

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,

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

Thomas D. Blackman
Project Lead, Environmental Remediation

cc: via email (without enclosure)
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,

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

Thomas D. Blackman
Project Lead, Environmental Remediation

cc: (via email without enclosure)

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

TABLE OF CONTENTS

Section	Page
Table of Contents	i
List of FIGURES.....	ii
List of TABLES	iii
Appendices.....	iii
Acronyms and Abbreviations.....	iv
Section 1 Introduction	1-1
1.1 Purpose of the Wetland Restoration, Monitoring, and Maintenance	1-1
1.2 Objectives	1-3
Section 2 Existing Site Conditions and Background	2-1
Section 3 Wetland Monitoring and Data Collection.....	3-1
3.1 Activities Performed	3-1
3.2 Recorded Observations	3-3
3.2.1 Wetland Plot Descriptions.....	3-5
3.2.1 Site Wide Observations	3-15
Section 4 Conclusions.....	4-1
Section 5 References	5-1

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

Figure 1-1	Wetland restoration monitoring area	1-4
Figure 2-1	Location of Cow Pen Creek and Dark Head Cove near the Middle River Complex.....	2-3
Figure 3-1	Map of wetland monitoring plot locations	3-2
Figure 3-2	WP1 Photo looking southwest away from Martin Boulevard. Dominant herbaceous vegetation is creeping bentgrass. Planted small trees and shrubs are visible.....	3-6
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	3-7
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.....	3-8
Figure 3-5	WP4 Photo looking down Cow Pen Creek. Soils are saturated to the surface, herbaceous vegetation, shrubs, and trees are doing well. ..	3-9
Figure 3-6	WP5 Photo of near-shore emergent zone. No emergent vegetation was observed.....	3-10
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	3-11
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.....	3-12
Figure 3-9	WP8 Photo of emergent wetland zone near shore. North shore looking down Cow Pen Creek.....	3-13
Figure 3-10	WP9 Photo of forested wetland. West shore of forested wetland looking towards Lockheed Martin Complex.	3-14
Figure 3-11	Predicted and observed water level at Baltimore's Fort McHenry during July 2018.	3-16
Figure 4-1	Site-wide observation map of bare areas in restored wetlands along Cow Pen Creek.....	4-2

LIST OF TABLES

Table 3-1	Vegetation Data Recorded during 2018 Wetland Monitoring Middle River Complex, Middle River, Maryland	3-4
Table 3-2	Soil and Wetland Hydrology Observations Middle River Complex, Middle River, Maryland	3-5

APPENDICES

Appendix A—Final Vegetation Drawings
Appendix B—Additional Site Photographs From Annual Wetland Monitoring, July 2018

