



# Wetland Inventory and Mapping at Fredericksburg and Spotsylvania National Military Park, Virginia

Natural Resource Technical Report NPS/MIDN/NRTR—2013/790



**ON THE COVER**

Wetland-1 located West of the FRSP Natural Resources Management Office taken 10 May 2012.  
Photograph by: Dr. Peter James Sharpe

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## Abstract

The objective of this investigation was to delineate and map all wetlands and associated waterways subject to jurisdiction under Section 404 of the Clean Water Act and all wetlands subject to National Park Service (NPS) procedures for implementing Director's Order #77-1: Wetland Protection within Fredericksburg and Spotsylvania National Military Park – Fredericksburg Battlefield (FRED). This investigation adhered to the U.S Army Corps of Engineers (USACE) Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region as the primary methodology for making wetland determinations in the field. However, under D.O. #77.1 the National Park Service (NPS) must also assess any potential wetland habitats that fall within the broader Cowardin et al. (1979) definition of wetlands and deepwater habitats. A total of 37 palustrine wetlands encompassing 139.63 acres (56.50 ha) of land were identified and delineated from May – November 2012. All of the identified and mapped palustrine wetland systems meet both the U.S. Army Corps of Engineers criteria and the Cowardin et al. (1979) definitions. No new riverine systems were identified and mapped over the course of this investigation within the park boundary. The majority of the larger wetland systems were located in areas previously identified by park staff and USGS/NPS vegetation mapping, however, a significant number of previously smaller unmapped wetland areas were identified over the course of this investigation including the identification and verification of three vernal pool habitats. Our results also showed greater overall NWI accuracy compared to the USGS/NPS vegetation mapping at the 1:40,000 scale within the park study area boundary. The results shed valuable light on the efficacy of NWI mapping products for landscape level wetland status and trends analysis critical for supporting broad scale National Park Service management efforts such as the Natural Resources Condition Assessment program (NRCA) and State of the Parks reports. The improved boundary information and revised wetland mapping will also significantly improve the park's ability to effectively manage, protect, and monitor these unique resources.



## **Acknowledgments**

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# Introduction

The primary objective of this report is to describe and document the wetland inventory and mapping work performed from May to November 2012 within a 1,241 ac (502 ha) study area of the Fredericksburg and Spotsylvania National Military Park – Fredericksburg Battlefield (FRED). This report was prepared, in part, to satisfy the regulatory requirements of the U.S. Army Corps of Engineers (USACE), which has jurisdictional authority over wetlands and waterways of the United States under the purview of Section 404 of the Clean Water Act and the NPS under Director's Order #77.1, and the Organic Act of 1916.

The results of this report will provide the park with a definitive inventory of all of the existing palustrine wetland systems and their associated boundaries with sub-meter accuracy within the study area boundary, excluding any in-holdings. These efforts will assist the park with their environmental compliance needs, as well as, long term planning efforts such as Development Concept Plans, the Natural Resource Condition Assessment, and State of the Parks reporting.

## Study Area Description

Our study area described below and shown in Figure 1 represents just over a third ( $\approx 39\%$ ) of the greater Fredericksburg and Spotsylvania National Military Park a 3,157 ha (7,800 ac) unit of the National Park Service located in Orange, Spotsylvania, Caroline, and Stafford counties, Virginia, and in the City of Fredericksburg, Virginia (Figure 1).

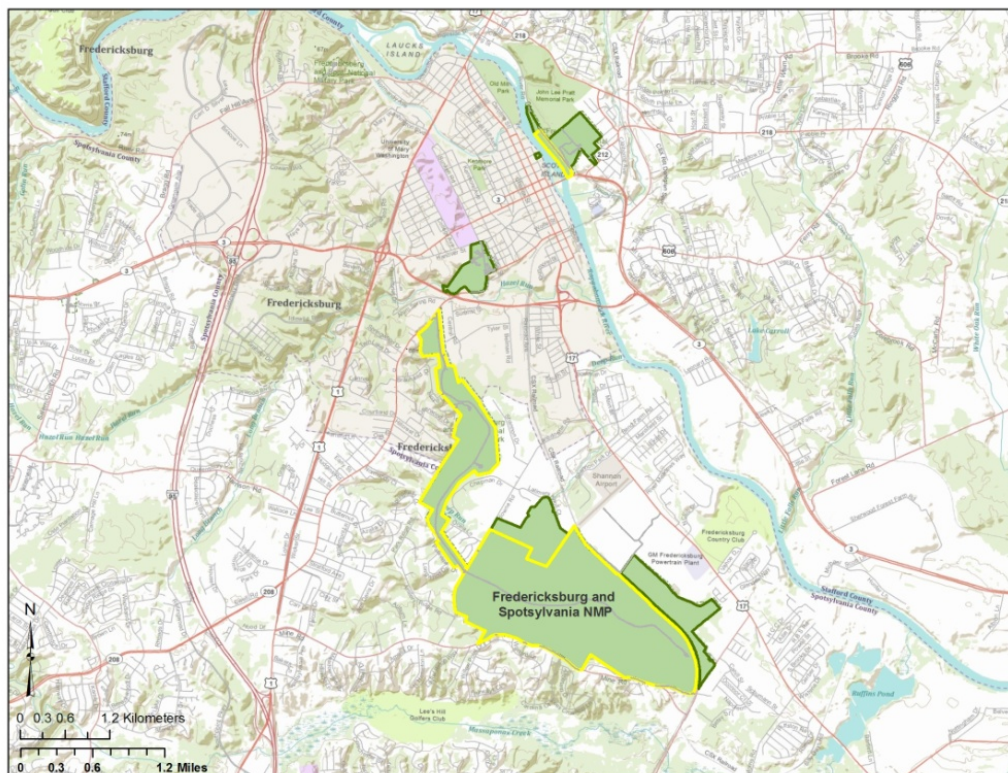


**Figure 1.** Site location map of the Fredericksburg and Spotsylvania National Military Park, Fredericksburg Battlefield unit (FRED), wetlands investigation.

The park has eight principal units spread out over 375.6 km<sup>2</sup> (145mi<sup>2</sup>) of the Virginia Piedmont and Atlantic Coastal Plain. The park was originally established in 1927 to commemorate four major engagements of the Civil War, the battles of Fredericksburg, Spotsylvania Court House, Wilderness, and Chancellorsville (NPS 1986). The original park boundary also included the Fredericksburg National Cemetery, created in 1869 to recognize the soldiers who fought in the four battles. The park was initially under the direction of the Secretary of War and it was the duty of the commissioners to survey and preserve the lines of opposing armies in each battle (NPS 1986). An Executive Order in 1933 transferred the park from the responsibility of the War Department to the Department of the Interior. Since that time, the four battlefields have grown by several thousand acres and additional park units have been added: Stonewall Jackson Shrine (1937), Salem Church (1965), and Chatham Manor (1977) (Taverna and Patterson, 2008). Lands within the legislative boundary of the Fredericksburg Battlefield (FRED) were investigated with the exception of any active inholdings (see mapping exhibits Appendix B) and park areas located on the northeast side of the active railroad tracks at FRED.

Approximately 90% of the park is in the northern Piedmont physiographic province, with the remaining 10% falling within the northern Coastal Plain. The fall line dividing the two physiographic provinces runs roughly from Chatham Manor through Fredericksburg Battlefield. This report focuses only on those portions of Fredericksburg and Spotsylvania National Military Park (FRSP) that lie within the northern Coastal Plain (Fredericksburg Battlefield – FRED). Much of this portion of the park consists of successional and intermediate aged Virginia pine (*Pinus virginiana* Mill.), and secondary pine-hardwood forests that have developed after repeated cutting or agricultural abandonment. The most mature remnant stands on mesic uplands are characterized by associations of American beech (*Fagus grandifolia* Ehrh.), several oaks (*Quercus* spp.), and American holly (*Ilex opaca* Aiton var. *opaca*) (Taverna and Patterson, 2008). The most significant geologic feature within this portion of the park is the fall line separating the piedmont from the Atlantic Coastal Plain. The fall line runs directly west of the town of Fredericksburg, VA and the wetland study area. Above the fall line (to the west) the Rappahannock River is narrow with many rapids and below the line (to the east) the river is under tidal influence and broadens to more than 800 m (2,624 ft) (Thornberry-Ehrlich, 2010). Study area park soils located east of the fall line are thus derived from unconsolidated sediment deposits of the Atlantic Coastal Plain (Thornberry-Ehrlich, 2010)

An anthropogenic feature of cultural and natural resource significance within the wetlands investigation study area is the presence of approximately 43,138 linear feet (13,148 m) of civil war era earthworks. The enabling legislation for the park directs the NPS to protect and preserve these features for interpretation and visitor experience, however, these features exhibit a strong influence on the landscape as they have significantly altered the natural overland flow patterns of the park where they are present and over time (since the 1860s) have likely promoted the formation of wetland habitats (Figure 2).

The FRED unit has some of the lowest overall elevations in the park with the highest ridges in the southern end of Fredericksburg Battlefield being no higher than 260 ft (80 m) and some of the lower lying areas surveyed along the Rappahannock River being just above sea level. Flowing primarily along the northeastern portion of the FRED study area the Rappahannock River is the principal water feature of this portion of the park. All of the identified and mapped wetland habitats ultimately provide surface water drainage to the Rappahannock River either by

direct connectivity such as those habitats found within the river's floodplain or via Hazel or Deep Run located within the park boundary further south.



**Figure 2.** View of a FRED (Coastal Plain Physiographic Province) Wetland (Wetland-11 photographed here) 31 May 2012. The wetland occupies the seasonally saturated ditch created by the civil war era earthwork (right hand side of photograph).



## Methods

The NPS through Director's Order #77-1 requires mapping of wetlands and all other "waters of the United States" via a slightly different criteria than the USACE 1987 manual and associated regional supplements, thus the two types of wetland determination methods employed at FRSP were: (1) the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual (2010) and (2) the 1979 USFWS *Classification of Wetlands and Deepwater Habitats of the United States*.

