activities are designed to ensure the goals and objectives established in the *Maryland Nontidal Wetland Mitigation Guidance* (MDE, 2011) are met by the end of the five-year monitoring period (in 2022). Second-year (2019) monitoring results indicate that the restored wetland area is progressing towards meeting these goals. The total area for forested wetland is short, but scrub-shrub wetlands attain, and emergent wetlands exceed, preconstruction goals. Appendix B contains a technical memorandum that delineates currently existing wetlands by type, as well as the revegetation plan to account for the shortage in forested tidal wetlands. Methods from the United States Army Corps of Engineers (USACE) wetlands delineation manual (USACE, 1987) and subsequent Atlantic and Gulf Coastal Plain regional supplement (USACE, 2010) were used to determine the extent of wetland areas. A summary of the five-year monitoring goals and their status after the second year of monitoring follows.

Vegetated Wetland Goal: Greater than 85% of the wetland mitigation site will be vegetated (either by planted or naturally revegetated plants) by native wetland species like those found in the nontidal wetland lost, or by a species composition acceptable to the Nontidal Wetlands and Waterways Division. Vegetative communities not acceptable to the Division would include those communities dominated by common reed or other nuisance vegetation, or communities that are dominated by facultative upland or upland species.

Second Year Monitoring Status: The wetland mitigation site is estimated to be approximately 90% vegetated with native wetland species. The main exception are areas designed as emergent wetland where inundation or flooding has occurred frequently enough to result in mortality. A current shortage (17,000 square feet) of forested wetland exists as compared to preconstruction design. Plot 7, on the southeastern shore of the school side of the creek, was designed as forested wetland and has become well vegetated with herbaceous emergent vegetation. Most of the trees planted in the designed forested wetland areas have died, most likely due to the frequent flooding from higher than normal tides (see Figure 3-11). This area is under evaluation for planting with flood-tolerant tree species (Appendix B).

Hydrology Goal: The entire wetland restoration or creation area must have sufficient hydrology to support a prevalence of wetland vegetation. The Army Corps of Engineers and United States Environmental Protection Agency define wetlands as "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

Second Year Monitoring Status: The entire site continues to have varying but ample wetland hydrology to support a prevalence of wetland vegetation.

Wetland Vegetation Goal: For this determination, wetland vegetation is that which is readily observable in the field and can easily be used to help identify the extent of the wetland area. The area will be evaluated to determine the extent of the wetland and that the entire area meets the definition of a wetland using the appropriate regional supplement to the Corps of Engineers Wetland Delineation Manual (USACE 2010).

Second Year Monitoring Status: Wetland vegetation is observable in the field and can be used to identify the extent of most of the wetland area. Vegetation is becoming more established and diversity is increasing. The entire wetland area should be identifiable by wetland vegetation, except for the inundated areas that resemble mudflats.

Hydric Soil Goal: The entire wetland restoration or creation area must meet the Hydric Soil Technical Standard developed by the National Technical Committee for Hydric Soils for saturated conditions and aerobic conditions (USDA, 2015).

Second Year Monitoring Status: The restored wetland area was either flooded, or soil was saturated to wet at the surface. Soil was sampled at each site and was determined to be hydric. Soil was evaluated for hydric characteristics using the ACOE regional supplement. Soil colors were determined using a Munsell Soil Color chart (Munsell Color, 2010).

Functional Goal: The site will provide the functional goals and objectives established in Appendix F of the *Maryland Nontidal Wetland Mitigation Guidance* (MDE, 2011).

Second year Monitoring Status: No direct measurement of nutrient removal and sediment control were observed, but these functions are likely to be occurring for the wetland types and positions in the landscape.

SECTION 5
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FIGURES

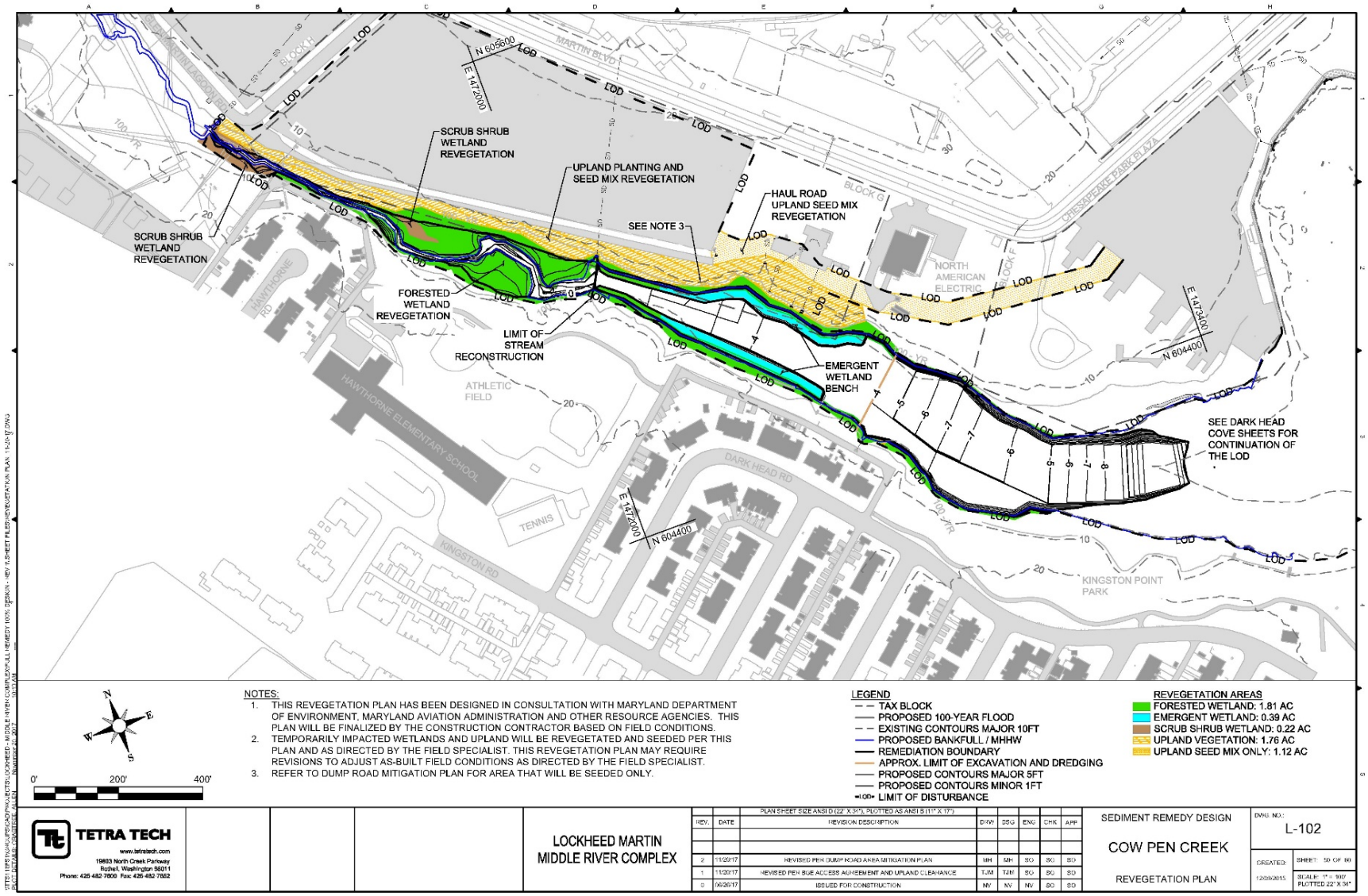

Figure 1-1. Wetland restoration monitoring area.

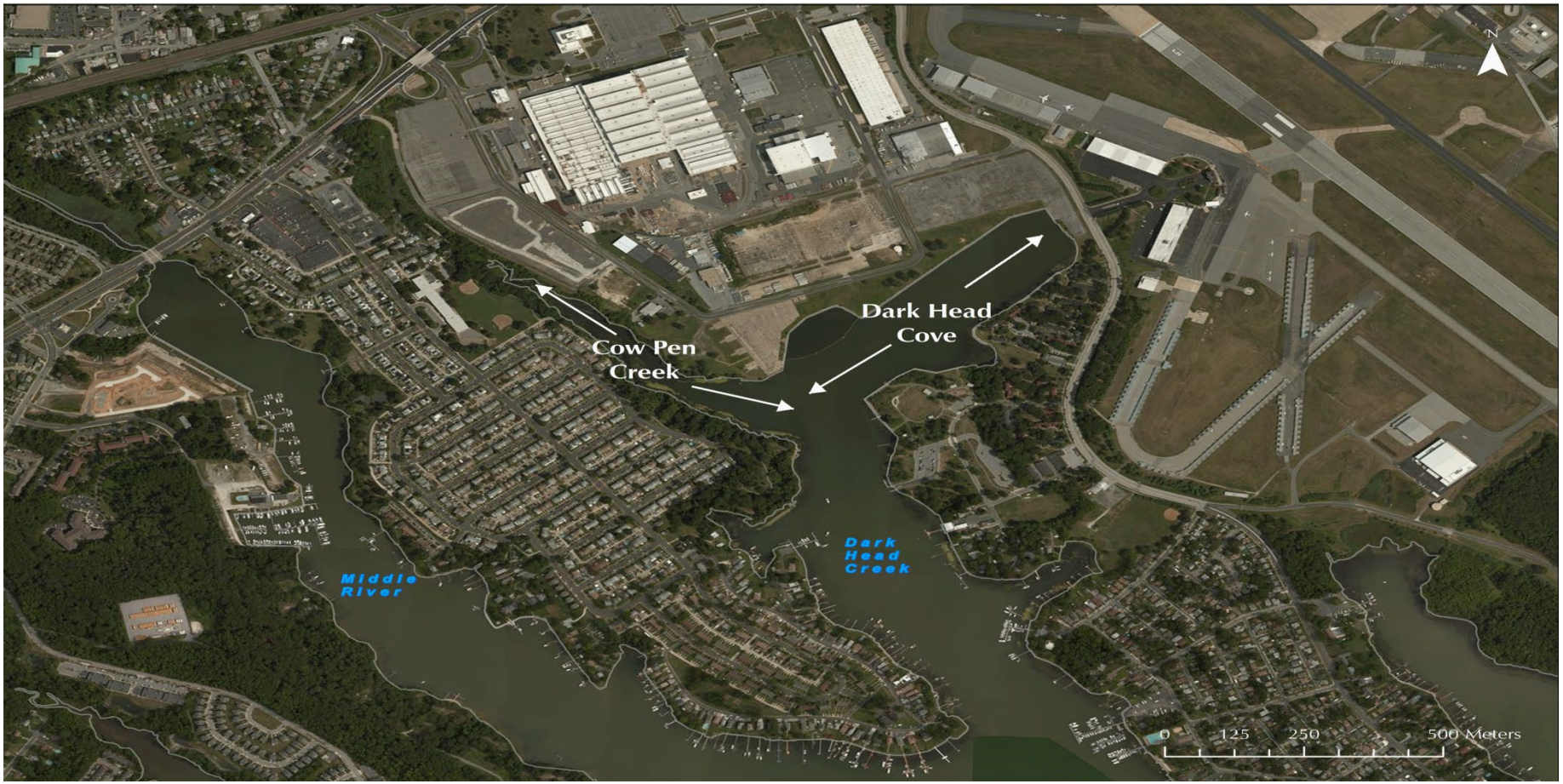

Figure 2-1. Location of Cow Pen Creek and Dark Head Cove near the Middle River Complex.

Figure 3-1. Map of 2019 wetland monitoring plot locations.

Figure 3-2. Scrub-shrub wetland near power line (Plots 1 and 2), facing southeast.

Figure 3–3. Forest wetland on upslope (Plot 3), facing east.

Figure 3-4 Forested wetland including willows near Cow Pen Creek (Plot 5), facing southeast.

Figure 3-5. Forested wetland with willows bordering Cow Pen Creek (Plot 6), facing northwest.

Figure 3-6. Forested and emergent wetland on Hawthorne side of Cow Pen Creek (Plot 7), facing northeast**.**

Figure 3-7. Farthest downstream scrub shrub wetland (Plot 8), facing southeast.

Figure 3-8. Forested wetland on Lockheed Martin side of Cow Pen Creek (Plot 9), facing southeast.

Figure 3-9. Boundary between forested (Plot 10) and emergent wetland (Plot 11), facing southeast.

Figure 3-10. Emergent wetland on downstream bench (Plot 12), facing southeast.

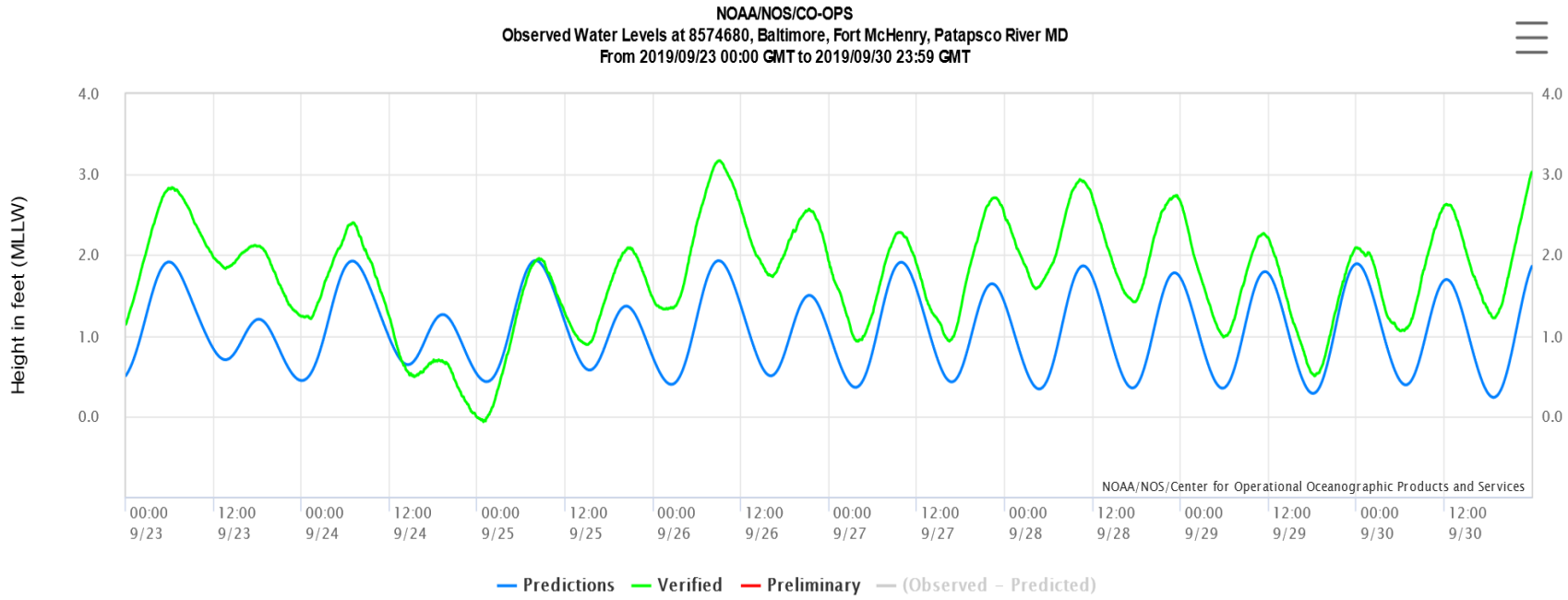

Figure 3-11. Observed water levels at NOAA's tidal observation station at Baltimore, Fort McHenry, Patapsco River September 23-30, 2019. Observed values (green line) are compared with long-term predicted levels (blue line). NOAA data from https://tidesandcurrents.noaa.gov/waterlevels.html?id=8574680&units=standard&bdate=20180721&edate=20180727&timezone=GMT&datum=MLLW&interval=6&action=

TABLES

Table 3-1 Vegetation Data Recorded during 2019 Wetland Monitoring

Table 3-2 Soil and Wetland Hydrology Observations in 2019

Table 3-1
Vegetation Data Recorded during 2019 Wetland Monitoring
Middle River Complex, Middle River, Maryland

Plot ID	Latitude	Longitude	Wetland type	Dominant vegetation	Ground cover (%)	Woody stem (count)	Dominant species (%)	Woody plantings survival (%)	Invasive species present (yes/no)	Invasive groundcover (%)
1	39.3283	-76.4376	Scrub-shrub wetland*	*Agrostis stolonifera*	100	4	90	100	no	0
2	39.3273	-76.4377	Scrub-shrub wetland*	*Agrostis stolonifera*	100	4	90	100	yes	5
3	39.3281	-76.4375	Upland	*Fescue sp.*	95	0	70	NA	no	0
4	39.3278	-76.4373	Forested wetland	*Agrostis stolonifera* *Salix nigra*	100	13	50	100	no	0
5	39.3276	-76.4370	Forested wetland	*Agrostis stolonifera,* *Salix nigra*	100	8	40	100	no	0
6	39.32748	-76.4367	Forested wetland	*Agrostis stolonifera,* *Salix nigra*	100	9	50	100	no	0
7	39.3268	-76.4360	Forested wetland– Emergent boundary	*Hibiscus moschuetos,* *Plantanus occidentalis,* *Impatiens campensis*	90	6	50	10	no	0
8	39.3271	-76.4364	Scrub-shrub wetland*	*Agrostis stolonifera* *Hibiscus moschuetos*	100	12	40	100	no	0
9	39.3271	-76.4361	Forested wetland	*Agrostis stolonifera* *Salix nigra*	100	5	40	100	no	0
10	39.3267	-76.4354	Forested wetland	*Agrostis stolonifera* *Liquidambar styraciflua,* *Plantanus occidentalis*	100	6	50	100	no	0
11	39.3266	-76.4354	Emergent wetland	*Typha latifolia,* *Pluchea odorata*	100	0	30	NA	no	0
12	39.3262	-76.4342	Emergent wetland	*Pontederia cordata* *Peltandra virginica*	25	0	25	NA	no	0

NA- not applicable

*Shrubs are present and thriving but are not yet large enough to be considered dominant.

