Appendix H
White Paper: A Report on the Historical Impacts and Protection of Wetlands at NASA Wallops Flight Facility

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WHITE PAPER

A Report on the Historical Impacts and Protection of Wetlands at NASA Wallops Flight Facility

National Aeronautics and Space Administration
Goddard Space Flight Center's Wallops Flight Facility
Wallops Island, VA 23337

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TABLE OF CONTENTS

List of Figures

List of Tables

ACRONYMS AND ABBREVIATIONS

ac	acres
EPA	Environmental Protection Agency
GIS	Geographic Information System
ha	hectares
HUC	Hydrologic Unit Codes
NASA	National Aeronautics and Space Administration
NRCS	Natural Resource Conservation Service
NWI	National Wetland Inventory
PEIS	Programmatic Environmental Impact Statement
U.S.	United States
USDA	U.S. Department of Agriculture
VIMS	Virginia Institute of Marine Science
WETCAT	non-tidal wetland assessment
WFF	Wallops Flight Facility
W-PAWF	Watershed-based Preliminary Assessment of Wetland Functions

1.0 INTRODUCTION AND METHODS

1.1 INTRODUCTION

An extensive analysis of historical impacts to wetlands at the National Aeronautics and Space Administration (NASA) Wallops Flight Facility (WFF) and surrounding areas was performed in support of the Site-wide Programmatic Environmental Impact Statement (PEIS). The geographic boundary of the analysis is the two 12-digit Hydrologic Unit Codes (HUCs) (020403030504 and 020403040101) that encompass the Wallops Main Base, Mainland, and Wallops Island, as well as adjacent areas (**Figure 1)**. The study area totals 20,539 hectares (ha) (50,753 acres [ac]). To fully analyze the impact development has had on wetland size and functional value, the temporal extent of the study was defined as 1938 through 2025. The first period beginning in 1938 establishes the timeframe in which the NASA site was relatively undisturbed with the exception of agricultural fields, the Wallops Coast Guard Life Saving Station, and a hunt club. The year 2025 was chosen to encompass all proposed projects evaluated in the Site-wide PEIS.

Initially, the cumulative impacts analysis planned to use wetland permit data from the United States Army Corps of Engineers and the Virginia Marine Resources Commission to calculate the permitted wetland losses since the inception of the Clean Water Act in 1972. However, it was determined that this data was incomplete or not in a format that could be used for this analysis.

1.2 OBJECTIVES

The overall objective of the historical wetland impacts analysis was to compare the changes in the extent and function of wetlands over time. This objective was accomplished using the following steps:

1) Determine the historical extent of wetlands within the two 12-digit HUC study area.
2) Determine the historical wetland impacts within NASA boundaries and outside NASA boundaries.
3) Assign a functional value to:
    a) historically impacted wetlands,
    b) current wetlands, and
    c) cumulatively proposed to be impacted wetlands.
4) Evaluate the change in total functional value from 1938 to 2025 attributable to the Proposed Action evaluated in the Site-wide PEIS.

1.3 METHODS

Methods used to accomplish the objectives are described in the following sections.