### Interim Regional Supplement USACE Method

The USACE method for identifying the wetland / upland boundary uses the definition as outlined in the U.S. Army Corps of Engineers *Wetlands Delineation Manual*, 1987, which defines a wetland 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. Wetlands generally include swamps, marshes, bogs, and similar areas."*

Wetland boundaries were primarily determined by establishing a series of transects from a known wetland into known upland locations surrounding the wetland under examination. At random intervals along the transect investigators looked for evidence of hydric soils, hydrophytic vegetation, and wetland hydrology. The wetland/upland boundary line was thus delineated using the transect data and any obvious topographic changes (e.g. abrupt toe-of-slope line) along the wetland/upland perimeter that might occur.

### Hydrophytic Vegetation Criteria

For determining the presence of hydrophytic vegetation, plant species within each community were visually identified by strata (e.g. trees, saplings/shrubs, herbs and woody vines) and listed in descending order of dominance. The USACE defined sampling stratum has 5 percent or more total plant cover. If a stratum had less than 5 percent cover during the growing season, then those species and their cover values were recorded on the data form, assuming application of Indicator 3 (Prevalence Test) was necessary such as in the case of a site possessing wetland soil, hydrology, but did not meet the criteria for the first two hydrophytic plant community assessments (e.g. Rapid Test or Dominance Test). However, these species were not generally included on the data sheets if the wetland determination could be made via Indicator 1 (Rapid Test) or Indicator 2 (Dominance Test). For Indicators 1 and 2 only those species that comprised 5% or more of a given strata were assessed. Vegetation survey plots conformed to current USACE interim supplement guidelines and involved the use of a series of nested circular plots radiating outward from the soil/hydrology test pit (Figure 3). Plot sizes were as follows:

1. Tree stratum – 30 ft (9.1 m) radius
2. Woody vines – 30 ft (9.1 m) radius
3. Herb stratum – 5 ft (1.5 m) radius
4. Sapling/shrub stratum – 15 ft (4.6 m) radius

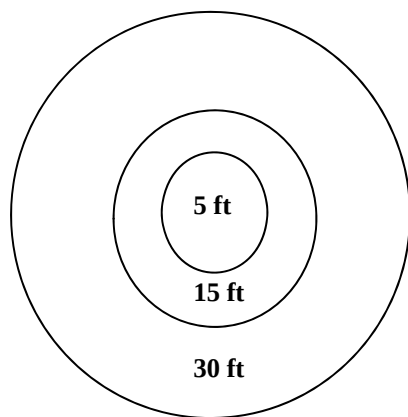


**Figure 3.** Typical wetland vegetation survey plot conforming to USACE interim regional supplement Atlantic and Gulf Coastal Plain (2010) guidelines.

The wetland indicator status of observed dominant plant species was determined using the U.S. Army Corps of Engineers Atlantic and Gulf Coastal Plain National Wetland Plant Species List, 2012 with additional verification through the USDA plants database and are listed below:

- **OBL** (Obligate Wetland Plants) occur greater than 99 percent of the time in wetlands under natural conditions.
- **FACW** (Facultative Wetland Plants) occur between 67 and 99 percent of the time in wetlands under natural conditions.
- **FAC** (Facultative Plants) occur between 33 and 67 percent of the time in wetlands under natural conditions.
- **FACU** (Facultative Upland Plants) occur between 1 and 33 percent of the time in wetlands under natural conditions.
- **UPL** (Obligate Upland Plants) occur less than 1 percent of the time in wetlands under natural conditions.

The wetland plant indicators were given for each dominant plant species identified on the attached Routine Wetland Determination forms (provided under separate to Gregg Kneipp and Jim Comiskey). Dominance was determined as the most abundant species that individually or collectively accounted for more than 50 percent of the total absolute coverage of vegetation in the stratum, plus any other species that, by itself, accounts for at least 20 percent of the total (i.e. the 50/20 Rule).

The interim regional supplement to the original 1987 USACE manual identifies four primary indicators of hydrophytic vegetation, any of which, when met, signifies that the community indicates a wetland plant community. For purposes of brevity this section will only cover the two most commonly encountered indicators at FRSP (e.g. Indicators 1 and 2). For a complete description of all of the indicators the reader is directed to view the U.S Army Corps of Engineers (USACE) Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (2010).

For a plant community to meet the vegetation criteria under Indicator 1 the following description must be met: "All dominant species across all strata are rated OBL or FACW, or a combination

of these two categories, based on a visual assessment.” Under Indicator 2 (the most commonly employed indicator at FRSP more than 50 percent of the dominant plant species across all strata must be rated OBL, FACW, or FAC.

### Hydrology Criteria

Wetland hydrology indicators provide evidence that episodes of inundation or soil saturation lasting more than a few days during the growing season have occurred repeatedly over a period of years and that the timing, duration, and frequency of wet conditions have been sufficient to produce a characteristic wetland plant community and hydric soil morphology. The growing season begins when two or more non-evergreen vascular plant species growing within the study area exhibit one or more of the following biological indicators:

1. Emergence of herbaceous plants from the ground
2. Appearance of new growth from vegetative crowns (e.g., in graminoids, bulbs, and corms)
3. Coleoptile/cotyledon emergence from seed
4. Bud burst on woody plants (i.e., some green foliage is visible between spreading bud scales)
5. Emergence or elongation of leaves of woody plants
6. Emergence or opening of flowers

Growing season conditions can also be met if soil temperatures measured at 12 in. (30 cm) depth is 41 °F (5 °C) or higher. Hydrologic indicators of wetland conditions are based on the direct observation of surface water or groundwater during a site visit (Group A indicators), evidence that the site is subject to flooding or ponding, although the inundation need not be directly observed at the time of the investigation (Group B indicators). The inundation (Group B) indicators include water marks, drift deposits, sediment deposits, and similar features. Other hydrologic indicators consist of evidence that the soil is saturated currently or was saturated recently such as oxidized rhizospheres and the presence of reduced iron or sulfur in the soil profile (Group C indicators), which indicate that the soil has been saturated for an extended period. The final group of hydrologic indicators (Group D) consists of landscape, vegetation, and soil features that indicate contemporary rather than historical wet conditions. Wetland hydrology indicators are intended as one-time observations of site conditions that are sufficient evidence of wetland hydrology in areas where hydric soils and hydrophytic vegetation are present. For a site to meet the wetland hydrologic criteria it need only possess one primary indicator or two secondary indicators from one of the aforementioned groups.

### Hydric Soil Criteria

The National Technical Committee for Hydric Soils defines a hydric soil as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service 1994). One of the most significant changes to the original 1987 USACE manual with regards to wetland boundary determinations is in the area of hydric soil recognition and characterization. The new regional supplement still requires low chroma color soils and the presence of redoximorphic features, however, the revised indicators are much more specific and cover a broader range of potential wetland types than the original 1987 manual criteria. For a detailed description of each of the potential hydric soil indicators within the Atlantic and Gulf Coastal Plain Region please refer to Table 7 located within the regional supplement.

Soil pits were excavated to a maximum depth of 18 inches (45.72 cm) using a sharpshooter shovel with a 16 inch (40.64 cm) blade, unless on-site conditions such as shallow bedrock prohibited excavation or one or more of the hydric soil indicators were met. The data sheets for each mapped wetland include information on the soil profile colors, presence/absence of redoximorphic features, texture, and presence/absence of any shallow confining layers and their depths on-site.

#### **Application of the Cowardin et al. (1979) Method:**

In this investigation, FRSP wetland areas delineated according to criteria in the USACE regional supplement were further assessed and classified by applying wetland descriptions outlined in the USFWS publication entitled *Classification of Wetlands and Deep Water Habitats of the United States* (Cowardin et al. 1979).

The U.S. Fish and Wildlife Service Publication FWS/OBS-79/31 uses the taxonomic classification of systems to categorize wetlands by their geographic setting. The Cowardin wetland classifications are as follows: Marine, Estuarine, Riverine, Lacustrine and Palustrine. Of these systems, only the Palustrine were found within the FRSP study area. Four of the five above-mentioned wetland systems possess subordinate subsystems that address their geologic setting and all five systems can be refined to taxonomic descriptive units of class, subclass and dominance type. The class taxonomic component is subordinate to subsystem and provides a general description of the dominant existing vegetative life forms of the ecological community, the geomorphic setting, flooding regime and the substrate composition. The taxonomic level of subclass provides a refined description of the plant community. For example, Cowardin et al. (1979) identify the following subclasses: Palustrine Broad-Leaved Deciduous Forest (PF01) and a Palustrine Unconsolidated Bottom Mud (PUB3). Water regime modifiers were also added to the USFWS subclass definitions.

Palustrine systems are typically represented by all nontidal wetlands dominated by trees, shrubs, and emergent vegetation. Wetlands that have traditionally been called marshes, bogs, and swamps are collectively categorized under the Palustrine system. The Palustrine system also includes shallow, intermittent, or permanent bodies of water commonly referred to as ponds. Palustrine wetlands such as those occurring within FRSP are generally located landward of the waterways, streams, springs, and ponds. The maximum depth of water associated with a Palustrine system is 6.6 feet (1.98 meters), which is defined by the USFWS as the maximum water depth associated with the presence of non-persistent emergent vegetation.

The prevalent substrate texture underlying Palustrine systems are used to distinguish different wetland classes if the existing above-ground vegetation covers less than 30% of the ground surface. The substrate provides information on abiotic influences, such as wind, currents and deposition of eroded substrate material within the wetland system.

## **GPS Survey of Wetland Boundaries**

Blue wetland delineation flags were marked with a unique alpha numeric code and hung at regular intervals around the perimeter of each identified wetland habitat. The representative upland and wetland test pit positions were surveyed using a GPS (Global Positioning System). GPS-based coordinates were collected of wetland test pit and boundary flags between May 2012 and November 2012, using a Trimble 12 channel Pro XR receiver with an external Pro XR integrated GPS/MSK antenna in datum NAD83, UTM – zone 18, meter coordinates and TerraSync software. A minimum of 4 satellite vehicles were tracked. A maximum Position Dilution of Precision (PDOP) of 6 was maintained for each set and a minimum of 60 positions were taken at each point feature. The data were post-processed and differentially corrected using Pathfinder Office 5.40 and base data downloaded from the Loyola 8 Coop (LOY8) base station in Fredericksburg, VA. The data were then exported to shapefile format. Following this procedure we have estimated accuracies in the X and Y direction of 0 to 5 meters, using the above standards while selective availability (SA) is set to zero. No tests were done to confirm the X/Y direction accuracy during this investigation. Upon completion of the GPS survey work the wetland flagging was removed from the field to minimize impacts to the cultural and natural landscape within the park and to prevent boundary tampering in areas of FRSP subject to high visitor use.