Table 3-2
Soil and Wetland Hydrology Observations in 2019
Middle River Complex, Middle River, Maryland

Plot ID	Designed wetland type	Soil depth* (inches)	Matrix color	Percent matrix color	Redox features	Percent matrix color	Type	Loc	Texture	Remarks	Developing wetland type
1	Scrub-shrub	0–10	7.5 YR 3/1	100					Silt loam	Dark layer	Scrub-shrub
		10–14	10 YR 3/1	98	5 YR 5/6	2	Concentration	Matrix	Silt loam	Depleted matrix	
2	Scrub-shrub	0–10	7.5 YR 3/1	100					Silt loam	Dark layer	Scrub-shrub
		10–14	10 YR 3/1	98	5 YR 5/6	2	Concentration	Matrix	Silt loam	Depleted matrix	
3	Upland	0–14	7.5 4/4	100					Silt loam	Higher on bank, upland, for comparison	Upland
4	Forested	0–8	10YR 3/2	98	10 Y 7	2	Depletions	Matrix	Silt loam	Matrix depletions	Forested
		8-14	5 YR 5/6	98	10 Y 7/1	2	Poor linings	Matrix	Silt loam	Oxidized root channels	
5	Forested	0–8	10 YR 4/1	100					Silt loam		Forested
		8–14	10 YR 4/2	98	5 YR 4/6	2	Concentration		Silt loam		
6	Forested	0–7	5 Y 4/1	98	5 Y 4/6	2	Concentration		Silt loam	Saturated to surface	Forested
7	Forested–Emergent boundary	0–5	5 Y 4/1	100					Muck (silt)	Saturated to surface	Forested–Emergent
8	Scrub-shrub	0–7	5 Y 4/1	98	10 YR 5/6	2	Concentration		Silt loam	Saturated to surface	Scrub-shrub
9	Forested	0–7	2.5 Y 4/1	100					Silt loam	Saturated to surface	Forested
10	Forested	0–7	2.5 Y 4/1	98	7.5 YR 4/4	2	Concentration		Silt loam	Saturated to surface	Forested
11	Emergent	0–7	2.5 Y 4/1	100					Silt loam	Saturated to surface	Emergent
12	Emergent	0–2	2.5 Y 4/1	100					Muck (silt)	Inundated	Emergent

*Soil depth, holes were dug to the depth needed to document the presence or absence of indicators of hydric soil

APPENDICES

Appendix A–Additional Site Photographs from Previous Annual Wetland Monitoring, September 2019

Appendix B–Technical Memorandum on Current Wetland Status as Delineated in August 2019

Appendix C–Previous (2018) Wetland Monitoring Report

APPENDIX A–ADDITIONAL SITE PHOTOGRAPHS FROM PREVIOUS ANNUAL WETLAND MONITORING, SEPTEMBER 2019

APPENDIX A—ADDITIONAL SITE PHOTOGRAPHS FROM ANNUAL WETLAND MONITORING, SEPTEMBER 2019

Figure 1 – Upstream boundary of project area. Area is well vegetated although there are some non-native invasive plants such as this burdock.

Figure 2 – Good vegetation coverage in wetland areas that were not flooded, soil sampling site.

Figure 3 –Developing scrub-shrub wetland.

Figure 4 – Sampling soils.

Figure 5 – Sampling soils and determining soil color using Munsell Soil Color Chart.

Figure 6 – Area designated as shrub-scrub wetlands along Cow Pen Creek.

Figure 7 – Sampling along the upstream portion of Cow Pen Creek.

Figure 8 – Sampling soils for hydric soil indicators.

Figure 9 – Some patches of invasive common reed or phragmites are present but are being controlled with herbicide and a wipe applicator.

Figure 10 – Area designated as shrub-scrub wetland near the upstream boundary of the project area.

Figure 11 – Willow and eastern cottonwood along Cow Pen Creek are about four feet tall after two years.

Figure 12 – Sampling and describing soil including depth and color.

Figure 13 – Forested wetland area along Cow Pen Creek where trees are becoming established.

Figure 14 – Area designated as emergent wetlands along Cow Pen Creek. No emergent plants at this location.

Figure 15 – Determining soil color near a planted willow trees along the bank of Cow Pen Creek.

Figure 16 – Hydric soil have a grey color and chroma value of 2 or less.

Figure 17 – Willows growing along Cow Pen Creek in an area designated as forested wetland.

Figure 18 – Low area on side of Hawthorne School designated as forested with an abundance of emergent plants including marsh fleabane and pickerel weed. Some tree seedlings have become established from natural recruitment.

Figure 19 –Low area on side of Hawthorne School designated as forested with an abundance of emergent plants. Soils saturated to the surface with some ponding.

Figure 20 – Low area on side of Hawthorne School designated as forested with soils saturated to the surface.

Figure 21 – Saplings growing in area designated as forested wetland on the Lockheed Martin side of Cow Pen Creek.

Figure 22 – Area designated as emergent wetlands along Cow Pen Creek in downstream border of the restored site.

Figure 6 – Submerged soil benches created near the downstream boundary. This area was designed to support emergent vegetation and are about 25% vegetated with additional planting planned.

APPENDIX B–TECHNICAL MEMORANDUM ON CURRENT WETLAND STATUS, AS DELINEATED IN AUGUST 2019

Lockheed Martin Corporation
6801 Rockledge Drive MP: CCT-246
Bethesda, MD 20817
Telephone 301-548-2209

January 21, 2020

VIA PRIVATE CARRIER

Matthew Wallach
Tidal Wetlands Division
Wetlands & Waterways Program
Maryland Dept. of the Environment
1800 Washington Blvd, Suite 430
Baltimore, MD 21230

Subject: Transmittal of the Reconciliation Memo on Cow Pen Creek Wetland Restoration
Lockheed Martin Corporation; Middle River Complex
2323 Eastern Boulevard, Middle River, Baltimore County, Maryland

Dear Mr. Wallach:

In response to a Maryland Department of the Environment (MDE) request at the September 23, 2019, site visit and the November 20, 2019, Joint Evaluation Committee (JEC) meeting, the following memo was developed to reconcile some outstanding issues surrounding the remediation and restoration of Cow Pen Creek. The intent of this memo is to:

1) Reconcile the designed permitted area of wetland impact with the actual wetland area of impact including both excavated and disturbed (i.e., cleared of vegetation but not excavated areas).
2) Delineate the actual impacted wetlands with respect to areas tidally influenced and non-tidally influenced based on the field-determined tide level and the highest astronomical tide.

Permitted Design Impacts and Actual Impacts to Wetlands

As per the non-tidal and tidal wetland permits, all temporary impacts to tidal and non-tidal wetlands, non-tidal and tidal stream channel, 100-year floodplain, and 25-foot tidal and non-tidal wetland buffer were to be restored/replaced in-kind at a minimum of 1:1 as depicted in the site restoration and revegetation plan. The tidal and non-tidal permits indicated that the projected impact to wetlands would be approximately 100,175 square feet (Table 1; Figure 1).

In this section, the wetlands will be evaluated in whole, combining the tidal and non-tidal areas, to more accurately determine the area that was projected to be disturbed and the actual area that was disturbed. In the following section, the actual area disturbed is delineated with respect to tidal and non-tidal wetland and this analysis will be further evaluated using two different lines of tidal influence (i.e., field-determined tidal influence line and highest astronomical tide).

To more accurately determine the area needed to be restored in-kind based on the permit conditions, the actual construction area of disturbance has been delineated. During the remediation and reconstruction, there were field adjustments that decreased the actual area impacted, including the following:

1) The dredge line was moved further upstream and more remediation was able to be completed via dredge than land-based excavation.
2) All work was accessed from the Lockheed Martin side of Cow Pen Creek and impacts on the Hawthorne side of Cow Pen Creek were limited to areas inside the line of excavation.

Therefore, the area of impact decreased from design to construction; this area was limited to only the area

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within the line of excavation and to areas disturbed outside the line of excavation (i.e., cleared for construction access and cleared to diversion water lines but not excavated). In the next section, the areas that were actually excavated, those that were disturbed (i.e., cleared but not excavated), and those that were able to be left undisturbed are delineated based on the tidal/non-tidal line using two different methods.

Tidal and Non-Tidal Wetland Delineation

During the September 23, 2019 on-site meeting to tour the restored wetlands in Cow Pen Creek, MDE tidal regulators (Matt Wallach and Danielle Spendiff) requested the Cow Pen Creek wetlands that were impacted as part of the sediment remediation be divided between non-tidal wetlands and tidal wetlands. (Note: the MDE non-tidal representative, Cheryl Kerr, was not able to attend the meeting.) Using the non-tidal/tidal line originally delineated and provided in the JPA dated November 24, 2015, the restored wetlands were divided between non-tidal and tidal. The preconstruction non-tidal and tidal wetlands were calculated based on the tide line denoted in the JPA. The non-tidal and tidal wetlands were also calculated based on the highest astronomical tide (HAT), as this was suggested by MDE as being typical for other sites. The wetlands impacted during remediation were then calculated based on the resulting non-tidal or tidal designations to determine potential impacts during construction and shortfalls in reconstruction based on the current (August 2019) wetlands delineation. The wetlands impacted were determined for two levels of impacts: excavated or disturbed. Excavated wetlands that had both the soil and vegetation removed were backfilled and revegetated; whereas disturbed wetlands only had vegetation removed and were then revegetated.

Field-Determined Tidal Influence Line from JPA Used to Recalculate Permitted Non-Tidal and Tidal Wetlands Potentially Excavated by Construction

The field-determined tidal influence line (CDM, 2009) was obtained from Figure 2, which was originally Figure 5A from the JPA. As noted in Section 4.1.1 on page 4-2 of the JPA, approximately 44,867 square feet of tidal wetlands were originally proposed to be excavated (Table 2). The impacts to non-tidal wetlands are noted in Section 5.1.1 on page 5-3 of the JPA are summarized in Table 2. Approximately 15,682 square feet of non-tidal wetlands were originally proposed to be excavated (Table 2).

Actual Non-Tidal and Tidal Wetlands Impacted Based on Field-Determined Tidal Influence Line

The field-determined tidal influence line was then extrapolated on Figure 3 (previously Figure 1-A in the JPA) to determine impacts to preconstruction wetlands (i.e., excavated or disturbed), as well as the areas of wetlands that were undisturbed by the construction (Table 3). Because the limits of dredging were able to be moved upstream, thereby reducing wetland impacts from land access, and because all land-based work was completed from the Lockheed Martin side of the creek, the total area impacted by excavation was reduced. Therefore, the total wetlands impacted by excavation decreased from what was originally projected in the design, 60,549 square feet (Table 2) to what was actually impacted during construction, 46,174 square feet (Table 3). The final total wetlands area impacted by excavation was 46,174 square feet including 30,928 square feet forested wetlands (10,019 non-tidal and 20,909 tidal); 4,792 square feet scrub-shrub wetlands (4,792 non-tidal and 0.0 tidal); and 10,454 square feet emergent wetlands (0.0 non-tidal and 10,454 tidal) (Table 3).

Actual Non-Tidal and Tidal Wetlands Impacted Based on NOAA Highest Astronomical Tide

The HAT was obtained from the National Oceanic and Atmospheric Administration (NOAA) website (https://tidesandcurrents.noaa.gov/datums.html?datum=NAVD88&units=0&epoch=0&id=8574680&name=Baltimore%2C+Fort+McHenry%2C+Patapsco+River&state=MD) for Baltimore at Fort McHenry and was 1.44 feet in NAVD88. The HAT was extrapolated on Figure 2 and was also used to determine the potential impacts to preconstruction wetlands, as well as the area of wetlands that were undisturbed by the construction (Table 4). Use of the HAT did not change the total area of wetlands potentially or actually impacted, but it changed the delineation of the area between non-tidal and tidal, with non-tidal area decreasing and the tidal area increasing.

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Current Non-tidal and Tidal Wetlands Reconstructed in Excavated Areas Based on August 2019 Delineation
The current non-tidal and tidal wetlands established at the site within the line of disturbance were determined using the wetlands delineation conducted in August 2019 on the reconstructed wetlands and applying the field-determined tidal influence line (Figure 4 (previously Figure 1-B in the JPA); Tables 5 and 6). Those wetlands that were only disturbed (i.e., cleared of vegetation for access) are considered fully restored due to vegetation that is currently thriving in those areas (Cheryl Kerr concurred with the logic of considering these wetlands to be fully restored.).

The delineated wetlands (August 2019) within the excavated area were compared to those non-tidal and tidal wetlands impacted to determine the difference (Tables 3 and 4). In total, the reconstructed and established wetlands are approximately 15,682 square feet short of achieving a 1:1 mitigation ratio with the overall wetlands that were excavated. The breakdown between forested, scrub-shrub, and emergent with non-tidal and tidal areas is summarized in Table 5 using the field-determined tide line and in Table 6 using the HAT.

Summary and Conclusions
In summary, the overall shortage of established wetlands is approximately 15,682 square feet, with approximately 89 percent or more being in the tidal zone whether the field-determined tidal influence line or the HAT line is used (Tables 5 and 6). The wetland shortage observed in the non-tidal zone is expected to fill in with time and will be monitored over the next three growing seasons. Due to the larger shortage of reestablished wetlands in the tidal zone, a revegetation plan to promote wetland vegetation expansion, including establishing forested wetlands where they were originally designed but did not establish and establishing emergent herbaceous vegetation along the wetland benches will be developed. This revegetation plan will be submitted to MDE Tidal Wetlands office for concurrence

If you have any comments, we respectfully request to receive them by as soon as possible.

I am available for your questions; my office phone is (301) 548-2209.

Sincerely,

Thomas D. Blackman
Project Lead, Environmental Remediation

cc: via email
Gary Schold, MDE
Mark Mank, MDE
Cheryl Kerr, MDE
Christine Kline, Lockheed Martin
Norman Varney, Lockheed Martin
Michael Martin, Tetra Tech
Cannon Silver, CDM Smith

cc: (via Secure Information Exchange)
Jann Richardson, Lockheed Martin
Scott Heinlein, LMCPI
Christopher Keller, LMCPI
Glen Harriel, LMCPI
Tom Green, LMCPI

cc: (via mail with enclosure)
Brian Dietz, MDE
Becky Golden, MDE
Greg Golden, DNR
Kristy Beard, NOAA
Mike Musheno, LMCPI

Tables

Table 1. Tidal and Non-Tidal Wetlands – Summary of Permitted Impacts Table - Cow Pen Creek and Dark Head Cove Sediment Remediation
Originally Table ES-1 in the Non-Tidal permit, 15NT0409.