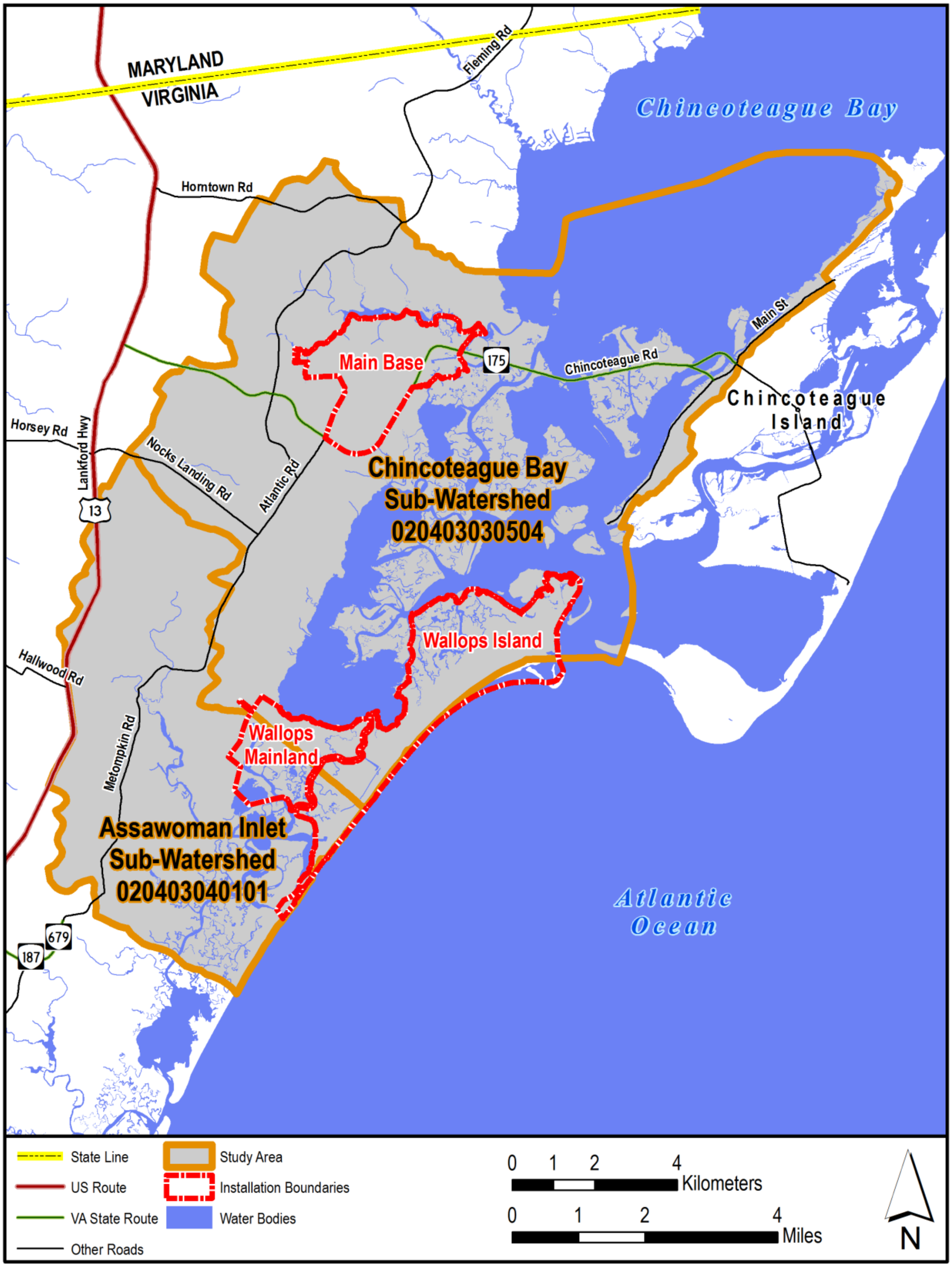

Figure 1. Cumulative Wetlands Study Area

1.3.1 Determining the Historic Wetland Extent

National Wetlands Inventory (NWI) data was combined with Natural Resource Conservation Service (NRCS) soils data and historic aerial photographs to determine the extent of wetlands within the study area. The 1920 NRCS soils survey was compared against the 1997 NRCS soils survey (United States Department of Agriculture [USDA] 1997) and it was determined that there were approximately 25% fewer acres of hydric soils in the 1920 soils survey, primarily due to the mapping conventions of the time (Stevens 1920). Therefore, the 1997 limit of hydric soils was considered the historic extent of wetlands.

1.3.2 Determining Historic Wetland Impacts

Historic aerial photography was used to calculate the wetland losses over time. A review of the historic aerial photography identified “areas of disturbance” compared to the 1997 historic hydric soils limit. These areas of disturbance were classified as: dredge area, fill area, impervious area, or miscellaneous disturbance. All aerial photographs were ortho-rectified and digitized to develop polygons for these areas of disturbance (i.e., loss of wetlands) using Geographic Information System (GIS) software. The wetland loss by wetland type was calculated for each year that photography was available.