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

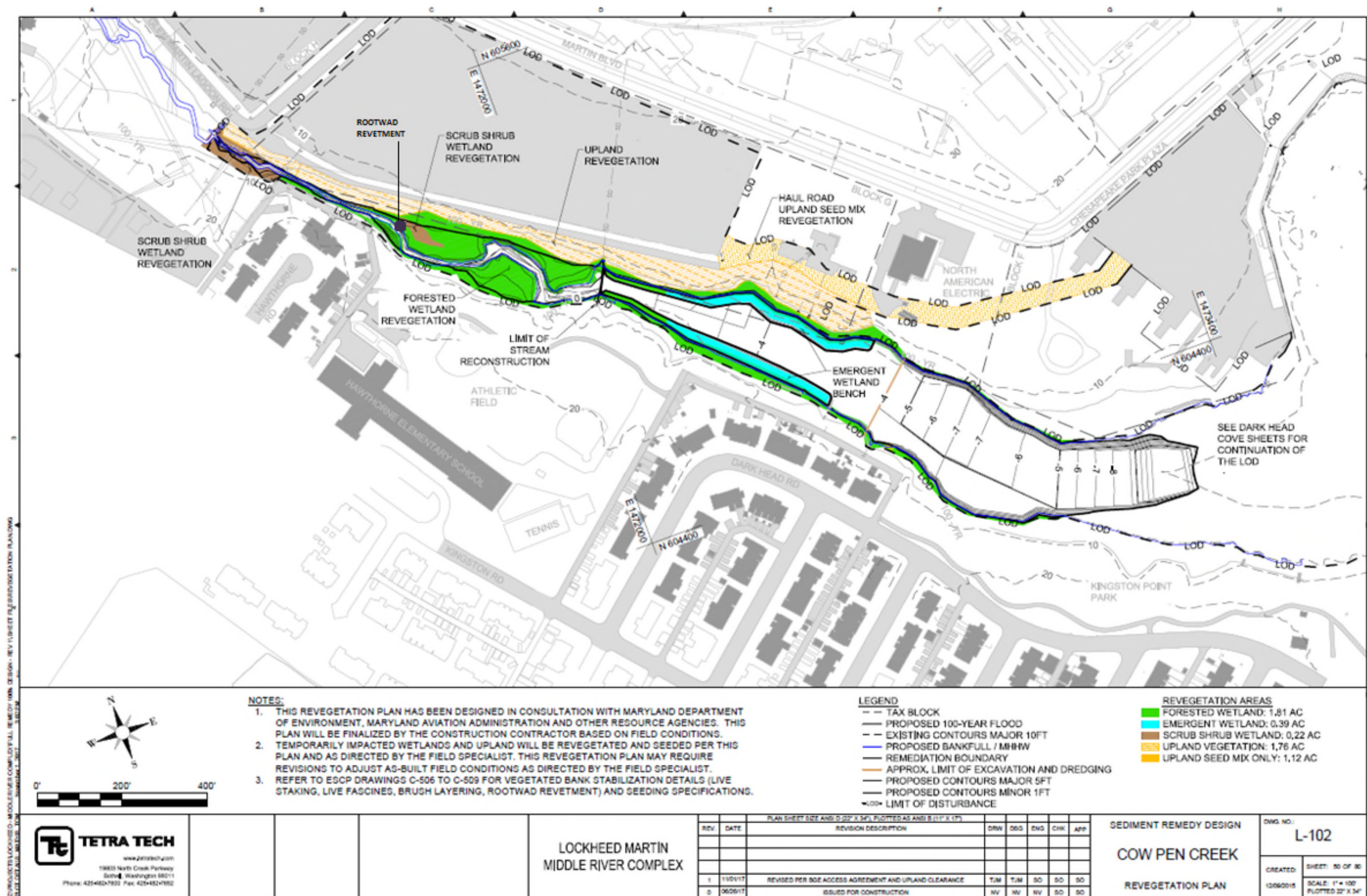


Figure 1-1 Wetland restoration monitoring area.

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 (ft²) randomly located sampling plots were monitored in the scrub-shrub habitat, while four 400 ft² 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 ft², 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	<i>Agrostis stolonifera</i>	100	9	95	100	no	0
WP2	39.3272	-76.4365	Scrub-Shrub Wetland	<i>Agrostis stolonifera</i>	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	<i>Agrostis stolonifera</i>	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	<i>Agrostis stolonifera</i>	10	9	5	40	yes	5
WP7	39.3267	-76.4355	Forested Wetland	<i>Agrostis stolonifera</i>	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	<i>Agrostis stolonifera</i> , <i>Ceratophyllum demersum</i>	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 angustifolia*) 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 (*Peltandra 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.

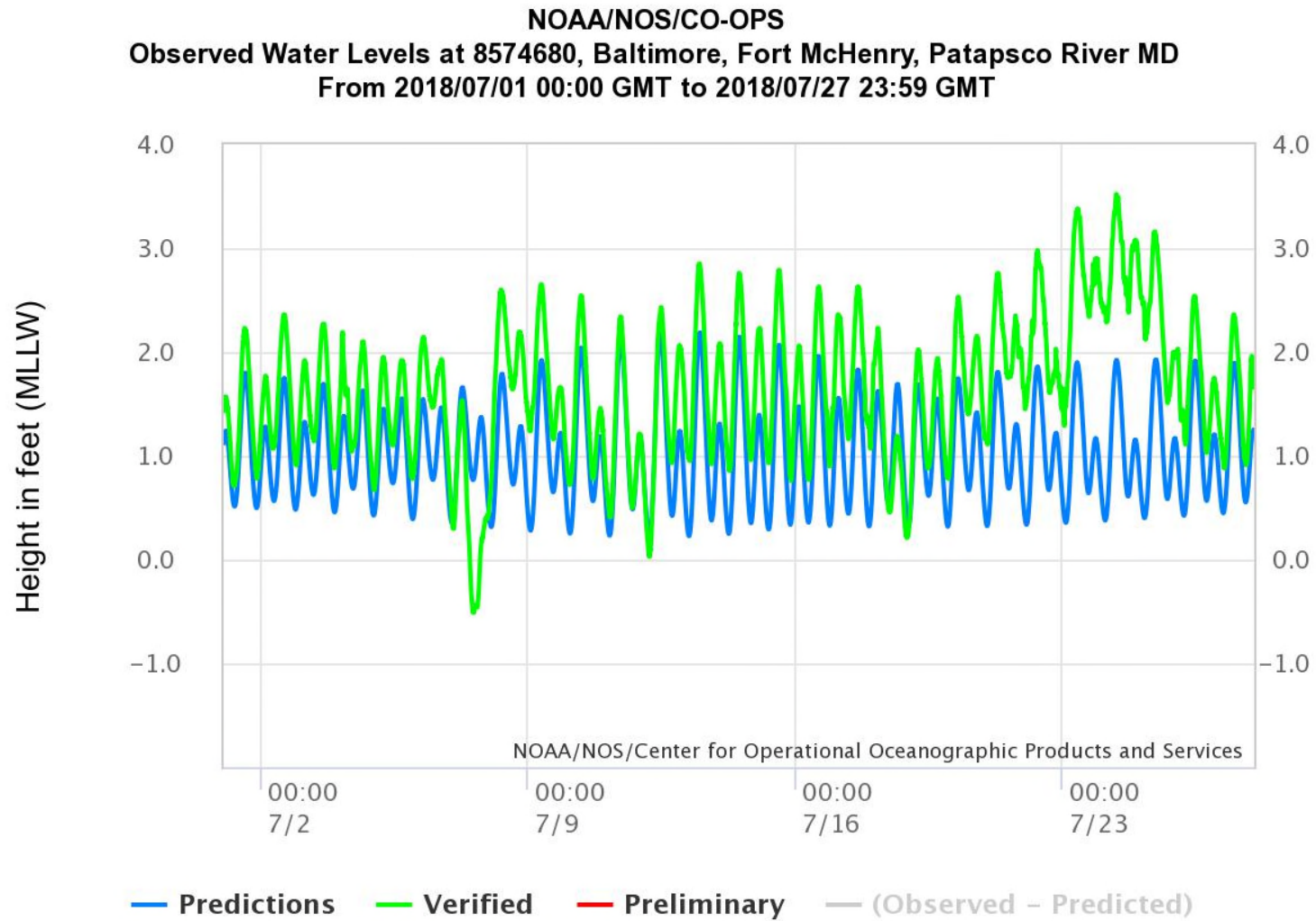


Figure 3-11 Predicted and observed water level at Baltimore's Fort McHenry during July 2018.