Impact Area No. (See Figure 3.)	Non-Tidal Wetlands							Tidal Wetlands				
	Temporary Non-Tidal Stream Impacts[1]		Temporary 100-Year Floodplain Impacts[1] (Sq. Ft.)	Temporary Non-Tidal Wetland Impacts (Sq. Ft.) [1]			Temporary 25-Foot Non-Tidal Wetland Buffer Impacts (Sq. Ft.)[1]	Temporary Tidal Stream/Channel Impacts[2]			Temporary Tidal Submerged Aquatic Vegetation Impacts (Sq. Ft.) [3]	Tidal Submerged Aquatic Vegetation to be Restored/Replaced[4] (Sq. Ft.)
	LF	Sq. Ft.		Palustrine Forested	Scrub-Shrub	Emergent		CY/TONS	LF	Sq. Ft.		
1 Excavate and access clearing	700	7,394	47,459	82,957	2,795	11,765	43,723	23,600 CY	1,600	190,760	200,000	200,000
2 Dredging	-	-	-	2,658	-	-	-	4,600 CY	300	51,150	17,800	17,800
3 Dredging	-	-	-	-	-	-	-	3,500 CY	-	30,492	21,780	21,780
4 Dredging	-	-	-	-	-	-	-	3,750 CY	-	52,272	10,890	10,890
5 Dredging	-	-	-	-	-	-	-	1,200 CY	-	17,424	10,890	10,890
6 Dredging	-	-	-	-	-	-	-	3,950 CY	-	39,204	21,780	21,780
7 *In situ* Treatment	-	-	-	-	-	-	-	20 T	-	26,136	-	-
8 *In situ* Treatment	-	-	-	-	-	-	-	190 T	-	461,736	-	-
9 *In situ* Treatment	-	-	-	-	-	-	-	40 T	-	108,900	-	-
Residual Layer Fill at Outfall 005	-	-	-	-	-	-	-	970 CY	-	52,272	-	-
Sheet Pile Install in Dark Head Cove	-	-	-	-	-	-	-	500 CY	1,400	2,100	-	-
Totals	700	7,394	47,459	85,615	2,795	11,765	43,723	42,070/250	3,300	1,032,446	283,140	283,140
GRAND TOTAL	**Non-Tidal Stream Impacted[1] = 700 LF / 7,394 Sq. Ft.**		**Floodplain Impacted[1] = 47, 459 Sq. Ft.**	**Non-tidal Wetlands Impacted[1] = 100,175 Sq. Ft.**			**Buffer Impacted[1] = 43,723 Sq. Ft.**	**Tidal Stream/Channel Impacted[2] = 3,300 LF / 1,032,446 Sq. Ft. 42,070 CY and 250 T**			**Submerged Aquatic Vegetation Impacted[3] = 283, 140 Sq. Ft.**	**Submerged Aquatic Vegetation Restored[4] = 283,140**

1. All temporary impacts to non-tidal wetlands, non-tidal stream channel, 100-year floodplain, and 25-foot non-tidal wetland buffer will be restored/replaced in-kind at a minimum of 1:1 as depicted in the site restoration and revegetation plan.
2. Impacts to the stream/channel bottom from excavation, dredging, *in situ* treatment, and placement of the residual management layer are expected to be restored naturally over time through recolonization of benthic community.
3. Rake cover density in these areas ranged between 5% and 15% cover.
4. Per the Submerged Aquatic Vegetation mitigation plan, the minimum target rake cover density in these areas will match preconstruction values.

Table 2. Summary of proposed impacts inside the limits of excavation referenced in the JPA (page 3-3) using the field-determined tidal/non-tidal boundary.

Wetlands Type	Non-Tidal (Sq. Ft.)	Tidal (Sq. Ft.)	Total (Sq. Ft.)
Forested	13,068[a]	34,848	47,916
Scrub-Shrub	2,614	0.00	2,614
Emergent	0.00	10,019	10,019
Total	15,682	44,867	60,549

[a] – 12,197 sq. ft. excavation; 871 sq. ft. clearing

Table 3. Summary of undisturbed non-tidal and tidal wetlands by type and total, as well as the actual total impacted overall wetlands using the field-determined tidal influence line (CDM, 2009) to delineate between non-tidal and tidal.

	Undisturbed by Construction (Sq. Ft.)			Disturbed but Not Excavated During Construction Using Field-Determined Tide Line (Sq. Ft.)			Excavated During Construction Using Field- Determined Tide Line (Sq. Ft.)			Total Wetlands (Sq. Ft.)
Wetlands Type	Tidal	Non-Tidal	Total	Tidal	Non-Tidal	Total	Tidal	Non-Tidal	Total	
Forested	29,621	3,920	33,541	9,583	4,792	14,375	20,909	10,019	30,928	78,844
Scrub-Shrub	0.00	2,614	2,614	0.00	2,178	2,178	0.00	4,792	4,792	9,584
Emergent	1,307	0.00	1,307	0.00	0.00	0.00	10,454	0.00	10,454	11,761
Total	30,928	6,534	37,462	9,583	6,970	16,553	31,363	14,811	46,174	100,189

Table 4. Summary of undisturbed non-tidal and tidal wetlands by type and total, as well as the actual total impacted overall wetlands using the highest astronomical tide line (NOAA, 2019) to delineate between non-tidal and tidal.

	Undisturbed by Construction (acres)			Disturbed but Not Excavated During Construction Using Highest Astronomical Tide (acres)			Excavated During Construction Using Highest Astronomical Tide (acres)			Total Wetlands (acres)
Wetlands Type	Tidal	Non-Tidal	Total	Tidal	Non-Tidal	Total	Tidal	Non-Tidal	Total	
Forested	31,363	2,178	33,541	13,939	436	14,375	30,056	871	30,928	78,843
Scrub-Shrub	0.00	2,614	2,614	436	1,742	2,178	2,614	2,178	4,792	9,584
Emergent	1,307	0.00	1,307	0.00	0.00	0.00	10,454	0.00	10,454	11,761
Total	32,670	4,792	37,462	14,375	2,178	16,553	43,124	3,049	46,174	100,188

Table 5. Summary of impacted non-tidal and tidal wetlands including forested, scrub-shrub, and emergent and current (August 2019) reconstructed wetlands within excavation boundary based on field-determined tidal influence line (CDM, 2009).

Wetlands Type	Non-Tidal (Sq. Ft.)			Tidal (acres)			Total (acres)		
	Preconstruction Wetlands Excavated	Current Reconstructed Wetlands within Excavation Boundary	Difference	Preconstruction Wetlands Excavated	Current Reconstructed Wetlands within Excavation Boundary	Difference	Preconstruction Wetlands Excavated	Current Reconstructed Wetlands within Excavation Boundary	Difference
Forested	10,019	7,841	-2,178	20,909	6,098	-14,811	30,928	13,939	-16,989
Scrub-Shrub	4,792	4,792	0.00	0.00	0.00	0.00	4,792	4,792	0.00
Emergent	0.00	436	+436	10,454	11,326	+872	10,454	11,761	+1,307
Total	**14,811**	**13,069**	**-1,742**	**31,363**	**17,424**	**-13,939**	**46,174**	**30,492**	**-15,682**

Table 6. Summary of impacted non-tidal and tidal wetlands including forested, scrub-shrub, and emergent and current (August 2019) reconstructed wetlands within excavation boundary based on highest astronomical tide line (NOAA, 2019).

Wetlands Type	Non-Tidal (acres)			Tidal (acres)			Total (acres)		
	Pre-construction Wetlands Excavated	Current Reconstructed Wetlands within Excavation Boundary	Difference	Preconstruction Wetlands Excavated	Current Reconstructed Wetlands within Excavation Boundary	Difference	Preconstruction Wetlands Excavated	Current Reconstructed Wetlands within Excavation Boundary	Difference
Forested	871	436	-435	30,056	13,504	-16,552	30,928	13,939	-16,989
Scrub-Shrub	2,178	1742	-436	2,614	3,049	+435	4,792	4,792	0.00
Emergent	0.00	0.00	0.00	10,454	11,761	+1,307	10,454	11,761	+1,307
Total	**3,049**	**2,178**	**-871**	**43,124**	**28,314**	**-14,810**	**46,174**	**30,492**	**-15,682**

Figures

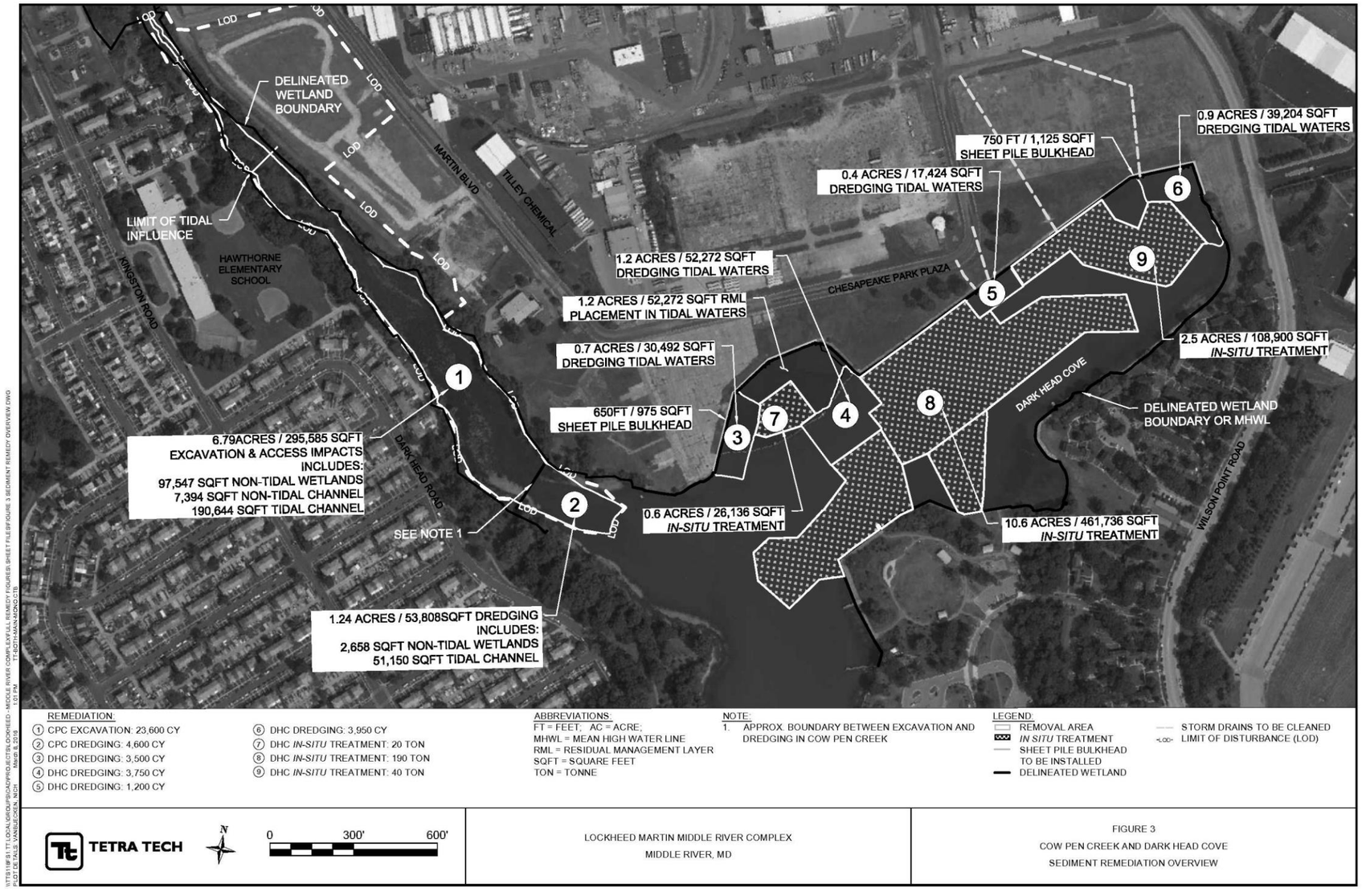


Figure 1. Delineation of impacted areas as noted in the non-tidal permit (originally Figure 3 from Tidal and Non-Tidal permits).

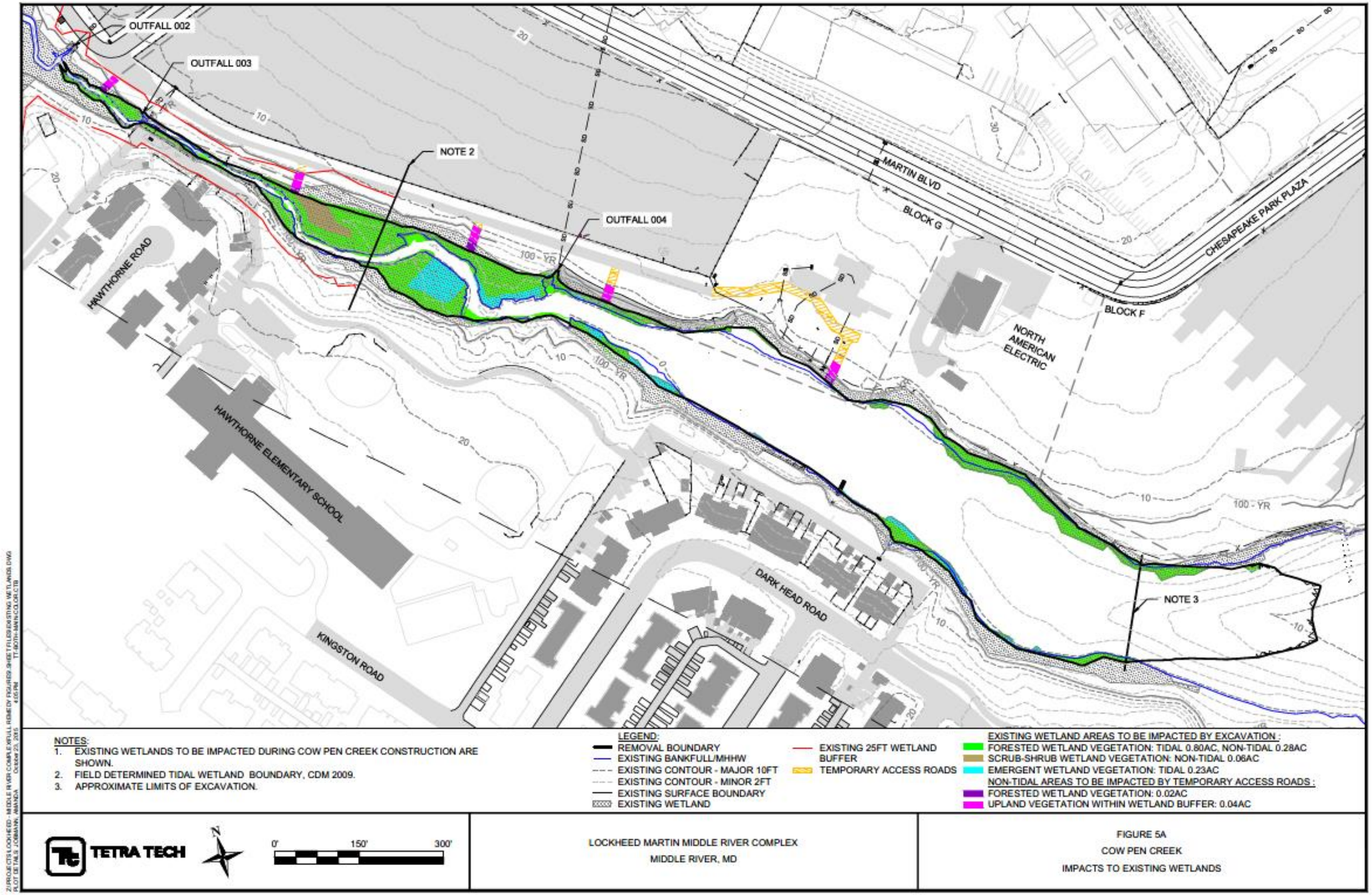
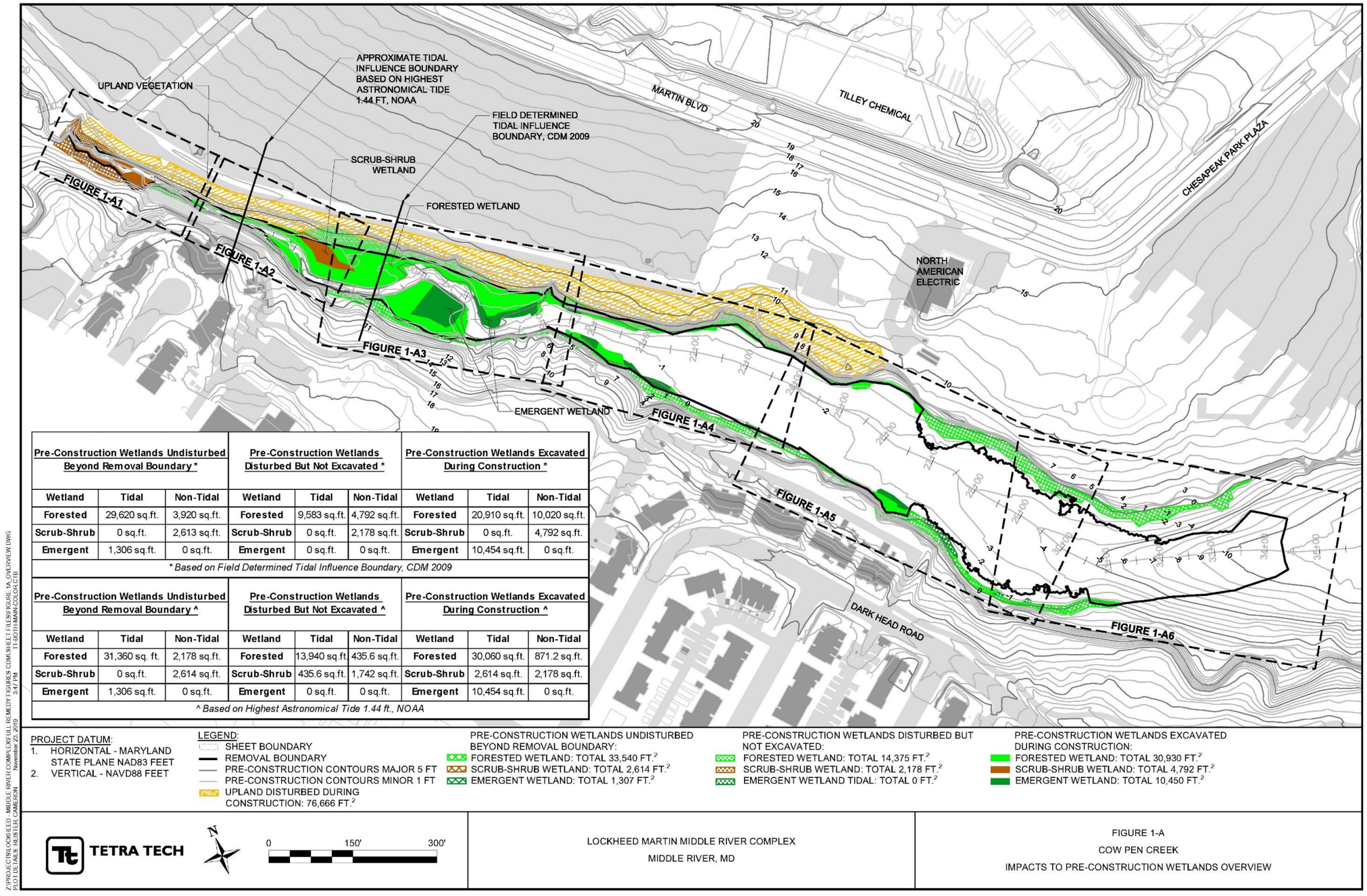