## **Data Analysis and Remote Sensing Comparisons**

In addition to basic summary statistics of wetland class frequency and acreage values that are provided as part of this baseline inventory. Comparisons between the field verified wetlands (hereafter “actual wetlands”), NWI, and USGS/NPS vegetation classification and mapping (Taverna and Patterson 2008; hereafter “VegMap”) wetlands were assessed for differences in the following metrics: (1) mean wetland frequency; (2) mean aerial extent of wetland habitat; (3) wetland acreage omitted (errors of omission); and (4) wetland acreage committed (e.g. areas mapped as wetland that are in fact upland – errors of Commission).

Digital NWI maps for the FRSP study area were downloaded and clipped to the park study area boundary in ArcGIS version 9.3 and projected into NAD 83 for overlay with the USGS/NPS vegetation mapping and the field verified wetland polygons. The USGS/NPS vegetation mapping data from the study area at 1:6,000 scale was modified such that only the vegetation polygons defined by the survey as representative of wetland formations (e.g. habitats with hydrologic modifiers of temporarily flooded, seasonally flooded, saturated, semipermanently flooded, etc...) were visible. Digital versions of the USGS/NPS mapping data coupled with the NWI information, and field verified wetland polygons at each park location were combined and converted to shapefiles for analysis in ArcGIS version 9.3.

Polygons representing errors of omission and commission were created using ArcMap 9.3. Areas of overlap between the datasets were erased, leaving only the area that was exclusive to one of the datasets. For example, the erase tool was used to remove the portion of the NWI polygons that was overlaid by the actual wetlands polygons. The remaining polygons represent errors of commission in the NWI dataset. The area of these polygons was recalculated and used for statistical analysis. The spatial data were exported into spreadsheet format and uploaded into SigmaPlot 12.0 for one way ANOVA analysis ( $\alpha = 0.05$ ) and Holm-Sidak means comparisons. We utilized 1:40,000 scale NWI data versus the 1:6,000 scale VegMap wetland estimates for this analysis.



## Results

A total of 37 unique palustrine wetland habitats comprising 139.63 ac (56.50 ha) and encompassing 7 unique Cowardin et al. (1979) classes were observed over the course of this investigation. Table 1 provides a summary of the wetland habitats, their size, and Cowardin et al. (1979) class/description of the X-axis codes shown in Figure 4. By far the most frequent wetland classes encountered within the FRED study area were palustrine forested wetland systems – PFO (n=34), followed by palustrine emergent wetlands - PEM (n=2), and palustrine scrub-shrub - PSS (n=1) habitats (Figure 4 and Table 1).

Wetland size at FRED ranged from a maximum of 74.03 ac / 29.95 ha (Wetland 36) to a minimum of 0.01 ac / 0.002 ha (Wetland 12). Mean and median wetland sizes at FRED were 3.77 ac / 1.52 ha and 0.52 ac / 0.21 ha respectively (Figure 5). This section will not describe in detail all 37 unique wetland features identified and mapped over the course of this investigation, however, for more detailed information about a particular site readers are encouraged to examine the wetland data sheets (provided to Gregg Kneipp and Jim Comiskey under separate cover), representative photographs (Appendix A), and mapping exhibits (Appendix B).

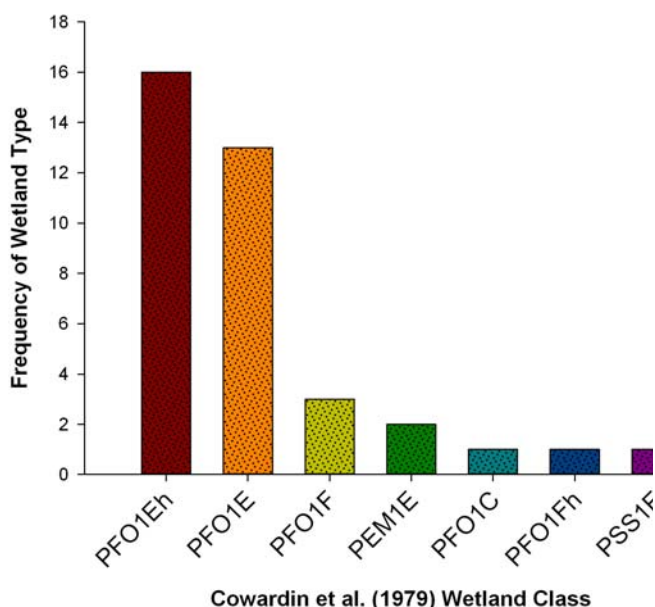


**Figure 4.** Frequency histogram showing the various Cowardin et al. (1979) wetland habitats identified during the May-November 2012 field investigation.

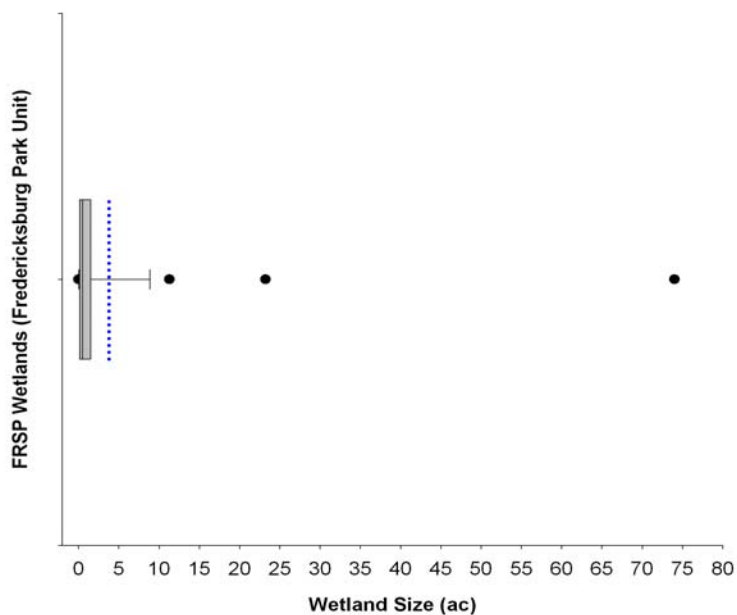


**Figure 5.** Box plot providing summary statistic information of wetland sizes. The dashed line indicates mean wetland size. All outliers are shown.

**Table 1.** Summary table of identified and mapped wetland habitats from FRSP May–November 2012. Sampling point identification codes correspond to the data points shown on the GIS mapping generated for this study and the data sheets found in Appendices A and C.

| Wetland ID<br>(Sampling Point ID) | Cowardin et al.<br>1979 classification<br>code | Cowardin et al. 1979 code description                                                       | Size  |          |
|-----------------------------------|------------------------------------------------|---------------------------------------------------------------------------------------------|-------|----------|
|                                   |                                                |                                                                                             | Acres | Hectares |
| Wetland -1<br>(WTP-1)             | PFO1E                                          | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated                  | 0.57  | 0.23     |
| Wetland-2<br>(WTP-2)              | PFO1E                                          | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated                  | 0.71  | 0.29     |
| Wetland-3<br>(WTP-3)              | PFO1Eh                                         | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated, diked/impounded | 0.22  | 0.09     |
| Wetland-4<br>(WTP-4)              | PFO1Eh                                         | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated, diked/impounded | 2.62  | 1.06     |
| Wetland-5<br>(WTP-5)              | PFO1Eh                                         | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated, diked/impounded | 2.34  | 0.95     |
| Wetland-6<br>(WTP-6)              | PFO1Fh                                         | palustrine forested broad-leaved deciduous<br>semipermanently flooded, diked/impounded      | 11.29 | 4.57     |
| Wetland-7<br>(WTP-7)              | PFO1Eh                                         | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated, diked/impounded | 0.39  | 0.16     |
| Wetland-8<br>(WTP-8)              | PFO1E                                          | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated                  | 0.08  | 0.03     |
| Wetland-9<br>(WTP-9)              | PEM1E                                          | palustrine emergent nonpersistent seasonally<br>flooded/saturated                           | 0.36  | 0.15     |
| Wetland-10<br>(WTP-10)            | PFO1E                                          | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated                  | 0.02  | 0.01     |
| Wetland-11<br>(WTP-11)            | PFO1E                                          | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated                  | 0.14  | 0.06     |
| Wetland-12<br>(WTP-12)            | PFO1Eh                                         | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated, diked/impounded | 0.01  | 0.004    |
| Wetland-13<br>(WTP-13)            | PFO1E                                          | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated                  | 0.05  | 0.02     |
| Wetland-14<br>(WTP-14)            | PFO1E                                          | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated                  | 0.06  | 0.02     |
| Wetland-15<br>(WTP-15)            | PFO1F                                          | palustrine forested broad-leaved deciduous<br>semipermanently flooded                       | 0.16  | 0.06     |
| Wetland-16<br>(WTP-16)            | PFO1F                                          | palustrine forested broad-leaved deciduous<br>semipermanently flooded                       | 0.66  | 0.27     |
| Wetland-17<br>(WTP-17)            | PFO1Eh                                         | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated, diked/impounded | 0.52  | 0.21     |
| Wetland-18<br>(WTP-18)            | PFO1Eh                                         | palustrine forested broad-leaved deciduous<br>seasonally flooded/saturated, diked/impounded | 8.27  | 3.35     |