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

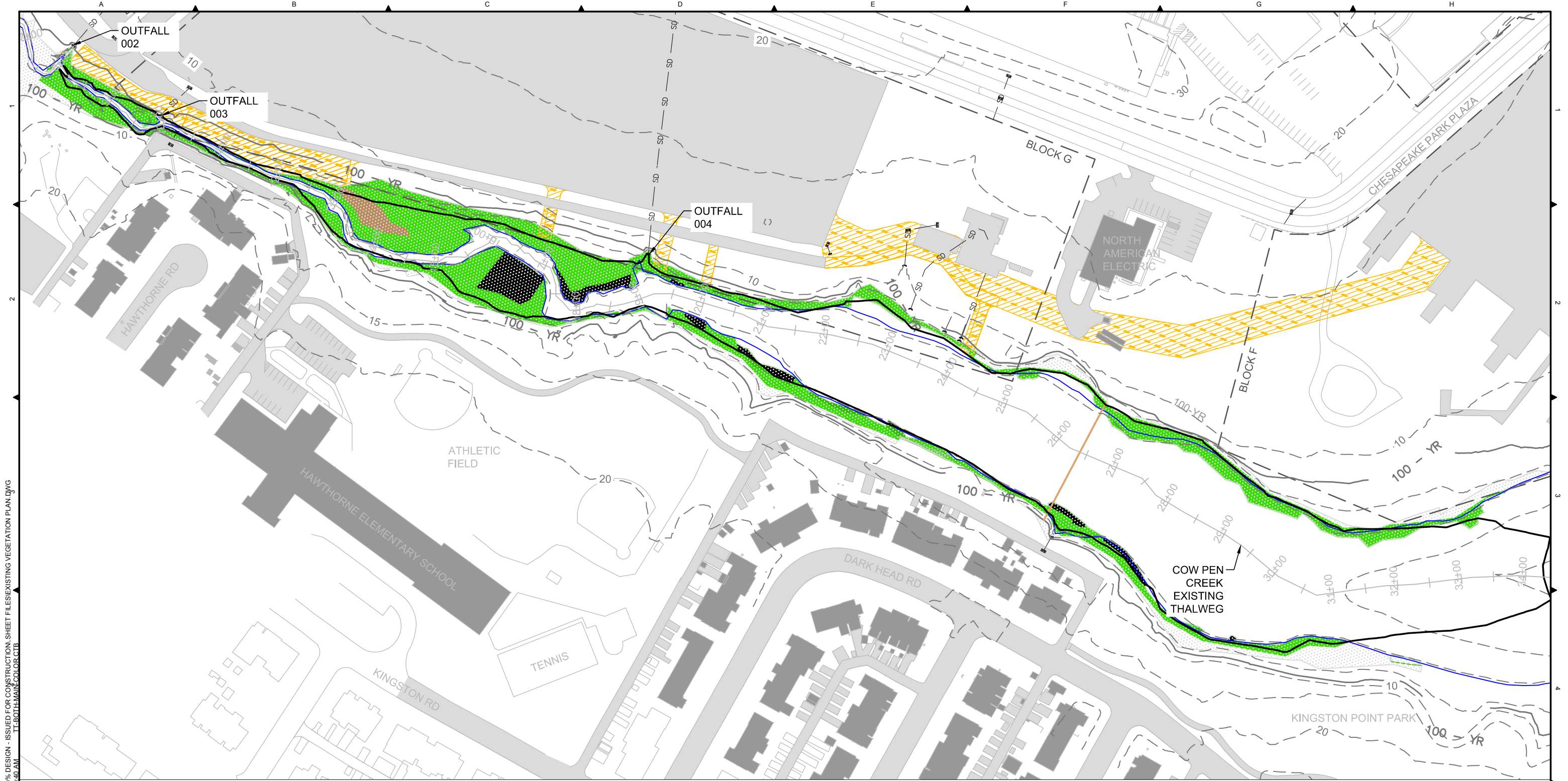
- Brinson, M.M., and R. Rheinhardt. 1996. The role of reference wetlands in functional assessment and mitigation. *Ecological Applications* 6: 69-76.
- Maryland Department of the Environment. 2011. *Maryland Nontidal Wetland Mitigation Guidance*. Nontidal Wetland and Waterways Division. Funded by EPA State Wetland Program Development Grant CD 993010-01-1. Second Edition.
- National Oceanic and Atmospheric Administration (NOAA). 2018. National Climate Report – July 2018. Access October 30, 2018 at <https://www.ncdc.noaa.gov/sotc/national/201807>.
- Tetra Tech, Inc. 2016a. *Sediment Remedy 100% Design for Cow Pen Creek and Dark Head Cove, Middle River Remediation Site*. Lockheed Martin Middle River Complex, Middle River, Maryland. Project Design Report. June.
- Tetra Tech, Inc. 2016b. *Sediment Remedy 100% Design for Cow Pen Creek and Dark Head Cove, Middle River Remediation Site*. Lockheed Martin Middle River Complex, Middle River, Maryland. Project Design Plan Set. September.
- Tetra Tech, Inc. 2017. *Cow Pen Creek Wetland Restoration Monitoring Work Plan*, Lockheed Martin Middle River Complex, Middle River, Maryland. November
- Tetra Tech, Inc., 2018a. *Season Two Cow Pen Creek Sediment Remedy Completion Report*. Lockheed Martin Middle River Complex, Middle River, Maryland. May.
- Tetra Tech, Inc. 2018b. *Cow Pen Creek Bank Stabilization and Floodplain Reconstruction Monitoring: 2018 Report*. Lockheed Martin Middle River Complex, Middle River, Maryland. October.
- United States Department of Agriculture (USDA). 2015. *Hydric Soils Technical Standard and Data Submission Requirements for Field Indicators of Hydric Soils*. Hydric Soils Technical Note 11. National Technical Committee for Hydric Soils. Washington, DC: USDA, NRCS.