Based on the availability of photography, the wetland losses were divided into two categories, 1) losses within the NASA boundaries, and 2) losses outside of the NASA boundaries within the remainder of the study area. Within the NASA boundaries, historic aerial photographs were available for the years 1938, 1949, 1957, 1963, 1966, 1974, 1979, 1988, 1994, and 2010 (Environmental Protection Agency [EPA] 1996, EPA 2004, and U.S. Army Corps of Engineers [USACE] 2000). Historic aerial photography for areas outside of the NASA boundaries was only available for the years 1938 and 1974.

1.3.3 Assigning Functional Values to Wetlands

A landscape level wetland assessment approach called Watershed-based Preliminary Assessment of Wetland Functions (W-PAWF) was employed to assign a functional value to wetlands. W-PAWF applies general knowledge about wetland function to emphasize wetlands of potential significance for numerous functions in a given study area (Tiner 2005). The new non-tidal wetland assessment procedure (WETCAT) currently underway at the Virginia Institute of Marine Science (VIMS) was considered for this analysis. However, it was determined that VIMS did not have any study sites within the geographic extent of this study area, and the methodology VIMS employed to evaluate the various non-tidal wetland areas used a suite of functions and values that differed enough from those used in the W-PAWF study that the datasets were not comparable. Therefore, the W-PAWF approach was used in this analysis. An overview of this approach is described below.

First, wetlands were classified according to criteria established by Tiner (2011) that includes landscape, landform, water flow path, and water body type. Habitats that were disturbed and no longer classified as wetlands were classified based on the closest adjacent wetland type, which, in this case, were all estuarine wetlands. All inland hydric soils (palustrine) were classified as palustrine forested wetlands following Tiner’s methodology (2003).

Following Tiner’s wetlands classification (Tiner 2003), the wetlands were then assigned a numerical quantity: low (0), moderate (1) and high (2) using W-PAWF for 10 wetland functions (**Table 1**). The maximum value a wetland could score was 20. However, the wetlands within NASA boundaries could only score a maximum value of 18 due to the fact that there are no streams within the NASA boundaries and Streamflow Maintenance for all wetlands would have a score of 0.

Table 1. Assigning Functional Values to Wetlands

Function	Importance to Wetland	Value		
		Low	*Moderate*	*High*
Surface water detention	Reduces downstream flooding and lowers flood heights, both of which aid in minimizing property damage and personal injury from such events.	0	1	2
Coastal storm surge detention	Estuarine and freshwater tidal wetlands are important areas for temporary storage of tidal waters brought into estuaries by storms (e.g., Nor'easters, tropical storms, and hurricanes).	0	1	2
Streamflow maintenance	Many wetlands are sources of groundwater discharge and some may be in a position to sustain streamflow in the watershed. Such wetlands are critically important for supporting aquatic life in streams.	0	1	2
Nutrient transformation	All wetlands recycle nutrients but those having a fluctuating water table are best able to recycle nitrogen and other nutrients. Vegetation slows the flow of water causing deposition of mineral and organic particles with adsorbed nutrients (nitrogen and phosphorus). Microbial action in the soil is the driving force behind chemical transformations in wetlands. Microbes need a food source (i.e., organic matter) to survive, so wetlands with high amounts of organic matter should have an abundance of microflora to perform the nutrient cycling function.	0	1	2
Retention of sediment and other particulates	Supports water quality maintenance by capturing sediments with nutrients or heavy metals (especially downstream of urban areas). Estuarine and floodplain wetlands plus streamside and lakeshore fringe and basin wetlands including in-stream ponds are likely to trap and retain sediments and particulates at significant levels. Terrene through-flow basins should function similarly. Vegetated wetlands will likely favor sedimentation over non-vegetated wetlands and are therefore rated higher.	0	1	2
Shoreline stabilization	Vegetation stabilizes the soil or substrate and diminishes wave action, thereby reducing shoreline erosion potential.	0	1	2
Provision of fish and shellfish habitat	Vegetated tidal and permanently flooded non tidal wetlands provide nursery, feeding and refuge habitat.	0	1	2
Provision of waterfowl and waterbird habitat	Wetlands designated as important for waterfowl (e.g., ducks, geese, mergansers, and loons) and waterbirds (e.g., wading birds, shorebirds, rails, marsh wrens, and red-winged blackbirds) are generally those used for nesting, reproduction, or feeding. The emphasis is on the wetter wetlands and ones that are frequently flooded for long periods.	0	1	2
Provision of other wildlife habitat	Wetlands provide habitat and conditions that provide significant habitat for other vertebrate wildlife (mainly reptiles and amphibians, interior forest birds, and mammals).	0	1	2
Conservation of biodiversity	The term "biodiversity" is used to identify wetlands that may contribute to the preservation of an assemblage of wetlands that encompass the natural diversity of wetlands in a given watershed. Four types of wetlands may be identified: 1) certain wetland types that appear to be scarce or relatively uncommon in the watershed, 2) individual wetlands that possess several different cover types (i.e., naturally diverse wetland complexes), 3) complexes of large wetlands, and 4) regionally unique or uncommon wetland types.	0	1	2
			Maximum Possible Total Value	**20**