**Table 1.** Summary table of identified and mapped wetland habitats from FRSP May–November 2012 (continued).

| Wetland ID<br>(Sampling Point ID) | Cowardin et al. 1979 classification code | Cowardin et al. 1979 code description                                                    | Size  |          |
|-----------------------------------|------------------------------------------|------------------------------------------------------------------------------------------|-------|----------|
|                                   |                                          |                                                                                          | Acres | Hectares |
| Wetland–19<br>(WTP–19)            | PFO1Eh                                   | palustrine forested broad-leaved deciduous seasonally flooded/saturated, diked/impounded | 0.13  | 0.05     |
| Wetland–20<br>(WTP–20)            | PFO1Eh                                   | palustrine forested broad-leaved deciduous seasonally flooded/saturated, diked/impounded | 0.21  | 0.08     |
| Wetland–21<br>(WTP–21)            | PFO1Eh                                   | palustrine forested broad-leaved deciduous seasonally flooded/saturated, diked/impounded | 0.29  | 0.12     |
| Wetland–22<br>(WTP–22)            | PFO1Eh                                   | palustrine forested broad-leaved deciduous seasonally flooded/saturated, diked/impounded | 0.06  | 0.02     |
| Wetland–23<br>(WTP–23)            | PFO1Eh                                   | palustrine forested broad-leaved deciduous seasonally flooded/saturated, diked/impounded | 0.57  | 0.23     |
| Wetland–24<br>(WTP–24)            | PFO1Eh                                   | palustrine forested broad-leaved deciduous seasonally flooded/saturated, diked/impounded | 0.09  | 0.04     |
| Wetland–25<br>(WTP–25)            | PFO1Eh                                   | palustrine forested broad-leaved deciduous seasonally flooded/saturated, diked/impounded | 0.30  | 0.12     |
| Wetland–26<br>(WTP–26)            | PFO1E                                    | palustrine forested broad-leaved deciduous seasonally flooded/saturated                  | 0.60  | 0.24     |
| Wetland–27<br>(WTP–27)            | PFO1C                                    | palustrine forested broad-leaved deciduous seasonally flooded/saturated                  | 0.67  | 0.27     |
| Wetland–28<br>(WTP–28)            | PFO1E                                    | palustrine forested broad-leaved deciduous seasonally flooded/saturated                  | 23.22 | 9.40     |
| Wetland–29<br>(WTP–29)            | PEM1E                                    | palustrine emergent nonpersistent seasonally flooded/saturated                           | 2.40  | 0.97     |
| Wetland–30<br>(WTP–30)            | PSS1E                                    | palustrine scrub-shrub, broad-leaved deciduous, seasonally flooded/saturated             | 1.79  | 0.72     |
| Wetland–31<br>(WTP–31)            | PFO1Eh                                   | palustrine forested broad-leaved deciduous seasonally flooded/saturated, diked/impounded | 3.41  | 1.38     |
| Wetland–32<br>(WTP–32)            | PFO1Eh                                   | palustrine forested broad-leaved deciduous seasonally flooded/saturated, diked/impounded | 0.43  | 0.17     |
| Wetland–33<br>(WTP–33)            | PFO1E                                    | palustrine forested broad-leaved deciduous seasonally flooded/saturated                  | 1.18  | 0.48     |
| Wetland–34<br>(WTP–34)            | PFO1E                                    | palustrine forested broad-leaved deciduous seasonally flooded/saturated                  | 0.27  | 0.11     |
| Wetland–35<br>(WTP–35)            | PFO1F                                    | palustrine forested broad-leaved deciduous semipermanently flooded                       | 0.56  | 0.23     |
| Wetland–36<br>(WTP–36)            | PFO1E                                    | palustrine forested broad-leaved deciduous seasonally flooded/saturated                  | 74.03 | 29.96    |
| Wetland–37<br>(WTP–37)            | PFO1E                                    | palustrine forested broad-leaved deciduous seasonally flooded/saturated                  | 0.94  | 0.38     |

Wetlands of interest within the FRSP study area were determined based on uniqueness of habitat and relative size. The first of these ecosystems and by the far the largest was Wetland-36, located adjacent to an existing CSX/Amtrak railway line and South Lee drive (Figure 6 and Appendix C, Maps 6 and 7). This site is a palustrine, forested, broad-leaved deciduous, seasonally flooded/saturated wetland site. As can be seen from the maps and the photograph in Figure 6, this system is situated very low on the landscape and appears to receive groundwater, as well, as surface water inputs. The wetland possesses a mature overstory dominated by red maple (*Acer rubrum* L.) with a sparse understory throughout much of the site composed primarily of highbush blueberry (*Vaccinium corymbosum* L.) and American holly (*Ilex opaca*). It appears from field observation of the southeastern boundary of the site that the existing railroad line likely serves as a type of dike promoting the retention of surface water within Wetland-36. This site represents the largest wetland polygon found within our study area (74.03 ac) and as such is worth considerable note.

Though considerably smaller in size compared with the aforementioned Wetland-36, the next two wetlands (Wetlands-28 and 31) are both palustrine forested, broad-leaved deciduous wetland systems located the east and west of South Lee drive respectively (Figure 7 and Appendix C, Maps 6 and 10).



**Figure 6.** Representative photograph of Wetland-36 located adjacent to South Lee Drive and active railway line (Taken 6 November 2012).



**Figure 7.** Representative photographs of two palustrine forested wetlands believed to have the potential for vernal pool habitat. Wetland – 31 (top) and Wetland – 28 (bottom) (W31 taken 22 October 2012 and W28 taken 24 July 2012). Author note – vernal pool taxa (wood frog *Rana sylvatica* egg masses) were observed within Wetland-28 on March 2013. A suspected spotted salamander, *Ambystoma maculatum* egg mass was observed in Wetland-31 (March 2013).

What makes these two systems unique is that both wetlands appear to have potential vernal pool habitat (confirmed in March 2013 – see Figure 7 caption). The representative photographs shown in Figure 7 depict depressional areas within each mapped polygon that could serve as spring breeding habitat for obligate vernal pool taxa. These two sites were previously known to park staff, but the exact areal extent and distribution of potential habitat wasn't quantified until this investigation.

The last wetland ecosystem within the FRSP study area that deserves special mention is the palustrine, scrub-shrub habitat located at Wetland-30. This area represents the only scrub-shrub wetland habitat within the FRSP study area boundary. Shown here in Figure 8 this ecosystem is dominated by low growing and small diameter at breast height river birch (*Betula nigra* L.) in the canopy and understory. The wetland area originated from a decommissioned dam and associated pond which were removed by the NPS in 2001. Though not a unique habitat to the region, this site is rare within the FRSP study area and as such may support species more commonly associated with this community type, namely Golden-winged Warblers, Yellow-breasted Chats, Brown Thrashers, Prairie Warblers, and Eastern Towhee.



**Figure 8.** View is of Wetland – 30 and the scrub-shrub community located therein. Photograph taken 16 October 2012.

An additional benefit/result of this survey was the identification of additional sites within the park that contained populations of invasive exotic plant species targeted for control specifically - *Microstegium vimineum* (Trin.) A. Camus (Japanese stilt grass) and *Wisteria* spp. Japanese stilt

grass in particular is a common herbaceous species found within and adjacent to wetland habitats and as such is not always detected via the inventory and monitoring network long-term forest vegetation monitoring or invasive exotic early detection protocols. The methodology employed for the wetland investigation involved a near total land traverse of the study area by foot, and as such required daily coordination with park staff for safety reasons. This daily communication subsequently involved a briefing of identified invasive plant populations and their locations (often times flagged in the field and located using GPS) which gave park staff an opportunity to either control those populations themselves or coordinate with the regional exotic plant management team (EPMT) for their removal.

### **NWI versus VegMap Comparison**

Our data analysis coupled with field observations and GIS overlays of the NWI (1:40,000 scale) and VegMap wetland polygons (Taverna and Patterson 2008) versus the Actual wetland boundaries within the FRSP study area revealed significant overall differences in terms of mean errors of commission ( $F_{2,85} = 8.05$ ,  $P < 0.05$ ), mean errors of omission ( $F_{2,101} = 4.09$ ,  $P < 0.05$ ), mean wetland frequency ( $F_{2,108} = 43.78$ ,  $P < 0.05$ ), and mean wetland acreage ( $F_{2,85} = 3.66$ ,  $P < 0.05$ ). Mean pairwise comparisons of VegMap errors of commission were significantly higher than both the NWI and Actual wetland errors of commission within the park suggesting that the VegMap remote sensed wetlands significantly overestimated the actual extent of wetland habitats (Figure 9 and Figure 10a). Pairwise multiple comparisons of mean errors of omission supported reported NWI claims of erring on the side of omitting rather than committing wetlands within a landscape as the data showed significant differences between mean NWI wetland acres omitted versus the Actual delineated wetlands (Figure 10b).

In terms of mean wetland frequency comparing NWI and VegMap estimates, both mapping techniques significantly underestimated the total number of wetlands within the park (Figure 10c), but mean frequency of NWI mapped wetlands was significantly higher than the VegMap predictions suggesting that NWI estimates provided a more accurate depiction of wetland frequency within the park. Additionally, when assessing mean wetland acreage within the park study area boundary we found no significant differences between NWI estimates and the actual mean wetland acreage, but significant differences when comparing VegMap estimates to NWI and actual wetland acreages (VegMap acreage estimates were much higher) suggesting again that the VegMap predictions were significantly inflated (Figure 10d). In short – the VegMap estimates predicted fewer individual wetlands on the landscape, but for those wetlands they did chose to map they estimated wetland polygons that were significantly larger than either NWI or the Actual wetland acreage, this is illustrated graphically in Figure 9.