APPENDICES

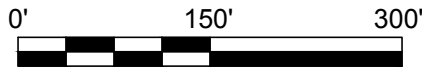
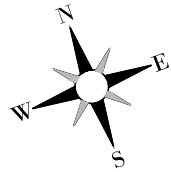
Appendix A—Final Vegetation Drawings

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

APPENDIX A—FINAL VEGETATION DRAWINGS



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



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).

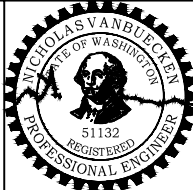
LEGEND

- - 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

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



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

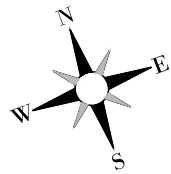
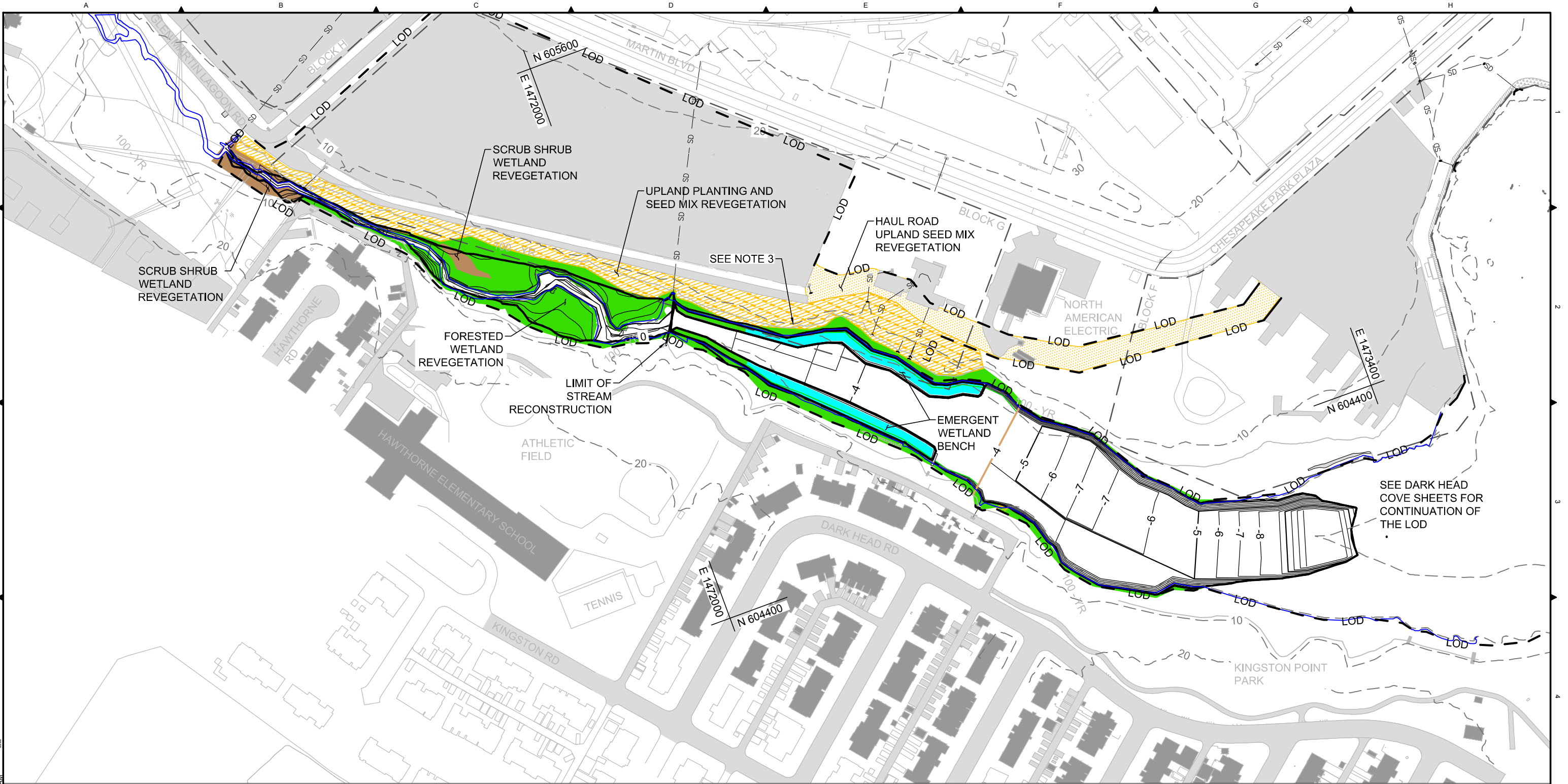
CREATED:

12/09/2015

SHEET: 49 OF 80

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

NTS11851\GROUPSCAD\PROJECTS\LOCKHEED - MIDDLE RIVER COMPLEX\FULL REMEDY 100% DESIGN - REV 11 SHEET FILES\REVEGETATION PLAN_11-20-17.DWG
PLOT DETAILS: CREATREE, ALLEN November 20, 2017 10:13 AM