1.3.4 Evaluating Change in Functional Value from 1938 to 2025

To assess the change in the 10 functions from 1938 to 2025, the wetland losses by habitat type in 1938 and 2025 were multiplied by the value for each function (0, 1 or 2) to generate a "functional unit total" for each time period following the methodology in Fizzell 2007. The functional totals for each year were compared to calculate a percent change in the function over time. The percent change over time was calculated with and without the Proposed Action to determine the change in functional value attributable to the Proposed Action addressed in the Site-wide PEIS.

2.0 RESULTS

In accordance with the objectives identified in Section 1.2 and the methods described in Section 1.3, the results of the historical analysis are presented in the following sections.

2.1 Functional Value of Current Wetlands in the Study Area

Based on the analysis of wetlands identified on the U.S. Fish and Wildlife Service (USFWS) 1998 NWI mapping (assumed as the current extent of wetlands), the majority of the wetlands present in the study area are estuarine intertidal and sub-tidal areas with a functional value of 17, classifying them as high value in 8 out of 10 functions. The next most common habitat is palustrine forested with a functional value of 14. **Table 2** provides a summary of the wetlands currently present in the study area with their functional value total.

Table 2. Summary of Wetland Areas Based on 1998 NWI Data

Cowardin Classification	Habitat	Functional Value	Hectares/Acres
E1UB	Estuarine Subtidal Unconsolidated Bottom	17	4,513/11,151
E2AB	Estuarine Intertidal Aquatic Bed	11	1/3
E2EM	Estuarine Intertidal Emergent	17	4,233/10,461
E2FO	Estuarine Intertidal Forested	15	14/35
E2RF	Estuarine Intertidal Reef	14	21/52
E2SS	Estuarine Intertidal Scrub-Shrub	17	55/136
E2US	Estuarine Intertidal Unconsolidated Shore	17	1,875/4,633
M1UB	Marine Subtidal Unconsolidated Bottom	7	87/214
M2US	Marine Intertidal Unconsolidated Shore	7	47/117
PAB	Palustrine Aquatic Bed	13	2/4
PEM	Palustrine Emergent	14	286/709
PFO	Palustrine Forested	14	968/2,394
PSS	Palustrine Scrub-Shrub	14	211/522
PUB	Palustrine Unconsolidated Bottom	9	74/183
PUS	Palustrine Unconsolidated Shore	9	22/54
		TOTAL	**12,409/30,668**
Source: USFWS 1998.			