Figure 2. Original figure from Sediment Remedy Environmental Assessment denoting the field-determined tidal influence line (CDM, 2009)



Pre-Construction Wetlands Undisturbed Beyond Removal Boundary *			Pre-Construction Wetlands Disturbed But Not Excavated *			Pre-Construction Wetlands Excavated During Construction *		
Wetland	**Tidal**	**Non-Tidal**	**Wetland**	**Tidal**	**Non-Tidal**	**Wetland**	**Tidal**	**Non-Tidal**
Forested	29,620 sq.ft.	3,920 sq.ft.	**Forested**	9,583 sq.ft.	4,792 sq.ft.	**Forested**	20,910 sq.ft.	10,020 sq.ft.
Scrub-Shrub	0 sq.ft.	2,613 sq.ft.	**Scrub-Shrub**	0 sq.ft.	2,178 sq.ft.	**Scrub-Shrub**	0 sq.ft.	4,792 sq.ft.
Emergent	1,306 sq.ft.	0 sq.ft.	**Emergent**	0 sq.ft.	0 sq.ft.	**Emergent**	10,454 sq.ft.	0 sq.ft.

** Based on Field Determined Tidal Influence Boundary, CDM 2009*

Pre-Construction Wetlands Undisturbed Beyond Removal Boundary ^			Pre-Construction Wetlands Disturbed But Not Excavated ^			Pre-Construction Wetlands Excavated During Construction ^		
Wetland	**Tidal**	**Non-Tidal**	**Wetland**	**Tidal**	**Non-Tidal**	**Wetland**	**Tidal**	**Non-Tidal**
Forested	31,360 sq. ft.	2,178 sq.ft.	**Forested**	13,940 sq.ft.	435.6 sq.ft.	**Forested**	30,060 sq.ft.	871.2 sq.ft.
Scrub-Shrub	0 sq.ft.	2,614 sq.ft.	**Scrub-Shrub**	435.6 sq.ft.	1,742 sq.ft.	**Scrub-Shrub**	2,614 sq.ft.	2,178 sq.ft.
Emergent	1,306 sq.ft.	0 sq.ft.	**Emergent**	0 sq.ft.	0 sq.ft.	**Emergent**	10,454 sq.ft.	0 sq.ft.

^ Based on Highest Astronomical Tide 1.44 ft., NOAA

PROJECT DATUM:
1. HORIZONTAL - MARYLAND STATE PLANE NAD83 FEET
2. VERTICAL - NAVD88 FEET

LEGEND:
- SHEET BOUNDARY
- REMOVAL BOUNDARY
- PRE-CONSTRUCTION CONTOURS MAJOR 5 FT
- PRE-CONSTRUCTION CONTOURS MINOR 1 FT
- UPLAND DISTURBED DURING CONSTRUCTION: 76,666 FT.^{2}

PRE-CONSTRUCTION WETLANDS UNDISTURBED BEYOND REMOVAL BOUNDARY:
- FORESTED WETLAND: TOTAL 33,540 FT.^{2}
- SCRUB-SHRUB WETLAND: TOTAL 2,614 FT.^{2}
- EMERGENT WETLAND: TOTAL 1,307 FT.^{2}

PRE-CONSTRUCTION WETLANDS DISTURBED BUT NOT EXCAVATED:
- FORESTED WETLAND: TOTAL 14,375 FT.^{2}
- SCRUB-SHRUB WETLAND: TOTAL 2,178 FT.^{2}
- EMERGENT WETLAND TIDAL: TOTAL 0 FT.^{2}

PRE-CONSTRUCTION WETLANDS EXCAVATED DURING CONSTRUCTION:
- FORESTED WETLAND: TOTAL 30,930 FT.^{2}
- SCRUB-SHRUB WETLAND: TOTAL 4,792 FT.^{2}
- EMERGENT WETLAND: TOTAL 10,450 FT.^{2}

TETRA TECH

0 150' 300'

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MD

FIGURE 1-A
COW PEN CREEK
IMPACTS TO PRE-CONSTRUCTION WETLANDS OVERVIEW

Z:\PROJECTS\LOCKHEED - MIDDLE RIVER COMPLEX\FULL REMEDY FIGURES CDM\SHEET FILES\FIGURE 1A_OVERVIEW.DWG
PLOT DETAILS: REUSTER, CAMERON November 23, 2019 3:47 PM TT-BOTHMANN-COLOR.CTB

Figure 3. Impacts to preconstruction wetlands based on the field-determined tidal influence line (CDM, 2009) and highest astronomical tide (NOAA, 2019)

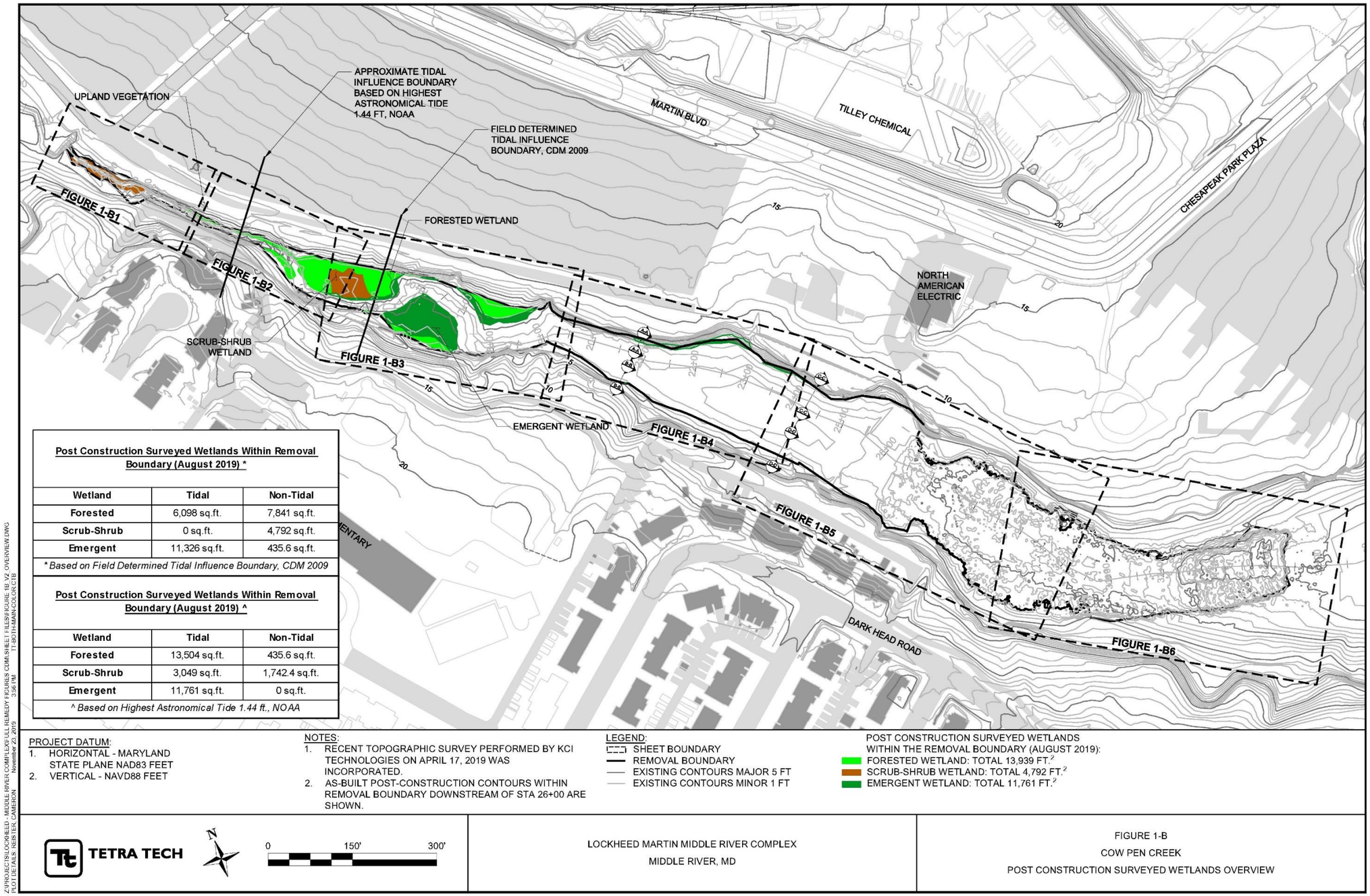


Figure 4. Current post-reconstruction wetlands based on the field-determined tidal influence line (CDM, 2009) and highest astronomical tide (NOAA, 2019).

APPENDIX C–PREVIOUS (2018) WETLAND MONITORING REPORT

Lockheed Martin Corporation
6801 Rockledge Drive MP: CCT-246
Bethesda, MD 20817
Telephone 301-548-2209

January 4, 2019

VIA PRIVATE CARRIER

Cheryl Kerr
Nontidal Wetlands Division
Wetlands & Waterways Program
Maryland Dept. of the Environment
1800 Washington Blvd, Suite 430
Baltimore, MD 21230

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

Dear Ms. Kerr:

For your information, please find enclosed two hard copies with a CD of the above-referenced document. This report describes the results from the initial site monitoring, per the methods outlined in *Cow Pen Creek Wetland Restoration Monitoring Work Plan* (Tetra Tech, November 2017).

If you have any comments, we respectfully request to receive them by February 15, 2019.

I am available for your questions; my office phone is (301) 548-2209.

Sincerely,

Thomas D. Blackman
Project Lead, Environmental Remediation

cc: via email (without enclosure)
James Carroll, MDE
Gary Schold, MDE
Mark Mank, MDE
Matthew Wallach, MDE
Christine Kline, Lockheed Martin
Norman Varney, Lockheed Martin
Michael Martin, Tetra Tech
Cannon Silver, CDM Smith

cc: via hard copy:
Tom Green, LMCPI
Mike Musheno, LMCPI

cc: via RMFT (electronic file transfer)
Jann Richardson, Lockheed Martin
Scott Heinlein, LMCPI
Christopher Keller, LMCPI
Glen Harriel, LMCPI

Lockheed Martin Corporation
6801 Rockledge Drive MP: CCT-246
Bethesda, MD 20817
Telephone 301-548-2209

January 4, 2019

VIA PRIVATE CARRIER

Matthew Wallach
Tidal Wetlands Division
Wetlands & Waterways Program
Maryland Dept. of the Environment
1800 Washington Blvd, Suite 430
Baltimore, MD 21230

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

Dear Mr. Wallach:

For your information please find enclosed two hard copies with a CD of the above-referenced document. This report describes the results from the initial site monitoring, per the methods outlined in *Cow Pen Creek Wetland Restoration Monitoring Work Plan* (Tetra Tech, November 2017).

If you have any comments, we respectfully request to receive them by February 15, 2019.

I am available for your questions; my office phone is (301) 548-2209.

Sincerely,

Thomas D. Blackman
Project Lead, Environmental Remediation

cc: (via email without enclosure)
Gary Schold, MDE
Mark Mank, MDE
Cheryl Kerr, MDE
Christine Kline, Lockheed Martin
Norman Varney, Lockheed Martin
Michael Martin, Tetra Tech
Cannon Silver, CDM Smith

cc: (via mail with enclosure)
James Carroll, MDE
Becky Golden, MDE
Greg Golden, DNR
Kristy Beard, NOAA
Tom Green, LMCPI
Mike Musheno, LMCPI

cc: (via Secure Information Exchange)
Jann Richardson, Lockheed Martin
Scott Heinlein, LMCPI
Christopher Keller, LMCPI
Glen Harriel, LMCPI

COW PEN CREEK
WETLAND RESTORATION MONITORING REPORT
2323 EASTERN BOULEVARD
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Prepared for:
Lockheed Martin Corporation

Prepared by:
Tetra Tech, Inc.

January 2019

Revision: 0

Michael Martin, P.G.
Regional Manager

Bob Murphy
Project Manager

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ACRONYMS AND ABBREVIATIONS

FAC	facultative species
ft^2	square feet
GIS	geographic information system
GPS	global positioning system
IRT	Interagency Review Team
Lockheed Martin	Lockheed Martin Corporation
MAA	Maryland Aviation Administration
MDE	Maryland Department of the Environment
MRC	Middle River Complex
OBL	obligate
SAV	submerged aquatic vegetation
Tetra Tech	Tetra Tech, Inc.
USACE	United States Army Corps of Engineers

SECTION 1
INTRODUCTION

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech Inc. (Tetra Tech) has prepared the following monitoring report documenting wetland restoration after sediment remediation was completed resulting from completion of the sediment remediation project at the end of 2017. Cow Pen Creek is located adjacent to the Lockheed Martin Middle River Complex (MRC) in Middle River, Maryland.

1.1 PURPOSE OF THE WETLAND RESTORATION, MONITORING, AND MAINTENANCE

As part of the sediment remedy at the Middle River Complex, the upper portion of Cow Pen Creek, including both the stream channel and adjacent floodplain area, was excavated to remove contaminated sediment. Following excavation, the areas were restored as per the approved project design (Tetra Tech, 2016a, 2016b). The restoration included reconstruction of the main channel and floodplains, placement of new channel substrate, streambank stabilization and vegetation, wetlands restoration, and revegetation of areas disturbed by sediment removal. The overall goal of restoration and mitigation was to replace the extent, function, and value for Cow Pen Creek wetlands and waters impacted by the remediation project. Documentation of the sediment removal action is provided in the *Season Two Cow Pen Creek Sediment Remedy Completion Report* (Tetra Tech, 2018a).

During remediation approximately 1.5 acres of channel substrate were removed and replaced with clean material. During the removal process and reconstruction of the stream, approximately four acres of vegetated habitat, including wetlands, were destroyed. The stream channel reconfiguration included wetland restoration, comprised of forested, scrub/shrub, and emergent (herbaceous) wetlands along Cow Pen Creek. This monitoring report focuses on wetlands restoration. As per the approved work plan (Tetra Tech, 2017), there are no established metrics to measure success of the wetland restoration. Tetra Tech will compare annual data in each subsequent monitoring report to determine whether the wetlands are improving in terms of the ground coverage, plant species,

and the goals and objectives established in the *Maryland Nontidal Wetland Mitigation Guidance* (MDE, 2011), by the end of the five-year monitoring period including:

a) Greater than 85% of the wetland mitigation site will be vegetated (either by planted or naturally revegetated plants) by native wetland species like those found in the nontidal wetland lost, or by a species composition acceptable to the Nontidal Wetlands and Waterways Division. Vegetative communities not acceptable to the Division would include those communities dominated by common reed (Phragmites australis) or other nuisance vegetation, or communities that are dominated by facultative upland or upland species.

b) The entire wetland restoration or creation area must have sufficient hydrology to support a prevalence of wetland vegetation. The Army Corps of Engineers and United States Environmental Protection Agency define wetlands as "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

c) For this determination, wetland vegetation is that which is readily observable in the field and can easily be used to help identify the extent of the wetland area. The area will be evaluated to determine the extent of the wetland and that the entire area meets the definition of a wetland using the appropriate regional supplement to the Corps of Engineers Wetland Delineation Manual.

d) The entire wetland restoration or creation area must meet the Hydric Soil Technical Standard developed by the National Technical Committee for Hydric Soils for saturated conditions and aerobic conditions (USDA 2015).

e) The site will provide the functional goals and objectives established in the Maryland Nontidal Wetland Mitigation Guidance (MDE, 2011; Appendix F).