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



19803 North Creek Parkway
Bothell, Washington 98011
Phone: 425-482-7600 Fax: 425-482-7652

LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

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

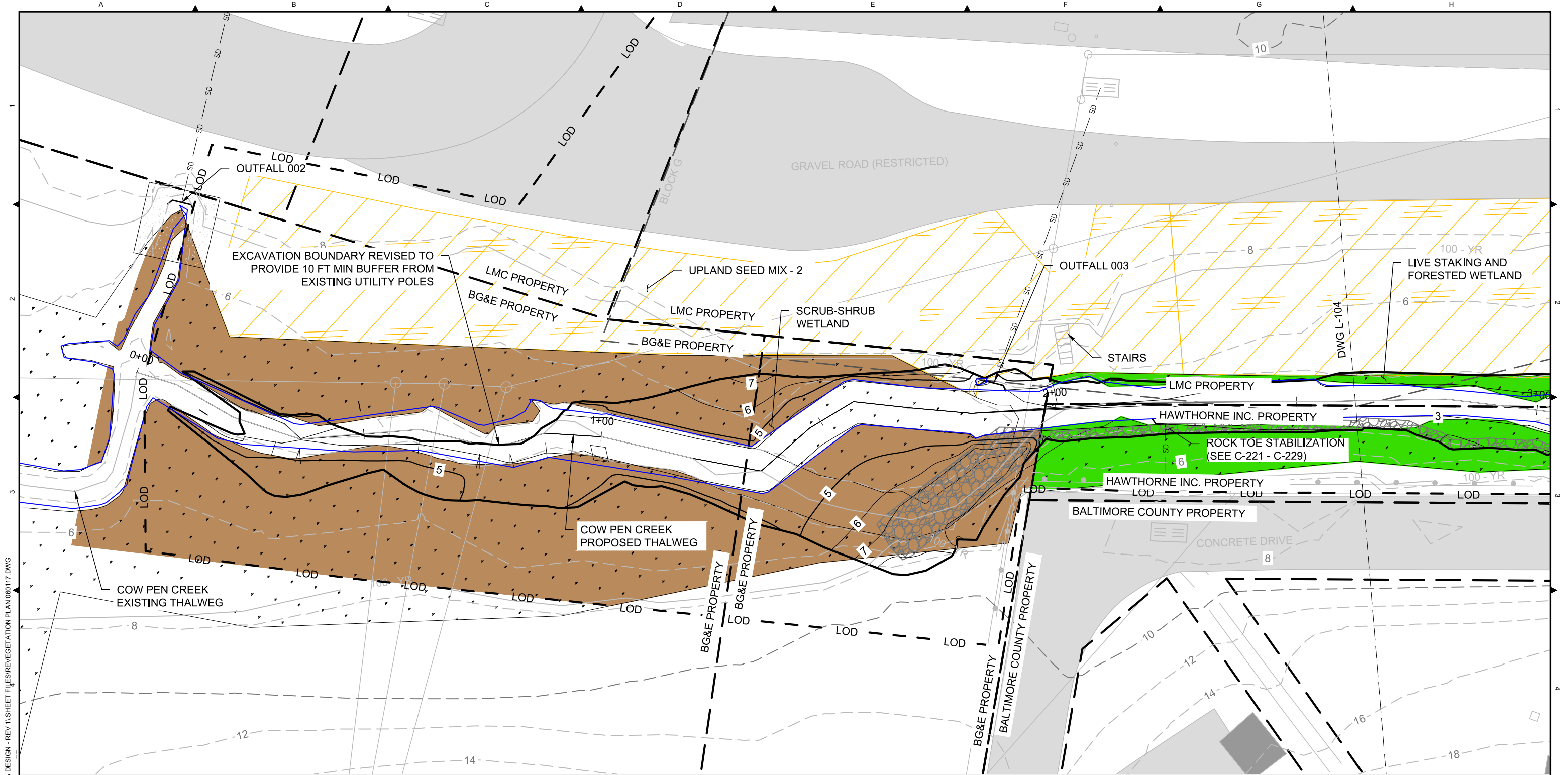
L-102

CREATED:

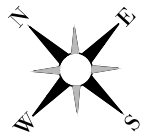
12/09/2015

SHEET: 50 OF 80

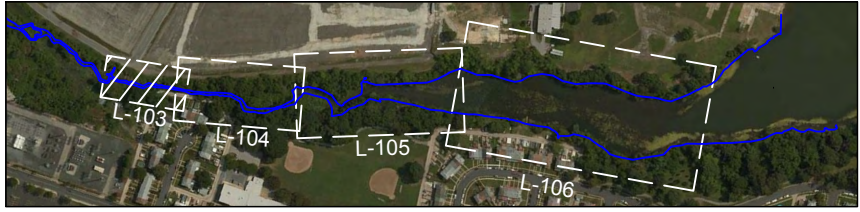
SCALE: 1" = 100'
PLOTTED 22" X 34"



Z:\PROJECTS\LOCKHEED - MIDDLE RIVER COMPLEX\FULL REMEDY\100% DESIGN - REV\1\SHEET FILES\REVEGETATION PLAN 080117.DWG
PLOT DETAILS MATIUS.TON September 22, 2017 10:21 AM



SHEET MAP:



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



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

LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

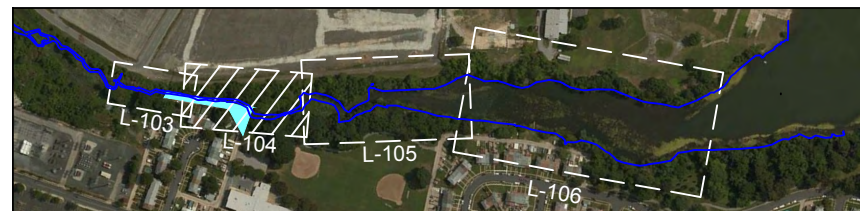
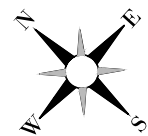
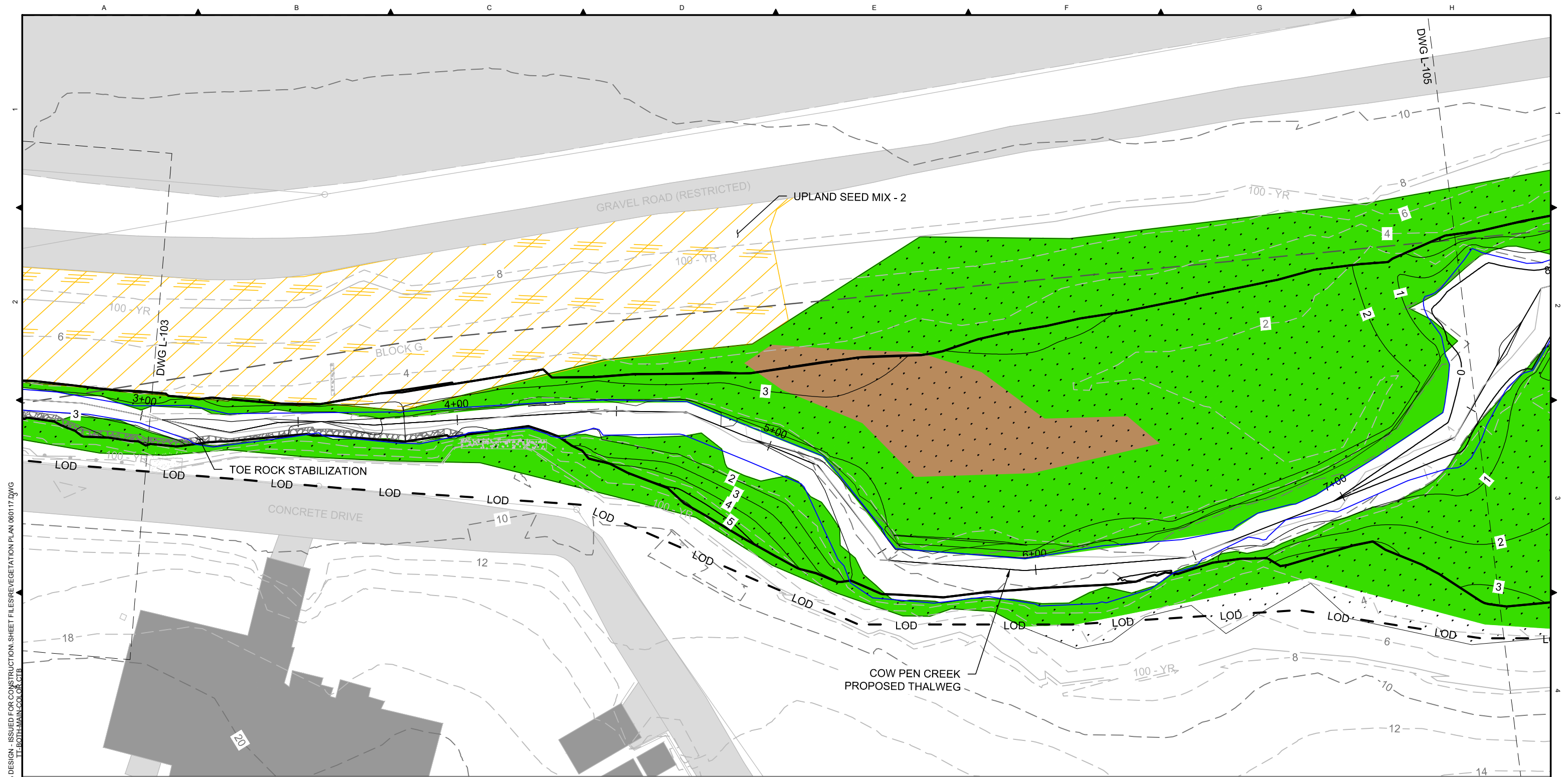
PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")						DRW	DSG	ENG	CHK	APP
REV.	DATE	REVISION DESCRIPTION								
3	09/22/17	REVISED PER BG&E ACCESS AGREEMENT	TJM	KB	SO	SO	-			
2	06/01/17	REVISED PLANTING PLAN	JA	KB/RS	JA	KB	-			
1	04/07/17	REVISED SEED MIX TABLES	TJM	KB	SO	SO	SO			
0	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"