2.2 Functional Value of Historical and Cumulative Wetland Impacts

2.2.1 Within NASA Boundaries

The results of the aerial photography review and calculation of historical wetland loss within the NASA boundaries for each year that photography was available are presented in **Table 3**. Also provided is the potential loss of wetlands associated with the Proposed Action addressed in the Site-wide PEIS and the cumulative loss of wetlands for past, present, and reasonably foreseeable future projects within NASA boundaries identified in the Site-wide PEIS.

The functional value for each wetland type established using Tiner methodology is provided in **Table 3.** It should be noted that the total area for each time period may not add up exactly due to rounding and conversion to metric. It should also be noted that the wetlands within NASA boundaries could only score a maximum value of 18 due to the fact that there are no streams within the NASA boundaries and Streamflow Maintenance for all wetlands would have a score of 0.

Including pre-NASA development (1938), 2014 UAS airstrip construction and shoreline renourishment activities of the No Action Alternative, and the Proposed Action, an approximate total of 550 ha (1,355 ac) of wetlands would be cumulatively impacted within the NASA boundaries. A total of 70% of the impacts (383 ha [946 ac]) that occurred on WFF happened between 1938 and 1974. The primary causes for historical wetland impacts within the NASA boundaries included development of the WFF buildings, runways, launch pads, infrastructure, and dredging the access channels. Additionally, every 3 to 5 years, the No Action Alternative of recurring beach renourishment will temporarily impact the same area of approximately 60 ha (150 ac) of marine subtidal and intertidal unconsolidated bottoms.

Table 3. Historical Wetland Impacts Within NASA Boundaries in Hectares/Acres[1]

Year	Cowardin Classification	Habitat	Functional Value	Hectares/Acres
1938	E1UB	Estuarine Subtidal Unconsolidated Bottom	17	0.4/1
	E2EM	Estuarine Intertidal Emergent	17	14/34
	PEM	Palustrine Emergent	14	0.2/0.4
	PFO	Palustrine Forested	14	1/2
	PSS	Palustrine Scrub Shrub	14	1/2
			TOTAL (ha/ac)	**16/39**
1949	E1UB	Estuarine Subtidal Unconsolidated Bottom	17	5/13
	E2EM	Estuarine Intertidal Emergent	17	11/27
	E2SS	Estuarine Intertidal Scrub Shrub	17	0.4/1
	E2US	Estuarine Intertidal Unconsolidated Shore	17	1/2
	PEM	Palustrine Emergent	14	1/2
	PFO	Palustrine Forested	14	3/7
	PSS	Palustrine Scrub Shrub	14	15/37
			TOTAL (ha/ac)	**36/88**
1957	E1UB	Estuarine Subtidal Unconsolidated Bottom	17	2/6
	E2EM	Estuarine Intertidal Emergent	17	22/55
	PEM	Palustrine Emergent	14	9/22
	PFO	Palustrine Forested	14	5/13
	PSS	Palustrine Scrub Shrub	14	9/23
	PUB	Palustrine Unconsolidated Bottom	9	0.4/1
			TOTAL (ha/ac)	**49/120**