1.2 OBJECTIVES

The restoration area is shown on Figure 1-1. The specific objectives of wetland monitoring are:

- monitor wetland vegetation along and in Cow Pen Creek
- maintain vegetation within Cow Pen Creek, as needed

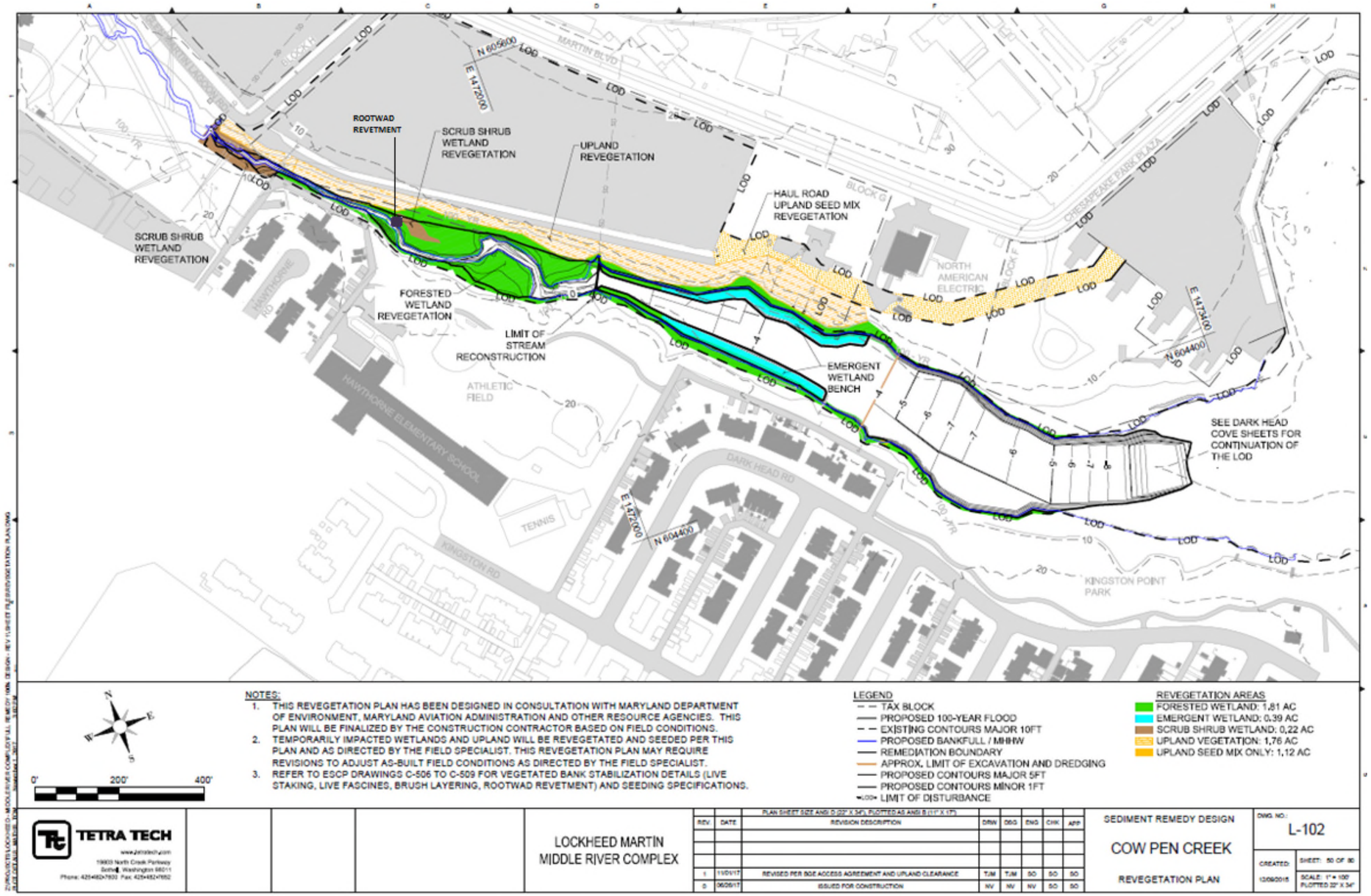

Figure 1-1 Wetland restoration monitoring area.

SECTION 2
EXISTING SITE CONDITIONS AND BACKGROUND

The Lockheed Martin Middle River Complex (MRC), 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 site is approximately 161 acres and includes 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 2-1).

Lockheed Martin started the removal of contaminated sediment from Dark Head Cove and Cow Pen Creek in 2014. Portions of Dark Head Cove and the lower reaches of Cow Pen Creek were conventionally dredged, and the sediment surface was restored by placing a six-inch-thick sand layer (residual management layer). During the remedial action in the upstream portion of Cow Pen Creek, approximately four acres of vegetated habitat including wetlands were damaged or removed. Wetlands are an important habitat for a variety of organisms, including ecologically important fish and invertebrate species (Brinson and Rheinhardt 1996). In addition, wetlands, particularly in the freshwater and oligohaline portions of the Middle River and Chesapeake Bay, provide an excellent food source for several waterfowl species. In response to the temporary loss of these ecosystems, and in compliance with a United States Army Corps of Engineers (USACE) permit and Maryland Department of the Environment (MDE) Tidal Wetlands License, Lockheed Martin implemented a wetland restoration project in 2017-2018. After sediment removal and stream reconstruction was completed, wetland areas were planted along both banks of Cow Pen Creek (see Figure 1-1).

Existing functions and values (e.g., habitat, physical and chemical conditions, scenic, recreational, and other values) in the floodplain of Cow Pen Creek were restored to the extent practicable

following the removal of contaminated soil. The restoration plan was developed to replace specific functions and values by designing features to provide habitat, provide moderate flood flow, stabilize the shoreline and retain sediment, remove toxicants, and provide aesthetic and recreational values. Restored features included replanting emergent vegetation to restore/improve fisheries habitat, and replanting floodplain forest/shrub vegetation to moderate flood-flow, stabilize shorelines, and retain sediment to aid toxicant reduction. Other features, including replanting of riparian vegetation, were designed to restore visual/aesthetic appeal of the stream corridor. Stream restoration features are detailed in the design documents (Tetra Tech, 2016a, 2016b).

Under the approved work plan, wetland vegetation was monitored in 2018 for forested/scrub-shrub system during the growing season (between May 1 and September 30) and for emergent systems between June 15 and September 30. Subsequent maintenance activities will be conducted twice annually, in the spring and in the fall: the spring maintenance will take place between May 1 and 30, and the fall maintenance will take place between September 15 and October 31.

Figure 2-1 Location of Cow Pen Creek and Dark Head Cove near the Middle River Complex.

SECTION 3
WETLAND MONITORING AND DATA COLLECTION

3.1 ACTIVITIES PERFORMED

Tetra Tech conducted annual monitoring of restored wetlands of Cow Pen Creek on July 26, 2018. The wetland vegetation survey and data collection were conducted in accordance with the methods specified in the approved *Cow Pen Creek Wetland Restoration Monitoring Work Plan* (Tetra Tech, 2017).

Plots were randomly selected using a geographic information system (GIS)-based system and a map of the restored area, using site parameters (e.g., total plot area) to ensure sampling plots fell completely within the target habitat type (Figure 3-1). The following were observations or counts were made in each plot. 1. dominant plants species were identified, 2. dominant species percent survival, 3. percent ground cover estimated, 4. woody stem counts, 5. invasive present, 6. percent invasive groundcover (Table 3-1).

Developing vegetation and habitats were assessed using at least the minimum number of sampling plots recommended in the Interagency Review Team (IRT) protocol; therefore, three 400 square foot (ft^2) randomly located sampling plots were monitored in the scrub-shrub habitat, while four 400 ft^2 plots in forest-dominated habitats, and two three-foot by three-foot sample plots, were randomly assessed in the herbaceous dominated community (Table 3-1). Figure 3-1 shows the location of the wetland sampling plots.

Figure 3-1 Map of wetland monitoring plot locations.

Observations were made, and data were collected to assess:

1. dominant vegetative species identification (all plots)
2. percent ground cover (all plots)
3. number of woody plant stems greater than 10 inches in height (total and number per acre–forest and scrub/shrub plots only)
4. percentage of dominant facultative species (FAC) or wetter (all plots) (facultative species are plant species that are equally likely to occur in wetlands [estimated probability 34% – 66%] or non-wetlands)
5. percent survival by planted species (all plots)
6. invasive/noxious species, including percent cover (all plots)

Other recorded data at each sampling plot included indicators of wetland hydrology and soil data (Table 3-2). On-site monitoring also documented bare spots comprised of more than 10 ft^2, areas of erosion, and areas of failed vegetation relative to the sampling plots. A photo point was established adjacent to each sampled plot, and a photograph was taken of each developing wetland area. Photo and sampling points were located using global positioning system (GPS) instruments, and locations were plotted on aerial photographic maps. The directionality of each photograph taken, as well as the habitat type photographed, were recorded.

3.2 RECORDED OBSERVATIONS

Sampling locations (numbered 1 through 9) are shown on Figure 3-1. Table 3-1 provides a summary of vegetation data observed and recorded at each site, corresponding to the monitoring and data collection objectives (see Section 3-1).

Table 3-1
Vegetation Data Recorded during 2018 Wetland Monitoring
Middle River Complex, Middle River, Maryland

Plot ID	Latitude	Longitude	Wetland type	Dominant vegetation	Ground cover (%)	Woody stem (count)	Dominant species (%)	Woody Plantings Survival (%)	Invasive species present (yes/no)	Invasive ground cover (%)
WP1	39.3280	-76.4375	Scrub-Shrub Wetland	*Agrostis stolonifera*	100	9	95	100	no	0
WP2	39.3272	-76.4365	Scrub-Shrub Wetland	*Agrostis stolonifera*	95	25	85	100	no	0
WP3	39.3272	-76.4364	Scrub-Shrub Wetland	None	0	0	0	0	no	0
WP4	39.3271	-76.4362	Forested Wetland	*Agrostis stolonifera*	95	11	90	100	no	0
WP5	39.3263	-76.4350	Emergent Wetland	*None*	0	0	0	0	no	0
WP6	39.3268	-76.4359	Forested Wetland	*Agrostis stolonifera*	10	9	5	40	yes	5
WP7	39.3267	-76.4355	Forested Wetland	*Agrostis stolonifera*	60	10	50	70	no	0
WP8	39.3265	-76.4350	Emergent Wetland	None	0	0	0	0	no	0
WP9	39.3268	-76.4360	Forested Wetland	*Agrostis stolonifera, Ceratophyllum demersum*	20	8	20	< 10%	yes	10

Table 3-2
Soil and Wetland Hydrology Observations
Middle River Complex, Middle River, Maryland

Plot ID	Latitude	Longitude	Designed Wetland Type	Wetland Type Based on Field Monitoring	Hydric Soil	Wetland Hydrology
WP1	39.3280	-76.4375	Scrub-Shrub Wetland	Scrub/Shrub	Developing	Soil Saturated to or near the surface
WP2	39.3272	-76.4365	Scrub/Shrub Wetland	Scrub/Shrub Wetland	Developing	Soil Saturated to or near the surface
WP3	39.3272	-76.4364	Scrub/Shrub Wetland	Scrub/Shrub Wetland	Developing	Soil inundated (flooded)
WP4	39.3271	-76.4362	Forested Wetland	Forested Wetland	Developing	Soil Saturated to or near the surface
WP5	39.3263	-76.4350	Emergent Wetland	Non-Vegetated	Developing	Inundated (flooded)
WP6	39.3268	-76.4359	Forested Wetland	Emergent and SAV	Developing	Inundated (flooded)
WP7	39.3267	-76.4355	Forested Wetland	Emergent and SAV	Developing	Inundated (flooded) or saturated to the surface
WP8	39.3265	-76.4350	Emergent Wetland	Non-Vegetated, Emergent	Developing	Inundated
WP9	39.3268	-76.4360	Forested Wetland	Emergent and SAV	Developing	Inundated

3.2.1 Wetland Plot Descriptions

The following section describes in detail the monitoring locations used to assess the wetland restoration. A qualitative assessment of each habitat type can be made using these descriptions and the tabulated summary of observations (Tables 3-1 and 3-2). An assessment of each sampling location is presented below.

WP1 (Appendix A: DWG L-103): This scrub-shrub wetland monitoring location is between stormwater Outfalls 002 and 003 (Figure 3-2). Ground cover is 100% with no bare spots, and the dominant herbaceous vegetation (with 95% coverage) is creeping bentgrass (*Agrostis stolonifera*), that was seeded according to the approved seed mix for wetland areas. Woody stem count in this plot was 9 and there appears to be 100% survival of planted woody material since no dead shrubs were observed (Table 3-1). Soil in the monitoring location was wet or saturated at the surface. Although not within the boundary of this plot, common reed should be monitored because it is growing adjacent to the site under the power lines. Three or four stems of what appears to be narrowleaf cattail (*Typha augustifolia*) are growing adjacent to the plot and can become an aggressive colonizer forming a mono-culture. No invasive ground cover was observed in the plot.

Figure 3-2 WP1 Photo looking southwest away from Martin Boulevard. Dominant herbaceous vegetation is creeping bentgrass. Planted small trees and shrubs are visible.

WP2 (Appendix A: DWG L-104): This scrub-shrub wetland monitoring location is near the center of the area designated on Figure 1-1 as scrub-shrub wetland vegetation (Figure 3-3). The vegetation at this plot is like the scrub-shrub of WP1. Ground cover was 90% with a few small bare spots, and the dominant herbaceous vegetation (with 85% coverage) is creeping bentgrass, which was seeded according to the approved seed mix for wetland areas. Woody stem count in this plot was 25 with survival greater than 90% (Table 3-1). Soil in this monitoring location was wet or saturated at the surface. No invasive plants were observed within this plot.

Figure 3-3 WP2 Photo looking southwest away from Martin Boulevard. Stream is in the foreground before the mature tree line. Planted vegetation is doing well in this area.

WP3 (Appendix A: DWG L-104): This scrub-shrub sampling plot is downstream or southeast of sampling plot WP2 (Figure 3-4). No woody stems (shrubs or trees) were observed within the sampling plot (0% woody plantings survival, Table 3-1). Signs of woody vegetation have disappeared at this monitoring location. The area inside this plot appeared to be continuously flooded due to the presence of algae and submerged aquatic vegetation (SAV). Shrubs and or trees that are typically grown in nursery potting mixes may not survive in not preconditioned for areas that are continually saturated or have inundated soils, Hibiscus or Button Bush would likely survive with the best chance of survival when grown in (or pre-conditioned) to saturated soils. The areas adjacent to WP3 contained both live and dead woody plants. No invasive ground cover or woody plants were observed within the plot.

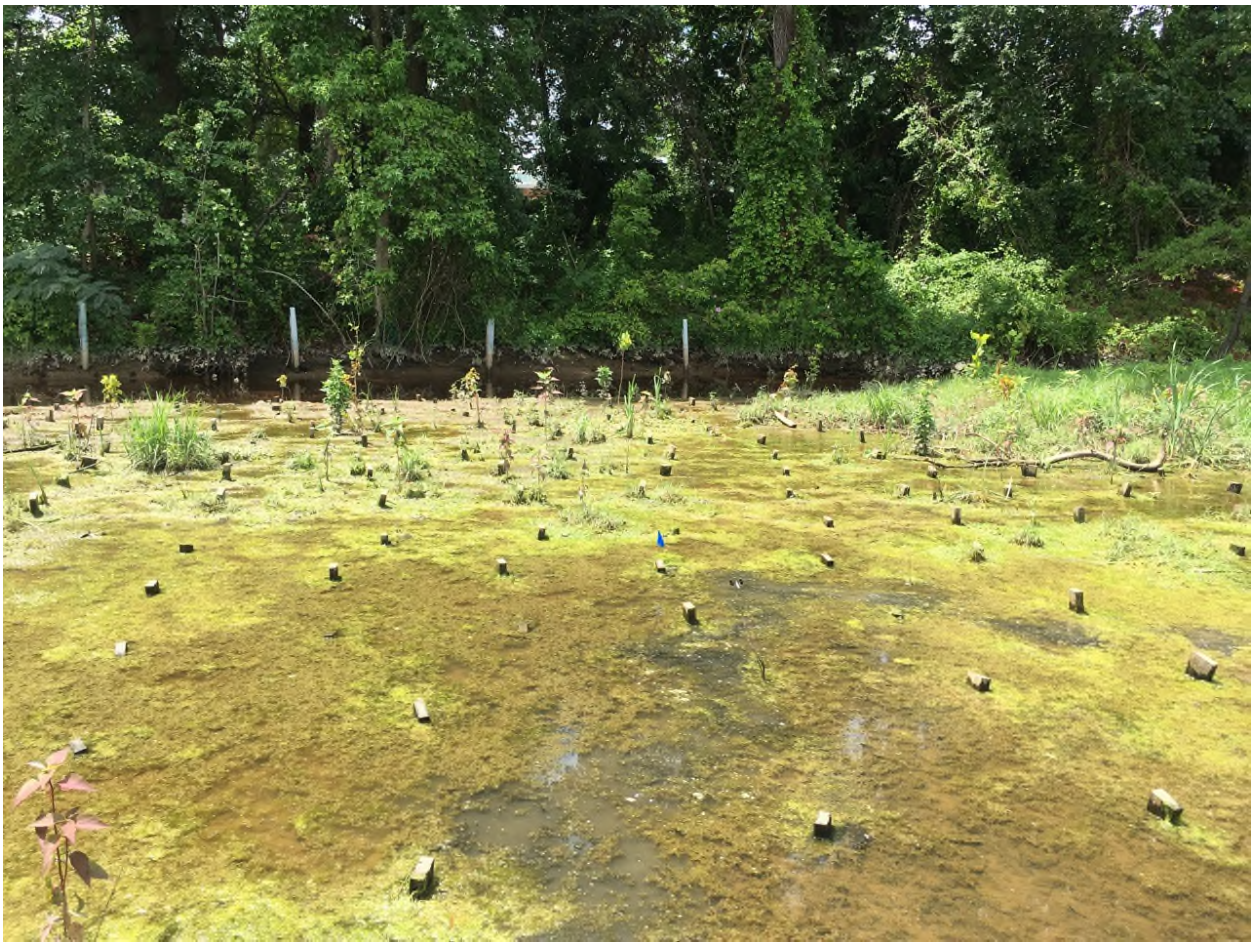

Figure 3-4 WP3 Photo looking southwest away from Martin Boulevard. This area appears to be semi-permanent or permanently flooded. Shrubs such as Hibiscus or Button Bush would likely survive here but they probably need to be conditioned before planting to the flooded anaerobic soil.