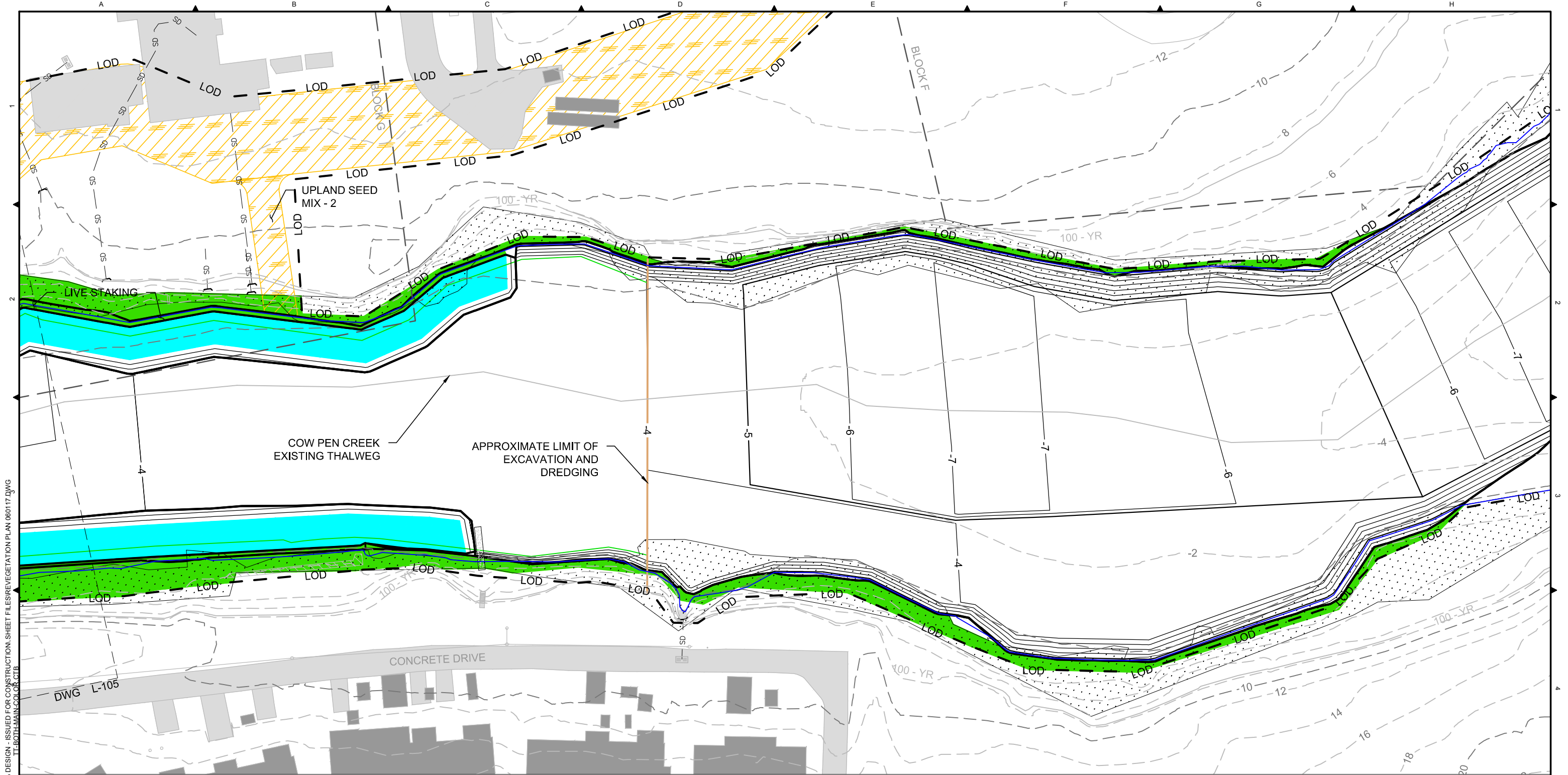


- LEGEND

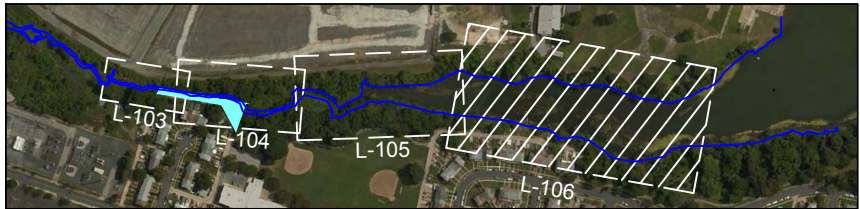
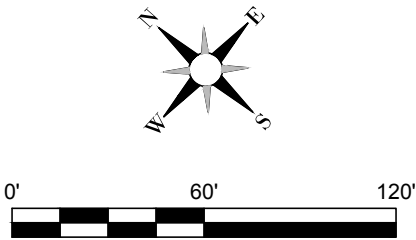


LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

SEDIMENT REMEDY DESIGN



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 T:\BOTHMAN\COLOR.CUTB



SHEET MAP:

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

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

LOCKHEED MARTIN
MIDDLE RIVER COMPLEX

REV.		DATE		PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")									
				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\DRAWING FILES\REVEGETATION PLAN 080117.DWG
August 21, 2017 11:04 AM
PLOT DETAILS MATIUS.TOV

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	<i>ACER RUBRUM</i> ²	RED MAPLE	FAC	CONTAINER	10	10	79	1 gallon
	<i>BETULA NIGRA</i>	RIVER BIRCH	FACW	CONTAINER	10	10	79	1 gallon
	<i>LIQUIDAMBAR STYRACIFLUA</i>	SWEETGUM	FAC	CONTAINER	10	15	118	1 gallon
	<i>PLATANUS OCCIDENTALIS</i>	SYCAMORE	FACW	CONTAINER	10	15	118	1 gallon
	<i>POPULUS DELTOIDES</i>	EASTERN COTTONWOOD	FAC	CONTAINER	10	10	79	1 gallon
	<i>SALIX NIGRA</i>	BLACK WILLOW	OBL	CONTAINER	10	20	158	1 gallon
Shrub	<i>CLETHRA ALNIFOLIA</i>	SWEET PEPPERBRUSH	FACW	CONTAINER	10	10	79	1 gallon
	<i>ITEA VIRGINICA</i>	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	<i>CLETHRA ALNIFOLIA</i>	SWEET PEPPERBRUSH	FACW	CONTAINER	8	25	37	1 gallon
	<i>EUONYMUS AMERICANUS</i>	STRAWBERRY BUSH	FAC	CONTAINER	8	25	37	1 gallon
	<i>ITEA VIRGINICA</i>	VIRGINIA SWEETSPIRE	FACW	CONTAINER	8	25	37	1 gallon
	<i>MAGNOLIA VIRGINIANA</i>	SWEETBAY MAGNOLIA	FACW	CONTAINER	8	25	37	1 gallon
Herbaceous Species	<i>HIBISCUS MOSCHEUTOS</i>	CRIMSON-EYED ROSE MALLOW	OBL	PLUGS	3	60	639	10 cubic inch
	<i>SOLIDAGO RUGOSA</i>	GOLDENROD	FAC	PLUGS	3	40	426	10 cubic inch