Table 3. Historical Wetland Impacts Within NASA Boundaries in Hectares/Acres[1] (cont.)				
Year	**Cowardin Classification**	**Habitat**	**Functional Value**	**Hectares/Acres**
1963	E2EM	Estuarine Intertidal Emergent	17	1/2
	PEM	Palustrine Emergent	14	2/4
	PFO	Palustrine Forested	14	4/11
			TOTAL (ha/ac)	**7/17**
1966	E1UB	Estuarine Subtidal Unconsolidated Bottom	17	20/49
	E2EM	Estuarine Intertidal Emergent	17	52/129
	E2US	Estuarine Unconsolidated Shore	17	29/72
	E2SS	Estuarine intertidal Scrub Shrub	17	0.4/1
	PEM	Palustrine Emergent	14	42/103
	PFO	Palustrine Forested	14	0.4/1
	PSS	Palustrine Scrub Shrub	14	105/260
	PUB	Palustrine Unconsolidated Bottom	9	0.8/2
	PUS	Palustrine Unconsolidated Shore	14	17/43
			TOTAL (ha/ac)	**267/659**
1974	E1UB	Estuarine Subtidal Unconsolidated Bottom	17	3/8
	E2EM	Estuarine Intertidal Emergent	17	2/5
	E2US	Estuarine Unconsolidated Shore	17	0.4/1
	PEM	Palustrine Emergent	14	0.01/0.03
	PFO	Palustrine Forested	14	0.8/2
	PSS	Palustrine Scrub Shrub	14	2/5
			TOTAL (ha/ac)	**8.5/21**
1979	E1UB	Estuarine Subtidal Unconsolidated Bottom	17	0.01/0.03
	E2EM	Estuarine Intertidal Emergent	17	0.1/0.3
	E2SS	Estuarine Intertidal Scrub Shrub	17	0.02/0.04
	PEM	Palustrine Emergent	14	0.01/0.03
	PSS	Palustrine Scrub Shrub	14	1/3
	PUB	Palustrine Unconsolidated Bottom	9	0.001/0.002
			TOTAL (ha/ac)	**1/3**

Table 3. Historical Wetland Impacts Within NASA Boundaries in Hectares/Acres[1] (cont.)				
Year	**Cowardin Classification**	**Habitat**	**Functional Value**	**Hectares/Acres**
1988	E2EM	Estuarine Intertidal Emergent	17	2/5
	PAB	Palustrine Aquatic Bed	14	0.2/0.5
	PEM	Palustrine Emergent	14	0.4/1
	PFO	Palustrine Forested	14	0.1/0.3
	PSS	Palustrine Scrub Shrub	14	4/11
	PUB	Palustrine Unconsolidated Bottom	9	2/4
			TOTAL (ha/ac)	**9/22**
1994	E2EM	Estuarine Intertidal Emergent	17	0.04/0.1
	PEM	Palustrine Emergent	14	0.4/1
	PFO	Palustrine Forested	14	0.4/1
	PSS	Palustrine Scrub Shrub	14	0.4/1
			TOTAL (ha/ac)	**1/3**
2012	M1UB	Marine Subtidal Unconsolidated Bottom	6	85/211
	M2US	Marine Intertidal Unconsolidated Shore	9	7/17
			TOTAL (ha/ac)	**92/228**
No Action Alternative[2]	PEM	Palustrine Emergent	14	1/2
	PSS	Palustrine Scrub Shrub	14	0.06/0.15
	M1UB	Marine Subtidal Unconsolidated Bottom	6	20/50
	M2US	Marine Intertidal Unconsolidated Shore	9	36/90
			TOTAL (ha/ac)	57/142
Proposed Action[3]	E1UB	Estuarine Subtidal Unconsolidated Bottom	17	1/2
	E2EM	Estuarine Intertidal Emergent	17	2/5
	E2US	Estuarine Unconsolidated Shore	17	0.4/1
	PEM	Palustrine Emergent	14	2/4
			TOTAL (ha/ac)	**5/12**
Cumulative Total by Habitat Type[4]	E1UB	Estuarine Subtidal Unconsolidated Bottom	17	32/79
	E2EM	Estuarine Intertidal Emergent	17	106/262
	E2SS	Estuarine Intertidal Scrub Shrub	17	0.8/2
	E2US	Estuarine intertidal Unconsolidated Shore	17	31/76
	M1UB	Marine Subtidal Unconsolidated Bottom	6	106/261

Table 3. Historical Wetland Impacts Within NASA Boundaries in Hectares/Acres[1] (cont.)				
Year	Cowardin Classification	Habitat	Functional Value	Hectares/Acres
	M2US	Marine Intertidal Unconsolidated Shore	9	43/107
	PAB	Palustrine Aquatic Bed	13	0.2/0.4
	PEM	Palustrine Emergent	14	56/139
	PFO	Palustrine Forested Palustrine Forested	14	15/37
	PSS	Palustrine Scrub Shrub	14	139/342
	PUB	Palustrine Unconsolidated Bottom	9	3/7
	PUS	Palustrine Unconsolidated Shore	14	17/43
			CUMULATIVE TOTAL (ha/ac)	**549/1,357**

***Notes**:* [1] Totals may not add up exactly due to rounding and conversion.
[2] No Action Alternative impacts based upon 2014 UAS Airstrip construction and beach renourishment.
[3] Future impacts are based on the upper end of the range of impacts presented in the Site-wide PEIS, Section 3.5.2.2.
[4] Includes historical impacts for all years photography was available and the Proposed Action.