WP4 (Appendix A: DWG L-104): This forested wetland sampling location is downstream and southeast of the WP3 plot and is bordered on the south and east by flooded areas (Figure 3-5). Ground cover is 95% with a few small bare spots, and the dominant herbaceous vegetation (with 90% coverage) is the creeping bentgrass that was seeded according to the approved seed mix for wetland areas. Adjacent to the plot, flooded areas lacked ground cover and contained SAV and algae due to prolonged flooded conditions. Woody stem count in this plot was 11, and survival appears to be 100% since no dead shrubs or trees were observed (Table 3-1). Soil in the monitoring location was wet or saturated at the surface. No invasive ground cover was observed within the plot.

Figure 3-5 WP4 Photo looking down Cow Pen Creek. Soils are saturated to the surface, herbaceous vegetation, shrubs, and trees are doing well.

WP5 (Appendix A: DWG L-105): This emergent wetland plot is on the southeast shoreline of Cow Pen Creek, downstream of the farthest downstream forested wetland area (Figure 3-6). The shoreline is relatively steep and rapidly transitions to upland forest. This area was flooded at the time of sampling, and no emergent vegetation was found during sampling within the sampling plot. There was a small stand of emergent vegetation consisting of pickerelweed (*Pontederia cordata*) downstream but outside of the plot area. Overall none of the planted emergent vegetation survived in this emergent wetland plot (Table 3-1).

Figure 3-6 WP5 Photo of near-shore emergent zone. No emergent vegetation was observed.

WP6 (Appendix A: DWG L-105): This forested wetland plot is on the southeastern shore where the creek bends with the resulting forested wetland along the shore (Figure 3-7). The sampling plot and adjacent areas appear to have been flooded with at least a few inches of water for long periods of time. The flooded soils are 70% covered with algae and SAV. Approximately 10% of the area is at water level and is vegetated with creeping bentgrass, the dominant herbaceous vegetation. Woody plants are mostly trees with protective tree tubes in place. Only 40% of the woody vegetation in this plot is alive, most likely due to the flooded conditions (Table 3-1). As noted previously, shrubs and or trees planted in continually saturated or inundated soils have the best chance of survival when grown in or pre-conditioned to saturated soils, as compared to those grown in typical nursery potting mixes then planted in anaerobic soils. The forested wetland areas adjacent to this plot contained both live and dead woody plants. No invasive herbaceous plants or woody plants were observed within the plot.

Figure 3-7 WP6 Photo of southern shore looking northeast. This area is shown on the design plan as forested wetland, but the area appears to be continually flooded; that may be the reason for limited survival.

WP7 (Appendix A: DWG L-105): This forested wetland plot is on the northwestern shore, downstream from WP6 and is the farthest downstream area of forested wetland (Figure 3-8). The soils transition from saturated at the surface to inundated or flooded. The trees and shrubs that are in areas prone to flooding have a low survival rate, while woody plants that have not been subject to flooding and are in wetland areas have a higher survival rate. Ground cover was 50% with a few small bare spots, the dominant herbaceous vegetation (with 50% coverage) is creeping bentgrass. No ground cover or SAV were observed within the flooded area of the plot. Woody stem count was 10 with no dead woody plants observed (Table 3-1). Dead woody plants were observed in the flooded area beyond the plot. Groundsel bush (*Baccharis halimifolia*) appeared as six to ten stems adjacent to the plot and appeared to have established by natural recruitment.

Figure 3-8 WP7 Photo looking southwest away from Martin Boulevard. Vegetation on soils that are not inundated is surviving. Dominant herbaceous vegetation is creeping bentgrass. Note groundsel bush (*Baccharis halimifolia*) on the right in the water appears to have established from natural recruitment.

WP8 (Appendix A: DWG L-106): This emergent wetland sampling plot is on the northwestern shore, downstream from the forested wetland areas (Figure 3-9). The plot was flooded at the time of sampling, no emergent vegetation or any vegetation was observed at the sampling point (Table 3-1). It is possible no vegetation was observed due to limited visibility.

Figure 3-9 WP8 Photo of emergent wetland zone near shore. North shore looking down Cow Pen Creek.

WP9 (Appendix A: DWG L-105): This forested wetland plot is on the southeastern shore where the creek bends from running towards the east to a southeast direction (Figure 3-10). Like the adjacent sampling plot, WP6, this area appears to be in an area prone to flooding and at the time of observation were covered with at least a few inches of water. The flooded soils are 20% covered with algae and SAV. About 10% of the area is at water level and is vegetated with creeping bentgrass, the dominant herbaceous vegetation. Woody plants are mostly trees with protective tree tubes in place. Only 10% of the woody vegetation in this plot are alive, most likely due to the continuous flooding (Table 3-1). The forested wetland areas adjacent to this plot contained both live and dead woody plants. No invasive herbaceous or woody plants were observed within the plot. The area is matted.

Figure 3-10 WP9 Photo of forested wetland. West shore of forested wetland looking towards Lockheed Martin Complex.

3.2.2 Site Wide Observations

Non-flooded Areas

In forested wetland and scrub-shrub areas that are not flooded or inundated, planted woody plants are alive and growing. Based on the approved seed mix and field observation the dominant herbaceous vegetation is the creeping bentgrass that covers greater than 90% of the area that is not flooded with less than 10% bare ground. These areas are shown on Drawing Sheets (DWG) L-103 and L-104 in Appendix A.

Flooded Areas

These areas are shown on sheet L-105 (Appendix A) and are designed as forested wetlands that are flooded and have less than 50% surviving woody plants. There is less than 5 percent herbaceous vegetation on small spots of ground at or above the water level. Much of the flooded area, 75% or more, has SAV or algae growing on the bottom or near the bottom. It should be noted that Maryland recorded one of the wettest July's on record and according to the observed water level recorded at Fort McHenry, a water level between 6 and 12 inches higher than what was predicted was observed for most of July (Figure 3-11). Therefore, those areas that seem to have been inundated for long-periods of time may have been due to the volume of water in the Chesapeake Bay due to second wettest July on record in Maryland (NOAA, 2018). According to the National Weather Service, Baltimore precipitation records for July include: three daily rainfalls (July 17 – 3.35 inches; July 21 – 4.79 inches; and July 24 – 4.07 inches); wettest two-week period on record (July 14 – July 28 – 16.37 inches); and the wettest 90-day period from May 2 through July 30 – 29.61 inches of rain.

Emergent Wetlands areas shown on sheets L-105 and L-106 (Appendix A) were absent of emergent vegetation growing out of the water. For example, no Green Arrow-Arum (*Peltrandra virginica*), Crimson-Eyed Rose Mallow (*Hibiscus moscheutos*), or Blue Flag Iris (*Iris versicolor*) were observed in or near the sampling plots but were planted according to revegetation plan (Appendix B, L-107). The banks above the water line were vegetated by what appears to be natural recruitment. There was no sign of vegetation, SAV or emergent, below the water. Visibility was limited to between 6 – 12 inches.

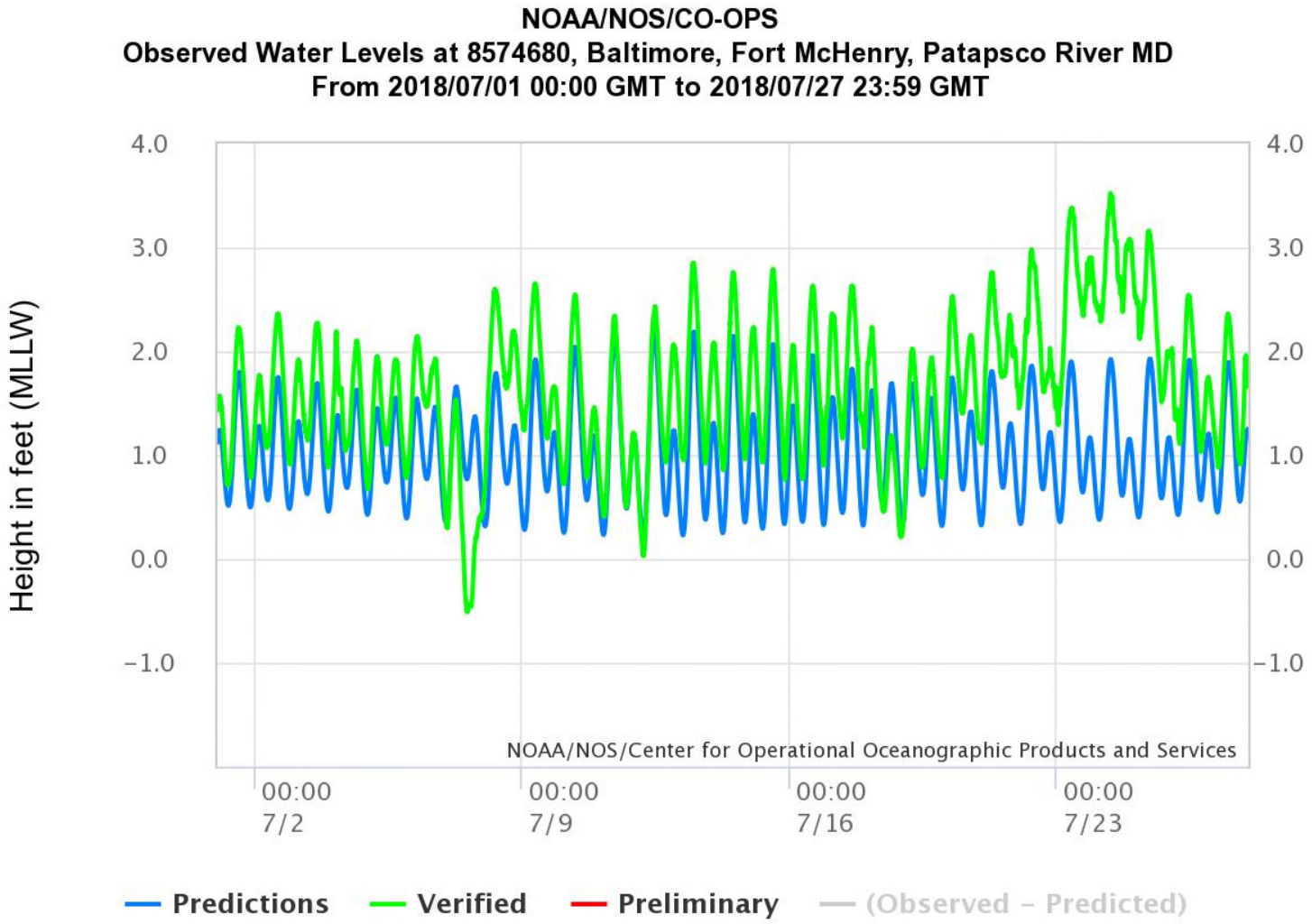

Figure 3-11 Predicted and observed water level at Baltimore's Fort McHenry during July 2018.

SECTION 4
CONCLUSIONS

Forested wetland

In areas of restored forested wetlands where the soils are not inundated or flooded, herbaceous vegetation is dominated by the creeping bentgrass. Creeping bentgrass was part of the approved seed mix and has become well established. Dominance by bentgrass was estimated at 80–90% but will likely change with time as more perennial wetland grasses or forbs start to colonize the area. Trees and shrubs in the restored wetland where soils were not inundated or flooded are healthy and growing. Downstream, where the channel widens, some areas of submerged soil designed as forested wetland were flooded and appear to have been for long-periods, so that they are more than 50% covered with algae or SAV. In these areas that appear to be more consistently inundated or flooded, tree and shrub survival varies, but observations indicate that less than 50% of planted trees and shrubs have survived (Figure 4-1). The field team did not check every tree protection tube, but many were empty or contained a dead stem.

Scrub-shrub wetland

Two areas of scrub-shrub wetland were restored, one in the BGE easement near the upstream portion of the site and one about half way downstream. Areas of scrub-shrub wetlands that are not flooded are dominated by bentgrass and contain planted shrubs and trees. Part of the downstream scrub-shrub wetland closest to the stream channel was flooded with two to three inches of water and appeared to be consistently inundated with water over extended periods of time (Figure 4-1). Most of the flooded area does not contain planted shrubs. The revegetation plan calls for shrubs in this area.

Figure 4-1 Site-wide observation map of bare areas in restored wetlands along Cow Pen Creek.

Emergent wetland

The site plan shows emergent wetlands along the downstream banks of the site. We observed one small patch of pickerelweed (*Pontederia cordata*) on the southern shore at or near the boundary of the site. The water along the shore was turbid but visibility was approximately 6 to 12 inches, yet no emergent vegetation or SAV was observed above or below the water. More than 90% of the area designated as emergent wetland lacked vegetation (Figure 4-1).

Upland

Although perhaps beyond the scope of this monitoring, the field team observed that many of the trees on the upland bank (out of the wetland) were dead. This could have been due to the dry spell experienced in June before rains returned in July. For more information regarding the monitoring of upland bank see the *Cow Pen Creek Bank Stabilization and Floodplain Reconstruction Monitoring: 2018 Report* (Tetra Tech, 2018b).

Summary

Field monitoring and maintenance activities are designed to ensure goals and objectives are met by the end of the five-year monitoring period as established in the *Maryland Nontidal Wetland Mitigation Guidance* (MDE, 2011). First year field monitoring results indicate the restored wetland area is starting to meet the goals. Below is a summary of the five-year monitoring goals and the status after the first year of monitoring.

Vegetated Wetland Goal: Greater than 85% of the wetland mitigation site will be vegetated (either by planted or naturally revegetated plants) by native wetland species like those found in the nontidal wetland lost, or by a species composition acceptable to the Nontidal Wetlands and Waterways Division. Vegetative communities not acceptable to the Division would include those communities dominated by common reed or other nuisance vegetation, or communities that are dominated by facultative upland or upland species.

> ***First Year Monitoring Status:*** The wetland mitigation site is estimated to be approximately 75% vegetated with native wetland species. The main exception is areas designed as emergent wetland where there appears to have been inundation or flooding for sufficient time to result in mortality.

Hydrology Goal: The entire wetland restoration or creation area must have sufficient hydrology to support a prevalence of wetland vegetation. The Army Corps of Engineers and United States Environmental Protection Agency define wetlands as "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

First Year Monitoring Status: The entire site has varying but sufficient wetland hydrology to support a prevalence of wetland vegetation.

Wetland Vegetation Goal: For this determination, wetland vegetation is that which is readily observable in the field and can easily be used to help identify the extent of the wetland area. The area will be evaluated to determine the extent of the wetland and that the entire area meets the definition of a wetland using the appropriate regional supplement to the Corps of Engineers Wetland Delineation Manual.

First Year Monitoring Status: Wetland vegetation is observable in the field and can be used to identify the extent of much of the wetland area. As vegetation becomes better established the entire wetland area should be identifiable by wetland vegetation.

Hydric Soil Goal: The entire wetland restoration or creation area must meet the Hydric Soil Technical Standard developed by the National Technical Committee for Hydric Soils for saturated conditions and aerobic conditions (USDA 2015).

First Year Monitoring Status: The restored wetland area was either flooded or soils were saturated to wet at the surface. Best professional judgement was used to indicate that hydric soils were forming. Soil samples will be taken during the second-year monitoring for indicators of hydric soils continuing to develop.

Functional Goal: The site will provide the functional goals and objectives established in Appendix F of the *Maryland Nontidal Wetland Mitigation Guidance* (MDE, 2011).