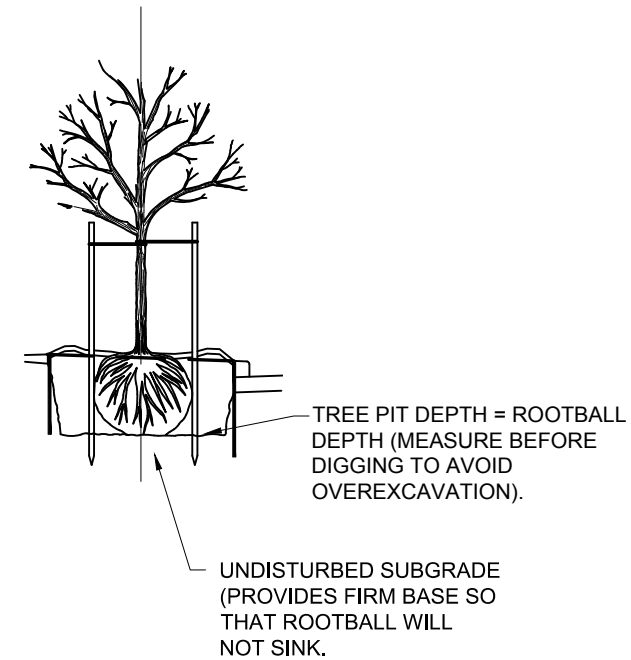
1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.
2 PERCENT COMPOSITION BASED ON GROWTH HABIT; COMPOSITION OF SHRUB SPECIES SUMS TO 100 AND COMPOSITION OF 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	<i>CAREX STRICTA</i>	TUSsock SEDGE	OBL	PLUGS	3	15	283
	<i>HIBISCUS MOSCHEUTOS</i>	CRIMSON-EYED ROSE MALLOW	OBL	PLUGS	3	20	378
	<i>IRIS VERSICOLOR</i>	BLUE FLAG IRIS	OBL	PLUGS	3	10	189
	<i>JUNCUS EFFUSUS</i>	COMMON RUSH	OBL	PLUGS	3	15	283
	<i>PELTRANDRA VIRGINICA</i>	GREEN ARROW-ARUM	OBL	PLUGS	3	10	756

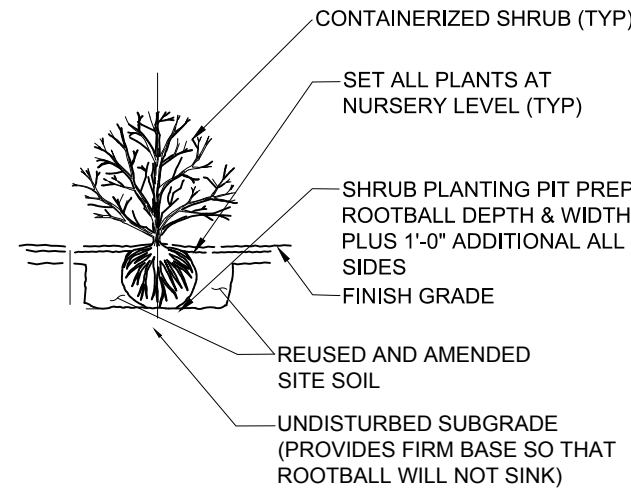
1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.

- NOTES:
- 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.
 - 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
 - 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:
 - 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.
 - SITE PREPARATION SUCH AS REMOVAL OF WEEDS OR OTHER SPECIES THAT WILL COMPETE WITH SEEDLINGS AND TILLING OF SOIL WILL OCCUR PRIOR TO PLANTING.
 - IF NECESSARY, SOIL AMENDMENT, SUCH AS FERTILIZER, WILL BE INCORPORATED PRIOR TO OR DURING PLANTING.
 - MEASURES SUCH AS TUBING WILL BE UTILIZED TO PROTECT PLANTS FROM HERBIVORY OR GRAZING .
 - 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.



TREE PLANTING DETAIL



SHRUB PLANTING DETAIL



- DETAIL NOTES:
- PLANTING INCLUDES REMOVAL OF STAKES ONE YEAR AFTER INSTALLATION.
 - SHAPE SOIL SURFACE TO PROVIDE 4' DIAMETER WATERING RING.

 TETRA TECH www.tetrattech.com 19803 North Creek Parkway Bothell, Washington 98011 Phone: 425-482-7600 Fax: 425-482-7652		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	REV.	DATE	PLAN SHEET SIZE ANSI D (22" X 34"), PLOTTED AS ANSI B (11" X 17")					SEDIMENT REMEDY DESIGN			DWG. NO.: L-107									
						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								
											COW PEN CREEK			CREATED: 12/09/2015	SHEET: 55 OF 80								
											REVEGETATION DETAILS			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: ANDREWS, JEREMY June 6, 2017 11:00 AM T:\BOTHMAN\COLOR.CTB

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 STYRACIFLU	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

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 - 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.



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

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 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.