2.2.2 Outside NASA Boundaries

Table 4 provides the results of the aerial photography review and calculation for historical wetland loss outside of NASA boundaries (photography was only available for the years 1938 and 1974). This table also includes the functional value established using Tiner's methodology. There was a difference in the coverage of the aerial photographs between the two analysis years (1938 and 1974). The majority of the difference was within estuarine areas; however, there were gaps of inland areas, as well. In 1938, 1,007 ha (2,488 ac) of the hydric soils within the aerial photography coverage area were identified as converted to agricultural fields. The conversion of wetlands (i.e., hydric soils) to agricultural use amounts to a 12.0% loss of wetlands. In 1974, 1,060 ha (2,620 ac) of the hydric soils within the aerial photography coverage area were identified as agricultural areas totaling a 12.6% loss of wetlands. Wetlands impacts after 1974 are unknown, but were assumed to be minor in nature; these impacts were not confirmed due to the lack of available USACE permit data that would quantify the permitted impacts from 1974 to present.

Table 4. Historic Wetland Impacts Outside of NASA Boundaries in Hectares/Acres							
Year	Study Area Size[1]	Average Hydric Soils	Aerial Photo Coverage[2]	Wetland Loss[3]	Cowardin Classification	Habitat	Functions and Values Total
1938	20,539 ha 50,753 ac	8,363 ha 20,665 ac	14,608 ha 36,097 ac	1,007 ha 2,488 ac	PFO	Palustine Forested	9
1974	20,539 ha 50,753 ac	8,363 ha 20,665 ac	17,013 ha 42,040 ac	1,060 ha 2,620 ac	PFO	Palustine Forested	9

***Notes**:* [1] Includes both HUC Codes, minus NASA property.
[2] Aerial Photo Coverage did not include the entire Study Area.
[3] Wetland loss is calculated by determining the area converted to agriculture compared to the 1997 hydric soils historic wetlands extent. Conversion to agriculture is the assumed wetland loss.

2.2.3 Total Study Area Comparison

Historical total wetland losses across the entire study area from 1938 to present (2012) totaled 1,555 ha (3,842 ac); 495 ha (1,222 ac) within NASA boundaries and 1,060 ha (2,620 ac) outside NASA boundaries.

Wetland losses within NASA's boundaries accounted for 32% of the wetland impacts in the total study area during this timeframe. The amount of historical wetland loss attributable to NASA within the total study area appears large; however, it is important to note that during that time period, NASA was one of the largest developments within the study area and a majority of the remaining portions of the study area remained undeveloped.

2.3 Evaluation of Change in Functional Value Over Time

As wetlands are lost over the study area, the overall function and total value of those wetlands will decrease. **Table 5** provides the total functional value for each of the 10 wetland functions and the percent change in value over time for the years 1938 and 2025 determined using the method described in Section 1.3.4. The year 2025 is the temporal extent of this study since there are no known proposed projects at WFF beyond this timeframe. **Table 5** provides data for the entire study area; however, since the Proposed Action would not affect the Streamflow Maintenance function, this function was removed from the analysis. The 2025 functional value was calculated with and without the Proposed Action to determine how much of the change in functional value is attributable to the Proposed Action. The change in functional value attributable to the Proposed Action would be minimal and range from 0.03% (fish and shellfish/waterbird habitat) to 0.05% (conservation of biodiversity).