First year Monitoring Status: No direct measurement of nutrient removal and sediment control were observed, but these functions are likely to be occurring for the wetland type and position in the landscape. Additional site photographs can be found in Appendix B.

SECTION 5
REFERENCES

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APPENDICES

Appendix A—Final Vegetation Drawings

Appendix B—Additional Site Photographs from Annual Wetland Monitoring, July 2018

APPENDIX A—FINAL VEGETATION DRAWINGS

OUTFALL 002

OUTFALL 003

OUTFALL 004

COW PEN CREEK EXISTING THALWEG

BLOCK G

BLOCK F

CHESAPEAKE PARK PLAZA

NORTH AMERICAN ELECTRIC

HAWTHORNE RD

HAWTHORNE ELEMENTARY SCHOOL

ATHLETIC FIELD

TENNIS

KINGSTON RD

DARK HEAD RD

KINGSTON POINT PARK

100 – YR

N

E

W

S

0' 150' 300'

NOTES:

1. EXISTING WETLANDS TO BE IMPACTED DURING COW PEN CREEK CONSTRUCTION ARE SHOWN. THE QUANTITY OF IMPACT AREAS INCLUDE A 5-FOOT BUFFER ZONE ALONG THE REMEDIATION BOUNDARY.
2. TEMPORARILY IMPACTED WETLANDS WILL BE REVEGATED IN ACCORDANCE WITH THE REVEGETATION PLAN (L-102 TO L-108).

LEGEND

- TAX BLOCK
- EXISTING 100 YEAR FLOOD
- EXISTING CONTOURS MAJOR 5FT
- EXISTING BANKFULL WIDTH
- REMEDIATION BOUNDARY
- APPROX. LIMIT OF EXCAVATION AND DREDGING
- EXISTING WETLAND

EXISTING WETLAND AND OTHER VEGETATED AREAS TO BE IMPACTED:

- FORESTED WETLAND: 1.97 AC
- EMERGENT WETLAND: 0.27 AC
- SCRUB SHRUB WETLAND: 0.06 AC
- OPEN WATER: 5.7 AC
- UPLAND VEGETATION 1.76 AC

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NICHOLAS VANBUSKIRK, STATE OF WASHINGTON, 51132, REGISTERED PROFESSIONAL ENGINEER

STATE OF MARYLAND, SENDA OKAM, No. 45103, PROFESSIONAL ENGINEER

PROFESSIONAL CERTIFICATION. I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND, LICENSE NO. 45103, EXPIRATION DATE: 02-24-2018

LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")

REV.	DATE	REVISION DESCRIPTION	DRW	DSG	ENG	CHK	APP
0	09/12/16	ISSUED FOR CONSTRUCTION	NV	NV	NV	SO	SO

SEDIMENT REMEDY DESIGN

COW PEN CREEK

IMPACTS TO EXISTING WETLANDS AND VEGETATION

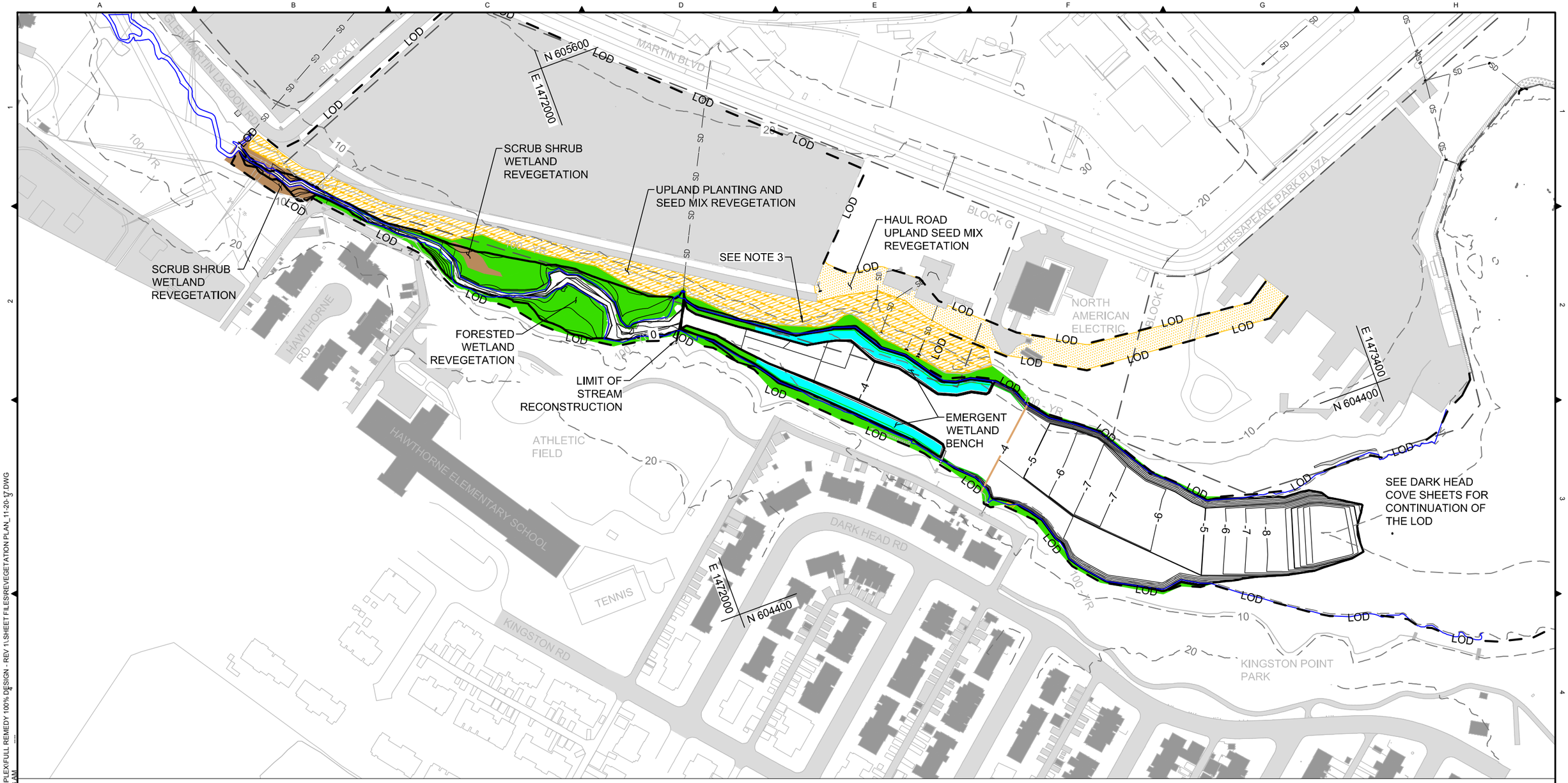
DWG. NO.: L-101

CREATED: 12/09/2015

SHEET: 49 OF 80

SCALE: 1" = 75' PLOTTED 22" X 34"

Z:\PROJECTS\LOCKHEED - MIDDLE RIVER COMPLEX\FULL REMEDY 100% DESIGN - ISSUED FOR CONSTRUCTION\SHEET FILES\EXISTING VEGETATION PLAN.DWG
PLOT DETAILS: VANBUECKEN_NICH
September 12, 2016
10:40 AM
TT-BOTH-MAIN_COLOR.CTB



NOTES:

1. THIS REVEGETATION PLAN HAS BEEN DESIGNED IN CONSULTATION WITH MARYLAND DEPARTMENT OF ENVIRONMENT, MARYLAND AVIATION ADMINISTRATION AND OTHER RESOURCE AGENCIES. THIS PLAN WILL BE FINALIZED BY THE CONSTRUCTION CONTRACTOR BASED ON FIELD CONDITIONS.
2. TEMPORARILY IMPACTED WETLANDS AND UPLAND WILL BE REVEGETATED AND SEEDED PER THIS PLAN AND AS DIRECTED BY THE FIELD SPECIALIST. THIS REVEGETATION PLAN MAY REQUIRE REVISIONS TO ADJUST AS-BUILT FIELD CONDITIONS AS DIRECTED BY THE FIELD SPECIALIST.
3. REFER TO DUMP ROAD MITIGATION PLAN FOR AREA THAT WILL BE SEEDED ONLY.

LEGEND

- TAX BLOCK
- PROPOSED 100-YEAR FLOOD
- EXISTING CONTOURS MAJOR 10FT
- PROPOSED BANKFULL / MHHW
- REMEDIATION BOUNDARY
- APPROX. LIMIT OF EXCAVATION AND DREDGING
- PROPOSED CONTOURS MAJOR 5FT
- PROPOSED CONTOURS MINOR 1FT
- LOD LIMIT OF DISTURBANCE

REVEGETATION AREAS

- FORESTED WETLAND: 1.81 AC
- EMERGENT WETLAND: 0.39 AC
- SCRUB SHRUB WETLAND: 0.22 AC
- UPLAND VEGETATION: 1.76 AC
- UPLAND SEED MIX ONLY: 1.12 AC

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LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")

REV.	DATE	REVISION DESCRIPTION	DRW	DSG	ENG	CHK	APP
2	11/20/17	REVISED PER DUMP ROAD AREA MITIGATION PLAN	MH	MH	SO	SO	SO
1	11/20/17	REVISED PER BGE ACCESS AGREEMENT AND UPLAND CLEARANCE	TJM	TJM	SO	SO	SO
0	06/26/17	ISSUED FOR CONSTRUCTION	NV	NV	NV	SO	SO

SEDIMENT REMEDY DESIGN

COW PEN CREEK

REVEGETATION PLAN

DWG. NO.: L-102

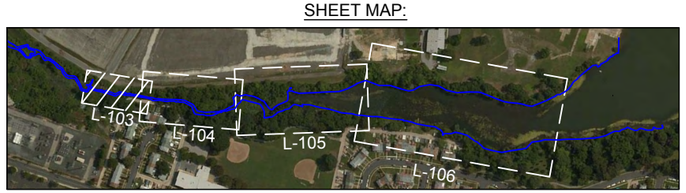
CREATED: 12/09/2015

SHEET: 50 OF 80

SCALE: 1" = 100'
PLOTTED 22" X 34"

OUTFALL 002
EXCAVATION BOUNDARY REVISED TO PROVIDE 10 FT MIN BUFFER FROM EXISTING UTILITY POLES
LMC PROPERTY
BG&E PROPERTY
UPLAND SEED MIX - 2
SCRUB-SHRUB WETLAND
OUTFALL 003
STAIRS
DWG L-104
LIVE STAKING AND FORESTED WETLAND
HAWTHORNE INC. PROPERTY
ROCK TOE STABILIZATION (SEE C-221 - C-229)
BALTIMORE COUNTY PROPERTY
COW PEN CREEK PROPOSED THALWEG
COW PEN CREEK EXISTING THALWEG
GRAVEL ROAD (RESTRICTED)
CONCRETE DRIVE
BLOCK G
100 - YR
LOD
SD
0+00
1+00
2+00
3+00

SHEET MAP:



0' 20' 40'

LEGEND
- TAX BLOCK/PROPERTY BOUNDARY
- PROPOSED 100-YEAR FLOOD
- EXISTING CONTOURS MAJOR 10FT
- PROPOSED BANKFULL / MHHW
- REMEDIATION BOUNDARY
- APPROX. LIMIT OF EXCAVATION AND DREDGING
- PROPOSED CONTOURS MAJOR 5FT
- PROPOSED CONTOURS MINOR 1FT
- LOD LIMIT OF DISTURBANCE

REVEGETATION AREAS
- FORESTED WETLAND: 1.81 AC
- EMERGENT WETLAND: 0.39 AC
- SCRUB-SHRUB WETLAND: 0.22 AC
- UPLAND VEGETATION: 1.76 AC

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LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")

REV.	DATE	REVISION DESCRIPTION	DRW	DSG	ENG	CHK	APP
3	09/22/17	REVISED PER BG&E ACCESS AGREEMENT	TJM	KB	SO	SO	-
2	06/01/17	REVISED PLANTING PLAN	JA	KB/RS	JA	KB	-
1	04/07/17	REVISED SEED MIX TABLES	TJM	KB	SO	SO	SO
0	09/12/16	ISSUED FOR CONSTRUCTION	NV	NV	NV	SO	SO

SEDIMENT REMEDY DESIGN

COW PEN CREEK

REVEGETATION PLAN

DWG. NO.: L-103

CREATED: 12/09/2015

SHEET: 51 OF 80

SCALE: 1" = 10' PLOTTED 22" X 34"

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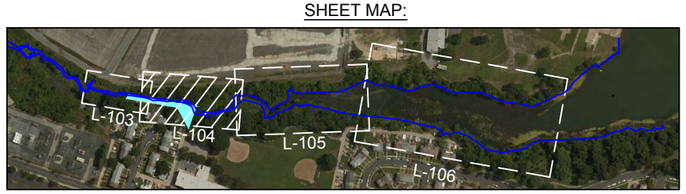
PLOT DETAILS: MATHIS, TOM
September 22, 2017
1:02 PM

SHEET MAP:



0' 30' 60'

LEGEND
- TAX BLOCK
- PROPOSED 100-YEAR FLOOD
- EXISTING CONTOURS MAJOR 10FT
- PROPOSED BANKFULL / MHHW
- REMEDIATION BOUNDARY
- APPROX. LIMIT OF EXCAVATION AND DREDGING
- PROPOSED CONTOURS MAJOR 5FT
- PROPOSED CONTOURS MINOR 1FT
- LOD LIMIT OF DISTURBANCE

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LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")

REV.	DATE	REVISION DESCRIPTION	DRW	DSG	ENG	CHK	APP
2	06/01/17	REVISED PLANTING PLAN	JA	KB/RS	JA	KB	-
1	04/07/17	REVISED SEED MIX TABLES	TJM	KB	SO	SO	SO
0	09/12/16	ISSUED FOR CONSTRUCTION	NV	NV	NV	SO	SO

SEDIMENT REMEDY DESIGN

COW PEN CREEK

REVEGETATION PLAN

DWG. NO.: L-104

CREATED: 12/09/2015

SHEET: 52 OF 80

SCALE: 1" = 15' PLOTTED 22" X 34"

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PLOT DETAILS: ANDREWS, JEREMY June 6, 2017 11:00 AM TT-BOTH-MAIN-COLOR.CTB

UPLAND SEED MIX - 2

UPLAND SEED MIX - 1

UPLAND SEED MIX - 2

OUTFALL 004

DEBRIS TO REMOVE AND REVEGETATE (FORESTED WETLAND AND UPLAND SEED MIX-2

END OF STREAM RECONSTRUCTION

COW PEN CREEK EXISTING THALWEG

DWG L-106

DWG L-104

BLOCK G

100 - YR

8+00

9+00

10+00

10+91

LOD

SD

N

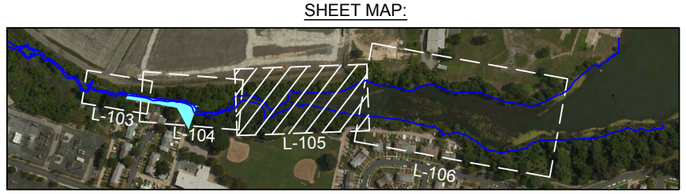
E

S

W

0' 40' 80'

SHEET MAP:



LEGEND

- TAX BLOCK
- PROPOSED 100-YEAR FLOOD
- EXISTING CONTOURS MAJOR 10FT
- PROPOSED BANKFULL / MHHW
- REMEDIATION BOUNDARY
- APPROX. LIMIT OF EXCAVATION AND DREDGING
- PROPOSED CONTOURS MAJOR 5FT
- PROPOSED CONTOURS MINOR 1FT
- LOD LIMIT OF DISTURBANCE

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LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")

REV.	DATE	REVISION DESCRIPTION	DRW	DSG	ENG	CHK	APP
2	06/01/17	REVISED PLANTING PLAN	JA	KB/RS	JA	KB	-
1	04/07/17	REVISED SEED MIX TABLES	TJM	KB	SO	SO	SO
0	09/12/16	ISSUED FOR CONSTRUCTION	NV	NV	NV	SO	SO

SEDIMENT REMEDY DESIGN

COW PEN CREEK

REVEGETATION PLAN

DWG. NO.: L-105

CREATED: 12/09/2015

SHEET: 53 OF 80

SCALE: 1" = 20' PLOTTED 22" X 34"

Z:\PROJECTS\LOCKHEED - MIDDLE RIVER COMPLEX\FULL REMEDY 100% DESIGN - ISSUED FOR CONSTRUCTION\SHEET FILES\REVEGETATION PLAN 060117.DWG
PLOT DETAILS: ANDREWS, JEREMY June 6, 2017 11:00 AM TT-BOTH-MAIN-COLOR.CTB