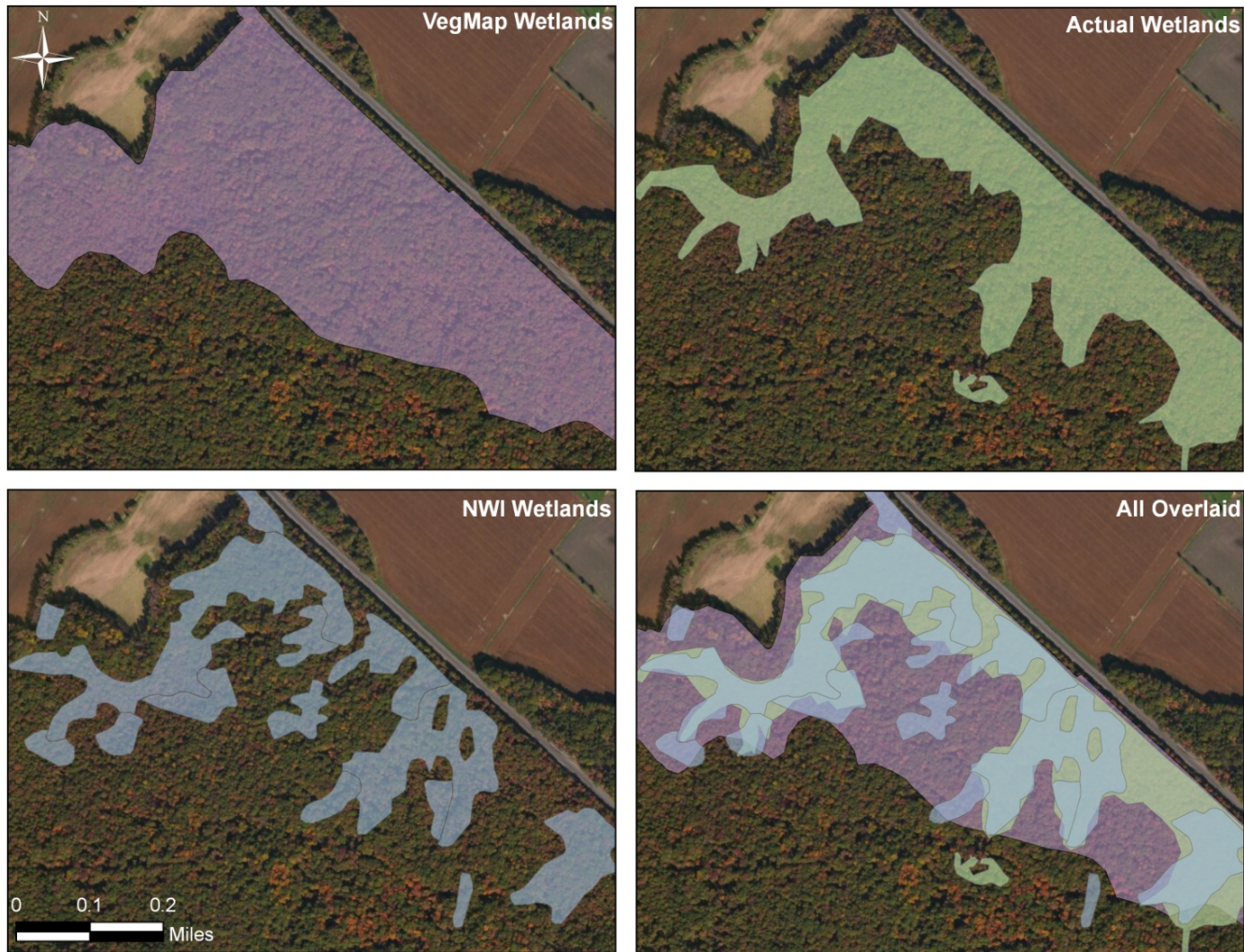


**Figure 9.** Image showing preliminary analysis of USGS/NPS vegetation mapping wetland polygons (VegMap; Taverna and Patterson 2008) (1:6,000 scale – upper left) compared against actual delineated wetland polygons (Army Corps/D.O.77.1 methods – upper right) and NWI data (1:40,000 scale – lower left panel). The lower right is all three layers overlaid (Actual wetland boundary, NWI, and VegMap). The inaccuracies of the VegMap compared to NWI mapping data are readily apparent. Wetland-36 is the “actual wetland” shown in this figure.

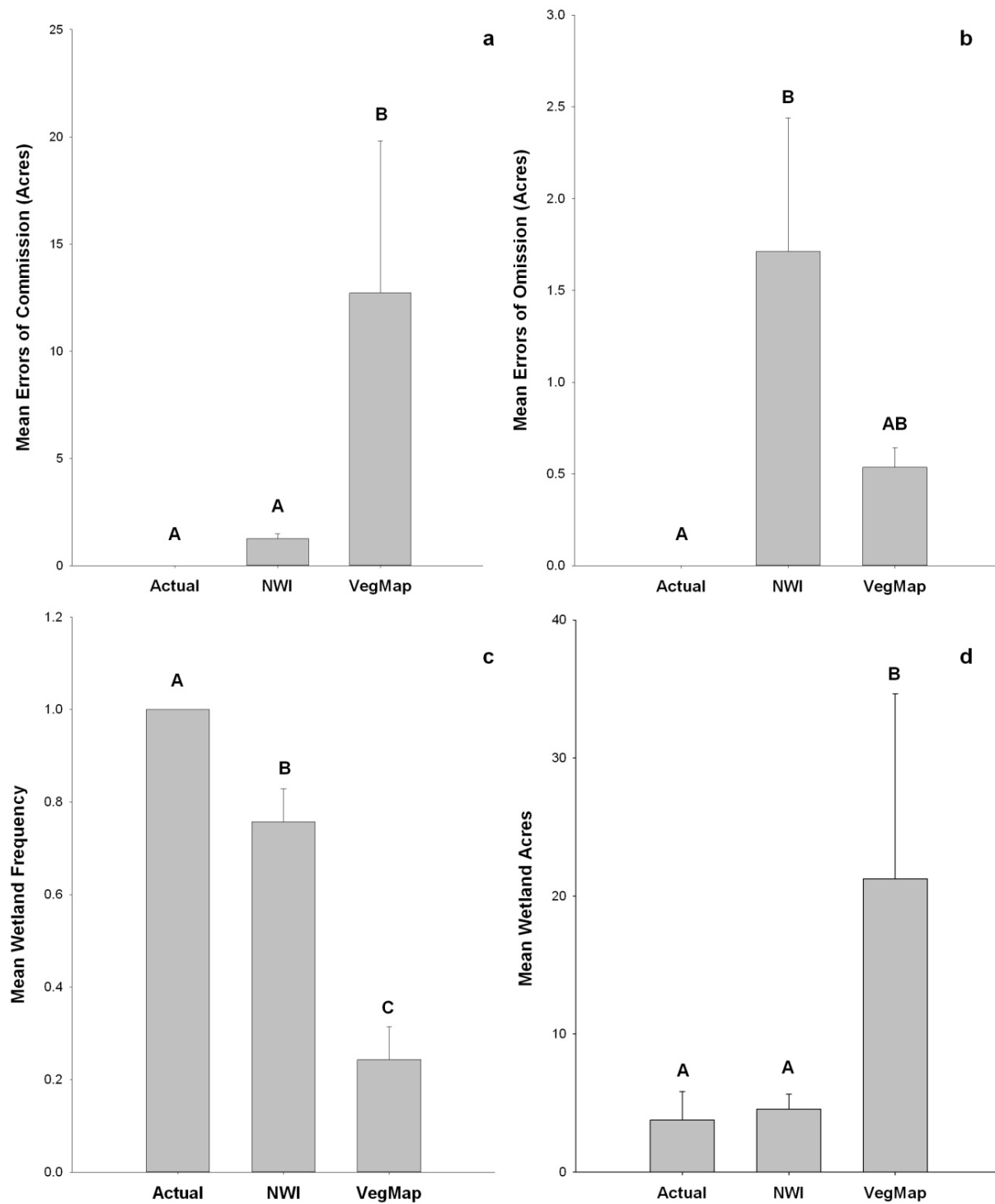


**Figure 10.** Graphic summaries of the four principal metrics used to assess the accuracy of NWI (1:40,000 scale) and USGS/NPS (VegMap) wetland estimates for FRED. Bars that do not share a letter denote significant differences at  $\alpha = 0.05$ .



## Discussion

A wetlands, waterways, and boundary determination following the U.S Army Corps of Engineers (USACE) Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region and the National Park Service D.O. #77.1 was performed at FRSP during the summer and fall of 2012. All of the lands within the legislative boundary of the Fredericksburg Battlefield (FRED) were investigated with the exception of any active in-holdings (see mapping exhibits Appendix B) and park areas located on the northeast side of the active railroad tracks at FRED. A total of 37 palustrine wetlands were identified, delineated, and mapped over the course of this investigation. No new (unmapped) waterways (riverine habitats) were observed over the course of this investigation though in some cases drainage swales were mapped to show connectivity between a wetland habitat and a water of the U.S.

From the results of this work it is our opinion that all of these wetland habitats possess sufficient hydrophytic, hydrologic, and soil characteristics to classify them as wetland sites based on the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region and meet the D.O. #77.1 criteria for wetland status as well. Additionally, due to either a direct surface water connection or their presence within the 100-year floodplain of a water of the U.S., it is our opinion that all of these wetland systems are subject to Section 404 of the federal Clean Water Act (1977) and D.O. #77.1 of the National Park Service.

The results of this work has not only provided the park with NPS/USACE compliant boundary data but the study also assisted the park with the identification of previously unknown source populations of invasive exotic plant communities within the FRSP study area, and identified previously unknown vernal pool habitats. The wetland data collected at FRSP has also been used to verify the efficacy of the USGS/NPS vegetation mapping versus NWI data for broad scale wetland tracking and planning efforts within the park. We found that the best NWI product available (1:40,000 scale mapping) was significantly better at predicting actual wetland composition within the park (FRSP) compared with the VegMap estimates in every category with the exception of committing errors of omission. The greater propensity of NWI estimates to err on the side of errors of omission rather than commission has been documented in the literature (Tiner 1997) and can be argued is by design to provide a more conservative estimate of wetland habitats within the landscape. Based on this analysis we would recommend that the park staff at FRSP utilize NWI data for the remaining park units not covered by this inventory for broad scale tracking and assessment of wetland distribution and trends. We believe that the comparison between the NWI and USGS/NPS wetland mapping products has potential broad transferability within and outside of the Northeast Region of the NPS as other parks grapple with the question of what data product provides the most accurate landscape level wetland information for their respective park.

This report has been prepared in accordance with generally accepted wetland investigation practices outlined by the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers and the National Park Service. The vegetation zone delineations are based upon our identification of plant species present at the time of our field examination, therefore, seasonal variation in the type and composition of plant species, in particular non-persistent herbaceous

plants, is to be expected. Hydrology observations portray conditions present at the time of the field study and depend upon the time of year and amount of prior precipitation when obtained. Observed precipitation data obtained through NOAA's National Weather Service website (<http://water.weather.gov/ahps/>) for our study area county (Spotsylvania) indicated that precipitation levels were generally below average from May – September 2012. This could have created a situation where we effectively missed wetland habitats that are seasonal in nature and thus would appear completely dry. However, because this assessment does not rely solely on the presence of standing water or saturated soils, but a combination of soil colors that remain in the absence of water, persistent vegetation types (herbaceous and woody), and morphological identifiers of ground saturation and inundation we are confident that we have captured the majority of the wetland habitats present within the study area. We have provided representative photographs of each wetland identified in the report (Appendix A) in an effort to provide a reader with a better idea of the prevailing site conditions present at the time of this investigation.