Table 5. Total Functional Scores for Each Wetland Function										
Change in the 10 Functions and Values With the Proposed Action										
Wetland Functions	**Surface Water Detention**	**Coastal Storm Surge Detention**	**Streamflow Maintenance ***	**Nutrient Transformation**	**Sediment & Particulate Retention**	**Shoreline Stabilization**	**Fish & Shellfish Habitat**	**Waterbird Habitat**	**Other Wildlife Habitat**	**Conservation of Biodiversity**
1938 Functional Score	64,042	62,901	387	62,880	63,089	62,376	54,748	58,292	59,087	35,247
2025 Functional Score	60,766	60,396	8	60,075	60,320	60,185	53,394	56,855	56,808	33,725
Change in Function and Value (%)	-5.11	-3.98	-97.85	-4.46	-4.39	-3.51	-2.47	-2.47	-3.86	-4.32
Change in the 10 Functions and Values Without Proposed Action										
Change in Function and Value (%)	-5.08	-3.94	NA	-4.42	-4.35	-3.47	-2.44	-2.43	-3.82	-4.27
Change in Functional Score Attributable to Proposed Action (%)	-0.04	-0.04	NA	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.05

Note: * The function of stream flow maintenance is not affected by the Proposed Action and was not included in this analysis.

3.0 CONCLUSIONS

In determining whether the historical and cumulative impacts to wetlands would potentially be significant, it is important to discuss the regulatory requirements in place to offset wetland impacts through avoidance and minimization measures. Unavoidable impacts to wetlands within the NASA boundaries since promulgation of the 1972 CWA (which established the basic structure for Section 404 permits) and Executive Order 11990 have been minimized to the greatest extent possible. As shown in **Table 3**, 383 ha (946 ac) of wetlands within NASA's boundaries were impacted between 1938 and 1974. Of these impacts, 258 ha (923 ac) were associated with wetland dredge and fill actions taken at Wallops Island from 1939 through 1966, primarily attributed to construction of the Wallops Island Causeway. No mitigation was performed for these wetland impacts since the regulatory authority did not exist to protect wetlands during this timeframe.

Since implementation of permit requirements and methodology for delineating wetlands (USACE 1987), 103 ha (255 ac) of wetlands have been or are planned to be impacted at WFF through other actions (1988 through present [2014]). Additionally, every 3 to 5 years, the No Action Alternative of recurring beach renourishment will temporarily impact the same area of approximately 60 ha (150 ac) of marine subtidal and intertidal unconsolidated bottoms. In accordance with the CWA and EO 11990, NASA has secured the proper permits through the USACE, Virginia Marine Resources Commission, Virginia Department of Environmental Quality, and Accomack County. The additional impact of up to 5 ha (12 ac) of wetlands from implementation of the Proposed Action addressed in the Site-wide PEIS would be avoided and minimized to the greatest extent possible. Any impacts that could not be avoided would be permitted through the USACE, Virginia Marine Resources Commission, Virginia Department of Environmental Quality, and Accomack County to ensure no net loss of wetlands.

Therefore, while unavoidable adverse impacts to wetlands would occur through implementation of the Proposed Action and have occurred cumulatively over time at WFF, no net loss of wetlands has occurred since 1988 due to the existence of regulations which require unavoidable impacts to be mitigated. Moreover, while the appropriate mitigation is determined at the time of permitting, it is often the case that the ratio of wetlands created to wetlands lost is greater than 1:1.

As shown in **Table 2**, there are currently 12,409 ha (30,668 ac) of wetlands throughout the entire study area, the majority of which have a functional value of 17. The Proposed Action has the potential to impact approximately 0.04% of the total wetlands within the study area. The cumulative loss in wetland functional value based on the methodology used by Tiner and Fizzell demonstrate a functional score loss of no more than 5.11% across all functions evaluated since 1938 (including the Proposed Action). The Proposed Action contributes 0.03 to 0.05% (depending on the function being evaluated) of this loss. Therefore, the Proposed Action would not contribute a significant cumulative impact to wetlands.

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