UPLAND SEED MIX - 2

LIVE STAKING

COW PEN CREEK EXISTING THALWEG

APPROXIMATE LIMIT OF EXCAVATION AND DREDGING

CONCRETE DRIVE

DWG L-105

BLOCK G

BLOCK F

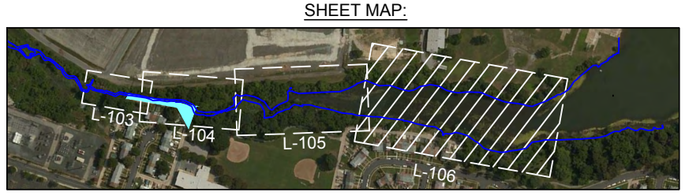
100 - YR

LOD

SD

0' 60' 120'

SHEET MAP:



LEGEND

- TAX BLOCK
- PROPOSED 100-YEAR FLOOD
- EXISTING CONTOURS MAJOR 10FT
- PROPOSED BANKFULL / MHHW
- REMEDIATION BOUNDARY
- APPROX. LIMIT OF EXCAVATION AND DREDGING
- PROPOSED CONTOURS MAJOR 5FT
- PROPOSED CONTOURS MINOR 1FT
- LOD LIMIT OF DISTURBANCE

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MIDDLE RIVER COMPLEX

PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")

REV.	DATE	REVISION DESCRIPTION	DRW	DSG	ENG	CHK	APP
2	06/01/17	REVISED PLANTING PLAN	JA	KB/RS	JA	KB	-
1	04/07/17	REVISED SEED MIX TABLES	TJM	KB	SO	SO	SO
0	09/12/16	ISSUED FOR CONSTRUCTION	NV	NV	NV	SO	SO

SEDIMENT REMEDY DESIGN

COW PEN CREEK

REVEGETATION PLAN

DWG. NO.: L-106

CREATED: 12/09/2015

SHEET: 54 OF 80

SCALE: 1" = 30' PLOTTED 22" X 34"

Z:\PROJECTS\LOCKHEED - MIDDLE RIVER COMPLEX\FULL REMEDY 100% DESIGN - ISSUED FOR CONSTRUCTION\SHEET FILES\REVEGETATION PLAN 060117.DWG
PLOT DETAILS: ANDREWS, JEREMY June 6, 2017 11:00 AM TT-BOTH-MAIN-COLOR.CTB

FORESTED WETLAND REVEGETATION								
Acres: 1.81								
Growth Habit	**Scientific Name**	**Common Name**	**Wetland Indicator Status[1]**	**Propagation Method**	**Spacing (feet o.c.)**	**Percent Composition**	**Quantity**	**Size**
Tree	*ACER RUBRUM*[2]	RED MAPLE	FAC	CONTAINER	10	10	79	1 gallon
	BETULA NIGRA	RIVER BIRCH	FACW	CONTAINER	10	10	79	1 gallon
	LIQUIDAMBAR STYRACIFLUA	SWEETGUM	FAC	CONTAINER	10	15	118	1 gallon
	PLATANUS OCCIDENTALIS	SYCAMORE	FACW	CONTAINER	10	15	118	1 gallon
	POPULUS DELTOIDES	EASTERN COTTONWOOD	FAC	CONTAINER	10	10	79	1 gallon
	SALIX NIGRA	BLACK WILLOW	OBL	CONTAINER	10	20	158	1 gallon
Shrub	*CLETHRA ALNIFOLIA*	SWEET PEPPERBRUSH	FACW	CONTAINER	10	10	79	1 gallon
	ITEA VIRGINICA	VIRGINIA SWEETSPIRE	FACW	CONTAINER	10	10	79	1 gallon

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.
2 USE MALE ONLY CULTIVARS TO REDUCE POTENTIAL FOR ADDITIONAL FOOD SOURCE

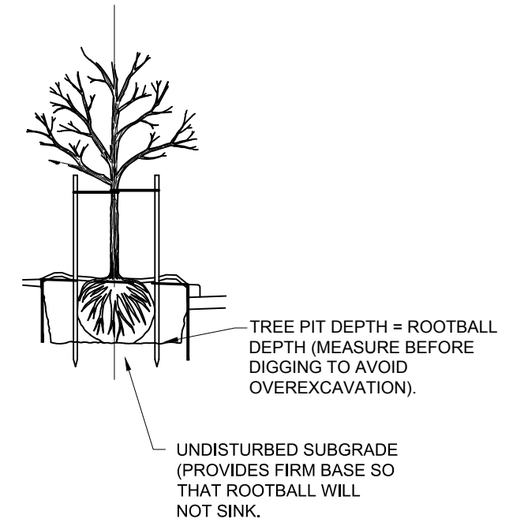
Scrub-shrub Wetland Revegetation								
Acres: 0.22								
Growth Habit	**Scientific Name**	**Common Name**	**Wetland Indicator Status[1]**	**Propagation Method**	**Spacing (feet o.c.)**	**Percent Composition[2]**	**Quantity**	**Size**
Shrub	*CLETHRA ALNIFOLIA*	SWEET PEPPERBRUSH	FACW	CONTAINER	8	25	37	1 gallon
	EUONYMUS AMERICANUS	STRAWBERRY BUSH	FAC	CONTAINER	8	25	37	1 gallon
	ITEA VIRGINICA	VIRGINIA SWEETSPIRE	FACW	CONTAINER	8	25	37	1 gallon
	MAGNOLIA VIRGINIANA	SWEETBAY MAGNOLIA	FACW	CONTAINER	8	25	37	1 gallon
Herbaceous Species	*HIBISCUS MOSCHEUTOS*	CRIMSON-EYED ROSE MALLOW	OBL	PLUGS	3	60	639	10 cubic inch
	SOLIDAGO RUGOSA	GOLDENROD	FAC	PLUGS	3	40	426	10 cubic inch

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.
2 PERCENT COMPOSITION BASED ON GROWTH HABIT; COMPOSITION OF SHRUB SPECIES SUMS TO 100 AND COMPOSITION OF HERBACEOUS SPECIES SUMS TO 100.

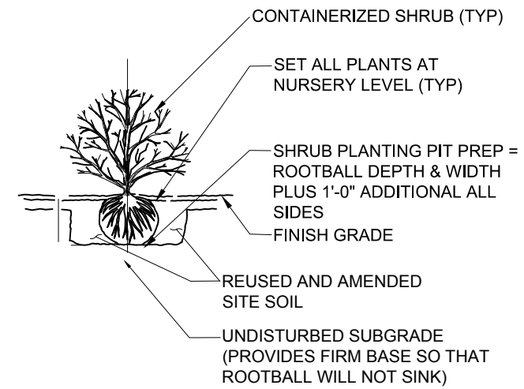
EMERGENT WETLAND REVEGETATION							
Acres: 0.39							
Growth Habit	**Scientific Name**	**Common Name**	**Wetland Indicator Status[1]**	**Propagation Method**	**Spacing (feet o.c.)**	**Percent Composition**	**Quantity**
Herbaceous Species	*CAREX STRICTA*	TUSSOCK SEDGE	OBL	PLUGS	3	15	283
	HIBISCUS MOSCHEUTOS	CRIMSON-EYED ROSE MALLOW	OBL	PLUGS	3	20	378
	IRIS VERSICOLOR	BLUE FLAG IRIS	OBL	PLUGS	3	10	189
	JUNCUS EFFUSUS	COMMON RUSH	OBL	PLUGS	3	15	283
	PELTRANDRA VIRGINICA	GREEN ARROW-ARUM	OBL	PLUGS	3	10	756

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.

TREE PLANTING DETAIL



SHRUB PLANTING DETAIL



NOTES:

1. THE ISSUED REVEGETATION PLAN (REVISION 0) WAS DESIGNED IN CONSULTATION WITH MARYLAND DEPARTMENT OF ENVIRONMENT, MARYLAND AVIATION ADMINISTRATION AND OTHER RESOURCE AGENCIES. THIS REVISION 2 REVEGETATION PLAN WAS PREPARED BY THE CONSTRUCTION CONTRACTOR (TETRA TECH, INC. AND EQR, LLC.) BASED ON FIELD CONDITIONS. REVISION 3 WAS PREPARED DUE TO CHANGES IN THE REVEGETATION PLAN WITHIN BG&E PROPERTY OF 0.16 ACRES WHERE FORESTED WETLAND WAS CHANGED TO SCRUB-SHRUB WETLAND.

2. LOCAL STOCK OF NATIVE SPECIES WILL BE USED TO THE EXTENT POSSIBLE AS THESE STOCKS WOULD BE BEST SUITED TO AND ADAPTED TO LOCAL CONDITIONS

3. PLANTING LAYOUT TO BE FIELD VERIFIED. TO FACILITATE PLANT SURVIVAL, FACTORS SUCH AS TOPOGRAPHY AND DISTANCE TO THE STREAM WILL BE TAKEN INTO ACCOUNT WHEN DETERMINING FINAL PLANT PLACEMENT. MEASURES TO BE IMPLEMENTED INCLUDE:
   a. FINAL PLACEMENT OF PLANTS WILL BE CHOSEN BASED ON MICROSITE CONDITIONS SUCH THAT SPECIES ARE BEST MATCHED TO THEIR SITE CONDITIONS, BECAUSE SOIL PROPERTIES AND WATER TABLE DEPTH CAN VARY OVER SHORT DISTANCES.
   b. SITE PREPARATION SUCH AS REMOVAL OF WEEDS OR OTHER SPECIES THAT WILL COMPETE WITH SEEDLINGS AND TILLING OF SOIL WILL OCCUR PRIOR TO PLANTING.
   c. IF NECESSARY, SOIL AMENDMENT, SUCH AS FERTILIZER, WILL BE INCORPORATED PRIOR TO OR DURING PLANTING.
   d. MEASURES SUCH AS TUBING WILL BE UTILIZED TO PROTECT PLANTS FROM HERBIVORY OR GRAZING .

4. PLANTINGS MAY NOT COVER THE ENTIRE MAPPED FOR EACH SPECIFIC ZONE (E.G., FORESTED WETLAND). MOST ZONES EXHIBIT A DIVERSITY OF MICROSITE CONDITIONS. AT THE TIME OF PLANTING THESE MICROSITE VARIATIONS WILL BE CONSIDERED AND PLANT SPECIES WILL BE PLANTED ACCORDINGLY.

DETAIL NOTES:

1. PLANTING INCLUDES REMOVAL OF STAKES ONE YEAR AFTER INSTALLATION.
2. SHAPE SOIL SURFACE TO PROVIDE 4' DIAMETER WATERING RING.

TETRA TECH
www.tetratech.com
19803 North Creek Parkway
Bothell, Washington 98011
Phone: 425-482-7600 Fax: 425-482-7652

STATE OF MARYLAND SENDA OCKAM No. 45103 PROFESSIONAL ENGINEER

PROFESSIONAL CERTIFICATION. I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND, LICENSE NO. 45103, EXPIRATION DATE: 02-24-2018

LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")

REV.	DATE	REVISION DESCRIPTION	DRW	DSG	ENG	CHK	APP
3	08/21/17	REVISED PER BG&E ACCESS AGREEMENT	TJM	KB	SO	SO	-
2	06/01/17	REVISED PLANTING PLAN	JA	KB/RS	JA	KB	-
1	04/07/17	REVISED SEED MIX TABLES	TJM	KB	SO	SO	SO
0	09/12/16	ISSUED FOR CONSTRUCTION	NV	NV	NV	SO	SO

SEDIMENT REMEDY DESIGN

COW PEN CREEK

REVEGETATION DETAILS

DWG. NO.: L-107

CREATED: 12/09/2015

SHEET: 55 OF 80

SCALE: 1" = N/A
PLOTTED 22" X 34"

Z:\PROJECTS\LOCKHEED - MIDDLE RIVER COMPLEX\FULL REMEDY 100% DESIGN - ISSUED FOR CONSTRUCTION\SHEET FILES\REVEGETATION PLAN 060117.DWG
PLOT DETAILS: MATHIS_TOM August 21, 2017 11:04 AM

UPLAND REVEGETATION								
Acres: 1.76								
Growth Habit	Scientific Name	Common Name	Wetland Indicator Status[1]	Propagation Method	Suggested Plant Spacing (feet o.c.)[1]	Percent Composition	Approximate Quantity	Size
Tree	*ACER RUBRUM*[2]	RED MAPLE	FAC	CONTAINER	10	30	230	1 gallon
	LIQUIDAMBAR STYRACIFLUA	SWEETGUM	FAC	CONTAINER	10	30	230	1 gallon
	POPULUS DELTOIDES	EASTERN COTTONWOOD	FAC	CONTAINER	10	30	230	1 gallon
Shub	*EUONYMUS AMERICANUS*	STRAWBERRY BUSH	FAC	CONTAINER	10	10	77	1 gallon

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.

WETLAND SEED MIX : TO BE APPLIED IN ALL WETLAND REVEGETATION AREAS						
Acres to be seeded:	**2.42** acre - total wetland area					
Pounds Required (per acre):	**131** lbs - per MAA specs. Seed mix.#3					
Scientific Name	Common Name	Wetland Indicator Status[1]	Propagation Method	Percent Composition	Quantity (lbs) per Acre	Total Quantity (lbs)
AGROSTIS STOLONIFERA	CREEPING BENTGRASS	FACW	SEED	60	83	201
POA PALUSTRIS	FOWL BLUEGRASS	FACW	SEED	30	34	82
PANICUM VIRGATUM	SWITCHGRASS	FAC	SEED	10	14	34

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, *REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0).* NOVEMBER 2010.

UPLAND SEED MIX - 1 : TO BE APPLIED IN ALL UPLAND REVEGETATION ZONE 1						
Acres to be seeded:	**1.26** acre					
Pounds Required (per acre):	**234** lbs - per MAA specs. Seed mix.#1					
Scientific Name	Common Name	Wetland Indicator Status[1]	Propagation Method	Percent Composition	Quantity (lbs) per Acre	Total Quantity (lbs)
FESTUCA ARUNDINACEA	FESTUCA ARUNDINACEA	VARIES	SEED	85	192	242
POA PRATENSIS	CERTIFIED KENTUCKY BLUEGRASS	FACU	SEED	10	28	35
LOLIUM PERENNE	PERENNIAL RYEGRASS	FACU	SEED	5	14	18

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UPLAND SEED MIX - 2 : TO BE APPLIED IN ALL UPLAND REVEGETATION ZONE 2						
Acres to be seeded:	**0.50** acre					
Pounds Required (per acre):	**115** lbs - per MAA specs. Seed mix.#2					
Scientific Name	Common Name	Wetland Indicator Status[1]	Propagation Method	Percent Composition	Quantity (lbs) per Acre	Total Quantity (lbs)
FESTUCA BREVIPILA (F. LONGIFOLIA)	HARD FESCUE	UPL	SEED	75	85	43
FESTUCA RUBRA SUBSP. *COMMUTATA*	CHEWINGS FESCUE	FACU	SEED	20	23	12
POA PRATENSIS	KENTUCKY BLUEGRASS	FACU	SEED	5	7	4

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, *REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0).* NOVEMBER 2010.

LIVE STAKES							
Acres: 0.05							
Scientific Name	Common Name	Wetland Indicator Status[1]	Propagation Method	Size	Percent Composition	Suggested Spacing	Approximate Quantity
BETULA NIGRA	RIVER BIRCH	FACW	LIVE STAKE	3 FT	25	3 FT O.C.	63
POPULUS DELTOIDES	EASTERN COTTONWOOD	FAC	LIVE STAKE		25		63
SALIX NIGRA	BLACK WILLOW	OBL	LIVE STAKE		50		126

NOTE:LIVE BRUSH LAYERING WILL CONSIST OF 2/3 BLACK WILLOW AND 1/3 MEADOWSWEET.

NOTES:

1. LIVE STAKING TECHNIQUES WILL BE APPLIED TO THE FOLLOWING LOCATIONS: STATION 0+10 TO 0+35; 1+05 TO 2+25; 4+00 TO 6+40; 7+20 TO 8+00; 9+00 TO 10+00. LOCATIONS MAY NEED TO BE ADJUSTED AS DIRECTED BY THE FIELD SPECIALIST.
2. REFER TO ESCP DRAWINGS C-507, C-508 FOR SEEDING SPECIFICATIONS.

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0	09/12/16	ISSUED FOR CONSTRUCTION	NV	NV	NV	SO	SO

SEDIMENT REMEDY DESIGN

COW PEN CREEK

REVEGETATION DETAILS

DWG. NO.: L-108

CREATED: 12/09/2015

SHEET: 56 OF 80

SCALE: 1" = N/A
PLOTTED 22" X 34"

APPENDIX B—ADDITIONAL SITE PHOTOGRAPHS FROM ANNUAL WETLAND MONITORING, JULY 2018

APPENDIX B—ADDITIONAL SITE PHOTOGRAPHS FROM ANNUAL WETLAND MONITORING, JULY 2018

Figure 1– Upstream boundary of project area. Invasive common reed in background.

Figure 2 – Good vegetation coverage in wetland areas that were not flooded.

Figure 3 – Scrub Shrub wetland; note that cattails are starting to grow.

Figure 4 – Downstream area designated on site plan as forested wetland. Area is flooded and most of the woody plants are dead.

Figure 5 – Area designated as emergent wetlands along creek. No emergent plants at this location.