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## Appendix A: Representative Photographs



1. Photograph of Wetland 1 taken 17 May, 2012 (Taken by P. Sharpe). See Wetlands Map 5.



2. Photograph of Wetland 2 taken 17 May, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



3. Photograph of Wetland 3 taken 17 May, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



4. Photograph of Wetland 4 taken 18 May, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



5. Photograph of Wetland 5 taken 21 May, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



6. Photograph of Wetland 6 taken 23 May, 2012 (Taken by P. Sharpe). See Wetlands Map 3.



7. Photograph of Wetland 7 taken 23 May, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



8. Photograph of Wetland 8 taken 30 May, 2012 (Taken by P. Sharpe). See Wetlands Map 2.



9. Photograph of Wetland 9 taken 30 May, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



10. Photograph of Wetland 10 taken 31 May, 2012 (Taken by P. Sharpe). See Wetlands Map 2.



11. Photograph of Wetland 11 taken 31 May, 2012 (Taken by P. Sharpe). See Wetlands Map 2.



12. Photograph of Wetland 13 taken 31 May, 2012 (Taken by P. Sharpe). See Wetlands Map 2.



13. Photograph of Wetland 14 taken 31 May, 2012 (Taken by P. Sharpe). See Wetlands Map 3.



14. Photograph of Wetland 15 taken 31 May, 2012 (Taken by P. Sharpe). See Wetlands Map 3.



15. Photograph of Wetland 16 taken 5 June, 2012 (Taken by P. Sharpe). See Wetlands Map 3.



16. Photograph of Wetland 17 taken 5 June, 2012 (Taken by P. Sharpe). See Wetlands Map 3.



17. Photograph of Wetland 18 taken 12 June, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



18. Photograph of Wetland 19 taken 12 June, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



19. Photograph of Wetland 20 taken 12 June, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



20. Photograph of Wetland 21 taken 12 June, 2012 (Taken by P. Sharpe). See Wetlands Map 5.



21. Photograph of Wetland 22 taken 12 June, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



22. Photograph of Wetland 23 taken 12 June, 2012 (Taken by P. Sharpe). See Wetlands Map 4.



23. Photograph of Wetland 24 taken 12 June, 2012 (Taken by P. Sharpe). See Wetlands Map 5.



24. Photograph of Wetland 25 taken 13 June, 2012 (Taken by P. Sharpe). See Wetlands Map 5.



25. Photograph of Wetland 26 taken 13 June, 2012 (Taken by P. Sharpe). See Wetlands Map 5.



26. Photograph of Wetland 27 taken 13 July, 2012 (Taken by P. Sharpe). See Wetlands Map 5.



27. Photograph of Wetland 28 taken 24 July, 2012 (Taken by P. Sharpe). See Wetlands Map 5.



28. Photograph of Wetland 29 taken 16 October, 2012 (Taken by P. Sharpe). See Wetlands Map 1.



29. Photograph of Wetland 30 taken 16 October, 2012 (Taken by P. Sharpe). See Wetlands Map 10.



30. Photograph of Wetland 31 taken 22 October, 2012 (Taken by P. Sharpe). See Wetlands Map 10.



31. Photograph of Wetland 32 taken 23 October, 2012 (Taken by P. Sharpe). See Wetlands Map 10.



32. Photograph of Wetland 33 taken 22 October, 2012 (Taken by P. Sharpe). See Wetlands Map 9.



33. Photograph of Wetland 34 taken 23 October, 2012 (Taken by P. Sharpe). See Wetlands Map 8.



34. Photograph of Wetland 35 taken 23 October, 2012 (Taken by P. Sharpe). See Wetlands Map 5.

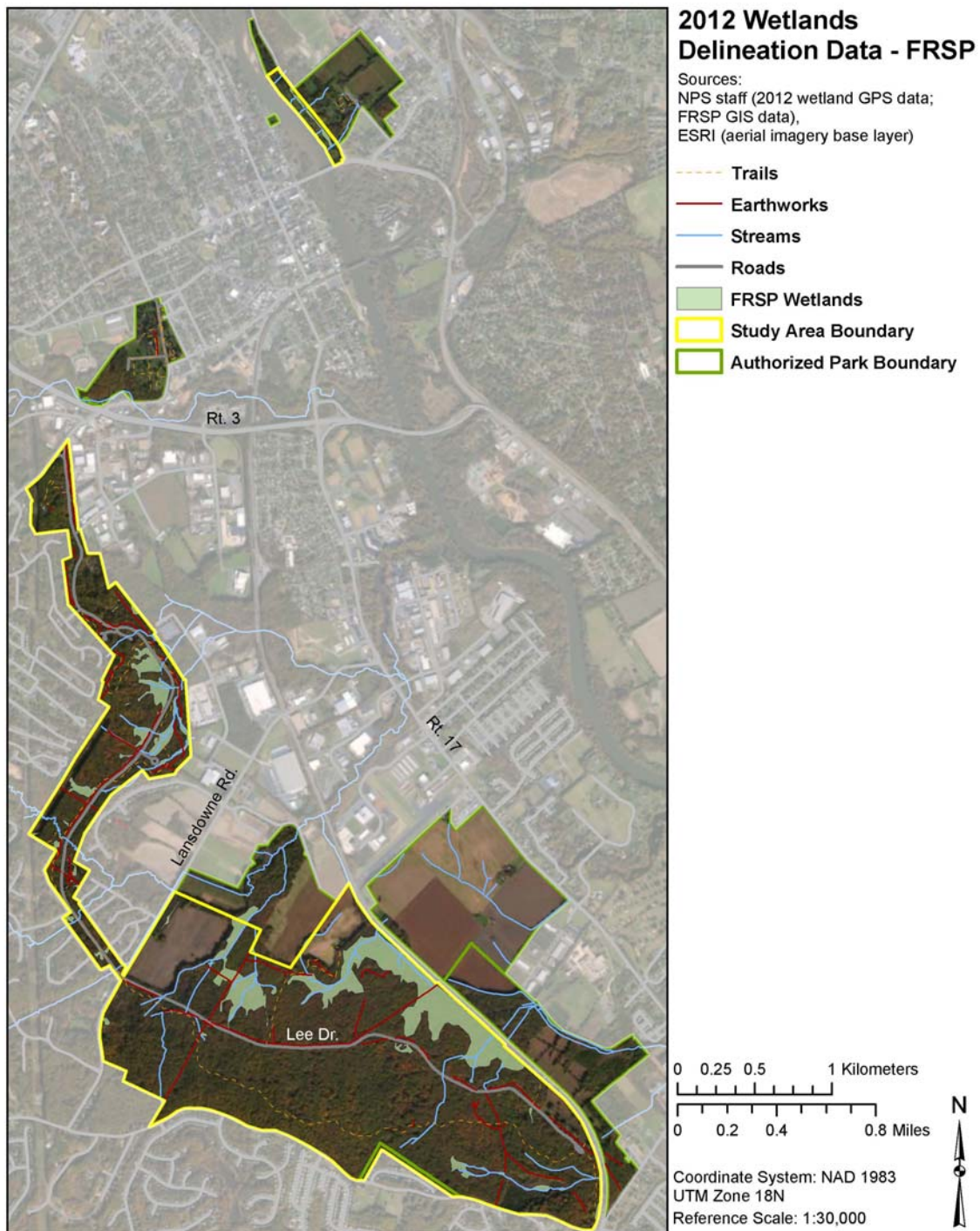


35. Photograph of Wetland 36 taken 6 November, 2012 (Taken by P. Sharpe). See Wetlands Map 6.

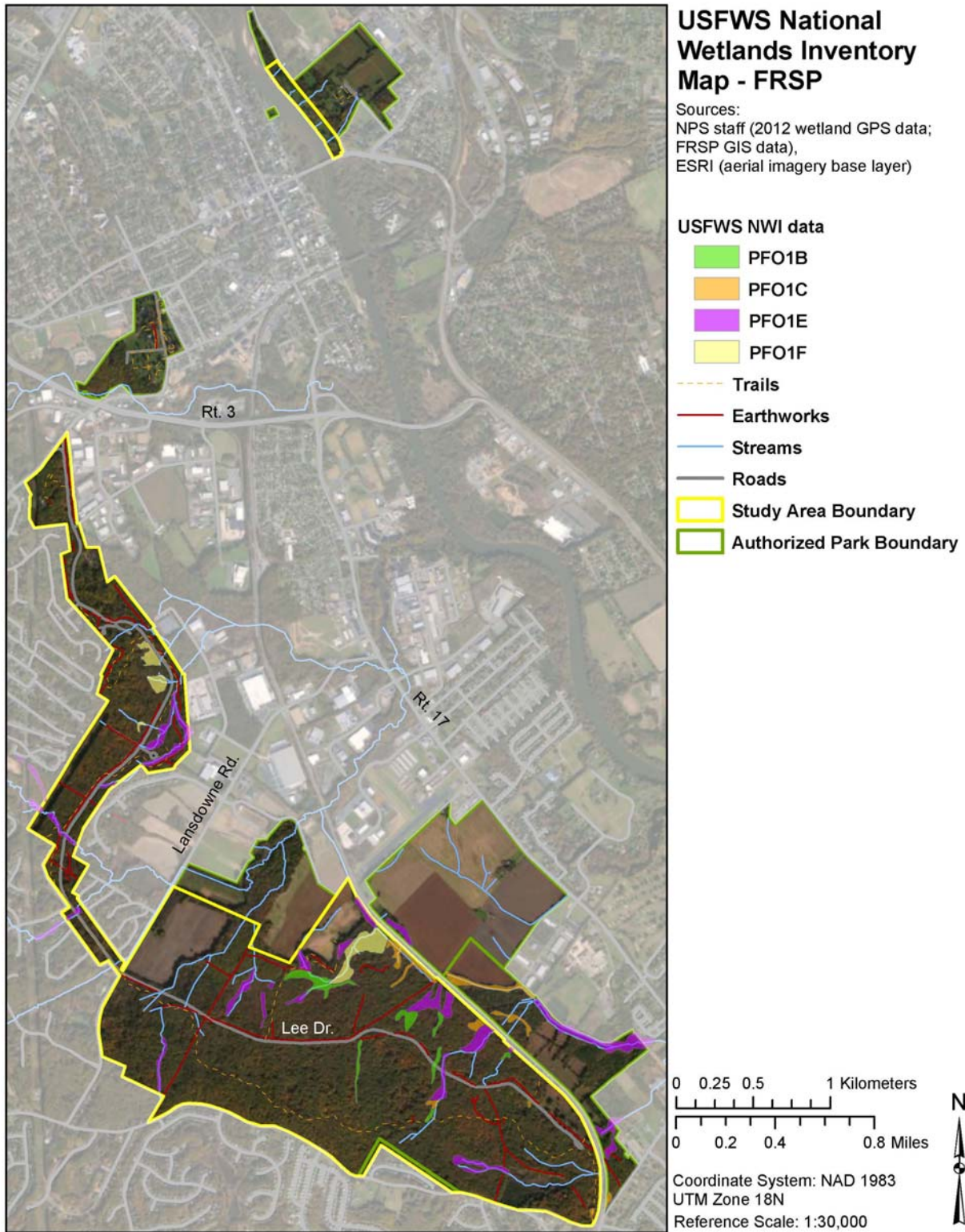


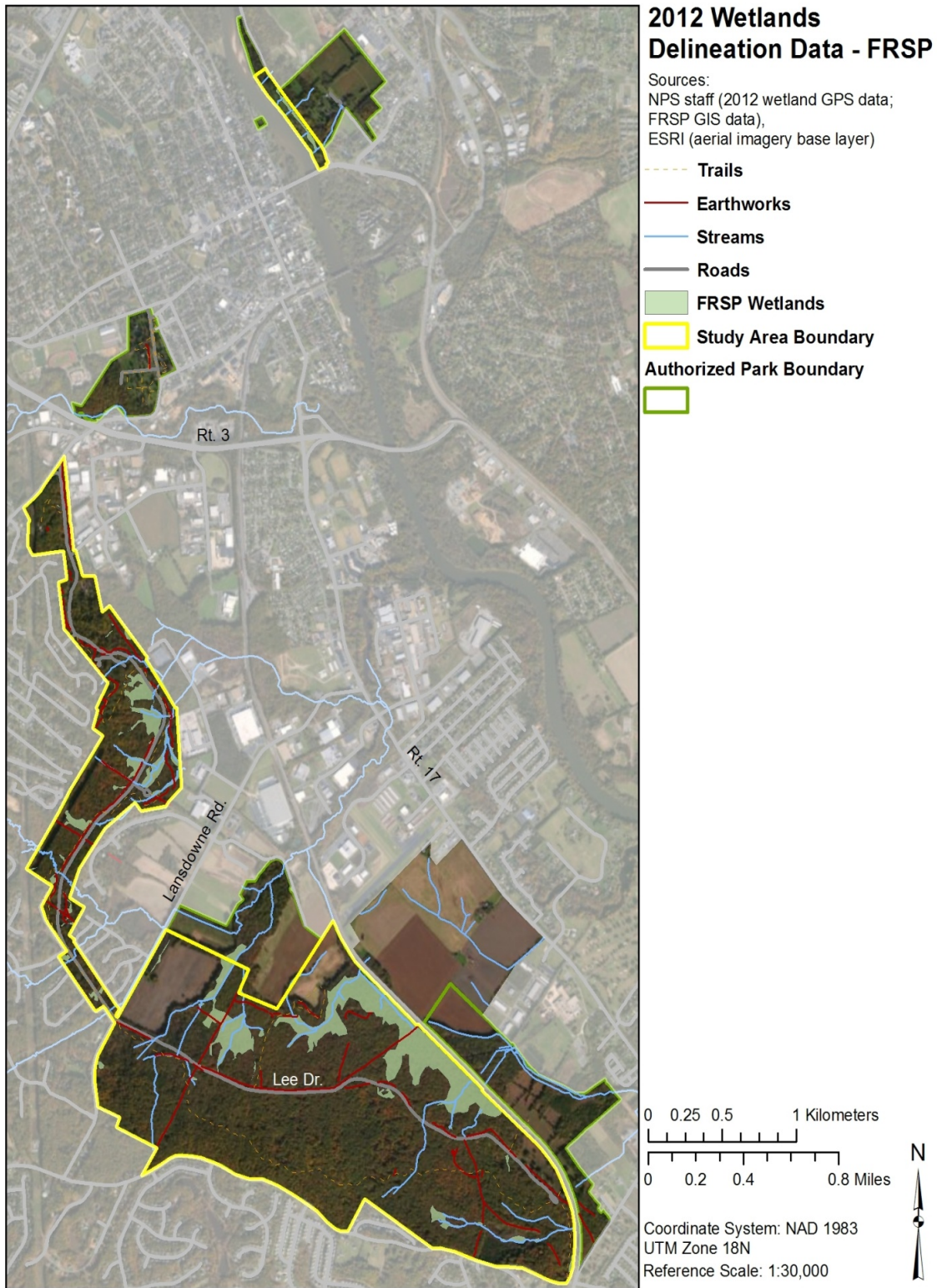
36. Photograph of Wetland 37 taken 29 November, 2012 (Taken by P. Sharpe). See Wetlands Map 10.

## Appendix B: Mapping Exhibits

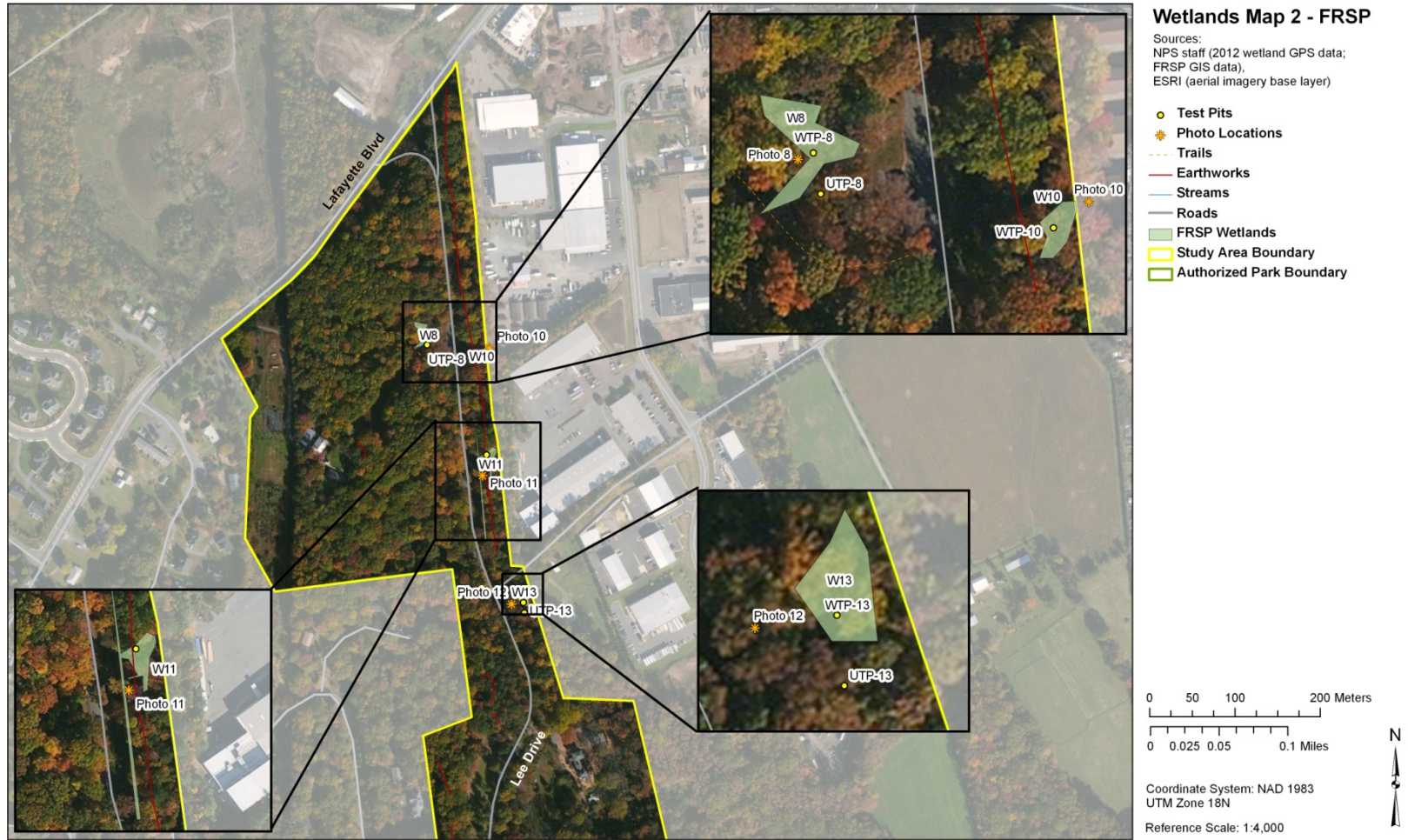


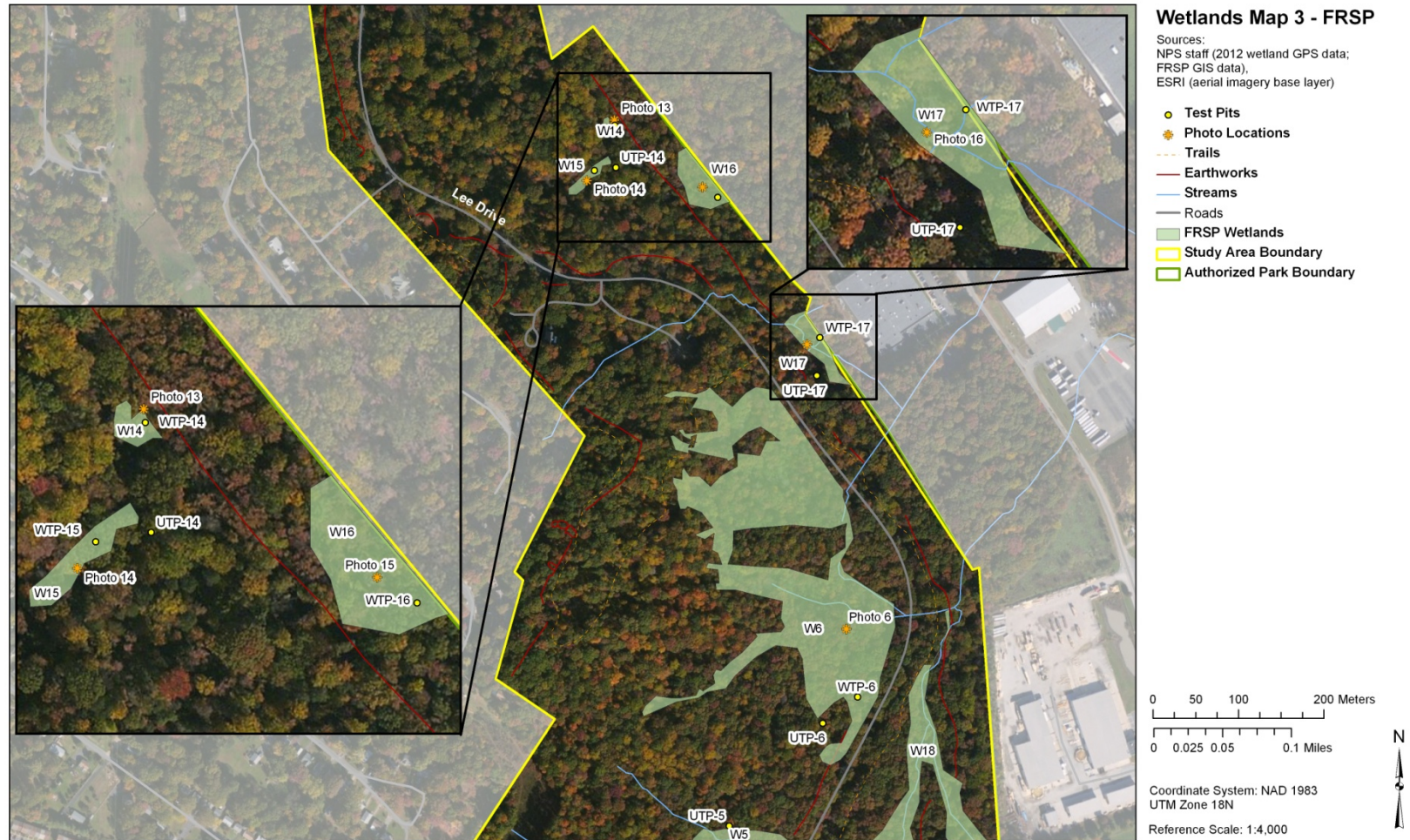




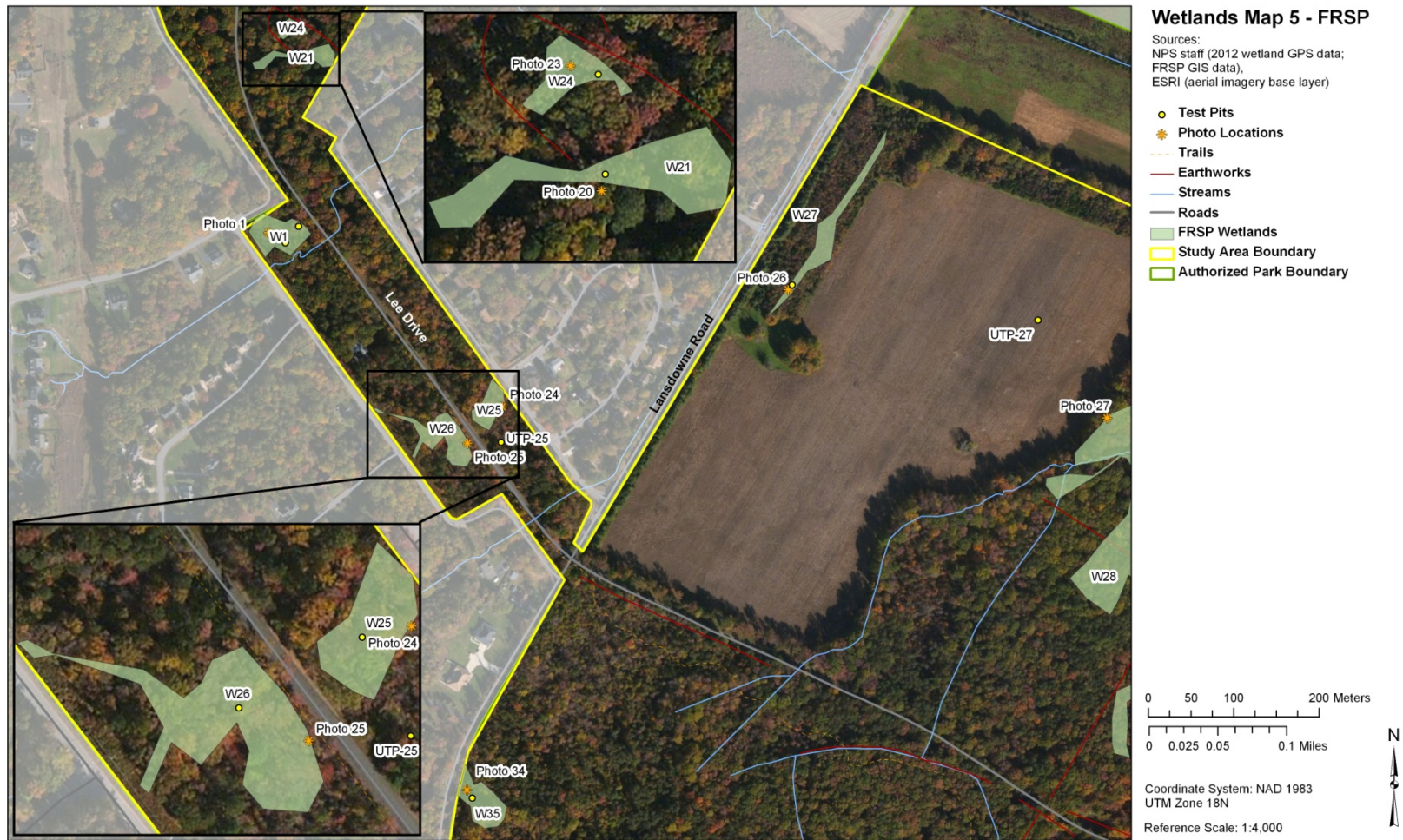
















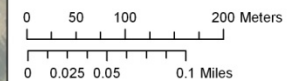




# Wetlands Map 10 - FRSP

Sources:  
NPS staff (2012 wetland GPS data;  
FRSP GIS data),  
ESRI (aerial imagery base layer)

- Test Pits
- ★ Photo Locations
- Trails
- Earthworks
- Streams
- Roads
- FRSP Wetlands
- Study Area Boundary
- Authorized Park Boundary



Coordinate System: NAD 1983  
UTM Zone 18N  
Reference Scale: 1:4,000





## Appendix C: Wetland Resource Brief

Northeast Region  
Inventory & Monitoring Program

National Park Service  
U.S. Department of the Interior



Mid-Atlantic Network

Wetlands Information Brief



### Wetland Habitats of Fredericksburg and Spotsylvania National Military Park

Wetlands are areas on the landscape that possess water, wetland plants, and wetland soils. Did you know that wetlands provide a variety of services to the general public including: water treatment, wildlife habitat, erosion control, and climate change mitigation? Despite these and many more benefits to our society these habitats are in danger. The U.S. Environmental Protection Agency estimates that in the 1600s, over 220 million acres of wetlands are thought to have existed in the lower 48 states. Since that time extensive losses have occurred, and now more than half of our original wetlands have been lost from

conversion to agricultural lands, land development, chemical contamination, excess nutrients, and climate change induced shifts in seasonal rainfall patterns. In order to protect these unique and valuable ecosystems the staff at Fredericksburg and Spotsylvania National Military Park in cooperation with National Park Service regional staff identified and mapped the wetland habitats within a 1,241 ac (502 ha) study area of the Fredericksburg Battlefield Unit (FRSP) from May to November 2012.

**Objective**  
Describe, document, and map all wetland habitats within Fredericksburg and Spotsylvania National Military Park

**Results**  
A total of 37 unique wetlands encompassing 139.63 acres / 56.50 ha of land were identified and mapped during the survey. All of the mapped wetland habitats met both the U.S. Army Corps of Engineers criteria and the Cowardin et al. (1979) definitions. The majority of the larger wetlands were located in areas previously identified by park staff and existing park vegetation mapping; however, a significant number of smaller, previously unmapped wetland areas were identified over the course of this investigation and the boundary data for those wetland areas was significantly improved. Additional information regarding known wetland areas that possess vernal pool habitat features was

  
*Wood Frog egg mass within park wetlands (M. Johnson photo)*

  
*View showing typical forested wetland found within FRSP (Wetland-6).*

**Importance**  
Wetlands play a vital role in our environment. Fish, wildlife, specially-adapted plant species, and human beings receive direct and indirect benefits from these unique ecosystems. For example, wetland habitats such as those found at Fredericksburg and Spotsylvania National Military Park benefit mankind through flood water storage, stream stabilization, water treatment, and nesting, resting, and escape cover for local wildlife. Situated at the boundary between land and water, wetlands are endowed with unique hydrologic, chemical, and biological processes that other lands do not possess. It is because of these factors that wetland habitats receive federal and state protection that most upland habitats have not been afforded.



## Management Applications

The revised boundary information and associated wetland mapping will significantly improve the park's ability to effectively manage, protect, and monitor its wetland resources. The discovery of several new wetland habitats previously unknown to park staff will also provide FRSP staff with additional research, interpretation, and wildlife inventory opportunities.

## How to delineate a wetland

Wetland boundaries were determined by establishing a series of transects from a known wetland into known upland locations surrounding the wetland under examination. At random intervals along the transect investigators looked for evidence of hydric soils, hydrophytic vegetation, and wetland hydrology. The wetland boundary was identified as the point where one of the three criteria was not met.



also conveyed to the park as a result of this survey.

## Wildlife of your Wetlands



Box Turtle



Black Rat Snake



Hickory Horned Devil



An example of investigation wetland mapping (wetlands are highlighted in light green) for the park is shown above.

## Acknowledgements

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**Park delineated:**  
Fredericksburg and Spotsylvania National  
Military Park

May 2013

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 326/121916, August 2013

**National Park Service**  
**U.S. Department of the Interior**



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Natural Resource Stewardship and Science  
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